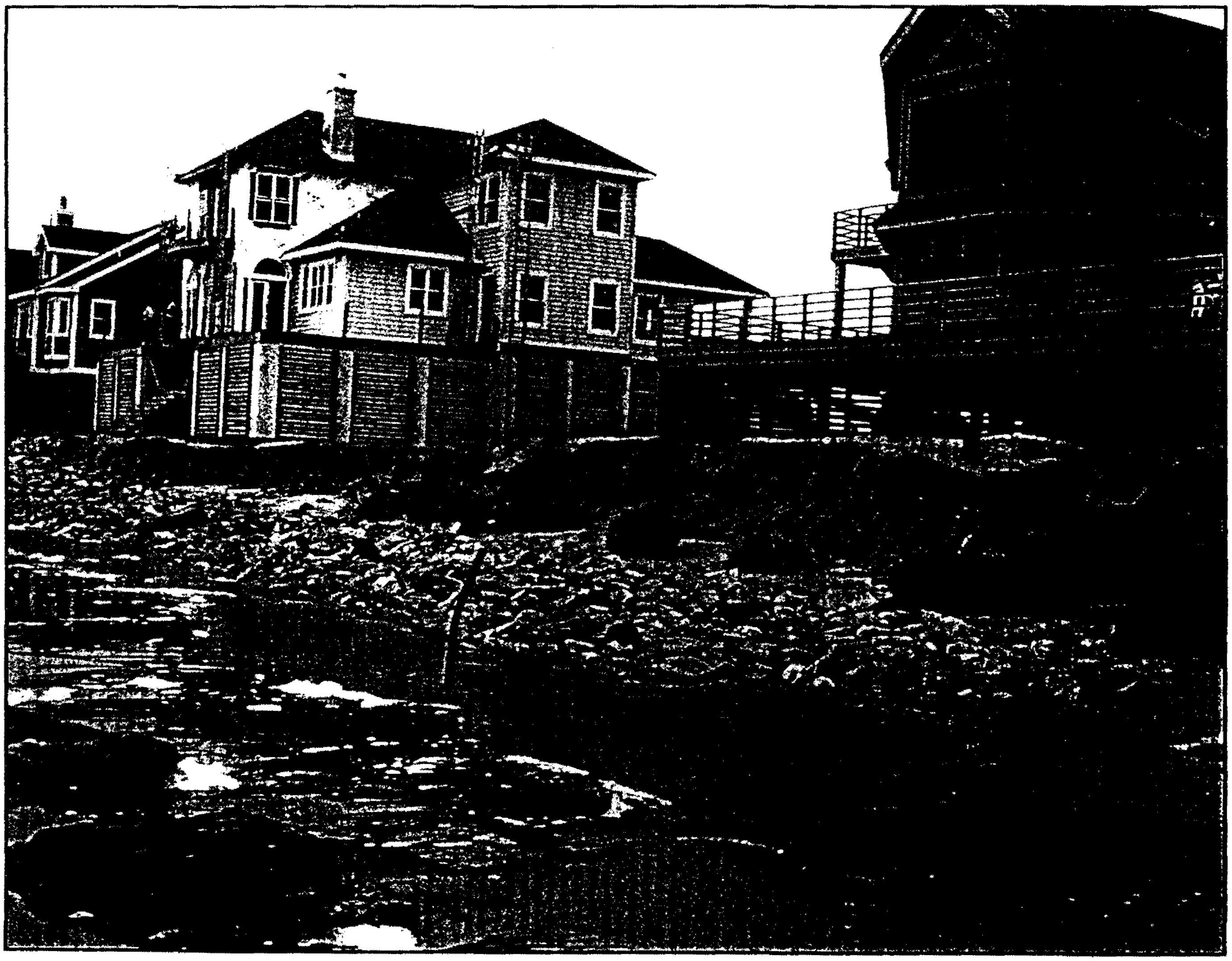
Coastal Erosion

Has Retreat Sounded?



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Cover photo: Isle of Palms, South Carolina, May 1991. (Photo courtesy of R. Platt.)

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Preface

In April 1888, the Brighton Beach Hotel, which was threatened with collapse due to coastal erosion, was physically moved in one piece to a new site. This feat was accomplished by its owner, the Brooklyn, Flatbush, and Coney Island Railroad, which literally harnessed its own resources to the problem. The hotel was jacked up, and 112 flatcars were rolled under it on 24 specially laid tracks. The flatcars, bearing the weight of the entire building, were towed behind six steam locomotives to the new site. The three-story hotel, which weighed 5,000 tons, safely arrived at its destination, 495 feet landward of its original position (*Scientific American*, 1888, p. 230).

Exactly a century later, in April 1988, the National Research Council of the U.S. National Academy of Sciences released a report prepared for the National Park Service on *Options to Save Cape Hatteras Lighthouse from the Sea*. The report recommended that the historic, 200-foot tall, 2,800-ton lighthouse be moved in one piece along a specially constructed concrete track to a new site several hundred feet landward (various sites were suggested). The report rejected several alternative options to protect the lighthouse in place, including construction of a seawall and revetment to encircle the structure, the addition of new groins, beach nourishment, offshore breakwaters, and the use of artificial seagrass to trap sand. The report urged that relocation of the lighthouse, rather than trying to battle the forces of shoreline recession, would be a desireable precedent for both public and private responses to shoreline erosion elsewhere.

The proposal was met with hostility from local residents and business interests that preferred to have the lighthouse protected where it was, rather than moved. According to the *New York Times* (April 15, 1988, p. A14):

> The recommendation [to move the lighthouse] is likely to cause a storm as violent as any winter nor'easter or autumn hurricane.

Four years have elapsed since the proposal was made, and the Cape Hatteras Lighthouse still stands precariously a few dozen feet from mean high tide, vulnerable to undermining and collapse if a storm the size of Hurricane Andrew hits the cape directly. The delay is not simply a matter

of local opposition. The National Park Service lacks a fleet of railroad cars or their modern equivalent and must therefore have the project authorized by Congress. Although relocation is projected to cost less than the seawall/revetment, which was approved in 1987, the sheer novelty of moving an object the size of Cape Hatteras Lighthouse seems to be a major impediment. Since the little-known precedent of the Brighton Beach Hotel, relocation of structures from eroding shorelines has been rare. Instead, our national response has been to fortify the coast, renourish the beaches and protect endangered structures in place.

During the 1980s, a new understanding of the physical nature of shoreline change emerged from the research of coastal geologists such as Orrin H. Pilkey Jr. at Duke University and Dag Nummedal at Louisiana State University, and coastal geographers such as Norbert Psuty and Karl Nordstrom at Rutgers, Stephen Leatherman at the University of Maryland, and Robert Dolan and Bruce Hayden at the University of Virginia. Much of this work focused on coastal barriers whose natural tendency to migrate landward threatens the safety of people and their investments, which have dramatically increased along the barrier shorelines since the 1960s. The collision between physical and human actions along the coast will worsen if recent estimates of possible sea level rise due to global warming are fulfilled (National Research Council, 1987).

Probably no one has outdone Orrin H. Pilkey, Jr. in calling for a new policy of retreat from eroding coasts. In his jointly authored book *The Beaches are Moving* (Kaufman and Pilkey, 1983), in his Duke University Press "Living with the Shore" series (with numerous collaborators), and as convenor of the the Skidaway Institutes in 1981 and 1985, Pilkey has proselytized on behalf of planning for "orderly retreat" in the face of sea level rise.

Of course, shorelines differ greatly in their physical characteristics, their level of investment, and the potential costs that erosion may inflict in time. No single adjustment or strategy is appropriate everywhere, as the proponents of retreat well recognize. Yet, the idea of retreat, as in the proposal to move Cape Hatteras Lighthouse, has encountered political and emotional resistence. And as documented by H. Crane Miller in Chaper 7 of this volume, the combination of high rentals and public financial incentives may pose an insurmountable obstacle to voluntary relocation, even where space is available and the alternative is the total loss of a structure.

Congress has said little on the subject of retreat from eroding coasts, while continuing to authorize insurance against flood-related erosion losses and funding shoreline stabilization projects. The only explicit enactment reflecting a retreat policy was the limited provision for federal assistance under the National Flood Insurance Program for relocating or demolishing homes threatened by erosion (the Upton-Jones Amendment: P.L. 100-242, Sec. 544, 1988). Discomfort with its responsibility to implement this amendment prompted the Federal Emergency Management Agency (FEMA) to contract with the National Research Council to conduct a broad review of the science and policy aspects of coastal erosion management in 1988. I was privileged to participate as a committee member in the two-year study that was conducted under that contract.

Our committee's report offered a number of specific recommendations for the establishment of an erosion management strategy under the National Flood Insurance Program (National Research Council, 1990). The essence of this strategy was "retreat," although the term was not used. Legislation was adopted by the House of Representatives (H.R. 1236) in May 1991 that incorporated several of our recommendations (see Chapter 2). Action on the Senate version is still pending at this writing.

The National Research Council report served as a springboard for this study. That report was largely prospective, in response to FEMA's need for advice to better utilize the National Flood Insurance Program to reduce national costs of erosion and erosion fighting. Limited attention was devoted to examining and comparing experiences to date, largely at the state level, with erosion management programs. No opportunity existed within the scope of that project to examine the performance of an erosion management law in the aftermath of an actual coastal disaster.

The present study carries forward the work begun in the 1990 National Research Council report. Using a cavalry metaphor, it seeks to answer the question: "Has retreat sounded?" The study is particularly concerned with the roles of the state, community, and private owners in promoting or impeding retreat from eroding shorelines. Jennifer Melville and I examined federal and state laws to identify: 1) the extent to which they promote retreat through mandatory setbacks for new or existing structures, and 2) issues that affect their effectiveness (Chapters 2, 3, and 4). Timothy Beatley, Sandra Manter, and I conducted a major case study of Folly Island, South Carolina, to evaluate the impacts of that state's Beachfront Management Act after Hurricane Hugo (Chapter 5). Brenda Mathenia reviewed Michigan's unique emergency homemoving program that responded to the hazard of high lake levels from 1985 to 1987 (Chapter 6). And H. Crane Miller explored financial and personal factors that influence private owners in Holden Beach, North Carolina, and Fire Island, New York (Chapter 7). A series of recommendations directed to the federal, state, and local levels of government concludes this study.

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1

Coastal Erosion: A Natural and Human-Caused Hazard

Introduction

The tidal and Great Lakes shorelines of the conterminous United States, ignoring smaller embayments and islands, extend approximately 36,000 miles (U.S. Army Corps of Engineers, 1971). A more inclusive measurement of tidal shorelines of the lower 48 states totals 53,677 miles, plus 4,500 miles along the American shorelines of the Great Lakes and their connecting waterways (National Oceanic and Atmospheric Administration, 1975).

The physical nature of these shorelines is diverse. According to the National Research Council (1990, p. 45), principal types of natural shorelines include:

- *crystalline bedrock* (e.g., central and eastern Maine coast);
- *eroding bluffs and cliffs* (e.g., outer Cape Cod, parts of Long Island, New York, and the Great Lakes);
- *pocket beaches* between headlands (e.g., Southern New England, California, and Oregon);
- *strandplain beaches* (e.g., Myrtle Beach, South Carolina; Holly Beach, Louisiana);
- *barrier beaches* (e.g., generally along Atlantic and Gulf of Mexico ocean coasts);
- *coral reef and mangrove* (e.g., South Florida); and

- *coastal wetlands* (e.g., Southern Louisiana; elsewhere generally landward of barrier beaches).

All of these shoreline types, except crystalline bedrock and certain types of coral formations, are potentially subject to erosion. Erosion may be defined as the landward displacement of the shoreline (mean high water line) in response to a variety of causative factors. Kaufman and Pilkey (1983, p. 15) ascribe the process of shoreline change (involving either recession or accretion) to a state of "dynamic equilibrium" among four variables: 1) beach material supply, including sand, shell fragments, coral, silt, and flotsam; 2) energy imparted by wind, waves, currents, and tides; 3) beach profile—sand and slope; and 4) relative sea level (including both eustatic sea level and local land subsidence or uplift). Nummedal (1983, p. 77) adds another variable affecting barrier beach position in particular—the volume of water being exchanged through flanking tidal passes (the tidal prism). It is the interaction of these physical variables, including their possible modification by deliberate or inadvertent human intervention, that determines the position of the water's edge over time.

In particular, the position and width of beaches depends upon the functioning of the *sand-sharing system*. Under natural conditions, beaches, dunes, and offshore bars all constitute elements of this system. Sand is transported by waves, tides, currents, and wind among these three elements, at some times building up beaches and dunes, at other times reducing them and depositing sand offshore in bars to be "reclaimed" when conditions are suitable (as in summer).

Sand may be lost to the local sand-sharing systems in several ways. It may be carried by ocean currents too far seaward into deep water to be available for restoration to the beach. Storm waves may transport sand over or through the dune line to create overwash deposits further landward. (This sand may possibly blow back to the dune and beach system.) Human activities may transport sand out to sea or truck it away for construction and other uses. Or coastal engineering projects, described below, may interrupt the flow of sand in littoral currents and cut off the supply of beach material to portions of the shoreline. All of these may cause beaches to recede landward and, if prevented from readjusting, to become narrower, steeper, and eventually to disappear.

Time Scales of Shoreline Change

The fluctuation of shoreline position occurs in several time scales, which complicates the measurement of and adjustment to erosion. At a geologic scale, shoreline position has fluctuated drastically in response to sea level change over the past half-million years (Dolan and Lins, 1986, p. 11). Periods of world glaciation caused sea level to decline by hundreds of feet, with consequent seaward advance of shorelines across the

continental shelf. During the Wisconsin glaciation that ended between 14,000 and 18,000 years ago, sea level was approximately 300 feet lower than at present, and the shoreline of North Carolina, for example, reached 50 to 75 miles further seaward than at present (Ibid., p. 12). The exact movement of shorelines in response to geologic changes in sea level depends upon the elevation and slope of regional coastal landforms, including the submerged continental shelf.

The present shoreline has evolved during the Holocene Period, extending approximately over the past 4,000 years. During this time, sea level has been rising in response to melting of glacial ice in high latitudes, and shorelines have generally been receding landward. This period has been marked by the formation of coastal barriers—the dominant landforms of the U.S. Atlantic and Gulf of Mexico coasts from southern Maine to the Mexican border.

Historical records of shoreline positions are available for some locations of the United States for as long as 200 years. Montauk Lighthouse on the tip of Long Island, New York, was originally sited by George Washington. Between 1868 and 1972, the shoreline at that location retreated about 60 feet (just short of the 90-feet-per-century rate that Washington had estimated) (Williams et al, 1990, p. 6). Pronounced shifts in shoreline location over the past century have been documented in many locations from old coastal maps, particularly "T sheets" published by the National Ocean Survey (NOS) beginning in the mid-19th century. Shoreline change rates in New Jersey, for instance, were estimated by using five sets of T sheets obtained from the NOS archives, as updated with aerial photography (National Research Council, 1990, p. 128). The methodology of combining and comparing disparate sets of T sheets and photographic records is discussed by Leatherman and Clow (1983).

For purposes of shoreline management and land-use planning, such records of historical shoreline change over the past century, or at least several decades, provide evidence of long-term erosion rates. Certain coastal locations have experienced drastic shoreline displacement due entirely to natural processes over this time scale. Hog Island on the Virginia Coast, for instance, has "rotated" since the mid-1800s, with its southern tip retreating over a mile landward while its northern portion accreted by 500 yards or more. The site of the 19th-century town of Broadwater on Hog Island that contained 50 homes and several hunting lodges is entirely submerged today (Rice, Niederoda, and Pratt, 1972, as cited in Williams et al, 1990, p. 4). The shoreline at the Cape Hatteras Lighthouse on the North Carolina Outer Banks receded over 2,000 feet between 1852 and the 1930s, at which time erosion control measures were initiated (which have proven largely futile in halting further erosion) (National Research Council, 1988, Figure 7).

Rapid erosion of the cliffs on the outer beach of Cape Cod was noted in the 1850s by Thoreau, who estimated their rate of retreat at about six feet per year (Thoreau, 1951, p. 149). This proved to be remarkably close to a 1985 estimate of four feet per year by Leatherman based on T sheet and photographic records for 1848, 1888, 1933, and 1970 (Benoit, 1989, p. 10). Since virtually no erosion control measures have been attempted on the Cape Cod outer beach, this is entirely attributable to natural shoreline recession, driven largely by sea level rise.

Shoreline change also is manifest at a seasonal time scale in many locations. Middle and North Atlantic beaches in the U.S. typically fluctuate in width and profile between winter and summer. Winter surf and severe storms ("northeasters") scour beaches and dunes, removing sand to offshore bars. The comparatively flat and narrow beach that remains in the spring is gradually restored to a higher, steeper, "summer berm" with the onset of milder sea conditions that return sand from the offshore bars to the beaches. Measurement of shoreline position therefore must be standardized for seasonal variation to avoid skewed estimates of change rates. If summer gains exactly equal winter losses, the net annual rate of shoreline change is zero.

Finally, shorelines may change their positions in a period of hours or even minutes during major coastal storms and hurricanes. High energy imparted by storm surges, waves, tides, and wind may scour beaches, overwash dunes, carve away bluffs and cliffs, and cause many years equivalent average erosion in a day or two. Such drastic short-term perturbations are major but not exclusive contributors to long-term erosion rates. Short-term losses of beaches and dunes may be offset in some cases by natural restorative processes, as in the normal return of offshore bar sand to the beach. But the undermining and collapse of bluffs, as on Cape Cod during the Halloween Storm of October 31, 1991, or along the Great Lakes during high lake levels in the mid-1980s, represents a permanent landward retreat of the upland edge.

Spatial Distribution of Coastal Erosion

While the average rate of erosion must be determined locally through historical shoreline records or shoreline modeling (National Research Council, 1990), erosion is known to be a widespread but not ubiquitous phenomenon along the U.S. coastlines (Figures 1.1, 1.2, and 1.3). In 1971, the U.S. Army Corps of Engineers, pursuant to congressional mandate, published its National Shoreline Study—to date the only nationwide survey of erosion that has been conducted. This report estimated that 20,500 miles out of 84,240 miles were experiencing "significant erosion." Of those, 2,700 miles were deemed subject to "critical erosion," possibly justifying counteractive measures. The terms "significant" and "critical" were derived from the enabling legislation but were not quantified, nor was the

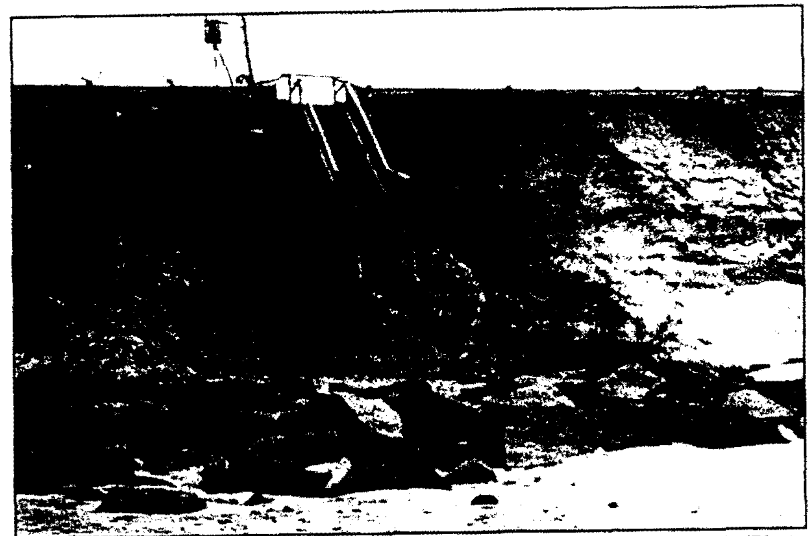

Figure 1.1. Erosion on the Atlantic Coast at Chatham, Massachusetts, 1991. (Photo by R. Platt.)

Figure 1.2. Erosion on the Pacific Coast at Bolinas, California, 1987. (Photo by R. Platt.)

Figure 1.3. Erosion on the Great Lakes at the Indiana Dunes on Lake Michigan, 1985. (Photo by R. Platt.)

methodology for estimating them standardized among Corps districts (General Accounting Office, 1975). The estimates were therefore subjective judgments by various staff using indefinite criteria. The report, however, crudely confirmed the prevalence of erosion risks along substantial portions of the nation's costs. Table 1.1 summarizes the regional data on the extent of "significant erosion."

The table indicates that over 80% of the North Atlantic, Lower Mississippi, and California shorelines were found to be significantly eroding. Those three regions involve very different physical shoreline types and erosion processes. The North Atlantic shoreline largely involves eroding bluffs and barrier beaches. Erosion in the Lower Mississippi coastal region consists primarily of wetland loss caused by land subsidence and reduction of riverine sediment supply due to channelization of the Mississippi River. (Louisiana is estimated to lose 50 square miles of wetlands annually). Erosion along the California coast primarily involves undermining of soft erodible sea cliffs. Beach erosion is also common due to deprivation of riverine sediments and loss of sand into deep offshore trenches (Kuhn and Shepard, 1983; National Research Council, 1990).

The spatial incidence and magnitude of coastal erosion has been more recently assessed by researchers at the University of Virginia. In collaboration with the U.S. Geological Survey (USGS) and the Federal Emergency Management Agency (FEMA), over 20 years, geographer

Table 1.1
Estimated Extent of Eroding Shorelines, 1971 (miles)

Region	Total Shoreline	"Significant Erosion"	Percent of Total Shoreline
North Atlantic	8,620	7,460	86.5%
South Atlantic	14,620	2,820	19.2
Eastern Gulf/ Lower Mississippi	1,940	1,580	81.4
Texas Gulf	2,500	360	14.4
Great Lakes	3,680	1,260	34.2
California	1,810	1,550	85.6
North Pacific	2,840	260	9.1
Alaska	47,300	5,100	10.7
Hawaii	930	110	11.8
U.S. Total	84,240	20,500	24.3

Modified from U.S. Army Corps of Engineers, 1971, Table 1.

