11 Fla. A & M U. L. Rev. 283

Florida A & M University Law Review
Spring, 2016

Article

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CHANGING WINDS AND RISING TIDES ON BEACH RENOURISHMENT IN FLORIDA: SHORT-TERM ALTERNATIVES AND LONG-TERM SUSTAINABLE SOLUTIONS USING LAW AND POLICY FROM FLORIDA AND NEARBY STATES

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*284 INTRODUCTION

Sandy beaches make up 825 miles of Florida's 1,260 total miles of coastline around the Sunshine State's peninsula. [1] These beaches are changing over time due to the natural erosional forces of wind and water. [2] Climate change has been widely predicted to bring more severe storms, increased storm surge, and permanently elevated sea levels for centuries beyond the year 2100. [3] In Florida, sea levels are expected to rise anywhere from two to six feet in the next eighty-five years, exacerbating ***285** the natural erosional forces. [4] Considering the millions of years that the Florida peninsula has existed, only in very recent human history have attempts been made to stop beach erosion to alter and control the

shape of Florida's coastlines. [5] Coastal engineering attempts to halt natural forces with man-made structures such as buildings, piers, groins, jetties, breakwaters, sea walls, ports, inlets, and in some cases, it creates new sandy beaches and world-class cities where none existed. [6]

> Starting in 1904, with the erection of a dance pavilion on a marshy, mosquito-infested spit of land, local developers began to enhance the appeal of the ocean coast of Biscane [sic] Bay in southeast Florida. In 20 years, Miami Beach was totally reshaped and turned into one of America's premier vacation destinations, in turn becoming some of America's most valuable real estate. "Rivaling the Egyptian pyramids in scope, engineering, and the sheer numbers of builders, Miami Beach was a living monument to modern America's passion for instant gratification." [7]

In an effort to protect the new real estate from the erosion that has always existed, engineers created beach nourishment. [8] This Article focuses on building up beaches through beach nourishment, defined as the act of adding new sand to widen a beach after the old sand has washed away (also called "beach building," and called "beach renourishment" when the act has been repeated to obtain the desired effect because the beaches are "re-nourished"). [9] Beach renourishment projects offer significant economic and recreational benefits, as evidenced ***286** by their completion in most of Florida's thirty-five coastal counties and at least fifteen U.S. States along the Atlantic and Gulf Coasts over the last fifty years. [10] However, these projects are not without their criticisms, as they arguably have many negative legal, environmental, and economic consequences to overcome. [11] Most importantly, Florida's current legislation and regulations relating to beach renourishment, for the most part, do not account for climate change. [12] With a fresh look at how other states are handling the effects of climate change, possible legal solutions specific to Florida are discussed.

This Article proposes that in the short-term, better funding, technological, and legal solutions for beach nourishment projects exist; and in the long-term, beach nourishment is not sustainable. By taking a practical approach to environmental problem-solving and examining innovative legal solutions, this Article focuses on how beaches may be renourished responsibly while alleviating some of the drawbacks. Part I addresses the science and economics of beach nourishment, specifically discussing beach ecosystems, costs, and sources of funding for nourishment projects. Close examination of the costs of beach renourishment reveals that the more often the projects have to be repeated in the context of current climate change impacts, the less economically feasible these projects are becoming. Part II discusses the legal foundation for Florida's beach nourishment projects, the Beach and Shore Preservation Act (BSPA). The BSPA is the funding and regulatory guidebook for beach nourishment in Florida, but it does not discuss climate change. Part III reviews legal and technical alternatives, such as soft armoring and coastal retreat, of other Atlantic and Gulf Coast States that do consider climate change impacts. Part IV then proposes legal and technical adaptation solutions that provide alternatives to beach renourishment, such as amending Florida's BSPA, using other available beach restoration technologies, increasing the use of local beach tax districts targeting private properties protected by public beach building, and limiting beach building projects while implementing ***287** eminent domain for damaged structures. The Article concludes that in the wake of rising sea levels over the next several decades, beach renourishment should not be considered a long-term solution to combat natural beach erosion. It is fiscally and environmentally irresponsible to continue using public funds from all taxpayers to pump eroding sand in front of the private property of a few taxpayers.

I. BEACH RENOURISHMENT IN FLORIDA IN THE FACE OF CLIMATE CHANGE

In order to understand beach nourishment and how its related laws will be affected by climate change, it helps to first have a working knowledge of the ecological cycle of coastal areas, including how beaches are naturally formed and artificially built.

A. The Ecological Basics of Beaches and Beach Renourishment

The natural environment is composed of living parts (such as plants and animals) and nonliving parts (such as nutrients and air). [13] These parts work and interact together on both microscopic and global scales in what are called ecological systems (ecosystems). [14] The primary energy source for all ecosystems is sunlight through photosynthesis. [15]

Sandy beaches are interesting and diverse because of their varying animal and plant habitats, and their connection to other distinct and separate ecosystems. Beaches are part of a category of ecosystems called marine ecosystems that are controlled by ocean energy flows. [16] Marine ecosystems in Florida include the blue-water ocean system (offshore), the continental shelf ecosystem (nearshore), shallow-water grass flats, coral reefs, estuaries, and beaches. [17] Beach ecosystems on a small scale are composed of the sand dune ecosystem and the wave zone ecosystem. [18]

*288 1. How Beaches are Naturally Formed without Human Intervention

Sand moves around beaches through the erosional forces of wind and water. [19] Sand typically erodes away from dunes during major storms that develop large waves and strong winds. [20] This is called avulsion, which is "the sudden or perceptible loss of or addition to land by the action of the water." [21] The eroded sand lost by avulsion typically settles into sandbars just offshore to create surf breaks, or it gets collected in deeper water. [22] Sand is also transported up and down a beach with what is called the longshore current, for example from Jacksonville to Miami and back again. [23] Beaches re-form during fair weather by small wave action that pushes sand up the beach. [24] This "gradual and imperceptible accumulation of land along the shore" is called accretion. [25] "'Gradual and imperceptible' means that, although witnesses may periodically perceive changes in the waterfront, they could not observe them occurring." [26] This imperceptibly accreted sand is called alluvion. [27]

Normal wave action also creates dunes when onshore winds deposit sand from the beach into the dune's vegetation and structures, gradually building up the dune. [28] Dune succession "starts with pioneer plants, such as the grasses and sea oats." [29] These plants gradually collect sand over years until a maritime forest develops, complete with dense vegetation such as "sable palms, oaks, and saw palmettos" which "makes the coast stable and secure against storms." [30] When the vegetation and dunes are removed or altered, "the sand starts to move with *289 the wind and becomes unstable. Protection against seawater breakthrough in hurricanes is removed." [31]

2. How Beaches are Artificially Formed with Beach Renourishment

Beach nourishment projects primarily utilize three techniques to transport sand to the beach: dredging, truck hauling, and jet pumps. [32] The time frame within which to complete the projects varies based on the distance and width to be covered, but it is typical to restore a beach at a pace of "300 to 500 feet a day." [33]

A key component of any beach nourishment project, the newly deposited sand, is sourced from a variety of different locations. [34] Geographically, sand from underwater sources may come from sand bars in the wave zone or surf break, from the nearest jetty with sand deposited through accretion, further out along the continental shelf, from boating channels, such as the Intracoastal Waterway, or from inlets and around jetties where longshore currents have deposited

sand. [35] Dry sand may also be trucked in from upland sources near the beach, or much farther inland from dedicated sand mines that contain beach-quality sand. [36]

Many beach renourishment projects have been criticized for their sand quality. [37] The quality of the sand used for renourishment is important because it must match the existing sand in texture, shape, density, durability, size, color, and chemical makeup. [38] "Constructing a beach nourishment project with analogous properties between offshore sediment and native or existing beach sediment is often difficult because ***290** such material does not exist in adequate volume at a reasonable cost." [39]

Sand dredged from offshore sources typically has not been naturally tumbled to round shapes because it is generally made up of decayed reefs, its color is different, it is less dense and durable, and it moves in suspension easier than the existing sand. [40] "If the grains of sand are too fine, they'll cloud the water and smother reefs and other marine life. Grains too dark in color can get too hot, which can affect sea turtle nests." [41] Thus, in hoping to restore tourism to beaches through nourishment, the dredging and increased turbidity in the water caused by improper sand grains degrades the marine communities that actually support recreational diving and commercial fishing, leading to an antithesis in the desired effect. [42]

The future availability of sand for these projects is finite based on past projects and future needs estimates. [43] For example, the U.S. Army Corps of Engineers ("ACOE") published a report in 2012 for Florida's Southeast region and estimated those counties' needs for fifty years, until 2062. [44] The report found that the sources of sand for Broward and Miami-Dade Counties were already 100% depleted. [45] On the bright side, ACOE determined that St. Lucie, Martin, and Palm Beach Counties have a surplus of sand in the amount of one hundred million cubic yards, even though as much as thirty-two percent of this surplus sand lies in federal waters where "authorizations for geotechnical investigations and leases for use must be obtained from the US Department of Interior." [46] Furthermore, the SAND Study did not account for the specific needs of sand types for each beach, and rather ***291** assumed for estimation purposes that all available sand would be available for all beaches. [47]