Robert Dolan and his colleagues have assembled a computer-based Coastal Erosion Information System (CEIS). This system assembles available geographical data on shoreline position and erosion rates for the entire coastline of the United States, including the Great Lakes. According to Dolan, Hayden, and May (1983, p. 287):

> The CEIS data base was created from the best and most comprehensive of the existing information sets contributed by coastal scientists and engineers nationwide. It includes rate-of-change data from ground surveys, maps, charts, and aerial photos. Initially, the approach was to obtain maximum coverage using the most readily available data sets. Preference was given to studies with a wide range, both temporal and spatial, and which were already available in graphic form. Once the broad reaches were covered, high resolution information was introduced . . . The

information is stored by grid cells which are 3' latitude or longitude on a side.

The CEIS data of course vary widely in resolution and reliability, since they are derived from diverse sources using a variety of mapping methodologies (National Research Council, 1990, p. 128). Subject to these limitations, CEIS nevertheless represents a considerable improvement over the methodology of the 1971 National Shoreline Study. It provides a more statistical, albeit inexact, picture of the spatial incidence of erosion. In particular, 403 out of 510 grid cells (79%) along the Atlantic Coast displayed some degree of erosion as of 1983 (Dolan, Hayden, and May, 1983, p. 288), thus confirming the dominance of shoreline recession along the U.S. east coast.

Statewide averages, however, mask local variation, which is characteristic of coastal erosion. According to Williams et al. (1990, p. 10):

> While the same dynamic processes cause continuous change on every coast, coasts do not all respond in the same way. Interactions among the different processes and the degree to which a particular process controls change depend upon local factors. They include the coast's proximity to sediment-laden rivers and tectonic activity, the topography and composition of the land, the prevailing wind and weather patterns, and the configuration of the coastline and nearshore geometry.

Human Intervention

A crucial variable in the determination of localized shoreline rates of change is the possibility of deliberate or inadvertent human intervention in natural coastal processes (Kaufman and Pilkey, 1983; Leatherman, 1988). The range of human adjustments to coastal erosion as summarized by Mitchell (1974) is displayed in Table 1.3. Physical "modifications of erosion hazard" involving various forms of coastal engineering are both causes of, and responses to, shoreline erosion. The primary forms of deliberate shoreline modification will be briefly summarized here. Measures listed under "modification of loss potential" that reflect a strategy of retreat (e.g., setbacks, relocation of structures, and public acquisition) are the main focus of this study and will be considered in all subsequent chapters.

Shorelines developed before the 1970s (e.g., New Jersey) frequently were *armored* with concrete or sheet steel seawalls, rock revetments, bulkheads, or other structures intended to protect landward private and public facilities from destruction due to erosion (Figures 1.4 and 1.5). Such devices often postpone the loss of valuable real estate, but generally at the cost of the oceanfront beach. Seawalls may in fact accelerate the loss of the

Table 1.2
Adjustments to Erosion—A Summary Profile

Technique	Adjustments to Loss	Modifications of Loss Potential	Modifications of Erosion Hazard	Adjustments Affecting Hazard Clause
Social	Loss Bearing Public Assistance i) Small Business Administration ii) Farmers Home Administration iii) Office of Emergency Preparedness Wave wash Insurance	Storm warning and evacuation systems Coastal Zoning i) setback regulations ii) preservation lines Building codes Public ownership	*Accelerated Sediment Loss* Regulations against destruction of dune vegetation	*Accelerated Sediment Loss* Prohibition of beach excavation and harbor dredging *Starvation* Reduction in soil conservation activities
Engineering		Moving endangered species Deep piling Landfill	*Accelerated Sediment Loss* Emergency filling and grading Beach nourishment Shore stabilization (sand fences) Grading slopes Bulkheads, seawalls, and revetments Breakwaters, tetrapods, artificial seaweed *Starvation* Groynes	*Accelerated Sediment Loss* Storm track modification *Starvation* Sand bypassing Removal of obstacles to passage of river slit

Source: J.K. Mitchell, 1974.

beach: "They confine the wave energy and intensify the erosion by concentrating the sediment transport processes in an increasingly narrow zone. Eventually the beach disappears, leaving the seawall directly exposed to the full force of the waves" (Williams et al., 1990, p. 16). Shorefront armoring today is generally disfavored, except for industrial or intensely urban shorelines (e.g., Chicago).

An alternative approach involves the use of *sand-trapping structures* built perpendicular to the shoreline that reduce wave energy and capture sand on their updrift side. These include rows of *groins* spaced at intervals along eroding beaches, as at Rockaway Beach and Long Beach on Long Island, New York. Groins extend from the high water line well into the surf zone and help to dissipate storm wave energy. They typically create a series of crescent-shaped mini-beaches against the side of each groin facing the littoral current, with corresponding pockets of sand deprivation on the opposite side. Where groins are properly spaced and designed, they may succeed in preserving a recreational beach for several years, albeit compartmentalized between the groins. Steepening of the offshore beach profile, however, may create a state of disequilibrium leading to undermining of the groins and eventual loss of beach sand and landward development during major storms. *Jetties* are another class of perpendicular sand-trapping structure that extend for sometimes a considerable distance into and beyond the surf zone at inlets or harbor mouths. Downdrift sand starvation and accelerated erosion rates often result from jetties, unless sand transfer facilities are installed to pump sand from the updrift to the downdrift side of the navigational channel. At Ocean City, Maryland, two inlet jetties built in the 1930s have caused landward recession of the downdrift shoreline of Assateague National Seashore of more than 500 meters.

Inlet dredging is another form of human interference with natural sand movement processes. Inlets through coastal barriers open and close capriciously during storms. Inlets that become established as routes for commercial, fishing, and recreational navigation to and from the ocean require ongoing management or they may simply fill up and close. Jetties are one approach, as mentioned above. With or without jetties, it may be necessary to dredge sediments from the inlet itself and perhaps from the ebb- and flood-tide deltas formed at either end of the inlet. Past practice has involved discharging dredged spoils, including much sand offshore, beyond the littoral sand transfer system. This is particularly the case on the Pacific Coast where the Continental Shelf is narrow and dissected by deep trenches. Such sand does not return to the nearby beaches, and increased erosion may result. The National Research Council (1990, p. 11) has urged that dredging activities be designed to retain beach-quality sand in the near-shore system.

Damming of coastal rivers has been a further source of sediment starvation to beaches, especially on the West Coast. Debris dams have been

Figure 1.4. Seawalls of irregular height at Bal Harbour, Florida. This picture also depicts the increase in density that accompanies new generations of coastal development. Compare the 1950s-era apartments on the right with the 1980s-era hotel on the left. (Photo by R. Platt.)

Figure 1.5. Riprap installed in San Diego to mitigate wave damage to shore road after natural rock shoreline has eroded away. (Photo by R. Platt.)

constructed on many streams in California to protect downstream metropolitan areas from debris flows and flooding. Sediments trapped by the dams would normally reach the coast and add to the supply of beach material. Although debris basins must be emptied periodically to restore their effectiveness, it is usually prohibitively expensive to transport the removed materials to the coast (McPhee, 1989).

Beach nourishment, sometimes accompanied by dune restoration, is an increasingly common practice along many residential and recreational shorelines. Nourishment involves pumping sand onto an eroding beach from a convenient source such as an inlet, offshore bar, or area of sand accretion (e.g., updrift from a jetty). Beach nourishment must be carefully designed in terms of shoreface slope and sand grain size. Nourishment has been most effective on shorelines of relatively low wave energy, particularly Florida. A 10-mile beach restoration project at Miami Beach in the early 1980s has proven to be relatively stable (Figure 1.6). Projects in more stormy latitudes (e.g., Ocean City, Maryland, and Long Island, New York) have experienced greater difficulty in retaining sand over time and often require expensive renourishment. Research at Rutgers University by Norbert Psuty, Karl Nordstrom, and their colleagues has contributed to the understanding of "soft" forms of beach stabilization through nourishment and dune restoration (e.g., Nordstrom et al., 1986; Psuty, 1987; Gares, 1987; Gares and Nordstrom, 1988). (For a review of international experience with beach nourishment, see Charlier, Meyer, and Decroo, 1989.)

Socioeconomic Effects of Erosion

It is well known that accessible coasts attract seasonal and year-round populations. Much of the North American population lives within a day's round-trip drive to an ocean or Great Lake shoreline. More distant inlanders travel occasionally to spend vacations or attend conventions and meetings at coastal resorts. Countless retirees also have migrated to coastal Shangri La's, ranging from Cape Cod to the barrier islands of the southeast Atlantic and the Gulf of Mexico, and to Carmel and La Jolla, California. Such demographic and economic pressures have transformed the sparsely developed "summer shores" and fishing villages of the 1940s and '50s (Burton, Kates, and Snead, 1969) into "cities on the beach" since 1970 (Platt, Pelczarski, and Burbank, 1987). This has placed billions of dollars of private and public investment at risk from coastal flooding, hurricanes, and erosion. Conflicts arise among adjacent units of political jurisdiction, between private and public claims to the shoreline, and between human activities and natural coastal processes such as erosion (National Research Council, 1990, p. 1).

The most vulnerable physical landforms, and often the most intensively developed, are the extensive coastal barriers that line the Atlantic and

Figure 1.6. Surfside, Florida, just north of Miami Beach. Congress required public access, including mini-parks such as this one, as a condition for receiving federal assistance in the restoration of the beach in 1980. (Photo by R. Platt.)

Gulf coasts and occur periodically along the Pacific Coast and Great Lakes. A coastal barrier geologically is "an unconsolidated elongate body of commonly sandy (or gravelly) sediments lying above high tide level and separated from the mainland by a lagoon or a marsh" (Nummedal, 1983, p. 78). Barriers are dynamic, often fragile, landforms that are vulnerable to overwash, wind, and wave damage. Storm surges of 10 to 15 feet above normal high tides may inundate entire barriers from ocean to bay, as occurred at Folly Island, South Carolina, during Hurricane Hugo (Platt, Beatley, and Miller, 1991). Evacuation of population at risk may be impaired by overtopping of causeways leading to the mainland. The natural tendency of barrier shorelines to recede landward in the face of storm surge, wind, and overwash is catastrophic to fixed investments located astride such migrating landforms.

The effects of erosion upon developed coastal barriers and other vulnerable shorelines are difficult to quantify, but are substantial. Thousands of private dwellings and commercial investments are subject to undermining within the next decade or two along ocean and Great Lakes coasts. Even if a dwelling resists collapse, on-site septic systems may be destroyed, thus making the structures they serve unusable. Public infrastructure such as roads, sewers, water lines, parking lots, bathhouses, rest rooms, and boardwalks are similarly at risk (Figure 1.5).

Land itself is an expensive casualty of erosion (and cannot be insured under the National Flood Insurance Program). Erosion nibbles and sometimes devours valuable coastal real estate. At Chatham, Massachusetts, on Cape Cod, a new inlet broke through Nauset Beach, a barrier spit, during a winter storm on January 2, 1987. The inlet widened within months to a mile across. Ocean surf caused the previously sheltered mainland shoreline to retreat 75 feet during 1987 (Giese, Aubrey, and Liu, 1989). Further loss of expensive building lots and about 10 houses occurred during the Halloween Storm of October 31, 1991 (see Figure 1.1). The same storm reshaped the shoreline at Coast Guard Beach in the Cape Cod National Seashore, continuing the destruction of public facilities that began with the famous northeaster of February 1978.

The exact contribution of erosion to the damage caused by coastal storms is impossible to separate from flooding and wind damage. The National Flood Insurance Program, which provides coverage against erosion damage to structures in certain circumstances (see next chapter), does not distinguish between erosion and flood losses. Erosion indeed often serves as the advance wedge of flooding, exacerbating the vulnerability of coastal structures to eventual loss one way or the other. But erosion losses may also occur independently of an immediate flooding event. Destabilized sea cliffs or bluffs along the Pacific Coast or the Great Lakes may simply collapse without warning during good weather (Wood, 1989). Bluff erosion also may be induced by rainfall drainage and groundwater seepage, as distinct from high water levels and wave attack. The effect upon homes located on the bluff crest is, however, the same.

Conclusion

This chapter has broadly reviewed some of the physical and socioeconomic aspects of coastal erosion as a natural, and sometimes human-induced, hazard. The next chapter will address the evolution of public response, particularly at the federal level, to this hazard. Prevailing forms of adjustment to erosion have evolved over the course of this century from strict reliance upon *in situ* efforts to control the hazard through coastal engineering technology to a loss-sharing approach under the National Flood Insurance Program, and then to a new strategy of avoidance through retreat from eroding shorelines. The evolution of these alternative forms of adjustment will be summarized in the next chapter. The balance of the volume will examine the status of the retreat strategy as reflected in state, local, and private decision making.

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2

The Evolution of Federal Response to Coastal Erosion

Introduction

The United States has never developed a comprehensive, consistent national policy in response to the problem of coastal erosion. Over the past 60 years the federal government has lurched from one approach to another, according to the conventional wisdom of the moment and the whims of the congressional appropriation process. As with other types of natural hazards, the enactment of new laws, policies, and programs has closely followed significant and well-publicized coastal disasters (Table 2.1). But such hasty and ad hoc attempts to mitigate coastal erosion have often lacked a coherent scientific or economic rationale. Furthermore, measures that have been authorized have frequently been abandoned due to dwindling public commitment as memories of the disaster fade.

The formulation of a comprehensive national policy on coastal erosion has been impeded by a number of factors:

1) differences in types of coastal erosion from one location to another are caused by the physical type of shoreline, the effects of human intervention (coastal engineering), the available sand supply, and the geographic incidence of storms and other erosive events;
2) the multiplicity of units and levels of coastal management entities (e.g., private and public riparian owners, municipalities, counties, special districts, states, and federal agencies that exercise authority over various aspects of coastal resource management);

Table 2.1
Selected Milestones in Public Response to Coastal Erosion
(Time proximity not significant in every case. See text for discussion.)

Year	Disaster	Legislation	Actions or Reports
1900	Hurricane-Galveston, Texas		Galveston Seawall built
1926	Hurricane-Miami Beach, Florida		ASBPA founded
1930			COE Beach Erosion Board established
1938	Great New England Hurricane		
1954-55	Six hurricanes-New England	P.L. 84-71	COE Shore Protection Manual released
1962	Ash Wednesday North-easter-New England	P.L. 87-874	New Jersey Seawall and Dune Rebuilding under-taken
1963			COE-CERC Established
1965	Hurricane Betsy-Gulf of Mexico	P.L. 89-339	
1966			White Report (House Document 465) and Clawson Report Pub-lished
1968		NFIP Act	
1969	Hurricane Camille-Gulf of Mexico		
1972	Hurricane Agnes-East Coast	Federal CZMA	
1973		P.L. 93-234	NPS Shoreline Policy Instituted
1978	Northeaster-New England		FIA Erosion Conference Held
1979	Hurricane Frederic-Alabama		FIA Erosion Regulations Established
1980	Hurricane David-Gulf Coast		
1981			Sheaffer and Roland Report Completed
1982		Federal CBRA	

Year	Disaster	Legislation	Actions or Reports
1983	Hurricane Alicia-Texas		
1985	Great Lakes Flooding	Michigan Relocation Program	
1987	Chatham, Massachusetts Breach	Upton/Jones Amendment	South Carolina Beachfront Management Report and NRC Sea Level Rise Report Published
1988		South Carolina Beachfront Management Act	NRC Cape Hatteras Report Released
1989	Hurricane Hugo-Puerto Rico, South Carolina, and North Carolina		
1990		Amendments to the South Carolina Beachfront Management Act	NRC Coastal Erosion Report Issued
1991	Halloween Storm-New England	H.R. 1236 Passed *Lucas*-South Carolina Supreme Court	
1992		S. 1650/S. 2907 *Lucas*-U.S. Supreme Court	

ASBPA = American Shore and Beach Preservation Association
CBRA = Coastal Barriers Resources Act of 1982
CERC = Coastal Engineering Research Center (U.S. Army Corps of Engineers)
COE = Corps of Engineers (U.S. Army)
CZMA = Coastal Zone Management Act of 1972
FIA = Federal Insurance Administration
NFIP = National Flood Insurance Program
NPS = National Park Service
NRC = National Research Council

3) the problem of cost sharing of erosion mitigation projects in light of the intermixture of public and private interests in the coastal zone (e.g., public recreation vs. private homeowner or tenant use of beaches);
4) the interrelationship of coastal erosion and coastal flooding;
5) the lack of reliable long-term data to estimate average annual erosion rates for many locations;

6) the uncertain relationship between long-term (gradual) and short-term (episodic) erosion;
7) the conflict between economic and environmental objectives in coastal management programs;
8) the variety of approaches to erosion hazard mitigation (e.g., shoreline armoring, sand trapping, beach nourishment, and retreat);
9) the prevalence of external (downdrift) impacts of localized efforts to stabilize eroding shorelines; and
10) the circumstances of political representation in Congress for coastal areas experiencing erosion hazards.

Despite these pitfalls and complexities, the nation has attempted to address the enigmatic hazard of coastal erosion in various ways. Figure 2.1 depicts a general model of institutional response to coastal hazards wherein three systems of spatially distributed phenomena interact: 1) the physical environment; 2) the human or "built" environment of coastal development; and 3) the political/legal context of resource management decision makers (e.g., owners, investors, legislatures, regulatory agencies, and courts). The latter are influenced in part by their direct (albeit imperfect) perception of changes in the coastal physical environment and by socioeconomic data regarding losses to human communities caused by flooding, erosion, wind, and other physical phenomena (Mitchell, 1974). As these two classes of inputs indicate the need for response from one or more resource managers, the vector of *mitigation actions* is modified through changes in laws, regulations, court decisions, investment decisions, or other institutional means. This chapter traces the evolution of mitigation actions in response to bitter experience with coastal disasters and, increasingly, in response to the advice of researchers and expert panels that refine the "environmental perceptions" of responsible private and public coastal managers.

Redesigning the Coast: The Army Corps of Engineers

The U.S. Army Corps of Engineers is the nation's oldest water resource development and management agency. Its civil works activities date back to the General Survey Act of 1824 and the creation of the Board of Engineers for Internal Improvements in 1825 (Moore and Moore, 1989). Its functions at that time were largely directed to navigation improvements, particularly in the Ohio and Mississippi River valleys. With the creation of the Mississippi River Commission in 1879 under the Corps' jurisdiction, it assumed wider responsibility for the alleviation of flooding along that river as an adjunct to its navigability mission. The Flood Control Act of 1917 further expanded the Corps' functions in both the Mississippi Valley

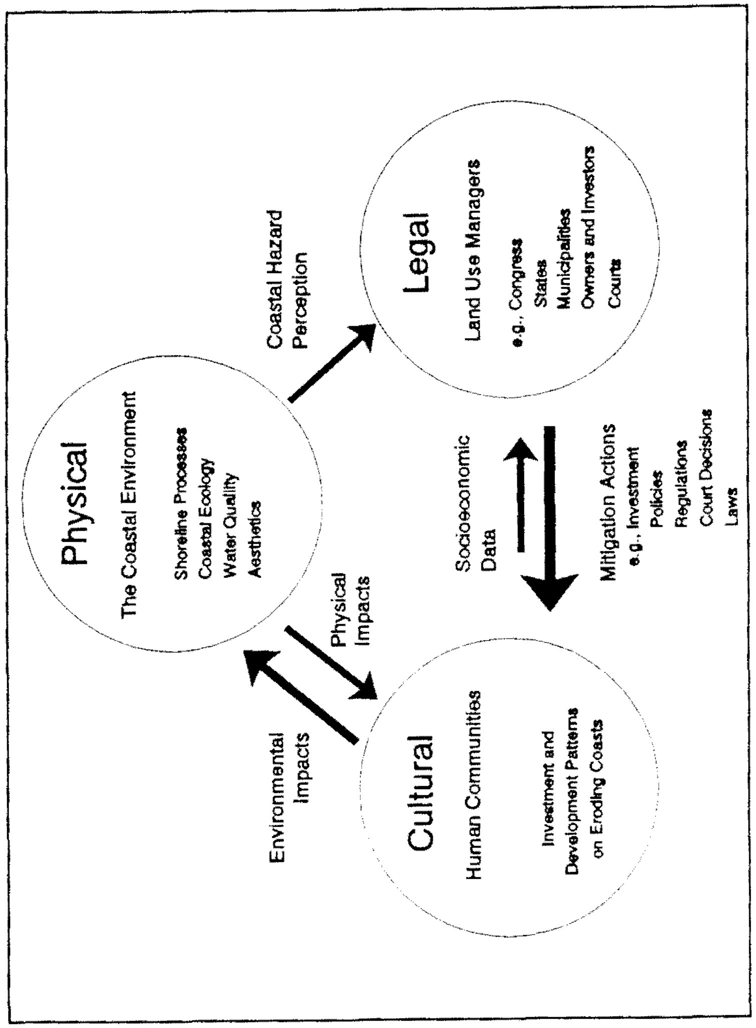

Figure 2.1 A model of societal response to coastal hazards.

and along the Sacramento River in California, subject to substantial nonfederal cost-sharing requirements. The Lower Mississippi Flood Control Act of 1928 broadened exclusive reliance upon levees to contain flood waters to include floodways, spillways, and channel improvements. In the 1936 Flood Control Act, Congress added flood storage (reservoir) projects to the arsenal of Corps flood control strategies and expanded the program geographically to the entire nation. By this time, the Corps had also become a comprehensive river basin planning agency under authority of House Document 308 (1926). The Corps' "308 plan" for the Tennessee River Valley became the river development blueprint for the Tennessee Valley Authority when that agency was created by Congress in 1933 (White, 1969; Schad, 1979; Rosen and Reuss, 1988).