Sand quality is important for more than just environmental reasons. Florida's primary tourism website acknowledges the various kinds of beach sands as a tourist attraction. [48] Florida has pure white sand beaches, black and gray sand beaches, brown sand beaches, shelly sand beaches, orange sand beaches, and mixtures of sand and shell. [49] Recognizing the importance of sand quality for aesthetics, recreational use, and environmental compatibility, the Florida Administrative Code provides guidelines for suitable sand to be used as "compatible fill." [50]

3. Damage to Both Underwater Ecology and Dry Sand Ecosystems

The quality of sand to be used in beach nourishment projects is specified in the Florida Code, because if it is too fine, it will erode from the beach faster than natural sand. [51] The reason is that the wave action on the beach causes the fine sand to suspend in the water, leading to increased turbidity. [52] "A beach filled with offshore derived carbonate sand, invariably, becomes a long term source of both persistent fine sediment release and persistent degraded nearshore water quality." [53] Specifically, the nearshore water quality is "degraded" because both aesthetics and ecological functions are impaired. [54]

Aesthetically, murky ocean water is not clear and inviting for recreational purposes. [55] Water that contains elevated levels of nutrients and suspended solids, such as fine sand and sediment, absorbs light and looks dark, usually brown, as

opposed to non-threatening ***292** clear blue water.[56] There are several risks that affect beachgoers, such as the fear of increased accidental shark bites, the inability to see below the surface and watch where they are stepping, the increased risk of water-borne diseases, and low visibility of coral reefs for snorkelers.[57]

Ecologically, increased turbidity blocks sunlight that is critically necessary for photosynthesis, and suspended solids eventually settle on non-sandy habitat such as sea grasses and coral reefs.[58] As a result of beach renourishment projects, coral reefs in southeast Florida are in steady decline.[59] Much of this decline can be attributed to foreign sediment settling on the coral because the act of dredging the bottom of the ocean stirs up sediment and destroys existing underwater habitat.[60]

Due to the need for strict compliance with the existing sand quality standards and the Florida Code, sources of sand for beach renourishment are limited.[61] In fact, underwater sand sources for Florida's Miami-Dade and Broward counties have already been completely depleted, and those counties now have to source underwater sand from "state or federal waters off St. Lucie, Martin, and Palm Beach counties."[62] This shortage of underwater sand is forcing the sand search to upland/inland areas miles away.

When taken from any upland source, there is arguably a loss of habitat at that source, but of course some habitats are more sensitive than others due to ecological factors such as species diversity and richness. ***293** [63] Most habitat loss occurs when sand is mined from inland areas along the Lake Wales Ridge, the Central Florida Ridge, and other similar upland areas.[64] These ridges are ancient sand dunes that are millions of years old.[65] The areas near the Lake Wales Ridge and other ridges not only provide habitat for many of Florida's threatened and endangered species,[66] but they are also one of Florida's primary recharge areas for our main source of drinking water, the Floridian Aquifer.[67]

Once the new sand is hauled in via truck or pumped from a barge, the new sand deposited on the beach smothers out the existing aquatic life in the wave zone ecosystem.[68] Sand dwellers such as sunrise tellins, auger snails, mollusks, coquina clams, slipper shells, and sand crabs live in the sand and filter out nutrients in the water.[69] The influx of new beach sand from underwater or upland sources brings with it foreign organisms not accustomed to the sandy beach environment.[70]

B. Beach-Building Economics: How Often Does This Have to Be Done, How Much Does It Cost, and Who Pays For It?

Repeated instances of beach renourishment projects add up, and the shorter timeframe between projects will make them less economically feasible for the taxpayers who are footing the bill.

1. Varied Costs

According to the United States Geological Survey ("USGS"), in 1997, the cost of beach renourishment projects vary but "typically cost[ ] well over a million dollars for each mile of beach, and [the project] ***294** needs to be repeated as often as every four years."[71] To help fund this process, local municipalities, the State of Florida, and the Federal Government share the costs.[72] According to Pinellas County, costs for these projects are typically split with "[sixty percent] federal (ACOE), [twenty percent] state (Florida Department of Environmental Protection) and [twenty percent] local."[73] Some local municipalities, such as the Captiva Erosion Prevention District,[74] have adopted local taxing districts under Florida's Beach and Shore Preservation Act.[75]

Projects in Pensacola and Destin "claimed $12.3 million in state funds" for the 2014-2015 fiscal year alone.[76] These costs are quite variable, taking into account a number of factors including: "proximity of the borrow site, sand type of borrow site, time of the year work is to be done ... quantity of material available at the borrow site, ... exposure of the native beach, and extent of any mitigation measures required to lessen adverse environmental impacts on borrow sites."[77] To date, there has been no government funding for beach renourishment projects in response to sea level rise; the only funding response has been to hurricanes.

The life, or economic feasibility, of a restored beach varies according to its location, local weather patterns, and the frequency and intensity of major storms in the area.[78] With some of the world's largest and most destructive storms occurring within the last few years, climatologists have widely predicted that major storms will become more frequent leading into 2100.[79] Therefore, the length of time it ***295** takes for nourished sand to wash away, and for the beach to reach its pre-nourished state, is expected to shorten as the seas rise.

2. Varied Nourishment Intervals

Nourishment interval is an indicator of how long a project will last, "the assumed time between nourishment operations that are required to replace erosion losses and to bring the beach back to its design width."[80] Beach nourishment projects have notoriously short lifespans, or nourishment intervals, which even the proponents of these projects know do not last long.[81] The Mayor of St. Augustine reported in a news article covering the completion of a beach renourishment project on St. Augustine Beach, that the nourished sand would hopefully "last five to seven years, but only Mother Nature knows."[82] Municipalities with beach preservation districts provide historical guidance, with Captiva performing every eight to nine years,[83] and the Town of Jupiter Island performing "at regular intervals of three to seven years, depending on the need."[84]

According to a study performed by the Beaches and Shores Resource Center at Florida State University, for beaches on the Atlantic coast of Florida the "[a]verage volume above MHW[85] of [sixteen] projects receded [twenty-nine percent] one year post-construction and continued to retreat at an average rate of [eight percent] per year from the second year to the sixth year post-construction."[86] What this means is that six years after renourishment of an Atlantic coast beach in Florida, ***296** approximately sixty percent of the renourished sand has eroded back into the ocean. Gulf coast beaches typically performed marginally better than Atlantic coast beaches because they "retained higher percentage of the nourishment material and approached stability earlier."[87] In a white paper published by the Indian River County Department of Public Works Coastal Engineering Section, the "renourishment interval" for one of their own projects was estimated to be nine years.[88] The ACOE uses estimates from six to seven,[89] to every ten[90] years. Florida is not alone in having excessive beach nourishment cycles, for example, one beach in North Carolina "has been replenished more than 20 times since 1965, at a cost of nearly $54.3 million (in 2011 dollars)."[91]

In conclusion, beach nourishment projects have a limited life expectancy: municipalities with special taxing districts use a nourishment interval of three to nine years, the USGS says every four years, project proponents say five to nine years, and scientific studies show a 60% loss of renourished sand after six years on average.

3. Case Study: Brevard County Economic Analysis

Contrast the time frames of three to nine years above with a Brevard County, Florida study of the "potential storm damage reduction benefits" of beach renourishment projects, in which the study's authors used a greater sixteen-year total life for an eighty cubic yard per foot (cy/ft.) beach renourishment project whereupon one hundred percent of nourished

sand is expected to have washed away. [92] The study also included the expectation that a 100-year storm had a one percent chance of occurring in any given year [93] despite evidence that 100-year storms have recently been more prevalent than a 1/100 ***297** chance and will be more prevalent in the future due to climate change. The focus area of the study was a 14.5-mile long section of beach in south Brevard County with an estimated "total approximate 'market value' of all oceanfront structures and land ... of $665M." [94] This includes 643 parcels of land with 388 oceanfront structures. [95] Value of land alone was approximated at thirty-two dollars per square foot, which "equates to an oceanfront land valuation of about $700,000 per half-acre lot." [96] The goal of this study is to assess the feasibility of protecting predominantly private property which, based on calculations, is valued at $8,686 per linear foot of shoreline. [97]

Damage to building values were modeled on a formula that considered the erosion of the bluff/dune in physical relation to distance from the building. [98] For example, the damage estimate is

> 2% of the structure value if the bluff eroded to within 20 feet or less of the structure, and 4% of the structure value if the bluff eroded to within 10 feet of the structure. If the bluff eroded landward of the structure's seaward edge, then damage was assessed as 4% plus the fraction of the building's footprint undermined by the erosion. If more than 25 percent of the structural footprint becomes undermined by bluff erosion, then damage was assessed as 100% of the structure's value. [99]

Finally, project costs for the entire 14.5-mile long study area were considered for both a "40 cy/ft. project represent[ing] a small-scale conventional beach nourishment, equal to about half that placed in the 2002-[20]03 South Reach project" and a "larger 80 cy/ft. conventional beach nourishment project." [100] For the purposes of this Article and considering that sea level is projected to rise and not fall, the values used for the 80 cy/ft. conventional project are assumed, which includes "unit prices of beach nourishment sand between $15.50/cy and $18/cy." [101] In this case, "[n]ourishment of the entire 14.5-mile long study area would require approximately 6.14 million cubic yards of fill and would cost an estimated $104.7M (plus design, permitting, monitoring, etc.)." [102] This equates to an average of $1,363 per linear feet of shoreline. ***298** [103] These values are all variable in total amount based in part on the state's coastline that was observed in the study, future costs of construction, and the cost of the study itself since costs increased as the project moved south. [104]