The Corps thus performed primarily an inland and riverine mission until the 1930s. Aside from miscellaneous port and harbor improvements, the Corps and the federal government generally paid little attention to coastal shoreline management prior to that time. Seashores were generally inaccessible except to the wealthy, who were equipped with private railroad cars and yachts. Before World War I, even millionaires imitated traditional coastal fishing villages and huddled on the more accessible and safer bay side of coastal barriers, as at Jekyll Island, Georgia. As late as 1928, Henry Beston, in his book *The Outermost House*, described the ocean shore of Cape Cod as a virtual wilderness.

With the advent of affordable automobiles and improvement of the nation's road system in the 1920s, tourism to the coast began to flourish. Oceanfront cottages, apartments, hotels, boardwalks, and amusement parks proliferated in popular seaside resorts such as Cape May and Atlantic City, New Jersey. As buildings crowded closer to the water's edge and shorefront property values soared, damage due to beach erosion and flooding became more frequent and costly.

This was initially not a federal concern. In 1888, when the Brighton Beach Hotel on Coney Island, New York, was threatened by erosion, its owner—the Brooklyn, Flatbush, and Coney Island Railroad—jacked the hotel up and moved it 450 feet inland on a flotilla of flatcars (*Scientific American*, 1888, p. 230) (see Preface). When a hurricane devastated Galveston, Texas, in 1900 and killed about 6,000 people, Galveston County built a 6-mile, 21-foot-high seawall that still stands today (minus most of the beach in front of it). The Corps provided some technical advice and later extended the wall to its present length of about 10 miles (Martin Reuss, U.S. Army Corps of Engineers, personal communication, 1991).

Private and local efforts to cope with mounting erosion losses however, were often ineffective or counterproductive.

> Local landowners, as well as local shore communities, were expending, in the aggregate, millions of dollars for uncoordinated and often totally inappropriate structures in an attempt to combat

erosion. Furthermore, the effects of these structures were often either negligible at best or, as in many cases, even exacerbated the problem (Quinn, 1977, p. 14).

The impetus for a federal role in coastal erosion protection originated in New Jersey, where seashore tourism was most widely developed in the 1920s, particularly at Cape May, Atlantic City, and Long Branch. In 1922 the New Jersey legislature commissioned a study of erosion problems to be conducted by the state's Board of Commerce and Navigation. The Corps of Engineers played a minor advisory role in the board's study that led to two reports on the erosion and protection of the New Jersey beaches in 1922 and 1924 (New Jersey Board of Commerce and Navigation, 1922; 1924). Meanwhile, a parallel study was initiated under a newly formed Committee on Shoreline Studies of the National Research Council, whose membership included Douglas Johnson, a geologist at Columbia University, and Isaiah Bowman, director of the American Geographical Society.

An outgrowth of these two investigations was the founding of the American Shore and Beach Preservation Association (ASBPA) in 1926 as a private, nonprofit organization. Through its journal *Shore and Beach* and its lobbying activities, ASBPA strongly advocated a federal shoreline protection program. At its behest, in 1930 Congress established the Beach Erosion Board (BEB) within the Army Corps of Engineers to undertake studies and provide technical advice regarding erosion. The federal government shared the costs of BEB studies equally with interested states (Quinn, 1977, pp. 13-22).

In 1936, Congress adopted P.L. 74-834, which authorized assistance for constructing—but not maintaining—coastal protection works where "federal interests" were involved. The Corps interpreted this to include only federal property, and little work was performed under this act. The Great New England Hurricane of 1938 devastated the shores of Long Island and southern New England with a 25-foot storm surge and killed 600 people. Following another devastating east coast hurricane in 1944, P.L. 74-834 was repealed and replaced in 1945 by P.L. 79-166, which authorized a broader research effort on coastal erosion and substituted "public interest" for "federal interest," thus broadening the scope of federal involvement. The following year, P.L. 79-727 authorized federal participation of up to one-third of total costs in coastal erosion protection projects affecting public property (Quinn, 1977, pp. 38 and 49). While still short of the level of federal participation in riverine flood projects (up to 100%), the coast was beginning to become an object of national concern.

During 1954 and 1955, six hurricanes struck the Middle Atlantic and New England coasts in a period of 13 months, killing more than 500 people and causing more than $2 billion in property damage (Moore and Moore, 1980, p. 62). In June 1955 Congress adopted P.L. 84-71, charging the Corps

to investigate hurricane hazards along the eastern and southern seaboard of the United States with respect to:

> the behavior and frequency of hurricanes, and the determination of methods of forecasting their paths and improving warning services, and of possible means of preventing loss of human lives and damages to property with due consideration of the economics of proposed breakwaters, seawalls, dikes, dams, and other structures, warning services, or other measures which might be required.

The mention of "warning services" and "other measures" was perhaps the first hint of congressional interest in what would later be termed "nonstructural" methods for adjusting to coastal hazards. Meanwhile, additional shore protection projects were authorized during the 1950s. In 1954 the Beach Erosion Board published the 390-page technical manual *Shore Protection Planning and Design* to guide coastal engineering practices. Increasing attention during this decade was given to beach nourishment as a "soft" alternative to the construction of seawalls, jetties, groins, and other "hard" structures (Quinn, 1977, p. 81)

The 30-year federal commitment to shoreline stabilization as the dominant response to coastal erosion and flood hazards was reinforced by the Ash Wednesday Northeaster of March 5-9, 1962, which devastated shoreline real estate from Florida to New England. Lasting over five high tides, the storm scoured beaches, flattened hundreds of houses, and, by opening and closing inlets, rearranged the geography of the Atlantic coastal barriers. Geographers Robert Kates and Ian Burton surveyed public opinion after the March storm and found "a strong public demand for protective coastal engineering by governmental agencies" (Burton, Kates, and Snead, 1969). Congress responded to this demand by adopting P.L. 87-874, which enlarged federal participation in coastal projects to 50% of total costs and assumed the entire cost of coastal erosion studies (Moore and Moore, 1980, p. 65). In 1963, P.L. 88-172 abolished the Beach Erosion Board and created in its place the Coastal Engineering Research Center (CERC), which continues to the present time in its facility at Vicksburg, Mississippi. By 1969, about 180 individual coastal studies, covering some 23,000 miles of shoreline, had been completed or were in progress. By that time, 103 beach erosion projects had been authorized, of which 43 had been completed (Koisch, 1969).

In 1968 Section 106 of the River and Harbor and Flood Control Act charged the Corps to conduct a national survey of the incidence of shoreline erosion. The ensuing National Shoreline Study report (U.S. Army Corps of Engineers, 1971) documented 20,500 miles of "significant erosion" in the total shoreline of 84,240 miles. (Excluding Alaska, some 15,400 miles, or 42% of the remaining shoreline, was considered "significantly eroding.") About 2,700 miles of the 20,500 subtotal were classified as "critically eroding." The report estimated the cost of shore protection for the areas of "critical" erosion at about $1.8 billion plus average annual costs of $73 million for continued beach nourishment (Ibid., p. 25). This would potentially involve federal participation in the protection of nonpublic shorelines, which had been first approved in certain circumstances in 1956 (Quinn, 1977, p. 84)

The National Shoreline Study methodology and findings were open to question. In particular, the designations "significant" and "critical" were not quantified as to rate of erosion. Criticality was based on subjective assessment of the extent of shoreline investment at risk along eroding coasts. Furthermore, the General Accounting Office (1975) noted that methods for estimating the degree of erosion hazard differed among Corps districts and that no means of monitoring ongoing trends existed. By this time, the hegemony of the Corps over shoreline management had ended and new approaches, agencies, and programs were entering the coastal scene.

Reallocating Losses: The National Flood Insurance Program

In September 1965 Hurricane Betsy struck the Gulf Coast with 150-mile-per-hour winds, causing over $2 billion in damage in Louisiana and Mississippi. The Southeast Hurricane Disaster Relief Act of 1965 (P.L. 89-339), passed two months after Betsy, charged the newly created Department of Housing and Urban Development (HUD) with investigating

> alternative programs which could be established to help provide financial assistance to those suffering property losses in flood and other natural disasters, including alternative methods of Federal disaster insurance.

Significantly, this provision addressed HUD rather than the Corps and called for reconsideration of the need for a National Flood Insurance Program that had been authorized in 1956, but was never funded.

At about the same time, the Bureau of the Budget created a Task Force on Federal Flood Control Policy. The latter, chaired by geographer Gilbert F. White, and the HUD study, conducted by resource economist Marion Clawson, each completed their reports in August 1966 (U.S. Congress, 1966a; 1966b). Although neither addressed coastal erosion per se, both would jointly influence the future course of national policy on flood hazards. The White report questioned the longstanding reliance upon strictly structural approaches to flooding, both riverine and coastal. While conceding that engineered flood control projects are appropriate and cost-effective under particular circumstances, the report stated that

> additional tools and integrated policies are required to promote sound and economic development of the flood plains. Despite subtantial efforts, flood losses are mounting and uneconomic uses of the Nation's flood plains are inadvertently encouraged. The country is faced with a continuing sequence of losses, protection and more losses (U.S. Congress, 1966a, p. 1).

The White Task Force called for an "integrated flood loss management program" that would include improved forecasting and warning systems, floodplain land use controls, floodproofing of buildings that need to be in floodplains, and urban renewal programs to remove structures and occupants that should not be in floodplains. The report cautiously endorsed the concept of national flood insurance, but urged that it be tried on an experimental basis to see whether or not it encouraged new investment in hazardous areas. The Clawson report agreed that a national flood insurance program could reduce federal disaster expenses by charging actuarial rates to occupants of hazardous areas. Both reports urged that such a program, however, would need to be accompanied by land use controls to limit future development in designated hazard areas (Platt, 1986).

The National Flood Insurance Act (P.L. 90-448, Title XIII), which ensued from these reports, marked a watershed in national policy on floods, and by implication, on coastal erosion. The act established the National Flood Insurance Program (NFIP) within the Department of Housing and Urban Development. The program would: 1) map and designate flood hazard areas throughout the nation; 2) establish land use and building standards for future development in such areas; and 3) within communities that voluntarily adopt such standards into local laws, offer insurance at affordable rates against flood damage to structures and their contents. The NFIP thus introduced economic and legal measures to limit or redistribute the burdens of flood losses that would supplement, and eventually almost replace, reliance on flood control projects. (For more detailed discussion of the NFIP, see Arnell, 1984; Platt, 1986.)

The NFIP started slowly in the absence of floodplain maps and incentives for communities to enroll. In 1972 two disasters refocused congressional attention on flood issues—the Rapid City, South Dakota, flash flood and Hurricane Agnes. The Flood Disaster Protection Act of 1973 (P.L. 93-234) jump-started the NFIP. It compelled the purchase of an NFIP policy as a condition to receiving a loan for purchase or improvement of structures in designated flood hazard areas from any federal or federally insured lender. This precedent stimulated communities to adopt local floodplain management laws and resulted in a vast expansion in NFIP coverage. By 1991, about 17,000 communities were enrolled in the program, with about 2.4 million policies in effect covering some $140 billion worth of flood-prone structures and their contents.

The 1973 Flood Disaster Act (P.L. 93-234) also added coastal erosion as an insurable hazard under the NFIP. Section 107 of the act stated that

> (c) The term 'flood' shall also include the collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels (42 U.S.C.A, sec. 4121).

Representative Sidney Yates of Illinois sponsored this section to address the losses caused by bluff erosion during periods of high levels on the Great Lakes. It also applied, however, with rather uncertain effect to eroding ocean shorelines. The limitation "exceeding anticipated cyclical levels" has no clear meaning in the tidal context, but the NFIP has since covered erosion losses to structures and their contents—but not to the land itself—where the loss was "flood-related." In practice, coastal erosion losses are combined with flood losses, and no separate accounting of erosion claims paid under the NFIP is available.

In July 1978 the Federal Insurance Administration (FIA) hosted a workshop at Cape May, New Jersey, to solicit the advice of coastal geologists, geographers, and other researchers on how the NFIP should manage erosion hazard areas. Based on the consensus of that meeting, FIA revised its regulations to provide for the mapping, designation, and regulation of erosion hazard areas (E Zones). If and when E zones were established by FIA, local communities would

> require setbacks for all new development from the ocean, lake, bay, riverfront or other body of water to create a safety buffer consisting of a natural vegetative or contour strip. This buffer will be designated by the Administrator according to the flood-related hazard and erosion rate, in conjunction with the anticipated 'useful life' of structures . . . The buffer may be used for suitable open space purposes, such as agriculture, forestry, outdoor recreation and wildlife habitat areas, and for other activities using temporary and portable structures only. (44 *Code of Federal Regulations*, Part 60.5).

This rather utopian language was never implemented, and no E Zones have ever been mapped or designated by the National Flood Insurance Program.

The NFIP has made a significant impact on recent shoreline development, albeit in a vertical, if not a horizontal, direction. Structures built or substantially improved in communities where the NFIP is in effect must be elevated on pilings (Figures 2.2 and 2.3). Minimum elevation requirements during the 1970s were based on the estimated height of a hypothetical 100-year storm surge in the locality in question. This standard was criticized for failing to account for the impact of waves reaching above the estimated "still water" level. Elevation requirements were revised to include projected wave heights. The first floor must be at or above the specified elevation (including wave heights) or insurance premiums will be prohibitive and a building permit may be denied by the local government.

Elevation, however, does nothing to retard erosion; retreating shorelines will simply continue to move toward and beneath the elevated structure until collapse eventually occurs. Of course, once utilities, septic fields, and safe access to a structure are disrupted, it may not legally be inhabited, and thus it becomes a derelict hulk towering over the surf zone.

Related Federal Programs Since 1970

The National Flood Insurance Program, with modifications yet to be mentioned, has been the mainstay of federal response to coastal flood hazards, although it poorly addresses the problem of erosion. However, it has not operated in a policy vacuum. Several other federal initiatives since 1970 have addressed the coast with different congressional mandates and *modi operandi*. As with the NFIP, each has been to some degree confounded by the phenomenon of shoreline erosion.

Coastal Zone Management

While the NFIP tiptoed around the controversial issue of erosion setbacks, no other federal agency was willing to grasp this nettle. In theory, the NFIP concern with coastal hazards overlapped with broader coastal planning initiatives under the Coastal Zone Management Act of 1972 (CZMA) (P.L. 92-583; 16 U.S.C.A. 1451 et seq.) (Platt, 1978). That act, like the Stratton Commission Report on which it was based (Commission on Marine Science, Engineering and Resources, 1969), strongly reflected the concerns of coastal ecologists and recreation planners, but was silent on coastal hazards. In 1976, the federal Office of Coastal Zone Management published a study entitled *Natural Hazard Management in Coastal Areas* that documented the effects of coastal erosion, among other hazards. The CZMA was amended in 1977 to include among its purposes:

> the management of coastal development to minimize the loss of life and property caused by improper development in flood-prone, storm surge, geological hazard, and erosion-prone areas and in areas likely to be affected by or vulnerable to sea level rise . . . and by the destruction of natural protective features such as beaches, dunes, wetlands, and barriers islands (CZMA, Sec. 303(2)(B)).

But mindful of political hostility to federal intervention in state and local land use management, Congress merely directed that state plans must include:

> a planning process for assessing the effects of, and studying and evaluating ways to control, or lessen the impact of, shoreline erosion, and to restore areas adversely affected by such erosion (CZMA, Sec. 306(d)(2)(I)).

Figure 2.2. An elevated oceanfront house on Sullivan's Island, South Carolina, that survived Hurricane Hugo better than its landward "slab-on-grade" neighbor (foreground). (Photo by R. Platt.)

Figure 2.3. After Hurricane Hugo, many coastal homes in South Carolina were elevated by house movers, but almost none were relocated further from the water's edge. (Photo by R. Platt.)

This weak language provides no mandate for state (and certainly not federal) regulation of erosion-prone shorelines. A number of state hurricane plans and erosion studies have been supported by federal Coastal Zone Management (CZM) funding (Office of Ocean and Coastal Resource Management, 1988). Certain states have independently adopted setbacks and other controls over new or rebuilt development along eroding coasts (e.g., the North Carolina Coastal Area Management Act of 1974 (CAMA), the New York Coastal Erosion Act of 1981, and the South Carolina Beachfront Management Act of 1988 (as amended in 1990) (see chapter 3).

In practice however, the isolation between the NFIP and the CZM program that prevailed during the 1970s has essentially continued to the present time. The NFIP is concerned with insurance and building practices at the level of municipalities and property owners, while the CZM program has primarily supported large-scale planning studies by 29 eligible coastal states and territories.

Public Ownership

Significant reaches of ocean shoreline, much of them subject to erosion, have been preserved in relatively natural condition through public or quasi-public ownership. The National Park Service (NPS), a unit of the Department of the Interior, owns and manages 10 national seashores and four national lakeshores under diverse acts of Congress. Additional segments of eroding shoreline lie within the Gateway National Recreation Area bordering the New York Bight. Since 1973 NPS has sought to "let nature have its way" with erosion. In the Cape Cod National Seashore, parking lots and bathhouses have been moved landward in place of trying to halt the high rate of erosion of the shoreline (which was noted by Henry David Thoreau in 1845). Pursuant to advice of the National Research Council (1988), NPS intends also to relocate the Cape Hatteras Lighthouse away from the eroding shoreline, despite local opposition (*New York Times*, 1991, p. C10).

The Department of Defense owns extensive tracts of erodible, but potentially valuable, coastal property within military bases, as at Virgina Beach, Jacksonville, and San Diego. The closing of certain bases and the disposal of coastal property poses a choice between sale for development or transfer to a public preservation agency. Even where development is permitted, the federal government may impose permanent restrictions on building in erosion or flood hazard areas.

Federal ownership is supplemented by state, county, and local coastal parks and preserves. Additional areas are controlled by nonprofit conservation organizations, notably The Nature Conservancy, the National Audubon Society, and the Trust for Public Lands and their regional counterparts. Several Virginia barrier islands are preserved by The Nature Conservancy as the Virginia Coastal Reserve. Such nonprofit ownership assures a tight degree of control against development and acceptance of erosion as a natural process.

Slightly over half of the shoreline of coastal barriers bordering the Atlantic and Gulf of Mexico is protected through public or quasi-public ownership (Platt, 1987, p. 10); the rest is private and eligible for development. The eroding bluffs of Cape Cod are owned by the NPS; elsewhere non-barrier-eroding shorelines are typically in private ownership. The Pacific Coast is substantially in public ownership or subject to building restrictions (e.g., under the California Coastal Commission). Erosion on the West Coast threatens public infrastructure and buildings on unstable bluffs and cliffs more commonly than beachfront dwellings. Public ownership is comparatively modest on the Great Lakes, and during periods of high lake levels, hundreds of private homes are threatened by bluff collapse (see chapter 6).

Ownership of eroding shorelines by public or nonprofit conservation organizations is the most effective deterrent to erosion losses: vulnerable development and infrastructure within the reach of flooding and erosion may be entirely banned. This avoids not only the direct economic costs of erosion losses, but also the need for public measures to protect property at risk through shoreline stabilization. Furthermore, outright ownership provides various other benefits, such as preservation of fragile ecosystems and habitat, recreational access, and sometimes promotion of tourism in nearby communities.

But while avoiding many of the costs of erosion, the ownership strategy involves substantial costs of a different nature. The cost of acquiring oceanfront land, whether or not subject to erosion, is prohibitive, running into hundreds of thousands of dollars per acre for accessible sites. The National Park Service at Cape Cod and elsewhere has sought to mitigate such high costs by acquiring future interests that will vest after the present owner's death or a fixed period of time (typically 25 years). Easements of development rights (conservation easements) allow public control over land while leaving the title to the land in private ownership. (The cost of such an easement will probably be a high proportion of the cost of outright purchase.) Another cost of public or quasi-public ownership is the loss of property taxes to the local jurisdiction.

Federal Regulation

Federal police power to regulate the use of private land is unpopular under the American federalist system. Land use controls are theoretically the prerogative of the states, which generally delegate them to local municipalities and counties. Some states have begun to formulate their own policies on coastal erosion. However, whether or not states and localities make effective use of their powers to regulate private land use,

the federal government is politically constrained from intervening in erosion hazard areas or elsewhere to deter unwise coastal development.

There are several exceptions to this doctrine of federal nonintervention in private land usage (Platt, 1991, chapters 11 and 12). Since 1972, the U.S. Army Corps of Engineers has been charged with regulating encroachments on wetlands under Section 404 of the Clean Water Act. Wetlands are broadly defined to include a variety of coastal and inland habitats according to ecological and hydrological criteria. But open ocean shorelines and most Great Lakes coasts generally do not fall within the Corps' definition of wetlands. (Bay shorelines, however, which often are subject to erosion of a milder form than open coasts, are typically wetlands and thus subject to Corps jurisdiction.) The longstanding Corps authority to regulate dredge and fill activities in "navigable waters" (dating back to the 1899 Rivers and Harbors Act) does not generally apply landward of the mean high tide line. Eroding beaches, dunes, and bluffs therefore fall into a regulatory void between wetlands and navigable waters.

Disaster Assistance

A new series of coastal disasters struck New England in 1978; the Gulf of Mexico coast in 1979 (Hurricane Frederic), 1980 (Hurricane David), and 1983 (Alicia); Hawaii in 1982 (Hurricane Iwa); and California during the winter of 1982-83. These collectively raised new questions concerning the role of federal disaster assistance and flood insurance in encouraging unwise building along hazardous coasts. Federal disaster programs, including the NFIP, were consolidated in the new Federal Emergency Management Agency (FEMA) by President Carter in 1979. The following year, FEMA was directed by the Office of Management and Budget to investigate opportunities for mitigating flood hazards immediately after any presidential declaration of a major disaster involving flooding. This new policy was intended to channel disaster assistance toward reducing future losses, rather than simply rebuilding the status quo. Long-term hazard mitigation planning was also required for stricken areas under the Federal Disaster Assistance Act, which (as amended by the Stafford Act in 1990) requires that

> the State or local government [receiving federal disaster assistance] shall agree that the natural hazards in the areas in which the proceeds of the grants or loans are to be used shall be evaluated and appropriate action shall be taken to mitigate such hazards, including safe land-use and construction practices (Sec. 409 of P.L. 93-288, as amended by P.L. 100-707).