Models developed pursuant to the study, which predict the value of land and property damage, conclude that "[i]n the absence of any action, total oceanfront damages over the next ten years are predicted to be approximately $34.85M (present worth), of which $19.9M is associated with structures and $14.95M with land losses." [105] This equates to approximately $455 per linear foot of shoreline. [106]

To summarize, the study estimated property value of approximately $8,686 [107] per linear foot of shoreline, and every ten years there would be erosion damage to this property of $455 per linear foot of shoreline. [108] Erosion may be prevented by spending $1,363 per foot on beach renourishment every sixteen years, although other studies and historical evidence suggests it needs to be done more often. Ignoring discrepancies in repetition of these projects, the study predicts that costs for preventative measures will be three times the value of damage caused by erosion during a ten-year cycle. [109] Alternatively, in about six-and-a-half renourishment cycles of any frequency, the cost of renourishment will have exceeded the total predicted value of all land and buildings along the study area. [110] This means that once this beach has been renourished seven times, more public funds will have been expended on renourishment than the loss of private property values if every structure and each parcel of land was totally destroyed. [111] Based on either a five or a ten-year renourishment cycle, the timeframe for seven cycles to happen could be within thirty-five to seventy years, respectively.

The commencement of this timeframe is the date a beach is initially nourished. In Brevard County, specifically, the first of such projects took place in 1975. [112]

*299 II. FLORIDA'S EXISTING LEGAL FRAMEWORK

A. Regulating Beach Building with the Beach and Shore Preservation Act

Florida's constitution, as well as common law, identifies beaches and land submerged below coastal waters as two types of land held "for all the people" by the State of Florida as sovereign. [113] These "sovereign submerged lands" below the mean high water line are held in "public trust for the benefit of all the citizens of the State." [114] Florida's public trust doctrine "declares that Florida's beach sovereignty lands must be accessible to the public." [115]

With this in mind and declaring that "[b]each erosion is a serious menace to the economy and general welfare of the people" [116] of Florida, the Beach and Shore Preservation Act (BSPA) was created in 1961 for "beach restoration and nourishment projects." [117] The Act requires coastal construction permits for any construction or physical activity undertaken specifically for shore protection purposes including "artificial nourishment, inlet sediment bypassing, excavation or maintenance dredging of inlet channels, or other deposition or removal of beach material." [118] The intent of the BSPA is "the regulation of construction, reconstruction, and other physical improvements on waterfront properties," [119] and to provide funding for renourishment projects on beaches that have been identified by the state as "critically eroded." [120]

***300** State and federal permits are required for beach nourishment projects in Florida. [121] Because beach nourishment projects affect the sovereign submerged lands as described above, a "joint coastal permit" is required. [122] Before a permit is issued, beach nourishment studies must be conducted, which consider many factors, including:

> (1) benthic and hardbottom communities in the fill and borrow areas, and the likelihood of such communities reestablishing themselves after construction; (2) compatibility of the borrow material with the existing beach sediments; (3) the silt-clay ratios in the proposed borrow material, which is related directly to turbidity problems during and after construction; (4) the proposed frequency for future renourishment to maintain the nourished beach; (5) the effect of borrow site dredging on nearby shorelines; and (6) effects on sea turtle and shorebird nesting periods. [123]

B. Alternative Funding: Beach and Shore Preservation Districts and the Land Acquisition Trust Fund

For local municipalities that desire more control in both tax funding and implementation of beach building projects, Part II of the Beach and Shore Preservation Act [124] includes legislation enabling any county in the state to enact a special taxing district to "initiate and carry on such studies and investigations as may be necessary to plan a logical and suitable program for comprehensive beach and shore preservation." [125] At least three of these taxing districts are known by the author to exist in Florida: the St. Lucie County Erosion District, [126] the Town of Jupiter Island Beach Protection District, [127] and the Captiva Erosion Prevention District (CEPD). [128] The districts were established in 1967, [129] 1982, [130] and 2000, [131] respectively. Once established, these ***301** districts act as "public bodies" of the state. [132] Using the CEPD as an example, it "provides beach erosion control and preservation activities for the protection, preservation and restoration of Captiva's sandy beach" [133] and specifically allows more localized control to

"be proactive" with "ample lead time to optimize financing, enhance competitive bidding and manage a well-planned [sic] implementation ... to deliver the very best project, at the best price, for Captivans." [134]

A beach and shore preservation district "may levy upon all taxable property within each district an ad valorem benefits tax in any amount necessary to meet the requirements of the program but not exceeding the reasonable ability of the district to pay." [135] For example, the CEPD used a 0.3053-millage ad valorem property tax to pay for the administrative costs of the program. [136] A unique feature of these special taxing districts is that they allow the properties to be taxed "in proportion to benefits said property will receive as determined by the most recent economic analysis of the program." [137] This implies that benefits from beach renourishment, such as increased economic revenue from tourism related to the new wider beaches or protection from property damage, will be considered when setting the millage rate of the tax. [138] The millage can even be adjusted based on type of property because general and specific benefits are considered in relation to whether the benefit applies to the whole district or if it applies "to groups of specific properties." [139] This is exactly what the CEPD does in Captiva, as they have two tax types, the annual ad valorem tax, and a non-ad valorem special tax that is used when beach nourishment is needed. [140] The last time the CEPD performed beach nourishment was in 2013 and they did this without receiving federal funding as it was ***302** determined that they were ineligible. [141] The CEPD uses an engineer and an economist to assess different rates for the special tax on property owners, using several criteria including: a storm protection benefit that is scaled for beachfront property; a recreation benefit that applies to all property owners; criteria based on individual property value; and finally criteria based on beach "hot spots" where erosion is worse than in other areas, using a comprehensive survey from an engineer. [142]

Florida uses the Beach Management Funding Assistance Program, which was established in 1986 "for the purpose of working in concert with local, state and federal governmental entities to achieve the protection, preservation and restoration of the coastal sandy beach resources of the state." [143] Historically, "funding [for beach nourishment] came from a $30 million doc stamp fund that has since been eliminated and absorbed into the Amendment 1 revenue stream." [144]

Recently there has been discussion in the media [145] and within the major beach restoration lobbying group, the Florida Shore & Beach Preservation Association (FSBPA), [146] about using funds from the recently passed Amendment 1 [147] for beach renourishment projects. This constitutional amendment, called the Land Acquisition Trust Fund, was advertised during the recent public election as a fund for the acquisition of land for environmental preservation, and it states:

> Funds ... shall be expended only for the following purposes: As provided by law, to finance or refinance: the acquisition and improvement of land, water areas, and related property interests, ***303** including conservation easements, and resources for conservation lands including wetlands, forests, and fish and wildlife habitat, ... [and] beaches and shores. [148]

While special interest groups such as the FSBPA interpret this language as a blank check for more beach nourishment through "improvement" of beaches, it seems that a more cost effective and long-term strategy would be to use the plain language of the Land Acquisition Trust Fund to "acquire" land on Florida's beaches and shores, not to create land that will erode away.

C. The Beach and Shore Preservation Act's "Climate Change" Gag Order

The BSPA was not drafted, nor has it been updated, to anticipate climate change or sea-level rise. [149] The Act only points to "climate change" [150] as one of many topic options for third-party research reports for the Florida Oceans and Coastal Council, which was created in 2005 under the Oceans and Coastal Resources Act. [151] The Florida Oceans and Coastal Council followed this statutory option in 2009 when it drafted a report entitled Climate Change and Sea-Level Rise in Florida: An Update of the Effects of Climate Change on Florida's Ocean and Coastal Resources. [152] This report states that sea-level rise is a factual reality and that it will continue to rise for centuries, regardless of human intervention. [153] Broadly speaking, the report states that sea-level rise will be the driver for increased flooding, heightened storm ***304** surge, and erosion leading to the following effects: beach profile diminution from erosion, dissection of barrier islands, and changes in course and flow at inlets; changes in the survival of salt-sensitive flora and fauna at estuaries, tidal rivers, and coastal forests; impacts on coastal infrastructure such as destruction of seawalls, roads, bridges, and buildings; [154] threats to coastal water supply such as saltwater intrusion into fresh groundwater; reduced wastewater treatment capability; increased need for new sand sources for beach renourishment; a need for local governments to complete and follow coastal climate change adaptation plans; and finally, an increased need for pumps and other engineered flood-control systems. [155] Despite the clear language of this multi-disciplinary report, developed by Florida's top scientists in their respective fields, climate change or sea-level rise still does not appear as a topic for future planning in Florida's beach management statutes. [156]

Constitutional takings of private property became an issue in the past related to hurricane-induced avulsion. [157] In *Stop the Beach Renourishment, Inc. v. Florida Department of Environmental Protection*, [158] the U.S. Supreme Court held that "if the shoreline is lost due to an avulsive event, the public has the right to restore its shoreline up to that MHWL." [159] However, the issue of constitutional takings related to ***305** sea-level rise induced by climate change has yet to be addressed. [160] Arguably, if there are no government-funded beach renourishment projects adding sand to beaches abutting private property, then the constitutional takings issues have been avoided. That would permit the property owner to have total command of lost shoreline (caused by avulsion), requiring them to either pay for their own restoration or risk property loss to eminent domain efforts.