Additional advice regarding hazard mitigation has been offered by the Committee on Natural Disasters of the National Research Council, which has studied the physical and socioeconomic aspects of several coastal disasters (e.g., National Research Council, 1984a and 1984b).

The Coastal Barrier Resources Act

Coastal barriers, a particularly hazardous type of coastal landform, attracted increasing scientific and political attention during the 1970s. In 1977, the Department of the Interior established a Barrier Island Task Force to inventory and map segments of the Atlantic and Gulf Coast barrier chain that remained undeveloped and unprotected by public ownership. In 1981 the group Concerned Coastal Geologists, meeting in Georgia, called for the abandonment of beach stabilization efforts and for adjustment of human uses of shorelines to erosion hazards (Skidaway Institute, 1981). This strategy of retreat from eroding shores was restated in a second Skidaway position paper in 1985 (Skidaway Institute). Orrin H. Pilkey, Jr., one of the convenors of the Skidaway Institutes, edited the ongoing Duke University Press series of "Living with the Shore" handbooks prepared for various shorelines from the 1970s to the present. He also co-authored a landmark book on coastal erosion—*The Beaches are Moving* (Kaufman and Pilkey, 1979). Stephen P. Leatherman of the University of Maryland, another coastal geomorphologist, published his *Barrier Island Handbook* in 1979 (revised in 1982 and 1988). Coastal planners at the University of North Carolina studied hurricane hazards in relation to land management on coastal barriers (Godschalk, Brower, and Beatley, 1989).

Research findings by Sheaffer and Roland, Inc. (1981), as reported by H. Crane Miller (1980-81; 1981), regarding the federal costs of recovery from Hurricane Frederic were of particular interest to Congress. Miller estimated that it would be cheaper for the federal government to buy the remaining undeveloped coastal barriers outright than to subsidize their development and then bear the costs of rebuilding them after a disaster. The General Accounting Office reinforced this concern by reporting that the NFIP was at least a "marginal incentive," if not an outright stimulus, to coastal development (1982).

In response to these findings, the Coastal Barrier Resources Act of 1982 (CBRA) (P.L. 97-348; 16 USCA 3501-10) embraced a new strategy—withdrawal of federal growth incentives in specified locations. CBRA designated a Coastal Barrier Resource System (CBRS), comprising 186 units and 656 miles of total ocean shoreline identified by the Department of the Interior barrier island study. The Act terminated the availability of new flood insurance coverage within these nonpublic, undeveloped barriers and also suspended other federal growth incentives, including assistance for highways, bridges, causeways, sewer and water systems, and shore protection projects. Outside of CBRS units, however, federal flood insurance and other benefits remain in effect. The Cities on the Beach Conference in 1985 envisioned that CBRA might inadvertently intensify development pressures on developed barriers that remained eligible for federal incentives (Platt, Pelczarski, and Burbank, 1987).

Toward Erosion Management Under the NFIP

The Upton-Jones Amendment

The Great Lakes experienced spectacular erosion losses during a period of high water levels in the mid-1980s that undermined many homes and left hundreds more teetering on the edge of bluffs. In 1985 the state of Michigan undertook a limited program of subsidies to relocate such endangered structures landward (see chapter 6).

Meanwhile, Michigan Representative Fred Upton teamed up with Representative Walter Jones of North Carolina, whose state had adopted erosion setbacks under its 1974 Coastal Area Management Act, to propose a new erosion element for the NFIP. In the Upton-Jones Amendment to the National Flood Insurance Act (P.L. 100-242, Sec. 544; 42 U.S.C.A. Sec. 4013(c)), Congress for the first time authorized payments from the National Flood Insurance Fund (funded by NFIP premiums) for certain costs of demolishing or relocating insured structures that are "subject to imminent collapse or subsidence as a result of erosion." The amendment thus was intended to encourage the removal of erosion-prone structures prior to their actual collapse to avoid higher NFIP costs and public safety hazards. Eligibility for Upton-Jones benefits, however, was narrowly defined, and few claims have been filed by coastal property owners. As of May 2, 1991, only 228 claims had been approved nationwide, of which 177 were for demolition of endangered structures and only 51 for relocation (Michael Buckley, Federal Emergency Management Agency, personal communication, May 1991).

Further Proposals

Even as it struggled to implement Upton-Jones, FEMA contracted with the National Research Council in 1988 to broadly review the problem of coastal erosion and to offer recommendations for improving the NFIP response. The report of the Committee on Coastal Erosion Zone Management (National Research Council, 1990) proposed a complex set of revisions to the NFIP. The report urged that 10-, 30-, and 60-year erosion setbacks be established by FEMA along eroding coasts where new development was likely: these would be based on the best available historical data on average annual erosion rates (AAERs). Coastal communities participating in the NFIP would require development involving fewer than four units to be landward of the 30-year AAER line, with other larger projects landward of the 60-year line. Existing structures within the 10-year line would be eligible for relocation or demolition payments similar to the Upton-Jones program. If an owner of a structure seaward of the 10-year line took no action within two years after notification, NFIP coverage for that structure would be curtailed and/or subject to surcharge. No new structures or redevelopment would be permitted seaward of the 30-year setback line, and no new flood insurance would be issued in that zone.

These proposals were incorporated into Title IV of the Flood Insurance, Mitigation, and Erosion Management Act of 1991 (H.R. 1236) adopted by the U.S. House of Representatives on May 1, 1991, by a vote of 388 to 18. The Senate version (S. 1650), introduced by Senator John Kerry of Massachusetts, contained similar language but was replaced by S. 2907, a weaker version, in response to opposition from property owners. Its fate remains undetermined at this writing.

Conclusion

Several general observations may be drawn from the foregoing summary of the evolution of national response to coastal erosion. First, as with other natural hazards, federal policies and actions have been largely reactive to actual disasters (e.g., the adoption of public laws in the wake of the 1954-55 hurricanes and the 1962 Ash Wednesday northeaster). While congressional response before the mid-1970s was often direct, immediate, and makeshift, more recent legislation has benefited from serious research into the causes and effects of coastal disasters. This was the case with the Coastal Barrier Resources Act that ensued from the research on recovery from Hurricane Frederic by H. Crane Miller. The NFIP amendments currently under consideration are based on the National Research Council (1990) committee report on coastal erosion, more than any specific disaster (although Hurricane Hugo in 1989 helped to underscore the committee's proposals).

Second, public efforts to stabilize eroding shores have shifted decisively from reliance upon "hard" engineered shore protection toward the use of "soft" beach nourishment. Shore stabilization of any kind is increasingly challenged by proponents of "retreat," as reflected in the writings of Orrin H. Pilkey, Jr. and the National Research Council (1988) proposal to move the Cape Hatteras Lighthouse landward. For currently developed residential shorelines, however, retreat remains a rhetorical doctrine. Beach nourishment (predominantly at federal expense) remains the strategy of political choice despite the risk of sudden sand losses and the need for recurrent replenishment.

Third, state governments in several cases have moved more decisively than the federal government to adopt a retreat strategy in the form of minimum setback requirements for new or redeveloped shoreline construction. The Upton-Jones Amendment to the NFIP reflected, albeit ineffectively, experience in its sponsors' states of Michigan and North Carolina.

Fourth, recognition of erosion as a hazard in its own right, apart from coastal flooding, has only recently begun to emerge. Federal policy has

typically addressed storm-generated erosion as a short-term phenomenon with little attention to longer-term or gradual erosion resulting from the effects of relative sea level rise. Also the erosion impacts of shoreline modification (e.g., due to disturbance of littoral sand transport processes) were long ignored. The 1990 National Research Council report has underscored the earlier work of coastal geomorphologists that disclosed the persistence and inevitability of shoreline recession along many of the nation's coasts. This knowledge points to the need to manage the design and location of coastal development rather than attempting merely to manage the hazard itself.

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3

State Response to Erosion Hazard

by
Jennifer Melville and Rutherford H. Platt

Introduction

> The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people (United States Constitution, Amendment X).

Under the American federalist system, state governments retain important powers to address problems individually through their own legislation unless prohibited by the Constitution or by federal law. Land use regulation is normally considered a topic of state and local discretion, subject to the constraints of the U.S. Constitution. Even where Congress has partially addressed a topic, there remains much scope for concurrent state legislation, as long as it does not directly contradict or undermine federal policies. The federal law preempts state laws only where Congress expresses an intent to occupy an entire topic of legislation.

As outlined in the preceding chapter, Congress has by no means expressed an intent to preempt the field of erosion hazard mitigation. Indeed, it has very gingerly approached the issue through the National Flood Insurance Program (NFIP). Accordingly, the coastal states retain broad jurisdiction to regulate land use along their shorelines within the parameters of the Constitution. Much speculation exists at this writing regarding just what those parameters allow, in light of the June 1992 decision of the U.S. Supreme Court in *Lucas v. South Carolina Coastal*

Council (112 S.Ct. 2886) that reviewed the constitutionality of the South Carolina Beachfront Management Act with ambiguous implications. (See the discussion of this case in the South Carolina section of this chapter.)

Table 5.1, prepared by the National Research Council (1990), summarizes the status of coastal erosion management in 34 coastal states and territories (including states bordering the Great Lakes). This table was compiled from unpublished data obtained in surveys by the Coastal States Organization, the Association of State Floodplain Managers, and the Federal Emergency Management Agency (FEMA). It provides a snapshot of state programs as of 1990 and affirms the role of states as laboratories for experimentation in land use regulation. In particular, it lists 11 states that have established erosion setbacks for new or substantially rebuilt construction. (In 1991, Ohio adopted a setback requirement, bringing the list to 12 states.) These differ substantially in method of calculation, reference feature, applicable development, and length of protection period (i.e., standard for width of setback). Several other states have mapped erosion hazards for at least portions of their shorelines from various sources of data.

The table raises more questions that it resolves. The tabular format masks substantial differences among states. Furthermore, it presents in static form what is actually a dynamic and evolving process. For instance the 50-year setback listed for New Jersey has since been abolished by a state judicial decision invalidating that state's "emergency regulations" in 1991.

This chapter presents a series of state-by-state summaries of coastal erosion management programs prepared during 1990 and 1991. The states examined were selected nonrandomly to include most of those with significant erosion management programs (whether or not involving setbacks) from the Atlantic, Gulf of Mexico, and Great Lakes shorelines. The Pacific coast was not included, despite significant erosion hazards, due to the very different physical and institutional circumstances that apply there. (The National Research Council report contains a brief overview of experience in California.) These summaries are based upon careful review of state laws and regulations, agency documents, extensive discussions with program staff (by telephone, letter, and/or site visit), and review of pertinent secondary literature. A comparative summary follows in Chapter 4.

Table 3.1
Summary of State and Territory Erosion Management Programs

State/ Territory	Recession Rates from Aerial Photos	Recession Rates from Charts	Recession Rates from Ground Surveys	Erosion Setbacks Established*	Reference Feature	Years of Setback	Local Administration	One Foot per Year Standard	Fixed Setback	Floating Setback
Alabama	Y	Y	N	Y	MHW	NA	N	Y	N	
Alaska	Y	Y		N	NA	NA	NA	NA	NA	NA
American Samoa	N	N	N	N	NA	NA	NA	NA	NA	NA
California	Y	Y	Y	N	NA	NA	Y	NA	NA	NA
Connecticut	Y	Y		N	NA	NA	NA	NA	NA	NA
Delaware	Y	Y		Y4	TD	NA	Y	N	Y	N
Florida	Y	Y		Y5	NA	30	Y	N	Y	N
Georgia	Y	Y		N	NA	NA	NA	NA	NA	NA
Hawaii	N	N	N	Y	6	N	Y	N	Y	N
Indiana	Y	N	Y	N	NA	NA	NA	Y	NA	NA
Illinois	Y	Y	Y	N	NA	NA	NA		NA	NA
Louisiana	Y	Y	N	N	NA	NA	NA	NA	NA	NA
Maine	N	N	Y	N7	NA	NA	NA	NA	NA	NA
Maryland	Y	Y		N	NA	NA	NA	NA	NA	NA

State/ Territory	Recession Rates from Aerial Photos	Recession Rates from Charts	Recession Rates from Ground Surveys	Erosion Setbacks Estab-lished*	Reference Feature	Years of Setback	Local Adminis-tration	One Foot per Year Standard	Fixed Setback	Floating Setback
Massachu-setts	Y	Y	N	N	NA	NA	NA	NA	NA	NA
Michigan	Y	N	N	Y	BC2	30	Y	Y	N	Y
Minnesota	Y	N	N	N	NA	NA	NA	Y	NA	NA
Mississippi	N	N	N	N	NA	NA	NA	NA	NA	NA
New Hampshire	N	N	N	N	NA	NA	NA	NA	NA	NA
New Jersey	Y	Y	Y	Y	MHW	50				
New York	Y	Y	N	Y	BC	30-40	Y	Y	Y	N
North Carolina	Y	N		Y	DC	3-60	Y	N	N	Y
N. Mari-ana 's	N	N	N	N	NA	NA	NA	NA	NA	NA
Ohio	Y	Y	N	N1	BC	30	NA	Y	Y	N
Oregon				N		NA	NA	NA	NA	NA
Pennsyl-vania	Y	N	Y	Y	BC	50 +	Y	Y	N	Y
Puerto Rico	N	N	N	N	NA	NA	NA	NA		
Rhode Island	N	N	Y	Y	DC	30	N	N7	Y	N
South Carolina			Y	Y		40	BL		Y	N
Texas	Y	Y	Y	N	NA	NA	NA	NA	NA	NA
Virgin Islands	N	N	N	N	NA	NA	NA	NA	NA	NA
Virginia	Y	Y		N	MHW	NA	Y			
Washing-ton				N	NA	NA	NA	NA	NA	NA
Wisconsin	Y	Y	N	N3	NA	NA	NA		N	Y

Note: 1 = setbacks may be established within two years; 2 = bluff crest or edge of active erosion; 3 = some counties have setbacks; 4 = has 100-foot setback regulation over new subdivisions and parcels where sufficient room exists landward of setback; 5 = not all counties have coastal construction control lines established; 6 = storm debris line or vegetation line; 7 = two feet per year standard. Y = yes; N = no; NA = not applicable; BC = bluff crest; MHW = mean high water; TD = toe of dune; DC = dune crest, toe of frontal dune, or vegetation line; BL = base line. A blank means no information was available.

*Most states have setbacks from water line, although they are not based on an erosion hazard.

Source: National Research Council, *Managing Coastal Erosion*. Washington, D.C.: National Academy Press, 1990. Table 5.1.

Florida

Introduction

Florida's ocean coastline is among the most diverse shorelines in the United States, containing barrier islands; mangrove swamps; coral keys; and long, sandy, mainland beaches. Dynamic barrier islands, spits, and capes line much of Florida's east coast, the panhandle, and the southern two-thirds of the west coast. Three large sections of Florida's coastline lack the barriers and beaches characteristic of the rest of the shoreline. Along the Gulf of Mexico's Big Bend, which stretches from Live Oak Island in Wakulla County to Anclote Key in Pinellas County, marsh grass and mangroves line the shore. Similarly, the Ten Thousand Island coast, located at the southern tip of the state, supports dense mangrove forests (Doyle et al., 1984). The Florida Keys, which are geologically different from the rest of the Florida coast, consist of uplifted coral reefs and carbonate sand banks.

Florida is now the third most populous state in the U.S. From 1970 to 1980 the population increased by approximately 3 million people, and the state's population is predicted to total nearly 17 million by 2010 (Godschalk et al., 1989). A very high proportion of Florida's population lives in coastal counties. Furthermore, the majority of the state's 32 million tourists visit and stay near the coast (Florida Atlantic University, 1986). The resulting development pressure is greatest on Florida's barriers and mainland sandy beaches. On the Gulf Coast, for example, most of the well-known recreational beaches and resort communities are located on barrier islands, while the Big Bend is significantly less developed (Doyle et al., 1984).

Approximately 538 miles of Florida's 802 miles of sandy beach shoreline are privately owned. About one-fifth of such private, sandy shorelines remains largely undeveloped. During the 1980s, approximately 15 miles of shoreline, just under 2% of Florida's sandy beaches, were newly developed. In the same period, public ownership of coastline increased by approximately 9% with the acquisition of 22 miles (Florida Division of Beaches and Shores, 1990).

Florida is potentially more vulnerable to hurricanes and coastal storms than any other U.S. state. Of the hurricanes that made landfall on the U.S. mainland in the last century, nearly 60% hit the Florida coast (Godschalk et al., 1989). Furthermore, all of the state's 8,400 miles of tidal shoreline are low-lying and vulnerable to serious hurricane flooding (Kusler, 1983). Since Hurricane Betsy in 1965, however, few hurricanes had directly struck Florida (Pilkey et al., 1984) until Hurricane Andrew devastated southern Florida in August 1992.

Over one-third of Florida's beaches are eroding. Of the 820 miles of shoreline surveyed, the Florida Division of Beaches and Shores has identified 338 miles of Florida's shoreline as "problem erosion areas." Of these 338 miles, 95 miles along the Gulf and 124 miles on the Atlantic are designated as "critical erosion areas"—stretches of shoreline where erosion threatens substantial development and recreational interests (Clark, 1990).

Historically, Floridians have used erosion control structures to stabilize their shifting shorelines. Florida's first seawall was built in 1690 in Saint Augustine (Pilkey et al., 1984). Today bulkheads, seawalls, and revetments are common along the Florida shore, and jetties lie along many of the inlets between barrier islands. Florida has increasingly turned to beach restoration and renourishment to preserve the state's eroding beaches. Between 1965 and 1984, 67.3 miles of Florida's shoreline were renourished. Most of Florida's beach replenishment projects have been undertaken in the state's heavily developed southeastern counties. In 1981, for example, 10 miles of Miami Beach were restored at a cost of $67 million. That project, which required moving 14 million cubic feet of sand from offshore sources, was the world's largest beach rebuilding project (Pilkey et al., 1984).

Coastal Management Program

Florida's Coastal Management Program was established under the Coastal Management Act of 1978 (Florida Laws, Ch. 380) and approved by the Federal Coastal Zone Management office in 1981 (Pilkey et al., 1984). Florida does not regulate its coastal zone through one comprehensive law, but rather through 25 state statutes. Although the Department of Environmental Regulation is the lead coastal program agency, 16 other state agencies are involved in administering the program (Balsillie, 1988). In particular, the Department of Natural Resources (DNR), which regulates coastal development, and the Department of Community Affairs play key roles in the coastal management program.

The Beach and Shore Preservation Act

The Beach and Shore Preservation Act (Ch. 161) is Florida's primary statute for regulating coastal development. The act, which is administered by the Department of Natural Resources (DNR) Division of Beaches and Shores, was first passed in 1965 and has since been significantly amended (Florida Atlantic University, 1986). In the act, the legislature asserted that Florida's beaches and coastal barrier dunes are among the state's most valuable natural resources and that these resources should be protected from "imprudent construction which can jeopardize the stability of the beach-dune system, accelerate erosion, provide inadequate protection to upland structures, endanger adjacent properties or interfere with public beach access" (161/053).[1]

Coastal Construction Control Lines

To ensure that such "imprudent construction" does not take place, the statute charges the DNR to define and establish Coastal Construction Control Lines (CCCL). These lines define the landward limit of the active beach-dune system and vary from a few to several hundred feet inland of mean high water. The specific location of the line is a function of the predicted storm surge and erosion resulting from a 100-year storm. The DNR has established control lines on a county-by-county basis for Florida's 24 sandy beach counties (161/053). Nine of Florida's 33 coastal counties are not considered to be predominantly sandy beach counties and do not, therefore, have CCCLs. The unregulated counties stretch from Wakulla to Pasco County, located on the Big Bend, and Monroe County in southern Florida (Balsillie, 1988).

The CCCL is a line of regulation—not of prohibition (Robert Dean, University of Florida, personal communication, June 1989). Prior to building or excavating seaward of the control line, a permit must be obtained from the DNR. The primary purposes of this permitting program are to 1) ensure that construction seaward of the control line is designed and sited to protect beaches and dunes from damage, 2) ensure that construction seaward of the line does not result in accelerated erosion on adjacent land, and 3) increase the chance that structures seaward of the line will survive severe storms (Florida Atlantic University, 1984).

Before granting a coastal construction permit, the DNR must consider: 1) shoreline stability and the impact of storm tides; 2) design features of the proposed structures or activities; and 3) potential impacts of the building or activities, including cumulative effects, on the beach-dune system. The department may grant a building permit in areas where a "reasonably continuous" line of existing construction located seaward of the control line is not "unduly threatened by erosion" (161/053).

The Beach and Shore Preservation Act also regulates construction of shore protection devices below mean high water (161/041). Prior to building such a structure, a coastal construction permit must be issued by the DNR. Certain types of structures and activities are exempt from the permit program: 1) construction on vegetative non-sandy shores; and 2) modification, maintenance, or repair of existing structures within the limits of existing foundations (Florida Atlantic University, 1986).

1. Statutory reference, following initial citation of a statute, will use the format (chapter/section).

Florida's Administrative Code (16B-33) sets specific standards and regulations for construction seaward of the control line: 1) all habitable structures must be pile-supported, elevated above the projected 100-year storm surge, and designed to withstand 140 m.p.h. winds; 2) existing beach topography must be protected; 3) the maximum effort must be made to protect all native, stabilizing vegetation; 4) seawalls and all nonessential coastal protection structures are generally not permitted; 5) in severely eroding areas, structures must be located as far landward as possible; and, 6) all construction must be designed to minimize erosive effects.

Before setting control lines, the DNR must hold a public hearing in the affected county. The results of the hearing must be considered prior to determining the location of the control line (161/053). Once the department has established CCCLs, their location must be recorded in public records (161/053).

To determine the appropriate location of a control line, the state considers long- and short-term erosion rates, existing upland development, and expected impacts of a 100-year storm. The state contracted with the Florida State University Beaches and Shores Resource Center to assess the impacts of predicted hurricane storm tides. The center uses the storm tide model developed by Robert Dean to predict water levels, wave heights, and dune and bluff erosion accompanying a 100-year storm event (Balsillie, 1988).

For each control line study, stereoscopic aerial photographs are taken. These are then reproduced to provide detailed maps with a 1:100 scale (Balsillie, 1988). These maps are compared to historical maps and photographs to determine long-term erosion rates. For a typical county, five to six surveys, dating from the mid-1800s to the present, are used to compute erosion rates (National Research Council, 1990).

To measure shoreline change over relatively short time periods, the state has established over 3,400 concrete monuments at 1,000-foot intervals along the coastline (National Research Council, 1990). These monuments are in turn referenced to a system of larger monuments that are located farther inland. As part of the state's ongoing CCCL delineation and monitoring program, beach profiles are periodically measured from the control line monuments. In addition, the state also conducts post-storm surveys that provide Florida with a comprehensive pre- and post-storm data base (Balsillie, 1988).

Erosion Setbacks

The 1985 State Comprehensive Growth Management Act (Ch. 85-55) amended the Beach and Shore Preservation Act to include a construction setback provision for all sandy beach counties. The amendment prohibits the DNR from granting most coastal construction permits on land that will be seaward of the seasonal high water line within 30 years (161/053). The 30-year erosion projection cannot, however, extend landward of an established CCCL (161/053).

The DNR can grant coastal construction permits for shore protection structures, piers, and minor structures seaward of the 30-year setback line. The DNR will permit construction of a single-family residence seaward of the line only if: 1) the parcel was platted prior to adoption of the amendment, 2) the landowner does not own another parcel adjacent to and landward of the parcel proposed for development, and 3) the structure is located landward of the frontal dune and as far landward as practicable (161/053). In addition, repairs or reconstruction of a building cannot "expand the capacity of the original structure seaward of the 30-year erosion projection" (161/053). The department can, however, issue a permit for landward relocation of a damaged or existing structure if the relocation will not damage the beach-dune system (161/053).

The DNR uses long-term erosion rates to delineate the location of the 30-year erosion projection. DNR must also consider the presence of shore protection structures and beach renourishment projects in determining the appropriate location of the erosion projection (161/053).

Coastal Building Zone

The 1985 Growth Management Act further amended the Beach and Shore Preservation Act to establish a coastal building zone extending landward of coastal construction control lines. Within the coastal building zone, strict building codes ensure that all major structures are designed and constructed to withstand the forces of and erosion caused by a 100-year storm event (Florida Atlantic University, 1986).

For mainland beaches, barrier spits, and peninsulas lying within Florida's sandy beach counties, the coastal building zone extends from the seasonal high water line to 1,500 feet landward of the coastal construction control line. On barrier islands, the entire island or the area from the seasonal high water line to a maximum of 5,000 feet inland from the control line is included in the building zone (161/54). All land areas within the Florida Keys, regardless of island size, also lie within the coastal building zone (Florida Atlantic University, 1986). In counties that lack CCCLs, the coastal building zone is equivalent to the National Flood Insurance Program's V-zone. (FEMA defines the V zone, which is a coastal high hazard area, as a special flood hazard area that extends from offshore to the inland limit of a primary frontal dune or any area subject to high velocity wave action from storms or seismic sources.)

Within the coastal building zone, major structures must conform to the state minimum building code, be designed to withstand all anticipated loads resulting from a 100-year storm, and be constructed and located in compliance with NFIP regulations (161/55). The statute defines major structures to include houses, mobile homes, commercial and public buildings, and all other construction that has the potential to substantially affect the coastal zone (161/54). Minor structures, such as dune walkways, tennis courts, and gazebos, need not meet these standards, but must be designed to "produce the minimum adverse impact on the beach and the dune system" (161/54 and 161/55).

Erosion Control Program

In 1986 the Florida legislature amended the Beach and Shore Preservation Act to address the statewide problem of beach erosion through a "state-initiated program of beach restoration and beach renourishment" (161/101). The legislature declared that "beach erosion is a serious menace to the economy and general welfare of the people of this state and has advanced to emergency proportions" (161/088). Correspondingly, the legislature concluded that state management was necessary to ensure that Florida's beaches were properly managed and protected (161/088). Although the state had funded and participated in coastal erosion control projects since 1965, most of these projects were locally initiated and were not part of a comprehensive state plan (Florida Atlantic University, 1986).

The statute directs the DNR to develop and maintain a comprehensive long-term management plan for restoration of Florida's critically eroding beaches (161/101). The plan must 1) address long-term solutions to the problem of severely eroding beaches, 2) evaluate each improved navigational inlet to determine its contribution to the erosion of adjacent beaches and provide specific recommendations for mitigating these impacts, 3) provide design criteria for beach restoration and renourishment projects, 4) evaluate feeder beaches as an alternative to direct beach restoration, and 5) establish a priority list for beach restoration and renourishment projects (Florida Atlantic University, 1986).

State funds for erosion control projects are available from Florida's Erosion Control Trust Fund (161/091). The fund provides money for erosion control; hurricane protection; and beach preservation, restoration, and renourishment projects (161/091). The state can pay up to 75% of the actual cost of restoring a critically eroding beach, while the local government in which the project occurs must provide the balance of the funds (161/101). State support for locally sponsored projects has largely been for beach restoration and renourishment and, to a lesser extent, dune restoration, revegetation, and dune walkovers (Florida Atlantic University, 1986).

For a project to be eligible to receive state monies, it must meet two criteria. First, the project must establish an "erosion control line," which is equivalent to the mean high water line prior to beach restoration. After the beach is renourished and correspondingly widened, the erosion control line marks the boundary between state and upland ownership and guarantees public use of the beach seaward of the line. Second, the project applicant must provide public access points with adequate parking facilities at one-half-mile intervals along the restored beach (Balsillie, 1988).

In 1986, as part of the comprehensive long-term plan for the management and restoration of Florida's critically eroding beaches, the Division of Beaches and Shores began identifying and classifying the state's eroding beaches (Clark, 1990). The division grouped Florida's erosion problems into three categories: 1) areas with high erosion rates; 2) areas with moderate or low erosion rates, but with a narrow beach fronting a highly developed area; and 3) restored beaches with an active maintenance program (Clark, 1990). These areas were then further defined as either 1) "critical erosion areas," where erosion threatens substantial development or recreational interests; or 2) "noncritical erosion areas," where erosion processes do not currently threaten development or recreational interests (Clark, 1990).

Local Comprehensive Planning

The Local Government Comprehensive Planning Act of 1975 (Ch. 163) requires that all local governments prepare, adopt, and implement comprehensive plans that address community growth and development needs (Pilkey et al., 1984). In the 1985 Growth Management Act, the Florida legislature strengthened the Planning Act in coastal areas and required that local, regional, and state comprehensive plans be consistent with each other. Under the Planning Act, coastal localities must include a "coastal management element" in their local plans (Godschalk et al., 1989). This section of the plan must be based on an inventory of the beach-dune system and existing coastal land uses and an analysis of the effects of future land uses on coastal resources (Florida Atlantic University, 1986).

Within the plan's coastal element, local governments must address disaster mitigation and redevelopment, designation of coastal high-hazard areas, beach protection, and shoreline use. The local plans must fulfill. among others, the following primary objectives: 1) protection of coastal resources, 2) limitation of public expenditures that subsidize development in coastal high-hazard areas, 3) direction of population away from coastal high-hazard areas, 4) management of development and redevelopment in coastal high-hazard areas to minimize risks to life and property, and 5) protection and enhancement of beach-dune systems (Florida Atlantic University, 1986; Godschalk et al., 1989).

If a local plan does not meet the requirements of the Growth Management Act, state funds to that jurisdiction may be curtailed (Godschalk et al., 1989). Furthermore, the state cannot issue funds to increase the capacity of local infrastructure unless improvements are consistent with

the coastal management element in the local plan. The state can also restrict a locality from receiving post-disaster federal assistance. The state may choose not to include local projects on a state application to the Federal Emergency Management Agency unless the municipality has adopted hazard mitigation and prevention plans (Godschalk et al., 1989)

Coastal Barrier Regulations

In the 1981 Coastal Barrier Executive Order (E.O. 81-105), the governor of Florida recognized the value of coastal barriers and set forth three requirements for state agencies that plan for, manage, and regulate the coastal zone. The governor directed that: 1) acquisition of coastal barriers was a priority, 2) federal and state money was not to be used to subsidize growth or post-disaster redevelopment on hazardous barriers, and 3) agencies were to manage growth in a manner consistent with the evacuation capabilities of coastal barriers (Florida Atlantic University, 1986).

The executive order did not provide state agencies with any specific powers to carry out its directives, but rather set forth the overall policy for state actions on coastal barriers. Subsequently, in the 1985 Growth Management Act, the legislature enacted specific amendments to discourage growth and unwise development on coastal barriers (380/27 and 163/178). In particular, the act directed that state funds could not be used to build bridges or causeways to barrier islands that were not already accessible (Florida Atlantic University, 1986).

Coastal Acquisition

Florida has one of the largest state acquisition programs in the country in terms of money spent and land purchased (Florida Atlantic University, 1986). Acquisition of coastal land is among the key components of the state's land protection program. Florida's Save Our Coasts program, authorized under the Land Acquisition Trust Fund (375/041), provides monies specifically for acquisition of coastal properties. Enacted in 1981, the Save Our Coasts program authorized a $200 million bond issue for purchase of sandy beaches, barrier islands, and beach access points. Through July 1986, the program had purchased 2,713 acres of coastal land, representing 13 miles of shoreline (Florida Atlantic University, 1986). The state's coastal acquisition efforts target areas where the local government is willing to make a financial contribution to purchase the land and to manage it after it is acquired. Parcels in areas with a need for additional recreational beaches and sites susceptible to repeated erosion are also the focus of the acquisition program (Glassman, 1983).

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Massachusetts

Introduction

Periods of glacial advance and retreat that ended 12,000 years ago sculpted the tidal coastline of Massachusetts into a mosaic of bays, islands, headlands, and moraines. Glacial relics include a chain of drumlins in Boston Harbor; moraines forming portions of Cape Cod, Nantucket, Martha's Vineyard, and the Elizabeth Islands; and the narrow peninsulas and estuaries that dissect the shore of Buzzards Bay. The coastline along the Massachusetts mainland is geologically dissimilar from the shores of Cape Cod and the islands. Much of the mainland coast comprises erosion-resistant headlands, barrier spits, and coastal banks, while barrier beaches and erodible bluffs make up most of the ocean-facing coasts of the cape, Martha's Vineyard, and Nantucket (Benoit, 1989). Over two-thirds of the state's 18,888 acres of coastal barriers are located on Cape Cod and those islands (Hankin, Constantine, and Bliven, 1985).

Approximately 360 miles (27%) of the 1,500-mile Massachusetts coastline is protected from development. One-fourth of this protected shoreline is federally owned, largely in the Cape Cod National Seashore and the Parker River National Wildlife Refuge. The state owns about 18% of the total protected shoreline, and county and municipal governments own approximately 36%. The remaining protected coastline is owned by private, nonprofit organizations (Massachusetts Department of Environmental Management, 1990). Except for portions of Martha's Vineyard and Nantucket, much of the state's unprotected oceanfront is developed. In particular, the coastline in the Boston metropolitan area is extensively developed as well as heavily stabilized with revetments and bulkheads (Benoit, 1989).

The Massachusetts shoreline is vulnerable to hurricanes and to northeasters. The latter occur in New England an average of once or twice a year (Benoit, 1986). Because northeasters occur so frequently and because 40% of the state's population lives in coastal communities, a great number of people and thousands of structures are at risk from such storms (Smrcina, 1988). Conversion of small summer cottages to large year-round residences as well as infill development on partly developed sections of the shoreline are increasing the number of people living along the shoreline (Steve Bliven, Massachusetts Office of Coastal Zone Management, personal communication, June 1990). The Blizzard of 1978 destroyed over 2,000

houses and caused 29 deaths and more than $300 million in damage in the state (Platt and McMullen, 1980; Kusler, 1983; Smith, 1983). Following the storm, FEMA acquired and removed 28 chronically flood-prone structures located on coastal barriers in the towns of Scituate and Hull and conveyed the barriers to those towns as permanent open space (Smrcina, 1988). This token effort, funded by Section 1362 of the National Flood Insurance Act, was offset by construction of larger, more valuable structures on adjoining sites.

In addition to the storm surges and high winds accompanying coastal storms, erosion resulting from storms and sea level rise also threatens structures along the Massachusetts coast. Cape Cod and the islands, which are highly dynamic landforms, are eroding at especially high rates. The average annual erosion rates for nearly all of Cape Cod's ocean beaches range as high as four feet per year. The south shore of Nantucket Island appears to have among the highest erosion rates in the state, with some stretches eroding at an average rate of 11.5 feet per year (Benoit, 1989). These are natural rates of erosion, not the result of shoreline modification.

Coastal Zone Management Program

The Massachusetts Coastal Zone Management (MCZM) program received federal approval in 1978. In 1983 the state legislature formally established the Massachusetts Office of Coastal Zone Management within the Executive Office of Environmental Affairs. Prior to the inception of MCZM, the state's involvement in reduction of coastal hazards was limited primarily to planning and funding shoreline protection structures (Clayton, 1983).

The geographic extent of the Massachusetts coastal zone, as defined in the MCZM Plan, extends from the seaward limit of the state's territorial jurisdiction inland to 100 feet landward of specified roads and rights-of-way (301 Code of Massachusetts Regulations 20.03). The MCZM program used roads and rights-of-way to define the inland limit of the coastal zone because they are easily recognizable boundaries. Specific roads or rights-of-way were chosen in order to approximate the inland edge of natural coastal systems and to include other land that could affect coastal resources (National Oceanic and Atmospheric Administration, 1978). The coastal zone encompasses all intertidal areas, coastal wetlands, beaches, and islands, including all of Cape Cod, Nantucket, Martha's Vineyard, and the Elizabeth Islands.

The MCZM management plan, written in 1978 and presently being revised, sets forth 27 major policies for use and management of the state's coastal areas. These policies reflect the state's management priorities and are used to guide the actions of state regulatory programs within the coastal zone (Smrcina, 1988). Several of the policies address coastal erosion hazards, such as: 1) protecting ecologically significant resource areas such as dunes and beaches for their value as storm buffers; 2) only approving permits for flood or erosion control projects that will have "no significant adverse effects on the project site or adjacent or downcoast areas"; 3) ensuring that state and federally funded projects lying within the 100-year coastal floodplain will "a) not exacerbate existing hazards or damage natural buffers, b) be reasonably safe from flood and erosion related damage, and c) not promote growth and development in damage prone or buffer areas"; and 4) encouraging "acquisition of undeveloped hazard-prone areas for conservation or recreation use, and" providing "technical assistance for hazard area zoning and mitigation of erosion problems" (NOAA, 1978).

Despite these policies, Massachusetts has not enacted legislation that specifically addresses and regulates erosion-hazard areas. The coastal policies are, therefore, implemented primarily through legislation that deals indirectly with coastal erosion, particularly the Wetlands Protection Act and the Coastal Wetlands Restriction Act.

Wetlands Protection Act

The Massachusetts Wetlands Protection Act (WPA) (MGLA Ch. 131, Sec. 40) regulates development within or adjacent to coastal and inland wetlands and other sensitive areas. The act does not prohibit development in such areas, but sets specific performance standards for new construction. The act defines coastal resource areas to include coastal wetlands, beaches, dunes, and other "land subject to tidal action, coastal storm flowage, or flooding," and land within 100 feet of such areas (131/40). Prior to any alteration of or building on coastal resource areas, a Notice of Intent must be filed with the appropriate municipal conservation commission. The conservation commission then determines whether the proposed project area is a "significant resource area" that should be regulated. When evaluating the significance of a site, the conservation commission must consider flood control and storm damage prevention. If the commission determines that the area is significant, the construction project must meet state standards established for that particular type of resource area. Although the state sets the performance standards, local conservation commissions have primary responsibility for administering and enforcing the act.

Regulations for the WPA established by the Massachusetts Department of Environmental Management spell out the specific standards for each category of resource area and for land within 100 feet of the resource area (310 CMR 10.02). The regulations set standards for the various resource areas, which include 1) coastal beaches, which extend from mean low water to the seaward edge of a dune line, coastal bluff line, or line of existing anthropogenic structures; 2) coastal dunes; 3) barrier beaches, which are defined to include the entire coastal barrier; and 4) coastal banks, which

are defined as the seaward face of an elevated landform adjacent to land subject to tidal action (310 CMR 10.27, 10.29, and 10.30).

The performance standards for resource areas considered to be significant for flood control or storm damage prevention are outlined below. On coastal beaches, all projects (except for erosion control structures that minimize adverse effects on erosion) must meet two requirements: 1) projects shall not have any "adverse effect by increasing erosion, decreasing the volume or changing the form of . . . a coastal beach or an adjacent or downdrift coastal beach"; and 2) any erosion control structure that interferes with littoral drift must meet the above regulation and other specific construction requirements (310 CMR 10.27). Any alteration of or construction on a coastal dune must not 1) adversely affect the ability of waves to remove sand from the dune, 2) disturb stabilizing vegetation, 3) increase the potential for storm or flood damage, or 4) interfere with dune migration (310 CMR 10.28). All the regulations pertaining to coastal beaches and dunes apply to barrier beaches (310 CMR 10.29). On coastal banks that are critical for storm damage prevention or flood control, construction must comply with the following regulations: 1) coastal engineering structures are prohibited except to prevent damage to buildings constructed prior to the effective date of the regulations, and 2) no structure on or 100 feet landward of a coastal bank may have an adverse effect on the sediment movement and stability of the bank (310 CMR 10:30).

Coastal Wetlands Restriction Act

The Coastal Wetlands Restriction Act (130/105), unlike the Wetlands Protection Act, explicitly authorizes the Department of Environmental Protection (DEP) to prohibit conversion or encroachment upon specified coastal wetlands. Under the Wetlands Restriction Program, the DEP identifies specific critical areas and then, after public hearings have been held, places restricting orders in the appropriate deeds. The coastal areas that can be regulated under the act include all "land subject to tidal action or coastal flowage and . . . contiguous land," such as dunes, salt marshes, and beaches (130/105). Although coastal erosion rates are not considered when determining which areas to restrict, some of the types of restricted areas tend to be erosion-prone.

As of early 1991, restrictive orders have been placed on private wetlands in 47 cities and towns. The Wetlands Restriction Program was dormant during the later 1980s, but was reactivated in 1990. A comprehensive inventory of the state's resource areas has been initiated by the Department of Environmental Protection (Charles Costello, Massachusetts Department of Environmental Protection, personal communication, May 1990).

Barrier Beach Executive Order

In 1980 Governor King issued Executive Order 181, which set forth state policy for managing barrier beaches. In the Executive Order, the governor pointed out that barrier beaches play a key role in storm damage prevention and flood control and concluded that "inappropriate development on barrier beaches has resulted in the loss of lives and great economic losses to residents and to local, state and federal governments."

The order mandates all appropriate state agencies to adopt the following policies: 1) make barrier beaches a priority in acquisition programs, 2) use disaster assistance funds to relocate willing sellers from storm-damaged barrier beaches, 3) do not use state and federal funds for construction projects that encourage growth and development in hazard-prone barrier beach areas, 4) make management plans for state-owned barrier beaches consistent with state wetland policy, 5) do not permit development in velocity zones or primary dunes areas of barrier beaches, and 6) use coastal engineering structures only on barrier beaches to maintain navigation channels at inlets and only if downdrift beaches are adequately supplied with sediment. Although the order directs state agencies to follow these management and acquisition priorities, it does not provide the state with any specific authority for regulating private or municipal uses of barrier beaches. The order has, however, enabled the Massachusetts Office of Coastal Zone Management to prevent other state agencies from building sewer lines, water supply systems, and other infrastructure that would encourage development on coastal barriers (Steve Bliven, Massachusetts Office of Coastal Zone Management, personal communication, June 1990).

Coastal Acquisition

In 1978 the Department of Environmental Management (DEM) initiated the Coastal Acquisition Program. By 1990, 1,568 acres of coastal land, at a cost of about $22 million, had been protected from development (Brown, 1990). Since the inception of the program, the number of coastal state parks has grown from eight to 16. DEM owns approximately 32 miles of coastal frontage, half of the 64 miles owned by all state agencies combined (Massachusetts DEM, 1990). Municipal governments own approximately 28 miles of the Massachusetts coast, some of which were acquired through a state self-help land acquisition program.

State Building Code

The Massachusetts State Building Code (780 CMR 744.0) requires that new construction or substantial improvements of existing structures within coastal high hazard areas must meet specific building requirements. In particular, buildings in high hazard areas must 1) be elevated on anchored

pilings so that the lowest part of the bottom floor is elevated above the 100-year storm level, and 2) be securely anchored to withstand high velocity winds and hurricane wave wash (Benoit, 1986).