III. LEGAL AND TECHNICAL ALTERNATIVES THAT CONSIDER CLIMATE CHANGE

As mentioned above, Florida's Beach and Shore Preservation Act generally does not consider the long-term effects of climate change, and also focuses heavily on beach nourishment as the primary tool for combating beach erosion. According to a contemporary study of beach planning, there are three main responses to rising sea levels: (1) retreat; (2) shoreline protection including armoring and beach nourishment; and (3) accommodating the sea with elevated construction techniques such as buildings on pilings. [161] Part III of this Article generally examines the first two responses, by looking at current or planned legal and technical alternatives to beach renourishment in use by other states. [162]

A. Soft Armoring Through Living Shorelines

Seawalls and other hard coastal armoring devices are disfavored due to unwanted detrimental effects to both the public's use of the beach and the environment, because "seawalls, by intensifying erosive wave action and preventing landward migration of the sea, generate loss of sand beaches between high and low tide that are usually open to public use, adversely affect marine life that relies on that intertidal area, and destroy coastal wetlands by preventing their migration ***306** inland." [163] The buzzword "living shorelines" has gained recent traction as a way to allow shorelines to move and grow as a "natural bank stabilization technique" without hard coastal armoring. [164] Living shorelines are a form of soft coastal armoring and are similar to dune restoration, as opposed to using hard structures such as sea walls and jetties. [165] Some

research even indicates that "construction and maintenance of living shorelines is more economical than armoring with hard structures and also requires less maintenance over time." [166] Although predominantly used for less intense wave energy areas like marshes, estuaries, and riverbanks, it also has adaptive uses to limited areas of inlets, sandy beaches, and dune ecosystems by "reducing wave energy while accommodating for sea level rise and managing sand movement" which "can be done by planting marsh grass and constructing reef breakwaters, helping to enhance the shoreline ecosystem and decrease erosion." [167] The technique is included in the state statutes of Virginia [168] and Connecticut; [169] and in the state administrative codes of New Jersey, [170] Maryland, [171] and Alabama. [172] Mississippi is also contributing to scientific research with the Mississippi-Alabama Sea Grant Consortium, [173] and has implemented a "'living shoreline general permit' [process] under the U.S. Army Corps of Engineers and the ***307** Mississippi Department of Marine Resources that can grant living shoreline permits within thirty days of application for areas where they are appropriate." [174] Further scientific research or isolated projects have been completed in Texas, Louisiana, Georgia, North Carolina, and Florida's west coast. [175] Although there are some small, limited projects in Florida, no statutory or regulatory schemes currently exist in Florida for living shorelines.

Other coastal erosion control alternatives to beach nourishment include technologies such as: constructed sand dunes, artificial reefs, marine mattresses, gabions, coastal bluff restoration, coir fiber logs and mats, anchoring systems, drift fences, geosynthetic tubes, and hybrid solutions. [176] These coastal engineering solutions demonstrate the existence of several soft armoring alternatives to pumping sand onto beaches and touch on the idea that beach renourishment is not the only option.

B. Coastal Retreat and Rolling Easements

Retreat and rolling easements are similar, but rolling easements are a type of retreat response. Each is discussed below.

1. Managed Coastal Retreat

Another major response to sea level rise is a legal remedy known as retreat. Retreat is defined as "allowing wetlands, beaches, and other coastal habitats to migrate naturally as the sea encroaches inland; moving people out of harm's way; and preventing new construction in vulnerable areas." [177] In early 2014, anticipating the effect of climate change on its coasts and desiring a roadmap for dealing with the future legal issues, the California Coastal Commission finished a public comment period for its *Draft Sea Level-Rise Policy Guidance*. [178] The draft document is "designed to assist local governments, permit ***308** applicants, and other interested parties in efforts to address sea-level rise ... including sea-level rise projections based on the best available science, guiding principles for beach preservation, background information on a number of adaptation strategies and methods, and other helpful resources." [179] For example, the guidance states as one of seventeen major principles that "[p]riority should be given to options that enhance and maximize coastal resources and access, including innovative nature-based approaches such as living shoreline techniques or managed/planned retreat." [180]

While managed or planned retreat is just getting its start in California through draft policy guidance, South Carolina has been implementing a "forty-year policy of retreat from the shoreline" since 1976 through statute. [181] Surprisingly, there has been little discussion of this policy in secondary sources, and it has not faced negative treatment in the courts. [182] Even so, in recognizing the need for periodic review of its beachfront management issues, in 2010 the State of South Carolina commissioned a report by its Shoreline Change Advisory Committee to re-examine the state's retreat policy in light of potential climate change. [183] In its Executive Summary, the Committee reported:

> The state's retreat policy does not provide for the immediate, active relocation of structures from the beach/dune system; however, by gradually eliminating erosion control structures, it ensures abandonment of property to allow the natural, inland migration of a healthy beach/dune system, if or when renourishment becomes unsustainable for a specific area or community. [184]

***309** South Carolina is recognizing the possibility that beach renourishment will become unsustainable due to climate change. The Committee's report was motivated in part by a separate report completed more than twenty years ago by the South Carolina Coastal Council's "Blue Ribbon Committee on Beachfront Management," which stated:

> Erosion is a natural process which becomes a significant problem when structures are erected in close proximity to the beach/dune system. Therefore, it is in both the public and private interest to plan a gradual retreat from the beach/dune system by discouraging new construction in close proximity to the beach/dune system and encouraging those who have erected structures too close to retreat from the beach/dune system. [185]

Considering the retreat policy good law, the 2010 *Shoreline Change* report further lays out "five recommendations for improved management to reduce risks to local beachfront communities." [186] The recommendations are as follows: "(1) Prevent the Seaward Expansion of Beachfront Development; (2) Strengthen the State's Beachfront 'Setback Area'; (3) Eliminate Inconsistent Public Subsidies; (4) Strategically Acquire Beachfront Lands and/or Easements; and (5) Strengthen the Role of Local Governments in Beach Management and Planning." [187] Most of these recommendations center on the idea of planned retreat from the shoreline. South Carolina has a very good model for Florida to use in at least recognizing the need to slowly retreat structures away from coastal shorelines.

In late 2012, Hurricane Sandy destroyed or significantly damaged hundreds of thousands of homes in New York and New Jersey, and at least 14.1 billion dollars' of federal assistance was provided to the public by FEMA. [188] In New York, post-Sandy rebuilding litigation in the Suffolk County Supreme Court occurred over zoning setback requirements for a damaged residence, and "retreat[ing] the new proposed residence landward and restor[ing] the dune system" was seen as a driving factor in approving the setback variances and nonconforming uses, and also as "a benefit to respondents, the community ***310** and the environment." [189] In *Calogiras v. Town of Southampton Bd. of Appeals*, the landward retreat of the residences was required due to movement of the coastal erosion line and the variances were granted on the condition that the residents submit a "dune restoration plan for approval prior to the issuance of a building permit, which will include repairing, restoring, and re-vegetating the dune in all disturbed areas, and the addition of dune sand and beach grasses to increase the overall stability of the dune system." [190] While no formal laws relating to coastal retreat exist, New York is setting a small precedent in the lower courts for granting structural retreat as a valid justification for granting zoning variances to allow new and reconstructed structures to move further landward, away from the sea.

Although not legal precedent, NASA is a leading independent agency of the federal government and its "plans for dealing with climate change [at Cape Canaveral] include a 'managed retreat' in which it will move infrastructure, potentially including launch pads, as needed." [191] NASA states that they "consider sea level rise and climate change to be urgent" and University of Florida researchers identified the "culprit" of dune and shore erosion as "sea-level rise and wave climate change." [192]

2. Rolling Easements in Texas

A rolling easement is a type of retreat response to rising sea level that includes "either (a) a regulation that prohibits shore protection or (b) a property right to ensure that wetlands, beaches, barrier islands, or access along the shore moves inland with the natural retreat of the shore." [193] In Texas, the Open Beaches Act protects the public's rights of access to, and use of, the public beaches of the state, and this includes public beach easements. [194] Before the 2012 Texas Supreme Court split decision in *Severance v. Patterson*, [195] Texas common ***311** law held that once a public easement to the vegetation line exists under the Open Beaches Act, the boundaries of the easement shift as the mean high tide and vegetation lines shift, creating a rolling access easement. [196] Texas does not, however, recognize rolling easements in avulsive events such as hurricanes. On this issue, the court held:

> Easements for public use of private dry beach property change size and shape along with the gradual and imperceptible erosion or accretion in the coastal landscape. But, avulsive events such as storms and hurricanes that drastically alter pre-existing littoral boundaries do not have the effect of allowing a public use easement to migrate onto previously unencumbered property. [197]

The *Severance* decision means that Texas cannot force the relocation or destruction of a home built on the beach now within the beachfront access easement without the payment of just compensation through exercise of eminent domain. [198] The 5-3 decision in *Severance* had three emphatic dissents, suggesting a possible change back to the historical common law of rolling easements, but with the current law rejecting rolling easements in avulsive events. [199] In fact, in *Brannan v. State*, the Texas Supreme Court reinforced the *Severance* decision and pointed towards payment of just compensation for beachfront homeowners when the houses were not allowed to be repaired or have access to utilities after storms "moved the vegetation line landward of petitioners' houses." [200] However, because the rolling easement theories in *Severance* and *Brannan* were narrowly applied to the situation when the vegetation line moves landward due to an avulsive event, this appears to leave Texas the option to enforce rolling easements related to climate change-induced sea level rise when it happens over a long period of time as a result of natural erosion.