Erosion Mapping

The MCZM program has mapped historical changes in the state's shoreline and determined average annual erosion and accretion rates for the entire coast. The program staff have generated 231 maps at 1:5,000 scale by analyzing recent and historic maps and aerial photographs of the Massachusetts coast. Each shoreline change map charts two or three historical shorelines as well as the present location of the coast. The MCZM staff used National Ocean Survey topographic maps, hydrographic maps, FEMA flood insurance topographic maps, orthophotos, USGS topographic quadrangles, and aerial photographs to determine the location of the Massachusetts shoreline over the last 140 years (Benoit, 1989). At present, these maps are not used to regulate use or construction within eroding areas. The state has not initiated mandatory setbacks for new construction in identified erosion-prone areas, but most of these are already developed or publicly protected.

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Michigan

The Physical Setting

The Michigan shoreline, with a total mainland coast of more than 2,200 miles, borders on Lakes Erie, Huron, Superior, and Michigan. Great Lakes islands account for another 1,000 miles of lakefront (Jannereth, 1983). Unconsolidated bluffs, windblown and vegetated dunes, sandy beaches, and rocky cliffs form Michigan's varied shoreline. The extent and pressure of shoreline development also varies, being slight along the Upper Peninsula and greater in southern sections of the Lower Peninsula. Residential development occupies nearly one-third of the state's lakeshore. Commercial and industrial development account for about 5%, and forests, farmland, parks, and wildlife refuges occupy the remainder of Michigan's shoreline (Michigan Department of Natural Resources (DNR), 1973).

Fine, white, sandy beaches extend along the western shore of the Lower Peninsula on Lake Michigan. The location and size of these beaches varies over time due to changes in patterns of erosion and deposition and lake level fluctuations. Low, vegetated, or high, windblown dunes are often located behind the beaches (Sommers, 1984). Because in part of its beautiful beaches, the southern portion of this coastline has experienced a significant amount of residential shoreline development.

Michigan's Lake Huron shoreline, located on the eastern side of the Lower Peninsula, comprises approximately 634 miles of mainland lakefront and 347 miles of island shore. Although residential development borders approximately 42% of Lake Huron's shoreline, this part of Michigan's lakefront also contains valuable waterfowl marshes. Metropolitan Detroit, located between Lake Huron and Lake Erie, is the only major urban center along Michigan's lakeshore. Approximately half of the Lake St. Clair/Lake Erie portion of Michigan's shore is developed, largely on artificial fill (Michigan DNR, 1973; Great Lakes Basin Commission, 1975; 1976).

Michigan's Upper Peninsula, which borders Lake Superior to the north and Lake Michigan to the south, is characterized largely by low-lying, wet areas. Seventy-four percent of Lake Superior's gently sloping shoreline supports boreal forest. Only about 12% of this shoreline is developed. Approximately one-quarter of Michigan's Lake Superior shoreline is in public ownership, including the high sand dunes and exposed sedimentary rock formations of Pictured Rocks National Lakeshore (Michigan DNR, 1973; Great Lakes Basin Commission, 1976).

Approximately 75% of Michigan's Great Lakes shoreline is erodible (Jannereth, 1983). The unconsolidated bluffs found along Lakes Michigan, Superior, and Erie are particularly prone to erosion. On the eastern side of Lake Michigan, dune erosion and bluff failure are serious problems. Shoreline erosion is also locally severe on the western shores of Lake Erie and Lake St. Clair (Great Lakes Basin Commission, 1976). Lakeshore areas that are receding at rates exceeding one foot per year are generally found along the eastern shore of Lake Michigan, portions of the western shore of Lake Huron and, to a lesser extent, along the western side of Lake Superior's southern shoreline. Many of the state's islands consist of erosion-resistant bedrock and are not eroding seriously. The few islands that do suffer from severe erosion are largely uninhabited and in public ownership, such as the islands lying within Sleeping Bear National Lakeshore.

Erosion along Michigan's Great Lakes is largely wave induced and, therefore, is most serious during periods of high water.[2] Even low energy waves can create severe erosion when lake levels are elevated. Periodically the Great Lakes exhibit extremely high and low lake levels, causing incidents of flood and erosion damage. In the early 1950s high water levels contributed to millions of dollars of property damage. By the early '60s the water had receded to a relatively low level, but by the late '60s and early '70s the lakes had reached century-high levels (Jannereth, 1983). At present, lake levels are again about average, following another high water period in the mid-80s. A preliminary survey has found that from 1985 to 1987 erosion and flooding caused damages of $222 million (National Research Council, 1990).

Shoreline Protection and Management Act

To protect its Great Lakes shoreline from environmental degradation and to reduce erosion and flood hazards, Michigan enacted the Shorelands Protection and Management Act (SPMA) in 1970 (Act 245, Ch. 281). The act has since been amended, and regulations pertaining to the act have been promulgated. However, because of lack of state fiscal support for the act, funds for implementing SPMA have come primarily from the federal Coastal Zone Management Program (Jannereth, 1983).

SPMA mandated the Michigan Department of Natural Resources (DNR) to identify and regulate three types of areas: 1) high risk areas, 2) environmental areas, and 3) flood risk areas. High risk areas are those parts of the Great Lakes shore that the state Natural Resources Commission has determined "on the basis of studies and surveys to be subject to erosion" (sec. 281.632). SPMA defines "environmental areas" as those parts of the shoreland "necessary for the preservation and maintenance of fish and wildlife" (sec. 281.632). "Flood risk areas" are those areas of the shore "subject to flooding from effects of levels of the Great Lakes" (sec. 281.632).

SPMA required the DNR to prepare plans for the use and management of these three types of shoreland, but left many of the details of such plans to the discretion of the agencies. The legislature did, however, mandate that the DNR "provide criteria for shoreland alteration control [and] provide for building setbacks from the water" (sec. 281.642). Consequently, the 1981 SPMA regulations define high-risk areas and set forth rules regarding setback and shoreline control structures in these areas.

2. Unless otherwise attributed, the following program description and analysis is based on telephone interviews with Martin Jannereth, Michigan Department of Natural Resources, between January and April 1990.

High-Risk Erosion Areas

The 1981 SPMA rules required the department to designate those portions of the Great Lakes coastline where "bluffline recession has been occurring at an average annual rate of 1.0 foot or greater per year, based on a minimum period of 15 years" as "high-risk erosion areas". Within these areas the state was required to determine setbacks "based on a projected 30-year period of bluffline recession" (Michigan Rule 281.22). The rules also mandated that, within zones designated as high-risk erosion areas, new permanent structures could not be installed and existing structures could not be moved lakeward of the setback line.

The DNR has documented average long-term erosion rates for the entire Michigan shoreline and has classified approximately 350 miles of the coast as high-risk erosion areas (National Research Council, 1990). Eroding bluffs are found along most of the designated coastline (McShane, 1988). Under the current rules, a high-risk area can extend from the mean high water line up to 1,000 feet inland from the bluffline (McShane, 1988). All lots lying completely or partly lakeward of the setback line are designated as high-risk areas. All new structures and additions within these areas must be setback from the receding bluffline for a distance that will protect them for at least 30 years; therefore, the setback line is a distance equal to 30 times the long-term annual erosion rate (Rule 281.22).

Prior to officially designating land as a high-risk erosion area, the DNR seeks input from local governments and invites all affected property owners to a meeting to discuss the impacts of the classification. After a comment period, the DNR sends official letters of designation to the affected property owners and local governments. Landowners can then formally appeal the high-risk classification. However, such appeals have occurred in less than one-half of 1% of all cases (Jannereth, 1983). After land is formally designated as high-risk, the state reviews all new construction on the site.

Existing structures in high-hazard areas located in front of the setback line cannot be "altered, enlarged or otherwise extended in a manner which increases its nonconformity" (Rule 281.22). In other words, existing structures cannot be moved lakeward and new additions must be located landward of the setback line. Furthermore, if a nonconforming structure deteriorates or is damaged to the extent that the cost of repair exceeds 60% of the building's replacement value, the regulations for new, permanent structures apply. If the cost of repair is less than 60%, the owner can restore the building to its previous condition (Rule 281.22).

If a property is not deep enough to meet the setback requirements, the state may permit the landowner to construct a movable structure lakeward of the setback line. Such an exception is only granted if 1) the waste-handling system is located landward of the structure, 2) the movable structure is located as far landward of the eroding bluffline as local zoning restrictions will allow, and 3) the building is "designed and constructed in accordance with proper engineering standards" (Rule 281.22). In addition, when the structure is moved, the landowner must remove all construction materials, including building foundations, from the site.

If the access route is too narrow or steep for a structure to be moved off the site, the state may allow the landowner to construct an erosion control device. The state will only consider granting a permit for the construction of a shore protection structure after all other options are exhausted (Jannereth, 1983). Furthermore, such an exception can be granted only if the building proposal meets the zoning and sewer requirements outlined above and if the erosion control structure meets or exceeds Great Lakes engineering standards (Rule 281.22).

Under SPMA, local governments may adopt their own shoreline zoning requirements. All such ordinances and amendments must, however, be reviewed and approved by the DNR. If local regulations gain the state's approval, the municipality reviews permits within its jurisdiction. Seven Michigan communities administered their own shoreline regulations in 1988 (Association of State Floodplain Managers, 1988). To ensure that their performance and regulations are consistent with SPMA rules, the DNR periodically reviews the actions of these local authorities (National Research Council, 1990).

Erosion Mapping

To determine the annual long-term erosion rates necessary for classifying high-risk erosion areas and delineating shoreline setbacks, the DNR surveyed the entire mainland shore and many of the islands. The DNR superimposed current and historic aerial photographs to determine the extent of shoreline retreat over periods of 15 to 40 years (Jannereth, 1983). By measuring erosion at different times, the average long-term rate incorporated recession rates that occurred during periods of high and low

water (National Research Council, 1990). Recession rate transects were measured from 100 to 750 feet apart, depending on the variability of the retreat for the particular strip of shoreline (Jannereth, 1983). For continuous lengths of lakeshore, recession rates of similar magnitude were averaged (Jannereth, 1983).

Revised Rules

New SPMA regulations were adopted in February 1992. Some of the major changes are outlined below.

The new rules include a much-expanded definition of "bluffline" that applies to a variety of shoreline types, including those without bluffs. In the new rules, a bluffline is defined as the "line on the elevated segment of the shoreland which is landward of the beach and which is the farthest landward extent of active erosion" (Rule 281.21). Where an "elevated segment" is not present, the bluffline is "the lakeward line of continuous, terrestrial vegetation." Where dunes and not bluffs exist, the bluffline is considered to be the base of the dune. This new definition will ensure that the setback is measured from the landward edge of active erosion, regardless of the site's physical features.

For high-risk erosion areas, the DNR will designate a "zone of imminent danger," that is, "the area landward of the bluffline where erosion is anticipated within the next 10 years" (Rule 281.21). To delineate the zone, the DNR will consider long-term annual erosion rates, bluff height, slope and composition, extent of vegetation, the presence of shore protection structures, groundwater seepage, lake levels, and the presence and extent of beach (Rule 281.21). Because other portions of the new rules would loosen some construction requirements, the DNR feels that the delineation of the zone of imminent danger is necessary to ensure the safety of both existing and new structures.

To ensure that buildings will not be threatened by dramatic erosion events, the new regulations mandate a procedure that the DNR has been undertaking informally—adding an additional 15 feet to all setback requirements (Rule 281.22). The DNR feels that this increased setback is necessary to account for severe short-term erosion resulting from landslides or high water.

The new regulations permit homeowners to construct additions to existing, nonconforming houses; however, several restrictions would apply. An addition would be permitted only if 1) the existing building and the addition are readily movable, 2) the addition does not reduce the structure's distance from the bluffline, and 3) the existing structure is not in the zone of imminent danger (Rule 281.22). If a nonconforming structure and the proposed addition are not readily movable, the footprint of the addition must not exceed 25% of the building's foundation size.

The new regulations also allow reconstruction of substantially damaged or deteriorating, nonconforming, existing structures. If such a damaged building requires repairs equal to between 60% and 100% of its replacement value, the structure can be rebuilt if: 1) the permanent structure was damaged by a force other than erosion, 2) the building is not reconstructed in the zone of imminent danger, and 3) the reconstructed building is readily movable (Rule 281.22). If, however, a building is completely destroyed, requirements for new structures remain in force.

Some of the DNR's proposed regulations for new buildings are now stricter. Notably, the new regulations make a distinction between large and small structures. A small building is defined as one with "a foundation size of 3,500 square feet or less and fewer than 5 individual living units" (Rule 281.21). All other buildings are considered to be large structures. Within high-risk erosion areas, the minimum setback would be doubled for all large buildings. New, small, permanent structures must also meet new requirements. Buildings that are built between the setback line and a distance equal to twice the minimum setback line must be readily movable. Exceptions to this rule are made only if the site is too narrow or steep for a building to be moved off the site (Rule 281.22).

The new rules would also change regulations pertaining to the construction of erosion control structures. In addition to the state's existing requirements, control structures must be designed to meet or exceed a 20-year storm event for small buildings and a 50-year event for large structures. Furthermore, buildings will have to be constructed at least 30 feet from the erosion-control device and landward of the zone of imminent danger. In order to build a structure to protect a large building, the owner is required to establish an escrow account for maintenance of the erosion control device and place a notice in the deed that the setback has been waived (Rule 281.22). Under the new regulations, local governments would be allowed to install a shore protection structure if the project meets the requirements for protection of large buildings and if a greater public good will result from constructing the device.

Sand Dunes Protection and Management Act

In July 1989, Michigan enacted two statutes (Public Acts 146 and 147) that amended and added force to the 1976 Sand Dunes Protection and Management Act (Public Act 222). Together the two statutes established protection for the state's "critical dune areas." Public Act 146 specified administrative procedures, while Public Act 147 provided a model zoning plan for sand dune protection. Because not all critical dune areas were regulated under SPMA, these acts provided necessary regulation of erosion-prone dunes that would not otherwise be protected. In particular, dunes within two miles of the high water mark of the Great Lakes were regulated under the sand dunes acts (Ch.4, Sec.2 of P.A. 222, as amended by P.A.s 146 and 147; Ch. 1, Sec. 2), while SPMA's high-risk erosion areas extended only 1,000 feet inland.

The sand dunes acts gave communities the option to create and implement a sand dune protection zoning ordinance that provides equal or greater protection than the state's model plan (3/16). If local governments do not adopt their own regulations, the DNR has permitting authority for uses of critical dune areas within those communities. The DNR periodically reviews the performance of approved local ordinances to ensure that they are consistent with the acts (3/22).

A landowner proposing any use within a critical dune area, as defined by DNR's 1989 atlas, must file an application with the local government or the DNR, depending on which body has permitting authority for that community (3/16). Decisions to grant or deny permits must be based on the model zoning plan or approved local ordinances (3/16). Communities and the DNR may also regulate lands within 250 feet of the critical dune area if they are found to be "essential to the hydrology, ecology, topography, or integrity of a critical dune area" (4/31).

The state's model zoning plan limits construction within critical dune areas in several ways. Landowners cannot build structures on slopes of 18% to 25% unless their plans are prepared by a registered architect or engineer. Building is forbidden on slopes greater than 25%. The zoning plan also prohibits silvicultural practices; removal of vegetation; or contour changes likely to increase erosion, decrease stability, or are more extensive than necessary for the proposed use (4/35). A less clear regulation states that uses "not in the public interest" are prohibited in critical dune areas. To determine whether a proposed use is in the public interest, the governing authority must consider the availability of alternative sites or methods and the extent to which impacts can be minimized (4/35).

The model zoning ordinance requires that all new structures must be located behind the crest of the first landward ridge of a critical dune. If construction is to occur within 100 feet of the dune crest, the proposed use must meet specific standards that will ensure that the dune's stability is not threatened (4/35). In addition, the acts define and regulate "special use projects" within critical dune areas. Such projects include 1) any industrial or commercial use, 2) multifamily uses of more than three acres, 3) multifamily uses on less than three acres where density is greater than four residences per acre, and 4) any use that would "damage or destroy features of archaeological or historical significance" (1/2a). A community with an approved zoning ordinance reviews special use project applications and forwards its opinion to the DNR. The DNR then reviews the community opinion and the proposal, as well as all other special use projects proposed for communities without approved sand dune ordinances (4/40).

Variances to the regulations outlined above may be issued if "an unreasonable hardship will occur to the owner of property if the variance or special exception is not granted" (4/36). A variance to the setback requirement will only be granted if the property is: 1) a nonconforming lot that was recorded prior to the adoption of the act, 2) a lot that has become nonconforming because of erosion, or 3) a property on which the base of the first landward dune is located 500 feet inland from the first foredune or line of vegetation (4/36). In addition, a nonconforming structure that was built prior to the enactment of this act and is destroyed by fire or forces of nature other than erosion may be rebuilt within the critical dune area (4/41).

Emergency Programs

From 1985 through February 1987, the Michigan DNR administered the Great Lakes Emergency Home Moving Program and the Great Lakes Flood Protection Program. These emergency programs were undertaken during a period of extremely high water levels in the Great Lakes. Through direct lending institutions, the state provided low-interest loans to property owners for relocation and protection of houses that were in danger of being destroyed by coastal erosion or flooding. The programs granted subsidies on loans up to $25,000, with the average subsidy totaling approximately $3,000.

The flood program provided loans to improve, relocate, or reconstruct sewers in flood-prone areas and to raise structures above the 100-year flood elevation. The Home Moving Program granted loans for relocation of structures imminently threatened by shoreline erosion. Under the latter program, 72 of the eligible applicants chose to protect their houses, receiving subsidies totaling $267,000. Sixty-four of the subsidies were used for relocation of structures and eight for construction of shore-protection devices. Shore protection structures were only funded if the threatened building could not be protected by other means (Congressional Research Service, 1987). (See a more detailed discussion of this program in Chapter 6).

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New Jersey

Introduction

New Jersey's 130-mile ocean coastline consists largely of barrier islands, spits, and beaches, many of which are artificially stabilized. Mainland beaches extend from Sandy Hook south to Point Pleasant, just north of Bay Head. Ten long, narrow barrier islands presently line the remainder of New Jersey's Atlantic shore from Bay Head to Cape May.

Since the mid-19th century, New Jersey's communities have attempted to stabilize their shifting shoreline by installing groins and bulkheads. Today more than 300 groins and 12 miles of massive seawalls are located along New Jersey's oceanfront. Over half of the state's ocean inlets are controlled with jetties or are regularly dredged (Nordstrom, 1987).

Beach renourishment and restoration projects have been undertaken to preserve many of the state's remaining beaches and to protect coastal development without installing additional shoreline hardening structures. The beaches at several resort areas, including Atlantic City, Barnegat Light, and Ocean City have been renourished (Nordstrom et al., 1986). Over 1 million square yards of sand was added to the beach at Ocean City in 1983, at a cost of $5.5 million. Within a few years after the project was completed, storms removed and redistributed much of the sand. The renourishment project did, however, temporarily protect buildings located behind the restored beach (Nordstrom et al., 1986).

New Jersey's coastal region is extensively developed and has become a major recreational area because, in part, of its accessibility to the New York and Philadelphia metropolitan areas (National Research Council, 1990). On New Jersey's Long Beach Island, for example, the year-round population of 6,500 swells to more than 500,000 during the summer (New Jersey Division of Water Resources, 1986). All of New Jersey's barrier islands are now developed and many are being redeveloped at higher densities as multiple-unit condominiums replace single-family houses (Ehinger, 1986; Nordstrom et al., 1986). About 25 miles of New Jersey's oceanfront have been permanently protected from development through public ownership (Mark Mauriello, New Jersey Department of Environmental Protection, personal communication, May 1990). This protected land lies primarily within the Gateway National Recreation Area on Sandy Hook, Island Beach State Park, and the Brigantine National Wildlife Refuge.

Except for areas of localized accretion due to erosion control structures, nearly all of New Jersey's oceanfront, from Sandy Hook to Cape May, is eroding at a rate of one to four feet per year. New Jersey's most erosion-prone coastal areas include Sandy Hook, Margate to Ocean City, Strathmere to Sea Isle City, and the southern tip of Cape May. In contrast, the oceanfront from Point Pleasant to Barnegat Inlet appears to be stable, or even accreting, perhaps due to the presence of substantial sand sources and protective dunes (Mauriello, 1989). Extensive stabilization of the shoreline, particularly from Sandy Hook to Manasquan Inlet, renders measurement of long-term erosion rates problematic (Mauriello, letter, 3/13/90).

Billions of dollars of private and public facilities and thousands of lives are at risk from coastal storms along the New Jersey coast (New Jersey Department of Environmental Protection, 1986). The state's shoreline is vulnerable to both hurricanes and northeasters. In recent years, northeasters have caused more damage in New Jersey than hurricanes, which strike the New Jersey coast about once a decade. Although a Class V hurricane is meteorologically possible, no hurricane greater than Class III has hit the New Jersey coast since 1900 (New Jersey Department of Environmental Protection, 1986). The potential for storm-caused damage is great due to the combination of dense oceanfront development, large summer populations, and limited evacuation opportunities (Nordstrom et al., 1986).

Coastal Management Program

New Jersey's coastal zone includes not only the Atlantic shoreline, but also estuaries, bays, riverfronts, and major watershed areas. The coastal zone reaches landward from about one to 25 miles inland from tidal waters, encompassing approximately one-fifth of New Jersey (Kinsey, 1985; Mauriello, personal communication, May 1990). The landward limit of the coastal zone is usually delineated by a roadway or railway right-of-way that parallels the shore, but along major rivers, the zone extends inland to encompass important drainage areas. Four counties containing 45 coastal municipalities are located on New Jersey's oceanfront: Cape May, Atlantic, Ocean, and Monmouth counties (Ehinger, 1986). Forty-seven New Jersey municipalities lie along the shores of Delaware Bay, Great Bay, Barnegat Bay, and other tidal rivers and estuaries (Gilman, 1983).