***312 IV. ADAPTATION SOLUTIONS WITH CLIMATE CHANGE IN MIND**

Climate change is affecting Florida's beaches with an increasing rate of erosion, making beach renourishment less effective, both structurally and economically, due to rising sea levels and shorter nourishment intervals. This part of the Article addresses practical alternatives to beach renourishment in Florida when future climate change is considered. The solutions may include both short-term and long-term responses dealing with alternatives in funding, technology, and legal theory.

A. Funding: Encourage More Beach Tax Districting and Use The Land Acquisition Trust Fund to Purchase Private Beachfront Property

These two methods are both short-term and long-term solutions to funding shortages that work in concert, with the short-term solution gradually giving way to more widespread use of the long-term solution. Beach tax districting is a short-term solution that will give local governments more control and funding for beach nourishment projects until they deem them unsustainable and adopt a policy of retreat. Use of funds from the Land Acquisition Trust Fund is a long-term solution that allows public purchase of abandoned or condemned private property along the beaches in the path of retreat.

1. Short-Term Solution: Beach and Shore Preservation Districts

Florida already has useful law on beach tax districts titled "Beach and Shore Preservation Districts" in Part II of the Beach and Shore Preservation Act.[201] For greater control over beach building in the short-term, more counties should adopt local "erosion control districts" much like Captiva,[202] St. Lucie County,[203] and Jupiter Island.[204] If other municipalities are worried about the negative effect of increasing taxes, they should consider that despite their special ad valorem tax, Captiva Island was recently named one of the top ten happiest ***313** seaside towns in America.[205] Local counties might delineate their beach tax districts by beach basins, much like watershed areas, which can be easily established by looking at floodplain maps overlaid with tax parcel maps and determining current base elevations relative to sea level to identify flood-prone properties in need of protection. In addition, the prorated property tax values are based on a number of factors such as: protection benefit to ocean frontage directly along a nourished beach, distance to the beach, and other factors relating to anticipated recreational benefits from renourished beaches.[206]

The best driver for getting more counties to adopt local taxing districts is limited federal or state funding. For example, if federal funding is typically 60% of the total cost of the project, a loss of that funding will require local beaches to seek funds elsewhere. The Captiva Erosion Prevention District last renourished their beaches in 2013, and they did not receive federal funding because they were determined to be ineligible.[207] Without the local beach and shore preservation district and federal funding, that 2013 nourishment project likely would not have happened.

Even with specialized beach tax districts, all eroding beaches in Florida will likely not be able to undergo renourishment. Selective beach renourishment, chosen by the local taxing board, will have to occur and be based on several geographic, economic, and demographic factors. Areas with high geographic potential for long-term renourishment viability will be favored over low-lying areas with little hope for a long-lasting beach. Beaches protecting economic centers, such as central business districts, concentrated areas of local commerce, and emergency services will take precedence over residential and undeveloped areas. Finally, beaches that border areas of high population density, such as large apartment and condominium buildings will take precedence over single-family residential areas.

2. Long-Term Solution: Land Acquisition Trust Fund

A long term solution to funding involves using money from the Land Acquisition Trust Fund[208] to purchase private property, either ***314** consensually or through condemnation, in concert with a policy of retreat or rolling easements. The FSBPA, a major beach nourishment lobby, and other groups suggest using the new excise tax funding from the Fund for beach building projects.[209] However, the funding should be used for exactly what the title of the Fund suggests, to acquire damaged or threatened private beachfront property, remove the structures, and place the land in the public trust.[210]

As the sea encroaches more on upland private property, eventually beach nourishment will potentially be used to restore entire parcels (such as a typical residential lot) back to private owners. This scenario is a waste of public funds, and Florida should therefore adopt the South Carolina policy of retreat or the Texas policy of rolling easements. In such cases, if the land of a private parcel is lost due to avulsion or if the structural foundation of a private building has been exposed, it shall not be restored with public funds. Rather, that parcel remains as is and it is up to the owner to wait for the beach to naturally accrete the sand back in place, if the structure is not in danger of public nuisance and the public still has access through the beach via the public trust. However, if the structure is in danger of condemnation, collapse, or public harm, the owner should legally import sand onto his or her parcel and repair the structure. If an owner does not commence legal repair of the structure within a reasonable time, then the structure shall be acquired by eminent

domain, paying just compensation with funds from the Land Acquisition Trust Fund.[211] Precarious structures would be condemned by the state, removed from the beach, and the land returned to the public trust.

B. Limit Beach Renourishment Activities and Amend Florida's Beach and Shore Preservation Act (BSPA)

Limiting statewide beach nourishment projects is a long-term solution that takes time to implement. To get there, the BSPA should be amended to statutorily reflect the policies in this Article, the reality of rising sea level, and the laws and techniques in use by the other Gulf and Atlantic states. These measures may sound drastic today, but will become the only fiscally responsible alternative as storms continue to erode beaches more frequently, and sea level rise makes adding more sand less practical and more of a race against the rising tide. People may wonder what will happen to Florida if we limit, or even stop beach ***315** nourishment activities. A good example of this doomsday scenario is to examine several beaches in Florida that have never been through a nourishment project. According to the Florida Department of Environmental Protection, these beaches include:

> St. George Island State Park, Perdido Key, Dog Island, Little Talbot Island State Park, Ponte Vedra, most of Volusia County, northern Brevard County, northern Vero Beach, southern Indian River County, north of Ft. Pierce Inlet, MacArthur Beach State Park, Town of South Palm Beach, Highland Beach, Golden Beach, northern Key Biscayne, northern Siesta Key, Cayo Costa State Park, and Caladesi Island State Park.[212]

The above list includes, by all accounts, some very beautiful beaches, even what some have called the best beaches in America, ahead of beaches in California and Hawaii.[213] They include state parks, barrier islands, remote sections of county beaches, and densely populated areas of south Florida.[214] Residents and tourists alike visit these beaches and find them attractive. Courtney Hackney, director of coastal biology and professor of biology at the University of North Florida recently stated it best, "[p]ossibly the best investments the state of Florida made, in terms of erosion, was the decision to purchase coastal areas for conversion to state park reserves. In these areas, the state never has to fund beach nourishment and yet, there is never an erosion problem."[215] It is clear that without beach nourishment, beaches not only survive, but thrive.

So, in the short term, "limiting" may mean focusing beach building efforts on areas of beach that provide protection for high-density urban centers such as Miami, Daytona Beach, and major public infrastructure such as schools, power plants, public safety facilities, ports, inlets, and hospitals. Gone are the days when public tax funds from the majority will be expended to fund beach renourishment projects that directly benefit the minority who own seasonal beachfront homes or vacation condominium rentals along lonely stretches of beach in counties some Floridians will never visit. These types of private structures may benefit from a beach renourishment tax district, as discussed ***316** above, if they continue to desire a wide beach in front of their properties.

In the long term, or at least until sea level rise makes the business of building beaches a practical impossibility, "limiting" will mean focusing beach-building efforts on the densest urban areas, like Miami. Wide sandy beaches in front of dense urban areas arguably protect the most value, in terms of: sheer population density and protection of human life from dangerous storms, highest aggregate property value within the storm surge area, use of the beach as a social and recreational outlet and way of everyday life, desire of the beach as a vacation destination, and of course, highest return on public tax dollar investment, dollar for dollar and per capita. Furthermore, because areas of dense human population typically do not make good flora and fauna habitat due to increased human activity on the beach and in the water, the negative environmental effects of beach renourishment in dense areas will have less of an impact than if they were done on rural beaches where nature outnumbers humans.

This brings us to other common concerns that flow around limiting or stopping beach renourishment activities. These concerns typically include the potential loss of sea turtle habitat, inability to maintain our inlets and ports, and ability of man-made structures to withstand storm forces without a wide beach to protect them.

Protecting property and the tourism revenue stream are the primary motivations behind the BSPA, while providing sea turtle nesting habitat is just a secondary environmental appeasement. When a beach naturally erodes, sea turtles still find nesting sites in dry sand as they have for thousands of years.[216] Sea turtles only need a small area of dry sand above the high tide line, not a one-hundred foot wide sandy beach for cars and people.[217] The modern problem is loss of nesting sites due to erosion of the dry sandy beach up to buildings, sea walls, and other types of coastal armoring.[218] Hard coastal structures should be removed through retreat and condemnation if the owners fail to adequately protect their property against climate change and the properties become lost to the sea. If this plan is followed, Florida's ***317** beaches will make better environmental habitats due to less overall

human intervention. The second concern has to do with maintaining ports and inlets. There is the concern that "the genesis of every state's beach-building program stems from the need to maintain open and navigable ports."[219] Sand that is eroding from beaches and moving with the longshore current gets deposited in the artificially deepened inlets, and this process is aggravated by constructed jetties, armoring, and other manmade structures near inlets.[220] "In an attempt to counter both the man-made and nature-made forces of coastal erosion, the [ACOE] partners with states and local governments to build beaches."[221] Beach nourishment projects help to redistribute sand from the ports and inlets.[222]

But there are alternatives to beach nourishment projects that do not require beach-building miles away from ports. These solutions are already in place at many inlets and they include sand-bypass systems and localized dredging within the inlet.[223] Sand-bypass systems simply take the sand from the accretion side of the inlet and move it to the sand-starved side of the inlet.[224] This is a comparably cost-effective and localized technique that does not require dredging sand from several miles offshore or hauling sand in via trucks from inland mines.[225] Localized dredging focuses on the down drift sand within the depths of the inlet or port and moves it to the areas of the nearby beach that are deprived of sand (because the sand got caught up in the deeper inlet).[226] Again, this is a localized solution that focuses on a limited area for the specific purpose of allowing navigable ports.

Another concern with limiting beach nourishment is the ability of structures to withstand the storm forces without a wide sandy beach as protection. Modern construction techniques are well-suited for rising ***318** seas and high winds. Florida's building codes have already been modified to account for high velocity coastal wind zones.[227] This change in the Florida building code was a reactive response to Hurricane Andrew.[228] A more proactive response to climate change should direct new building codes before, rather than after, a disaster. For example, just like high velocity wind zones, Florida's building codes could include high sea level coastal zones which include special adaptive construction techniques for rising sea level. Construction of new buildings and rebuilt structures that barely survive storms "should be elevated on pilings at least two feet above the 100-year flood level to allow future storm overwash to flow underneath."[229] An amendment to the Beach and Shore Preservation Act could lead the way in identifying the need for these changes.

In addition, Florida currently has no legislation regarding living shorelines. Although living shorelines will not always be completely applicable to the open beach environment due to their high wave energy, they do provide another alternative to both beach renourishment and coastal armoring at inlets, lower-energy sandy beaches, and dunes. Florida should join the other six Atlantic and Gulf coast states[230] to at least recognize this coastal adaptation technology as a viable alternative for private citizens who want to protect their property in a way that preserves the public's right to access while appeasing environmental concerns.

CONCLUSION

Looking back over the last fifty years, beach nourishment has been a workable solution to beach erosion. But in looking ahead to the next fifty years, its time as the preferred engineering and legal solution to beach erosion is quickly expiring. With sea-level rise expected to "continue for centuries even if the global mean temperature is stabilized," [231] holding the line on beaches in the long term is not ***319** sustainable. The time for change is now, because "to ignore the recent changes in storm activity and sea-level rise would be beyond ignorant and a disservice to all involved." [232] In a New York Times article relating to Hurricane Sandy and the costs of beach nourishment, S. Jeffress Williams, a coastal scientist with the United States Geological Survey stated, "[w]e cannot sustain the shoreline in the future as we have in the past, ... [p]articularly from a beach nourishment standpoint." [233] By examining the significant costs of a beach nourishment project in Brevard County, this Article has demonstrated that "[d]efending coastal development from the rising sea would prevent wetlands from migrating inland, expose large numbers of people to the hazard of living below sea level, and *often cost more than what the property being protected is worth*." [234]

The underlying concept of this Article is that without beach nourishment, Florida's beaches will still exist for Floridians. The challenge is to employ the ideas presented in this Article, from short-term funding solutions of increased local beach tax districting, living shorelines, and amending the BSPA, to more long-term solutions such as managed coastal retreat, rolling easements, and purchasing private beachfront property for the benefit of the public trust. These efforts combined with proper elevated construction techniques and limited coastal armoring will allow beaches to go through a natural course of change. Floridians will still want and be able to own property at the beach, tourists will still visit our beaches, animals will still find habitat at the beach, and better coastal recreation opportunities such as better surf breaks [235] and more bountiful fishing [236] may become available by allowing the coastal ecosystems to naturally form without human intervention. Picture this, if over the span of decades, sand is continually pumped onto beaches as sea levels rise and the man-made structures are destroyed, we might end up with wide, deserted, unpopulated beaches as barrier islands that are miles away from the new mainland, ***320** because "[f]or every foot the seas rise, the shoreline would move inland 500 to 2,000 feet." [237]

A University of Florida researcher studying coastal erosion near NASA's launch pads stated, "[w]hen you put immovable infrastructure right next to a dynamic environment, ... something has to give." [238] In the face of rising sea level, Floridians will have much greater challenges than wide beaches: relocating millions of coastal dwellers; pumping sea water from low inland coastal areas; litigation over private property rights; increased property insurance claims; zoning issues; moving public safety and power facilities to higher ground; and raising and relocating roads, bridges, and other critical infrastructure. [239] It makes sense to get a start on these issues by tackling the easy ones first, such as seriously reexamining the technology, the funding sources, and the legal aspects of beach nourishment in light of what we can expect about the dynamics of Florida's future coastal environment.

Footnotes

a The Author appreciates the help and support he received from Professor Randall Abate at the Florida A&M College of Law. The Author enjoyed researching and writing about the issues in this paper because he is a native Floridian and is passionate about Florida's environment and beaches. He currently works for GrayRobinson, P.A. in their Orlando office as an Associate.

1 RALPH R. CLARK, FLA. DEP'T OF ENVTL. PROT., BEACH CONDITIONS IN FLORIDA: A STATEWIDE INVENTORY AND IDENTIFICATION OF THE BEACH EROSION PROBLEM AREAS IN FLORIDA 89 (5th ed. 1993), http://www.dep.state.fl.us/beaches/publications/pdf/fl_beach.pdf; *see also* PHIL FLOOD, FLA. DEP'T OF ENVTL.

PROT., FLORIDA'S BEACHES AND SHORES 3, http://www.dep.state.fl.us/beaches/publications/pdf/actbook.pdf (last visited Dec. 28, 2016).

2 CLARK, *supra* note 1.

3 *See generally* FLA. OCEANS AND COASTAL COUNCIL, CLIMATE CHANGE AND SEA-LEVEL RISE IN FLORIDA: AN UPDATE OF THE EFFECTS OF CLIMATE CHANGE ON FLORIDA'S OCEAN AND COASTAL RESOURCES (2009), http://www.dep.state.fl.us/oceanscouncil/reports/climate_change_and_sea_level_rise.pdf. This Article does not debate the science of climate change, but instead presupposes that climate change is a factual reality and sea level rise of two to six feet will happen in Florida within the next eighty-five years. "Sea-level rise is not a science fiction scenario but a reality." *Id.* at 1. *See also*, Douglas Hanks, *Miami-Dade's GOP mayor on sea-level rise: "It's not a theory. It's a fact. We live it every day*, MIAMI HERALD (Jan. 18, 2017), http://www.miamiherald.com/news/local/community/miami-dade/article127251479.html.

4 *See generally id.*, *and* Ken Kaye, *New Report: Outlook Grimmer on South Florida Sea Levels*, SUNSENTINEL (Nov. 6, 2015, 10:35 AM), http://www.sun-sentinel.com/local/broward/fl-new-sea-rise-projections-20151108-story.html.

5 Florida developed its beach management program in 1986. *Beach Management Funding Assistance Program*, FLA. DEP'T OF ENVTL. PROT., http://www.dep.state.fl.us/BEACHES/programs/becp/index.htm. However, the United States' federal government has been involved in protecting Florida's shores since the 1960's. *See* AM. SHORE AND BEACH PRES. ASSOC., THE HISTORY OF PINELLAS COUNTY'S FEDERAL SHORE PROTECTION PROJECT (2009), https://www.pinellascounty.org/environment/coastalMngmt/pdfs/History-Shore-Protection-Project.pdf.

6 ANDREW MORANG & CHARLES B. CHESNUTT, U.S. ARMY CORPS OF ENG'RS, IWR REPORT 04-NSMS-4, HISTORICAL ORIGINS AND DEMOGRAPHIC AND GEOLOGICAL INFLUENCES ON CORPS OF ENGINEERS COASTAL MISSIONS, 19 (2004), http://www.iwr.usace.army.mil/Portals/70/docs/iwrreports/IWR04-NSMS-4.pdf.

7 *Id.* at 18. (quoting LENA LENCEK & GIDEON BOSKER, THE BEACH: THE HISTORY OF PARADISE ON EARTH (1998)).

8 *See id.* at 19-20 (stating that the Corps of Engineers was expanded to include shore protection measures in 1955).

9 *See* FLA. STAT. § 161.021(3) (2007); *see also* MORANG & CHESNUTT, *supra* note 6, at 20. These terms are generally used interchangeably throughout this article. *See*, infra note 34.

10 *See generally* Spreadsheet, NAT'L OCEANIC AND ATMOSPHERIC ADMIN., BEACH NOURISHMENT 7-11-02 STATES (July 11, 2002), http://coast.noaa.gov/archived/beachnourishment/html/human/socio/images/b3f2.pdf.

11 *See, e.g.*, Stop the Beach Renourishment v. Fla. Dep't of Envtl. Prot., 560 U.S. 702 (2010) (holding that the state of Florida did not unconstitutionally take property without just compensation by rebuilding a beach, thus affecting littoral rights of numerous homeowners by extending the distance of their property to the shoreline, because they had no rights in future exposed land that was once submerged).