Within the coastal zone, the Department of Environmental Protection's Division of Coastal Resources has a broad mandate. The division's responsibilities include planning and permitting of land development and enforcement of tidelands and shoreline laws. The division also undertakes coastal engineering projects and provides technical assistance and funding to local governments (Kinsey, 1985). The overall goals of the coastal management program are to 1) protect the coastal ecosystem; 2) concentrate patterns of coastal residential, commercial, industrial, and resort-related development and encourage open space preservation; 3) make decisions that ensure each coastal location is evaluated in terms of the advantages and disadvantages it offers for development; 4) protect the health, safety and welfare of people in the coastal zone; 5) promote public access to the waterfront; 6) maintain active port and industrial facilities; 7) maintain and upgrade existing energy facilities and site new facilities as needed; and 8) encourage residential, commercial, and recreational development (Nordstrom et al., 1986).

The Division of Coastal Resources regulates development within the coastal zone primarily through three laws: the Waterfront Development Act of 1914 (NJSA Title 12: Ch. 5, Sec. 3); the Wetlands Act of 1970 (NJSA 13:19A-1); and the Coastal Area Facility Review Act of 1973 (CAFRA) (NJSA 13:19-1). The oldest of these, New Jersey's Waterfront Development Act, was first passed in 1914 and subsequently amended. This act requires prospective developers to obtain a permit from the state for all proposed development located on navigable waters (Nordstrom et al., 1986). Until 1988, the act only applied to construction undertaken below mean high water. Through this act the state has regulated development of docks, wharves, piers, bulkheads, bridges, and other structures located seaward of mean high water (New Jersey Department of Environmental Protection, 1986).

The New Jersey Wetlands Act was first enacted in 1970 and last amended in 1983. The act provides the Department of Environmental Protection (DEP) with the authority to regulate, restrict, or prohibit "dredging, filling, removing or otherwise altering, or polluting, coastal wetlands" (Ch. 19A, Sec. 2). No regulated activity can legally take place in a wetland without a DEP permit (19A/4). Since passage of the Wetlands Act, the amount of tidal wetlands destroyed in New Jersey has dramatically decreased. Prior to passage of the act, nearly one-quarter of the state's wetlands were lost through dredging, filling, or diking (New Jersey Department of Environmental Protection, 1986).

Coastal Area Facility Review Act (CAFRA)

CAFRA, New Jersey's primary statute regulating coastal construction, states that the coastal zone should be

> dedicated to those kinds of land uses which promote the public health, safety and welfare, protect public and private property, and are reasonably consistent and compatible with the natural laws governing the physical, chemical and biological environment of the coastal area (19/2).

CAFRA mandates the Department of Environmental Protection to require permits for construction of all facilities within the coastal zone (19/5). Facilities are defined to include power plants; industrial uses; public

facilities, such as wastewater treatment plants, airports, highways, and sewer lines; and housing developments of 25 or more units (19/3).

CAFRA also requires the Department of Environmental Protection to prepare an inventory of the environmental resources, existing facilities, and land uses within the coastal area and to estimate the capability of coastal regions to "absorb and react to [human-caused] stresses" (19/16). CAFRA instructs DEP to use this information to develop "an environmental design for the coastal area" (19/16).

Although CAFRA is the state's main authority for regulating development within the coastal zone, it only applies to residential developments containing more than 24 dwelling units and commercial facilities generating 300 or more parking spaces. CAFRA's inability to regulate most residential and commercial developments renders it inefficient in limiting future storm damage (Weingart, 1983).

Emergency Rule Amendments

To remedy the Department of Environmental Protection's lack of authority for regulating small and medium-sized developments under CAFRA, the state adopted emergency amendments to the coastal development rules in 1988. The governor concurred with the department that "the current and imminent threat of continued development in land areas adjacent to the State's tidal water, beaches, dunes and wetlands . . . poses an imminent peril to the public health, safety and welfare and the environment" (Daggett, 1988). These emergency amendments were invalidated by the New Jersey Supreme Court on June 20, 1990. However, less than a month after this decision was handed down, Governor Florio adopted revised emergency amendments that address the objections raised by the Supreme Court. As did the 1988 amendments, this set of amendments enables DEP to regulate almost all developments in the coastal zone.

The emergency rule amendments expand the scope of the Waterfront Development Law to include upland portions of the area regulated under CAFRA. Under the new amendments, the regulated waterfront area extends 500 feet inland from the mean high water line, the most inland oceanfront beach, or the most inland oceanfront dune, whichever is farthest (7:7-2.3). Within this area, a permit for any construction, filling, or excavation is required. Prior to enactment of the emergency amendments, DEP could only regulate construction of major residential and commercial developments and shore protection structures built below high tide. DEP can now also regulate the siting and construction of new housing developments of less than 25 units, commercial facilities with less than 300 parking spaces, and shore protection structures built above the mean high water line (7:7-2.3). The emergency amendments have had a significant impact on the number of small developments, including single-family houses, constructed within the coastal zone. Prior to the amendments, such construction was unregulated and could legally take place on coastal dunes and eroding beaches (Mauriello, personal communication, May 1990).

The legislature is expected to amend CAFRA to give DEP much of the authority provided by the rule amendments. The new legislation will, however, probably compromise between CAFRA as it now stands and the emergency amendments (Mauriello, personal communication, April 1990).

Rules on Coastal Zone Management

DEP's Rules on Coastal Zone Management control the use and development of coastal resources under CAFRA, the Wetlands Act, and the Waterfront Development Act (NJAC 7:7E-1.1). The rules apply to the entire coastal zone, which is defined to include the "Coastal Area under the jurisdiction of CAFRA, all other areas now or formerly flowed by the tide, shorelands subject to the Waterfront Development Law, regulated Wetlands . . . and the Hackensack Meadowlands" (7:7E-1.2). The rules, which were last amended on August 20, 1990, establish a procedure for evaluating and regulating development within the coastal zone. Since the adoption of the emergency amendments in 1988, these rules apply to all coastal development.

Beaches, dunes, and "erosion hazard areas" are among the 45 "special areas" for which the rules provide specific management policies (7:7E-3.1). Erosion hazard areas are defined as "shoreline areas that are eroding or have a history of erosion, causing them to be highly susceptible to further erosion and damage from storms" (7:7E-3.23). Within erosion hazard areas, structures containing one to four dwelling units must be set back a distance equal to 30 times the annual erosion rate. For larger buildings, a 60-year setback is required (7:7E-3.19). The baseline from which the setback is measured depends on the physical character of the proposed development site. Depending on the particular site, the baseline is the crest of the coastal bluff, the dune crest, the first line of stable vegetation or, in areas without dunes, the landward edge of the beach or the eight-foot elevation line (7:7E-3.19).

Within erosion hazard areas, only specific categories of development are allowed. Linear developments (such as roads and sewer lines) that meet the policies set forth in the rules and shore protection activities that meet the appropriate coastal engineering policies are permitted. In addition, single- and two-family infill developments that meet the specific housing use policies included in the rules (7:7E-7.2) are permitted in erosion hazard areas. Construction of single-story, tourism-oriented commercial development is also allowed on existing municipal boardwalks in specified resort areas.

Development is prohibited on beaches and dunes except for uses that lack a "prudent or feasible alternative" and that will not cause "significant adverse long-term impacts" to the beach and dune system (7:7E-3.20 and 3.21). In evaluating impacts on beaches and dunes, the cumulative effects of existing developments and the proposed use must be considered. Certain uses and developments are specifically permitted, including removal of structures, dune fencing, planting of native dune vegetation, and reconstruction of existing amusement and fishing piers and boardwalks (7:7E-3.20 and 3.21).

The intensity of development permitted within the coastal zone is based on three ratings systems set forth in the rules: 1) coastal growth rating, 2) environmental sensitivity, and 3) development potential (7:7E-5.1). The rules divide the coastal zone into 14 areas to which the coastal growth ratings are applied. Each area is designated as: 1) a development region, with densely developed areas; 2) an extension region, with less built-up areas where uses should be channeled after full development of the development region; or 3) a limited growth region, which contains large areas of environmentally sensitive resources. In development regions, further development is favored over building in the other two regions. In extension regions, some infill and extension of development is allowed. Only infill development is usually permitted in limited growth regions (7:7E-5.3). The north shore region, which includes Sandy Hook and the mainland barrier beaches, is designated as a development region. The barrier island region, which includes the rest of the ocean shoreline, is considered an extension area. Within these broad regions, specific sites are further classified according to their environmental sensitivity and development potential.

Erosion Rate Mapping

The Coastal Resources Division has the ability to calculate long-term annual erosion rates for New Jersey's entire ocean coastline, for Raritan Bay, and for portions of Delaware Bay. These rates are used to determine the setbacks behind which new development must be sited. Erosion rates are determined on a site-by-site basis as they are needed (Mauriello, personal communication, April 1990). National Ocean Service topographic sheets, New Jersey orthophotos, and color-infrared aerial photos were used to determine historic recession rates. The earliest maps used to determine the erosion rates date from 1841 (Association of State Floodplain Managers, 1988; National Research Council, 1990). This data has been entered into a metric-mapping computer base that enables the division to plot any area along the coastline and produce an accurate, long-term shoreline change map.

Shore Protection Acts

The Beaches and Harbors Bond Act (P.L. 1978, ch. 157) galvanized state efforts to restore New Jersey's eroding beaches. The act instructed the Department of Environmental Protection to prepare a comprehensive Shore Protection Master Plan and provided $20 million for shore protection projects (Nordstrom et al., 1986). In 1983 an additional $50 million was appropriated under the Shore Protection Bond Act for erosion control and beach restoration projects (P.L. 1983, ch. 356).

The resulting shoreline master plan stresses the use of nonstructural approaches to beach erosion. The plan calls for renourishment and restoration of eroded beaches and dunes, rather than construction of jetties, groins, bulkheads, or revetments. To receive state shore protection funds, local governments must show compliance with DEP's rules on coastal zone management for beaches, dunes, public access, and erosion hazard areas. Towns seeking eligibility for state funds must adopt and enforce local ordinances that comply with state policies in these four areas. This compliance requirement ensures that the state does not fund shore protection projects in communities that permit construction on dunes and beaches, deny public access to the coast, and allow structures to be built too close to the ocean. The requirements apply to small projects, such as dune restoration, as well as to multimillion dollar renourishment projects (New Jersey Department of Environmental Protection, 1986).

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New York

Physical Settings

Ocean Shoreline

New York's 140-mile open ocean shoreline is located on the south shore of Long Island and its fringing barriers. The eastern third of this shoreline, from Southampton to Montauk Point, is characterized by coastal headlands, mainland beaches, coastal ponds, and barrier spits. The remainder of Long Island's ocean coastline between New York City and Southampton lies along five narrow barrier islands, bounded by six inlets.

The longest of the south shore barrier islands is Fire Island, which extends 32 miles from Fire Island Inlet to Moriches Inlet. Land use on Fire Island is a complex blend of preserved natural areas, recreational parks, and diverse seasonal communities. There is no lengthwise road, and the built-up communities are served by passenger ferries from mainland Long Island. Most of the island lies within the boundaries of the Fire Island National Seashore, which owns and manages certain areas and exercises limited jurisdiction over planning and redevelopment in the enclave summer communities. Long Island's two westernmost barrier islands, Rockaway Beach and Long Beach, are densely populated and have extensively armored shorelines. The oceanfront of Westhampton Beach, to the east of Fire Island, is developed at medium density with expensive seasonal homes. Following heavy damage caused by the 1962 Ash Wednesday storm, the Corps of Engineers constructed a total of 15 groins along much of the Westhampton Beach shoreline. Downdrift areas to the west of the groin field have since experienced accelerated erosion rates. Since 1982, 18 homes have been destroyed and another 30 rendered uninhabitable due to beach recession and frequent overwashes in that area (Long Island Regional Planning Board, 1989, pp. 3-31).

Long Island's ocean shoreline is highly vulnerable to hurricanes and coastal storms. Extensive development and limited evacuation routes increase the risk that storms pose to the island's inhabitants. The 1938 hurricane, which destroyed over 200 structures and killed 60 people on Long Island, illustrates the amount of damage that a storm can cause on the island (McCormick et al, 1984). Today, more than $10 billion of development on Long Island is at risk from a major coastal storm (New York Department of State, 1990).

Coastal erosion poses a threat to buildings along Long Island's south shore. Much of the island's oceanfront is eroding, in some areas as much as six feet per year (McCormick et al., 1984). Atlantic Beach, Long Beach, Ocean Beach, Westhampton Beach, Southampton, and East Hampton are among the south shore municipalities with average annual recession rates greater than one foot per year (New York Department of Environmental Conservation, 1989a). The locations of the municipalities listed above illustrate that high rates of coastal erosion are not limited to a particular part of Long Island's south shore, but that high recession rates are found along the length of the ocean shoreline.

The north shore of Long Island facing Long Island Sound largely consists of erodible bluffs composed of glacial till interspersed with coves and pocket beaches. Erosion is a less significant concern on this sheltered shoreline than along the ocean and Great Lakes.

Great Lakes

New York's Great Lakes shorelines extend along Lake Erie for 70 miles and for 210 miles along Lake Ontario. Low- to medium-height bluffs, some bordered by sandy beaches, characterize much of these shorelines. New York's Lake Ontario shoreline contains a significant area of high bluffs, chimney bluffs, and a unique sand-dunes complex. Portions of both of these areas are protected from development through state ownership (Diane Hamilton, New York Coastal Program, personal communication, August 1990).

Two large urban areas, Buffalo and Rochester, lie on New York's Great Lakes shorefront. Elsewhere, much of the lake frontage is lined with summer homes. Several state parks and wildlife refuges are also located on Lake Ontario and Lake Erie.

Shoreline erosion on the Great Lakes is due primarily to wave action. During periods of high water levels, even low energy waves can be damaging. When storms coincide with periods of high lake levels, extreme damage can result. In 1985, for example, during record high water levels in the Great Lakes, one storm generated 12-foot waves on Lake Erie. In the south Buffalo area, where the damage was concentrated, at least 12 houses were lost (C.H. Carter et al., 1987).

Approximately 66 miles of New York's Great Lakes shoreline are subject to serious erosion, with the most critical areas lying on the south shore of Lake Ontario (Boyd Kaler, Department of Environmental Conservation, personal communication, June 1990). The magnitude of long-term recession rates along the Great Lakes shoreline depends on topography, erodibility of the shoreline, and prevailing wave direction. For example, in New York's Erie County, high cliffs and well-vegetated dunes protect much of the shoreline, and, correspondingly, erosion rates are low. In Chautauqua County, bordering Erie County to the southwest, the

topography provides less resistance to erosion. Two communities in Chautauqua County, therefore, experience erosion rates greater than one foot per year (Boyd Kaler, Department of Environmental Conservation, personal communication, June 1990).

Along Lake Ontario, shoreline recession rates are as high as four feet per year, and 16 communities have long-term erosion rates greater than one foot per year. In the more populous counties, such as Monroe and Hamlin counties, shoreline hardening structures have temporarily reduced erosion rates. Correspondingly, some areas of the lakefront are now accreting, while creating erosion down-drift of the hardened shoreline. In contrast, the highly erodible bluffs in rural Wayne County are receding three to four feet per year (New York Department of Environmental Conservation, 1989b; Kaler, personal communication, June 1990).

Coastal Management Program

New York's Coastal Program, administered by the Department of State Division of Coastal Resources and Waterfront Revitalization, was established by the New York Waterfront Revitalization and Coastal Resources Act of 1981 (Executive Law, Article 42). The act defines the coastal area as coastal waters and adjacent shorelands—such as wetlands, coastal barriers, dunes, beaches, and erosion-prone areas—which would directly and significantly affect coastal waters by their use (Art. 42, Sec. 911). The Coastal Program has defined the coastal zone broadly to include 3,200 miles of ocean, bay, riverine, Great Lakes, and estuarine shoreline (including the Hudson River Valley north to Albany). The inland extent of the coastal zone varies considerably throughout the state and can be increased by municipalities.

Forty-four policies have been established to guide land and water uses in the coastal area and to ensure coordination and consistency among state and federal actions undertaken within the coastal area (New York Department of State, 1982). Eight of these policies address coastal erosion and flooding. The policy document states that within the coastal area, structures should be sited in ways that "minimize damage to property and the endangering of human lives caused by flooding and erosion." To meet this goal, permanent buildings should be set back from the shoreline within coastal erosion hazard areas. In addition, all activities and development undertaken within the coastal zone should minimize degradation of coastal protective features.

To carry out its 44 policies, the Coastal Program has three primary components: 1) local waterfront revitalization programs (LWRPs); 2) review of federal and state actions within the coastal area to ensure their consistency with the state's coastal policies; and 3) projects and activities that implement coastal policies.

In LWRPs, municipalities prepare detailed coastal management strategies and land use plans that set forth use and development standards for their waterfronts. These plans and standards, which carry out the 44 coastal policies, are enacted by specific laws and ordinances. Local governments receive financial and technical assistance from the Department of State for preparation of LWRPs. To comply with the Coastal Program's erosion policies, municipalities must ensure that protective coastal features will not be damaged by land use and development and that new development is not at risk from coastal erosion (42/915). To meet these goals, several municipalities have incorporated building setback provisions into their laws.

Coastal Erosion Hazard Areas Act

New York's Coastal Erosion Hazard Areas Act (New York Environmental Conservation Law, Art. 34) was passed in 1981 as part of the state's comprehensive coastal management program. However, the Department of Environmental Conservation (DEC), Coastal Erosion Management Section, and not the Coastal Program, administers the act. The act regulates construction within erosion-prone stretches of shoreline on the Great Lakes and Long Island.

The act asserts that erosion on portions of New York's shore endangers human lives and causes damage to public and private property and to natural resources. The act recognizes that erosion control structures are expensive, may be only partly effective, and may be harmful to adjacent properties, but that in some areas major erosion protection structures may be necessary to reduce future erosion damage (34/0101). The act sets forth specific coastal erosion goals and policies, some of which restate the Coastal Program's policies:

- identify erosion hazard areas;
- recognize and protect natural protective features;
- insure that "public actions . . . which are likely to encourage new permanent activities or development within coastal erosion hazard areas should not occur" (unless the area is already protected by structural or nonstructural means) (34/0102); and
- use publicly financed erosion control structures only "where necessary to protect human life, existing investment in development or new development which requires a location within the erosion hazard area" (34/0102).

Erosion Hazard Areas

The act defines "coastal erosion hazard areas" as 1) those areas of the shore that are likely to erode within 40 years, based on shoreline recession analysis, which uses the landward limit of active erosion as a baseline; and 2) "natural protective features," such as beaches, dunes, bluffs, and wetlands (34/0103). Prior to officially designating erosion hazard areas, the DEC must notify all affected property owners and hold public hearings. Subsequent to the hearings, coastal erosion hazard area maps must be filed with local governments and affected landowners must be notified. To date, the DEC has filed erosion hazard maps in all but four of the municipalities regulated under the act (Boyd Kaler, DEC, personal communication, June 1990). The act instructs the DEC to review the boundaries of erosion hazard areas every 10 years and after major coastal storms (34/0104).

Under the law, the DEC will not regulate erosion hazard areas until local governments have had the opportunity to adopt local coastal erosion hazard area (CEHA) management programs. Within six months after erosion hazard area maps have been filed with a local government, the municipality may submit a local erosion hazard ordinance or law to the DEC. To receive approval from the DEC and to exercise authority within state designated coastal erosion hazard areas, the local law must meet or exceed the standards set forth in the state's regulations. If a municipality does not apply to gain jurisdiction or if its program fails to receive state approval, then the appropriate county has six months to submit a CEHA management program to the state. If the county does not submit a law that meets state standards, then the DEC will regulate erosion hazard areas in that municipality (34/0105, 0106, and 0107). To date, 22 of the 82 municipalities regulated under the act have state-approved erosion programs. Six of these communities lie on the Great Lakes and the remainder are located on Long Island (Kaler, personal communication, June 1990).

Coastal Erosion Management Regulations (6 NYCRR 505), which specify how and where new development can take place in erosion hazard areas, were adopted in 1983 and amended in 1988. The regulations set forth requirements and limitations on construction within two types of coastal erosion hazard areas: 1) *natural protective feature areas* and 2) *structural hazard areas*. Within the former, most construction is prohibited, while within the latter, movable structures, such as buildings on piles and trailers, are permitted. To undertake most activities in either type of area, a permit must be received from the DEC or from the local government along with an approved CEHA management program. The regulations provide several general standards for issuance of coastal permits: 1) the proposed activity must be reasonable and necessary and consider alternatives and the extent that the activity requires a shoreline location; 2) the proposed activity should "not be likely to cause measurable increases in erosion at the proposed site or at other locations"; and 3) the proposed activity must prevent or minimize adverse effects on natural protective features, existing erosion protection structures, and natural resources (505.6).

Natural Protective Feature Areas

The regulations define and set forth specific prohibitions and requirements for five different types of "natural protective feature areas": nearshore areas, beaches, bluffs, primary dunes, and secondary dunes (505.8). The physical extent of natural protective feature areas differs depending on the topography of the site (505.2). Nearshore areas are defined to stretch seaward from the mean low tide line 1,000 feet or to the point where the mean low water depth is 15 feet, whichever is greater. Beaches extend inland from mean low water to 1) the seaward toe of a dune or bluff or 2) 100 feet inland from the line of permanent vegetation. The seaward limit of a bluff is the landward limit of the beach or mean low water, and the inland limit is 25 feet landward of the bluff's receding edge. Primary dune areas stretch from the edge of the beach to 25 feet inland from the dune's landward toe. Secondary dune areas are defined as the zone between the inland edge of the primary dune and 25 feet inland from the secondary dune's landward toe.