12 *See generally* Dan Simpson, *Despite Climate Change Warnings, Florida GOP Governor Ignores Rising Sea Levels, Flooding Concerns*, REVERBPRESS (May 11, 2015), http://reverbpress.com/discovery/science/despite-climate-change-warnings-florida-gop-governor-ignores-rising-sea-levels-flooding-concerns/.

13 HOWARD T. ODUM ET AL., ENVIRONMENT AND SOCIETY IN FLORIDA 17 (1997).

14 *Id.*

15 BERNARD J. NEBEL & RICHARD T. WRIGHT, ENVIRONMENTAL SCIENCE: THE WAY THE WORLD WORKS 503 (4th ed. 1993).

16 ODUM ET AL., *supra* note 13.

17 *Id.* at 141.

18 *Id.*

19 FLOOD, *supra* note 1.

20 *Id.*

21 Bd. of Trs. of the Internal Improvement Tr. Fund v. Sand Key Assocs., Ltd., 512 So. 2d 934, 936 (Fla. 1987).

22 FLOOD, *supra* note 1.

23 *See* Natasha Zalkin, Comment, *Shifting Sands and Shifting Doctrines: The Supreme Court's Takings Doctrine Through and South Carolina's Coastal Zone Statute*, 79 CALIF. L. REV. 207, 214 n. 28 (1991) (describing littoral drift as a result of waves that hit the shore at an angle, then "sand is carried by the receding wave [and] is transported downdrift [sic] of its origin"). *See also Longshore Current Fact Sheet*, NOAA NAT'L WEATHER SERVICE WEATHER FORECAST OFFICE (Apr. 11, 2003), http://www.srh.noaa.gov/mlb/?n=longfactsheet (describing a littoral current as that which "flows parallel to the coastline").

24 *Sand Key Assocs., Ltd.*, 512 So. 2d at 936.

25 *Id.*

26 *Id.*

27 Cty. St. Clair v. Lovingston, 90 U.S. 46, 47 (1874); Stop the Beach Renourishment, Inc. v. Fla. Dep't of Envtl. Prot., 560 U.S. 702, 708 (2010).

28 ODUM ET AL., *supra* note 13, at 152.

29 *Id.*

30 *Id.*

31 *Id.*

32 ROBERT G. DEAN, BEACH NOURISHMENT: THEORY AND PRACTICE 5, 17 (2002).

33 Walton City. v. Stop the Beach Renourishment, Inc., 998 So. 2d 1102, 1106 (Fla. 2008).

34 Beach "nourishment" and "renourishment" are generally synonymous in this Article, with the Florida Statutes preferring "nourishment" after the initial beach "restoration" and the U.S. Army Corps of Engineers generally using "renourishment" when the process is repeated.

35 *See* U.S. ARMY CORPS OF ENG'R, BEACH NOURISHMENT: HOW BEACH NOURISHMENT PROJECTS WORK 6 (2007), http://www.asbpa.org/publications/fact_sheets/HowBeachNourishmentWorksPrimerASBPA.pdf.

36 *Upland Sand for Beach Renourishment*, E.R. JAHNA INDUSTRIES, https://www.jahna.com/the-jahna-standard/beach-renourishment/ (last visited Oct. 21, 2016).

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43 *See* LYNNE EDGERTON, THE RISING TIDE: GLOBAL WARMING AND WORLD SEA LEVELS 38 (1991) (discussing an issue concerning which communities should be given access to sand and which ones should be excluded, given the finite nature of the sand). *See also* FLA. STAT. § 161.144 (2007) (noting that the "[l]egislature recognizes that beach-quality sand for the nourishment of the state's critically eroded beaches is an exhaustible resource.").

44 SAND STUDY, *supra* note 38, at 4. Florida's Southeast Region consists of St. Lucie, Martin, Palm Beach, Broward, and Miami-Dade Counties. *Id.*

45 *Id.* at 22.

46 *Id.*

47 *Id.*

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58 *See Dispatches from the Deep: Light and Dark in the Sea*, AM. MUSEUM OF NATURAL HISTORY, http://www.amnh.org/explore/curriculum-collections/deep-sea-vents/light-and-dark-in-the-sea (last visited Oct. 21, 2015); *see also* Caroline Rogers, *Responses of Coral Reefs and Reef Organism Sedimentations*, 62 MAR. ECOL. PROG. SER. 185 (1990).

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65 *Lake Wales Ridge Nat'l Wildlife Refuge Factsheet*, U.S. FISH & WILDLIFE SERV., http://www.fws.gov/southeast/pubs/facts/lakcon.pdf (last visited Apr. 9, 2016).

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95 *Id.* at 66. These 388 oceanfront structures consist of private homes, residential condominiums, and hotels/resorts. *Id.*

96 *Id.* at 27.

97 $665,000,000 divided by 14.5 miles (or 76,560 feet).

98 OLSEN ASSOC. INC., *supra* note 92.

99 *Id.* at 28-29.

100 *Id.* at 30.

101 *Id.* at 65.

102 *Id.* at 30.

103 *Id.*

104 *See* OLSEN ASSOC. INC., *supra* note 92, at 30-31.

105 *Id.* at 67.

106 $34,850,000 divided by 14.5 miles (or 76,560 feet).

107 *See* calculations provided in note 97.

108 OLSEN ASSOC. INC., *supra* note 92, at 67.

109 $1,363 (cost of renourishment) divided by $455 (predicted damage) equals three.

110 $1,368 times 6.5 equals $8,892 (ignoring inflation of 3% per year for ease of arithmetic).

111 Note that this study did not include indirect intangible economic benefits, such as greater tourism revenues from a wide, nourished beach compared to a narrow, unnourished beach.

112 Spreadsheet, *supra* note 10 (note that there were sixteen other beach nourishment projects throughout Florida from 1963 to 1975).

113 *See Walton Cty.*, 998 So. 2d at 1110; *accord* FLA. CONST. art. X, § 11; Phillips Petroleum Co. v. Mississippi, 484 U.S. 469, 480 (1988); Whetstone v. City of St. Augustine, No. CA12-686, 2014 WL 5018672, at *5 (Fla. Cir. Ct. Sep. 11, 2014), *aff'd*, No. 5D14-3628, 2016 WL 542870 (Fla. Dist. Ct. App. Feb. 12, 2016).

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118 FLA. STAT. § 161.041(1) (2016).

119 *Sand Key Assocs., Ltd.*, 512 So. 2d at 938.

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138 "Millage rate" is defined "as the rate of taxation expressed as thousandths of a dollar per dollar ... [A] mill is one tenth of one percent and ten mills is the equivalent of a one percent tax rate. Millage rates are multiplied by the taxable value of property to determine the property tax." Pamela M. Dubov, Comment, *Circumventing the Florida Constitution: Property Taxes and Special Assessments, Today's Illusory Distinction*, 30 Stetson L. Rev. 1469, 1472 n.22 (2001).

139 FLA. STAT. § 161.37(2) (2000).

140 Telephone Interview with John Bralove, CEPD Assistant to the Administrator, Captiva Erosion Prevention District (Apr. 9, 2015).

141 *Id.* (noting that the CEPD did receive assistance from the State of Florida and Lee County).

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145 *Id.*; Dave Berman, *South Beaches Renourishment Planned in Wake of* Matthew, Florida Today (Dec. 24, 2016), http://www.floridatoday.com/story/news/local/environment/2016/12/23/south-beaches-renourishment-planned-wake-hurricane/95058288/ (County Commissioner Tobia debates using Amendment 1 funds to "put some sand in front of multi-million-dollar houses."); Tony Marrero, *Calls Grow Louder for Lawmakers to Use Amendment 1 Money for Beach Repair*, TAMPA BAY TIMES (Jan. 19, 2015), http://www.tampabay.com/news/environment/calls-grow-louder-for-lawmakers-to-use-amendment-1-money-for-beach-repair/2214245; Jim Ash, *Amendment 1 Framework Almost Done*, WUSF NEWS (Mar. 16, 2015), http://wusfnews.wusf.usf.edu/post/amendment-1-framework-almost-done.

146 Debbie Flack, *Governmental Update: It's That Time Again*, J. FLA. SHORE & BEACH PRESERVATION ASS'N. (Jan./Feb. 2015), at 1-4, http://docplayer.net/3649779-Shoreline-governmental-update-it-s-that-time-again-by-debbie-flack-inside-this-edition-fsbpa-the-economics-of-beaches-link.html.

147 Placed on Florida's November 4, 2014 ballot. Now FLA. CONST. art. X, § 28.

148 FLA. CONST. art. X, § 28(b)(1) (2014).

149 Other than one mention in FLA. STAT. § 161.74(2)(k), a search through the text of all of Chapter 161 does not reveal the words "climate change" or "sea-level rise." The Author conducted the majority of the research and editing to this Article prior to enactment of The Peril of Flood Act in May 2015. Although not Chapter 161, that Act is incorporated into FLA. STAT. § 163.3178(2)(f) (2016), and creates an obligation for local governments to evaluate and amend their comprehensive redevelopment plans to address "inappropriate and unsafe development in the coastal areas" and other issues associated with "the related impacts of sea-level rise." FLA. STAT. § 163.3178(2)(f)(1). The Act generally supports the principles discussed in this Article, such as coastal retreat. *See* FLA. STAT. § 163.3178(2)(f)(2) ("removal of coastal real property from flood zone designations"). As of February 2017, the City of Tampa is just one example of a local municipality taking action to address this new law. *See Sea Level Rise Vulnerability Assessment for the City of Tampa*, HILLSBOROUGH COUNTY CITY-COUNTY PLANNING COMMISSION, (Feb. 2017), http://www.planhillsborough.org/tag/peril-of-flood-act-report/.

150 FLA. STAT. § 161.74(2)(k) (2006).

151 FLA. STAT. § 161.73 (2005).

152 FLA. OCEANS & COASTAL COUNCIL, *supra* note 3.

153 *Id.* at 3. The report states it is probable that "[g]lobal sea level [s] will continue to rise long after 2100 even if greenhouse gas concentrations are stabilized well before the end of the century." The author asserts the inference that human intervention is required to stabilize greenhouse gas concentrations, but the report asserts that it is too late for human intervention to have an impact on sea levels.

154 *Id.* at 12 ("including 2 nuclear power plants, 3 state prisons, 68 hospitals, 74 airports, 115 solid waste disposal sites, 140 water treatment facilities, 334 public schools, 341 hazardous-material cleanup sites ... 1,025 houses of worship, and 19,684 historic structures.").

155 *Id.* at 1-19.

156 *Id.* at iii-iv (listing the individual members of the FOCC and their respective employers).

157 "'Avulsion' is the sudden or perceptible loss of or addition to land by the action of the water ...." *Sand Key Assocs., Ltd.*, 512 So. 2d at 936.

158 560 U.S. at 711. In *Stop the Beach*, Walton County, Florida, decided to conduct a beach renourishment project after a hurricane eroded much of the beaches. The beaches were placed on the State's list of "beaches of critical concern," sparking action under the BSPA. Some of the private landowners bordering the renourished beach formed a group (Stop the Beach Renourishment, Inc.) and sued Walton County under the theory of constitutional takings under the Fifth Amendment of the U.S. Constitution. The landowners argued that their beachfront property was, as a result of the beach renourishment project, so far removed from the beach due to the added land area, that access to the beach was now limited. They also argued they had the right to future accretions to their property, even when made by artificial means. The Court held that due to the doctrine of avulsion, and the fact that the hurricanes which caused the erosion were avulsive events, the doctrine of accretion did not apply. Therefore, Florida was correct in using the BSPA as a justification for restoring the beaches.

159 *Walton Cty.*, 998 So. 2d at 1117, *aff'd sub nom. Stop the Beach Renourishment, Inc.*, 560 U.S. at 702.

160 *See generally* Robin Kundis Craig, *Of Sea Level Rise and Superstorms: The Public Health Police Power as a Means of Defending Against "Takings" Challenges to Coastal Regulation*, 22 N.Y.U. ENVTL. L. REV. 84 (2014); *see also* J. Peter Byrne, *The Cathedral Engulfed: Sea-Level Rise, Property Rights, and Time*, 73 LA. L. REV. 69 (2012).

161 JAMES G. TITUS, U.S. ENVT'L PROT. AGENCY, ROLLING EASEMENTS 1 (June 2011), http://www.epa.gov/sites/production/files/documents/rollingeasementsprimer.pdf.

162 This Article does not go into detail regarding the third response to rising sea levels--construction techniques--although it is briefly mentioned because it is intertwined with the other two responses.

163 Joseph L. Sax, *Changing Currents: Perspectives on the State of Water Law and Policy in the 21st Century: The Accretion/Avulsion Puzzle: Its Past Revealed, its Future Proposed*, 23 TUL. ENVTL. L.J. 305, 355 (2010).

164 "Living shoreline projects utilize a variety of structural and organic materials, such as wetland plants, submerged aquatic vegetation, oyster reefs, coir fiber logs, sand fill, and stone." The living shorelines approach is used "to provide shoreline protection and maintain valuable habitat." *Living Shorelines*, NOAA HABITAT CONSERVATION, http://www.habitat.noaa.gov/restoration/techniques/livingshorelines.html (last visited Jan. 2, 2017).

165 *See id.* ("This approach uses plants, sand, and limited use of rock to provide shoreline protection and maintain valuable habitat.").

166 Niki L. Pace, *Wetlands or Seawalls? Adapting Shoreline Regulation to Address Sea Level Rise and Wetland Preservation in the Gulf of Mexico*, 26 J. LAND USE & ENVTL. L. 327, 340 (2011).

167 Press Release, Bill Sapp, Living Shoreline Team Receives Funding to Develop Design Guidelines & Workshops to Pres. Alabama & Mississippi Coasts, S. Envtl. Law Ctr. (Apr. 1, 2014), https://www.southernenvironment.org/news-and-press/press-releases/living-shoreline-team-receives-funding-to-develop-design-guidelines-worksho.

168 VA. CODE ANN. § 28.2-104.1 (2014).

169 CONN. GEN. STAT. ANN. § 22A-92 (2015).

170 N.J. ADMIN. CODE § 7:7E-4.23 (2015).

171 MD. CODE REGS. 26.24.01.02(B) (2015).

172 ALA. ADMIN. CODE r. 220-4-.09 (2015).

173 *Living Shorelines*, MISS.-ALA. SEA GRANT CONSORTIUM, http://masgc.org/livingshorelines (last visited Dec. 2, 2017) ("MASGC-funded scientists are evaluating the effectiveness of different types of living shorelines and are creating ways to help people decide which option would work best for them.").

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175 *See generally Living Shorelines and Coastal Erosion*, OYSTER RESTORATION WORKGROUP, http://www.oyster-restoration.org/living-shorelines/ (last visited Dec. 2, 2017); *see generally also Living Shorelines Database*, COASTS, OCEANS, PORTS AND RIVERS INST., http://mycopri.org/ (last visited Apr. 19, 2016).

176 Peter M. Hanrahan, *The Evolution of Coastal Erosion Control Technology*, FORESTER DAILY NEWS (Apr. 6, 2015), http://foresternetwork.com/daily/soil/erosion-control/the-evolution-of-coastal-erosion-control-technology-part-i/.

177 TITUS, *supra* note 161, at 1.

178 CAL. COASTAL COMM'N, *Sea-Level Rise Adopted Policy Guidance*, http://www.coastal.ca.gov/climate/slrguidance.html (last visited Apr. 19, 2016).

179 *The California Coastal Commission Announces the Release of Draft Sea-Level Rise Policy Guidance*, FEMA REGION IX NAT'L FLOOD INS. PROGRAM, http://www.r9map.org/Pages/EbulletinStory.aspx?storyID=61 (last visited Apr. 19, 2016).

180 CAL. COASTAL COMM'N, SEA-LEVEL RISE POLICY GUIDANCE 39 (Aug. 12, 2015), http://documents.coastal.ca.gov/assets/slr/guidance/August2015/0_Full_Adopted_Sea_Level_Rise_Policy_Guidance.pdf.

181 S.C. CODE ANN. § 48-39-280(A) (2015).

182 One case refers to the policy of retreat in reference to groins, but its holding is only directed at S.C. CODE ANN. § 48-39-290. *See* S.C. Coastal Conservation League v. S.C. Dep't of Health & Envtl. Control, 354 S.C. 585, 589 (2003) (holding in favor of the property owner by granting a permit for repair and construction of groins, a very narrow interpretation of the law).

183 This 2010 South Carolina report is very similar to the 2010 report by Florida's Oceans and Coastal Council mentioned above in FLA. OCEANS & COASTAL COUNCIL, *supra* note 3.

184 SHORELINE CHANGE ADVISORY COMM. OF THE S.C. DEPT. OF HEALTH AND ENVTL. CONTROL, ADAPTING TO SHORELINE CHANGE: A FOUNDATION FOR IMPROVED MANAGEMENT AND PLANNING IN SOUTH CAROLINA 1 (Apr. 2010), https://www.scdhec.gov/library/CR-009823.pdf.

185 *Id.* at 6.

186 *Id.* at 2.

187 *Id.* at 2-3.

188 *Sandy Recovery Office*, FEMA, https://www.fema.gov/sandy-recovery-office (last visited Apr. 19, 2016) (stating that public support includes that provided to "state, local, and tribal governments," and also reporting an additional $1.4 million in assistance to individual survivors, as well as $822 million for hazardous mitigation grants).

189 Calogiras v. Town of Southampton Bd. of Appeals, 984 N.Y.S.2d 630 (N.Y. Sup. Ct. 2013); *see also* In "Matter of Feshbach", Decision No. D012531, Apr. 16, 2009; In "Matter of Lawin", Decision No. 12837, Feb. 3, 2011, cited within *Calogiras*.

190 984 N.Y.S.2d 630 (N.Y. Sup. Ct. 2013).

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192 Steve Orlando, *Climate Change Already Showing Effects at Kennedy Space Center*, UF NEWS (Dec. 5, 2014), http://news.ufl.edu/archive/2014/12/climate-change-already-showing-effects-at-kennedy-space-center.html.

193 TITUS, *supra* note 161, at 41.

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195 370 S.W.3d 705, 724 (Tex. 2012).

196 TEX. NAT. RES. CODE ANN. § 61.011(a); *see also* Severance v. Patterson, 566 F.3d 490 (5th Cir. 2009).

197 *Severance*, 370 S.W.3d at 724-25; *see also* Brannan v. State, 390 S.W.3d 301 (Tex. 2013).

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