About 150 miles of New York's Great Lakes Shoreline—65 miles on Lake Erie and 85 miles on Lake Ontario—have been designated as natural protective feature areas. Some 818 structures presently lie within natural protective feature areas designated on the Great Lakes shorelines. The entire south shore of Long Island is also designated as such an area.

Most new construction, mining, excavation, and grading are prohibited within nearshore areas, beaches, bluffs, and primary dunes. On secondary dunes, new buildings and major additions to existing structures can be constructed after receiving a CEHA management permit and meeting specific building requirements. Several exceptions to the prohibition on new buildings and alteration of nearshore areas, beaches, and primary dunes are set forth in the regulations: 1) in nearshore areas, navigation channels, sand bypass systems, and beach nourishment may be permitted by the DEC; 2) in nearshore areas, beaches, and dunes, construction of permanent piers, docks, groins, seawalls, and other similar structures is permitted, pursuant to receipt of a CEHA management permit; 3) in nearshore areas and beaches, temporary docks, piers, and wharves under 20 square feet can be constructed without a permit; 4) on beaches, bluffs, and dunes, additions smaller than 25% of the existing structure can be built, and structures damaged by events not related to coastal flooding or erosion can be reconstructed; and 5) on bluffs and dunes, elevated walkways and stairways providing noncommercial, pedestrian beach access can be constructed without a permit (505.8).

Structural Hazard Areas

The DEC designates structural hazard areas on land that erodes at more than one foot per year. No new permanent structures can be built within structural hazard areas. The landward limit of such an area is a line located at a distance equal to 40 times the site's long-term average annual erosion rate. The baseline for measuring the 40-year erosion line is the landward boundary of the site's natural protective feature (505.2). To receive a permit for construction of a movable structure within the structural hazard area, several requirements must be met: 1) the movable structure cannot have a permanent foundation, and temporary foundations must be removed when the building is moved; 2) no structure can be placed within 25 feet of the landward limit of a bluff; 3) the weight of the structure must not place "excessive ground loading on a bluff"; 4) the permit application must include a plan for landward relocation of the movable structure; and 5) structures must be removed before the receding edge erodes to within 10 feet of the structure (505.7).

Long-term annual erosion rates have been established for the Great Lakes shoreline, but not for the south shore of Long Island. The DEC felt that their data did not provide them with a long enough time span to accurately determine long-term recession rates for Long Island, although many areas of the south shore are receding at a foot or more per year. Furthermore, the extent of shoreline stabilization and alteration on Long Island has obscured much of the natural rate of shoreline change (Boyd Kaler, DEC, personal communication, June 1990; William Daley, DEC, letter of January 2, 1990). Therefore, no structural hazard areas have been designated on the south shore of Long Island. On the Great Lakes, the DEC has designated nearly all the Lake Ontario shoreline (66.4 miles) as a structural hazard area. A total of 924 existing structures lie within the Great Lakes structural hazard areas (Boyd Kaler, personal communication, June 1990).

To calculate rates of shoreline change on the Great Lakes, the DEC used U.S. hydrographic charts dating from 1875 to 1879 and 1979 aerial photographs. Long-term erosion rates are measured at 200- to 400-foot intervals from the receding edge of the bluff, the rear dune toe, or the natural vegetation line. Erosion hazard area setbacks are then mapped at a scale of one inch to 200 feet (Saunders et al., 1990).

Erosion Protection Structures

To construct, modify, or restore erosion protection structures, a permit must be obtained from the DEC or a community with an approved CEHA management program. To receive a permit, the structure must be designed to control erosion for at least 30 years. In addition, the structure must be unlikely to increase erosion at the development site or at other locations and it must minimize adverse effects on natural protective features, other erosion protection structures, and natural resources. Lastly, the permit application must include a long-term maintenance program for the proposed structure (505.9).

Variances

Variances to the regulations pertaining to natural protective feature areas, structural feature areas, and erosion protection structures may be granted in certain cases. The applicant must demonstrate that compliance with the regulations "will cause practical difficulty or unnecessary hardship," and several criteria must be met: 1) no alternative site must be available; 2) all "responsible" measures to mitigate adverse impacts on natural systems are incorporated into the project design and are implemented; 3) the structure will be "reasonably safe from flood and erosion damage"; and 4) when public funds are used, public benefits outweigh adverse effects (505.13).

Proposed Policies for Long Island's South Shore

> A Long Island planning agency recommended today that almost 5,000 houses and businesses on Fire Island and in other shore resort areas threatened by erosion be gradually eliminated and that the barrier islands they stand on be returned to nature (*New York Times*, 1989a).

This draconian statement represented a worst-case synopsis of a far-reaching set of proposals jointly developed by the Long Island Regional Planning Board and the New York Coastal Program to address erosion and flooding hazards along the South Shore oceanfront (Long Island Regional Planning Board, 1989; *New York Times*, 1989b). Overall, the report contains: 1) data on coastal features and processes; 2) descriptions and maps of natural resources and significant fish and wildlife habitats; 3) evaluation of applicable government management and regulatory programs; 4) discussion of nonstructural and structural coastal management techniques; 5) a management program that identifies reaches of shoreline where new development is appropriate, where existing development should be relocated, and where structural erosion control may be warranted; and 6) a comprehensive land use plan.

The study team asserts that little public benefit is gained from spending public money to protect private development in Coastal High Risk Zones. The barrier islands of Jones Beach, Fire Island, and Westhampton Beach; Southampton Spit; and a section of the shore from Southampton to Montauk Point are all considered Coastal High Risk Zones. Correspondingly, the report team recommends that if storms or coastal erosion damage a private structure in a high risk zone equal to more than 50% of its replacement value, it should not be rebuilt in a location or configuration that would make the structure vulnerable to future damage. Regulations should prevent redevelopment, but if this does not occur, then as a last resort the government should acquire the property and structure.

This proposal is consistent with the report's recommendations for a "policy of strategic retreat from vulnerable coastal areas." The report does not recommend wholesale abandonment of coastal areas, but rather that buildings should be relocated away from vulnerable locations when they are subject to substantial erosion and flooding damage.

The study proposes structural and nonstructural responses to erosion for the entire shoreline, as well as detailed recommendations for specific reaches of the coast. The report sets forth three recommendations for the entire south shore:

1) maintain the continuity of transport of sand along the south shore with sand bypassing and restoration programs at stabilized inlets and groin fields;
2) design and implement management programs that stabilize navigation channels and maintain longshore sand transport across inlets; and
3) prevent new inlets from forming and artificially close new inlets that do not close naturally within a reasonable time.

On the Long Beach reach of shoreline, the report assumes that the primary land use will continue to be high density residential and that intensive use will continue in existing recreational areas. Therefore, the report recommends maintaining the shoreline's location with existing groins and dune construction.

Due to large public investment in beach facilities and public infrastructure, the report recommends stabilizing Jones and Gilgo beaches and maintaining recreational beaches. The preferred erosion management options for this stretch of the shoreline are beach nourishment and dune building using sand bypassed from inlets.

On Fire Island, which is a Coastal High Risk Zone, the report recommends phasing out existing medium-density seasonal use by prohibiting post-storm reconstruction. Erosion management on the island should be limited to beach nourishment and dune building and, where possible, setback and relocation strategies. The current recreational and wilderness area uses, which are consistent with the report's policies and goals, should continue on the island.

On Westhampton Beach, the report recommends ending residential use west of the groin field and phasing out private development on the entire barrier island by prohibiting post-storm reconstruction. This proposal is consistent with the policy for Coastal High Risk Zones. The report also delineates undeveloped land that should be acquired for open space and recreation. To maintain the beach beyond the groin field, the report recommends maintaining the shoreline's position with artificial beach fill and dune building.

At the eastern end of Long Island, existing low-density seasonal use can continue. A combination of beach renourishment, dune stabilization, building setbacks, and relocation are recommended for this area. The report team also recommends that the New York state government acquire some shorefront for open space uses. Within the Coastal High Risk Zone, the report recommends inland relocation of structures.

The next step to be taken with the South Shore Hazard Management Program is an economic analysis of the shore's Coastal High Risk Zones to determine if public expenditure at these locations can be justified. In particular, it is necessary to determine whether such expenditures would be consistent with State Coastal Policy 16, which states that "public funds shall only be used for erosion protective structures where . . . the public benefits outweigh the long term monetary and other costs including the potential for increasing erosion and adverse effects on natural protective features."

Coastal Conference Issues and Recommendations

In 1989, the New York Department of State held regional conferences to discuss and propose changes in the management of New York's coastal resources. The resulting consensus document points out that nearly a decade after initiation of the state's coastal program, the quality of the coast continues to decline and "poorly planned and ill-managed development" continues to take place within the coastal area (New York Department of State, 1990).

In response to the coastal program's lack of regulatory authority and the current piecemeal and reactive approach to coastal regulation and management, the report recommends establishing a comprehensive coastal permitting process to regulate all public and private development undertaken within the coastal area. Such a permitting process would probably subsume the coastal erosion hazard areas program under the Department of State Coastal Program.

The report concludes that the many federal, state, and local programs designed to eliminate inappropriate development in coastal hazard areas have been inadequate. It offers five specific recommendations that would improve the management of coastal hazard areas and decrease the risk to life, property, and natural resources from coastal hazards:

1) Develop Special Area Management Plans, such as the Proposed South Shore Hazard Management Program, for regions subject to flooding and erosion. These plans would identify appropriate land uses and determine the "most realistic government strategies for responding to hazardous conditions." To ensure that the plans are consistent with the Coastal Program's policies, the Department of State would coordinate the development of the plans. Until a plan is implemented, funding and approval of erosion control structures would be suspended.
2) "Eliminate public subsidies for development in hazard areas," including subsidized insurance, tax write-offs for losses, disaster assistance, and funding of new infrastructure.
3) Require that property owners disclose that their land lies within a coastal hazard area prior to transfer of property rights or to receipt of funds for development within a hazard area.
4) Develop minimum design and building standards for structures built within coastal hazard areas.
5) Improve data collection on coastal processes and the risks associated with coastal hazard areas.

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North Carolina

Introduction

A 320-mile chain of coastal barrier spits and islands fringes North Carolina's Atlantic Ocean coastline. Approximately half of this shoreline lies within the Cape Hatteras National Seashore, Cape Lookout National Seashore, or other publicly owned segments (National Research Council 1990). The remaining nonpublic portions of the great barrier chain face strong residential and commercial development pressures. Two decades of rapid development have left North Carolina's extensive system of barrier islands susceptible to substantial loss of life and property from coastal storms and long-term erosion (Owens 1985; Godschalk et al., 1989).

North Carolina's Outer Banks extend up to 30 miles seaward for 180 miles from the Virginia line to Cape Lookout. Offshore from the Banks lie the Diamond Shoals, known as the "Graveyard of the Atlantic" due to the hundreds of shipwrecks there. Inside the Banks lie Currituck, Albemarle, and Pamlico Sounds, which harbor vast ecological and recreational resources. Approximately 4,000 miles of shoreline border these sounds and the state's other estuarine waters (D.W. Owens, personal communication, March 1990). The mainland portions of the North Carolina coast remain quite rural and are not threatened with the degree or type of development pressure found on the offshore barriers.

Coastal Erosion

Studies of coastal shoreline change indicate that in the past 50 years more than half of North Carolina's oceanfront exhibited average annual erosion rates (AAERs) greater than or equal to two feet (National Research Council, 1990). The Division of Coastal Management's (DCM) 1986 update of coastal erosion determined that, of the 237 miles of ocean shoreline surveyed, approximately 70% was eroding (McCullough, 1988). An astounding one-fifth of this eroding coastline appears to be receding at rates exceeding six feet per year. The DCM study further concluded that the state's approximately 82 miles of south-facing oceanfront have lower long-term annual erosion rates than its easterly facing shores. These differing rates reflect the impacts that northeasters and offshore hurricanes have on easterly facing shores, such as Hurricane Bob in 1991.

Southerly shores, in contrast, are particularly vulnerable to storm damage and erosion resulting from direct hurricane hits (McCullough, 1988).

North Carolina has received more direct hurricane strikes than any other Atlantic coast state, except Florida (Godschalk et al., 1989). Correspondingly, North Carolina ranked second for receiving the most National Flood Insurance Program (NFIP) claims from the program's inception through April 1988. Within North Carolina's coastal high hazard zones (NFIP V zones), the NFIP has made payments on claims for 742 structures damaged by flooding and erosion, of which 309 were for repetitive losses (Federal Emergency Management Agency, 1988). Thus, nearly half the $4 million paid for losses in coastal high hazard areas in North Carolina were for repair of structures that had previously received NFIP payments. The large majority of buildings that have received NFIP monies in North Carolina are single family homes (FEMA, 1988).

In 1986, the DCM carried out a Threatened Structure Survey to determine the number of existing buildings threatened by shoreline erosion. The investigators surveyed buildings within four shoreline zones: the 100-year-storm recession zone and areas located within distances equal to 10, 30, and 60 times the long-term average annual erosion rate. Nearly 5,000 buildings lie between the line of stable natural vegetation and the 60-year AAER line. Of these, 777 structures are located between the vegetation line and the 10-year AAER line.

The Coastal Area Management Act of 1974

Recognizing the magnitude of the threat that erosion poses and the corresponding implications for property damage and loss of life, the state of North Carolina has established progressive legislation that attempts to reduce storm- and erosion-related damage. North Carolina's Coastal Area Management Act (CAMA) (North Carolina Laws, Ch. 113a-100 et seq.) provides the state with its primary coastal management tools. The Act, first passed in 1974 and subsequently revised, legislates two major approaches to reducing coastal hazards: state designation and regulation of Areas of Environmental Concern (AEC) and mandatory local planning in North Carolina's 20 coastal counties. The Act instructs the governor to appoint a 15-member Coastal Resources Commission (CRC) with the authority to formulate and oversee the regulation of coastal policy (113A/104). The Division of Coastal Management in the Department of Environment, Health and Natural Resources (DEHNR) Coastal Management Program administers the act and provides staff for the commission.

Areas of Environmental Concern

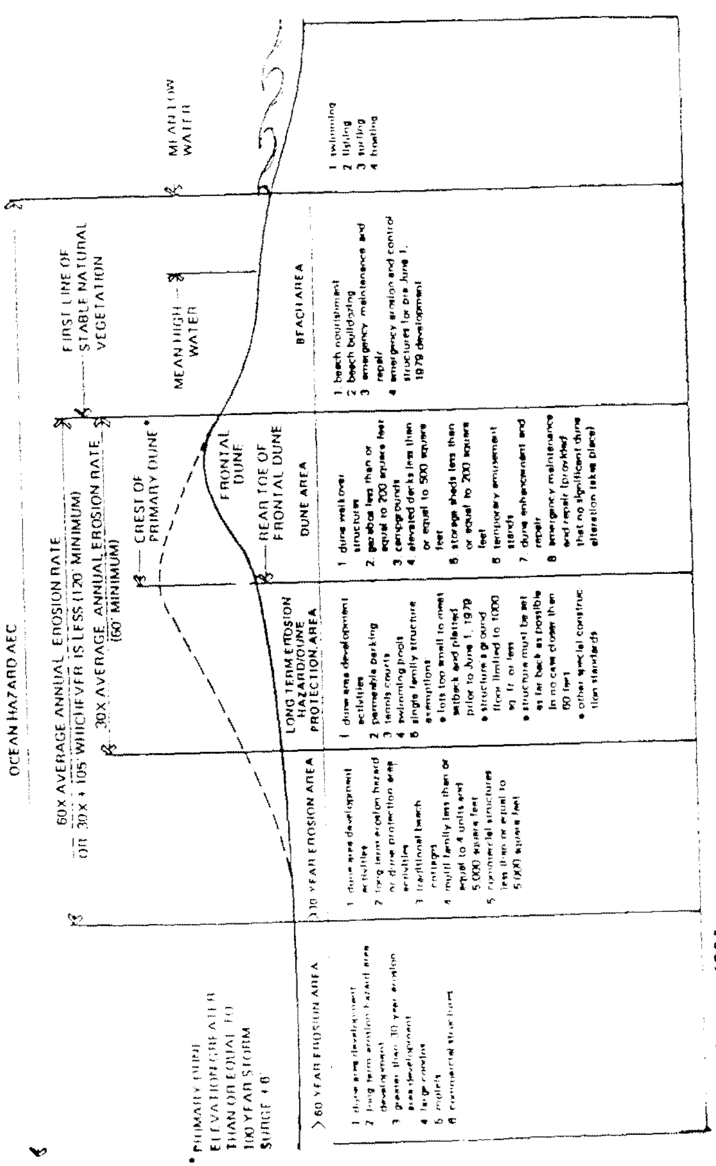
Among the CRC's responsibilities is the geographical delineation of Areas of Environmental Concern. Within these areas development must conform to local land use plans and to specific state standards determined for each category of AEC (Owens, 1985). The DCM reviews and has permitting authority for major development projects proposed for areas of environmental concern. "Major developments" are described in CAMA as those that require approval from the state or federal government, involve drilling, or occupy more than 60,000 square feet of land (113A/118). Other, smaller development projects must also conform to the same state performance and siting standards, but are reviewed by local governments. Permit decisions on major and minor developments may be appealed to the CRC (see Figure 3.1).

The primary categories of AECs defined in CAMA are estuarine areas, ocean hazard areas, public water supplies, and natural and cultural resource areas (N.C. Rules T15A, Subch. 7H). Estuarine and ocean hazard areas, the first two categories, encompass all lands adjacent to open water in North Carolina. In 1978, the CRC promulgated regulatory provisions pertaining to AECs. These rules apply to all of the state's coastal waters and wetlands and approximately 3% of the land area in the state's 20 coastal counties (Owens, 1985).

The act defines "ocean hazard areas" as "areas where uncontrolled, incompatible development could unreasonably endanger life or property, and other areas especially vulnerable to erosion" (113A/113). Such natural hazard areas include sand dunes, ocean beaches, and other areas exhibiting a "substantial possibility of excessive erosion" (113A/113). Estuarine and other inland coastal areas were not included within the ocean hazard areas designation because erosion and flooding problems are less acute in these areas than along the oceanfront and because the state's inland coastline is largely undeveloped (David Owens, Office of Coastal Management, personal communication, 1990).

The CRC's standards for coastal development within ocean hazard areas are based on three primary goals: 1) minimizing loss of life and property from storms and long-term erosion, 2) preventing encroachment of permanent structures on public beaches, and 3) reducing public costs resulting from inappropriate coastal development (N.C. Rules T15A, Subch. 7H). To meet their goals, the CRC defined and focused its regulatory authority on three particular ocean hazard areas: 1) ocean erodible areas, 2) high hazard flood areas (NFIP V Zones), and 3) inlet hazard areas. Ocean erodible areas are defined in North Carolina's administrative rules (Subch. 7H) as the "area in which there exists a substantial possibility of excessive erosion and significant shoreline fluctuation." This zone stretches from the mean low water line to the greater of the following three distances: 1) "a distance landward from the first line of stable natural

Figure 3.1
Permittable Development Activities Within Ocean Hazard Areas of Environmental Concern



Source: Owens, 1984.

vegetation to the recession line that would be established by multiplying the long-term annual erosion rate times 60," 2) the area between the vegetation line and the recession line that would be inundated by the 100-year flood, and 3) 120 feet landward of the vegetation line (N.C. Rules T15A, Subch. 7H). In delineating the location of ocean hazard areas, the DCM considered both average annual erosion rates and 100-year-storm recession estimates. Whichever distance is greater defines the landward edge of the ocean erodible area. Both short- and long-term erosion are considered, because in some areas, particularly on low, flat barriers, the 100-year-storm zone exceeds the average long-term erosion rate (Owens, personal communication, 1990).

Inlet hazard areas are defined as areas vulnerable to extensive erosion, flooding, and "other adverse effects of sand, wind and water" due to their proximity to shifting inlets (N.C. Rules T15A, Subch. 7H). These zones extend landward from the mean low water line to the distance that the inlet is expected to migrate (Godschalk et al., 1989). "High hazard flood areas" are defined in the state regulations as areas "subject to high velocity waters . . . in a storm having a one percent chance of being equalled or exceeded in any given year" as shown on NFIP flood insurance rate maps. If such rate maps are not available, other base flood elevation data approved by the CRC may be used to define the high hazard flood area.

Within ocean hazard areas, new construction and improvements that constitute 50% or more of the structure's market value must satisfy wind resistance, elevation, and pile requirements based on FEMA standards and state building code (Owens, 1984; Godschalk et al., 1989). These structural requirements were strengthened in 1985 when the state Building Code Council added provisions to the building code that applied specifically to the coastal zone (Godschalk et al., 1989). Furthermore, within ocean hazard areas no development that involves significant removal or relocation of sand or vegetation from frontal or primary dunes is permitted. Construction of public facilities, such as roads, bridges, and sewer lines, is not allowed unless the structure is of overriding public benefit, will not increase or be susceptible to erosion or flood hazard, and will not promote growth and development in ocean hazard areas (Godschalk et al., 1989).

Oceanfront Setbacks

Unlike much other coastal legislation and regulations, CAMA explicitly addresses coastal erosion hazards and charges the CRC and the DEHNR to mitigate these hazards. To meet this goal, the CRC established state-wide oceanfront setback regulations within ocean hazard areas. The setback requirements are based on average annual erosion rates, natural site features, and the nature of the proposed development. The setback is measured from the first line of stable natural vegetation. If a stable line of vegetation is not present, the DCM uses aerial photographs or ground surveys to project a reference line between stable vegetation adjacent to the site. This reference line is delineated on a map and the setback measured from that point (Owens, personal communication, 1990).

The setback regulations require that new structures smaller than 5,000 square feet and containing fewer than five residential units must be constructed the farthest landward of 1) a distance equal to 30 times the long-term annual erosion rate, 2) the crest of the primary dune (the first dune with an elevation equal to the 100-year-storm level plus six feet), 3) the landward toe of the frontal dune (the first dune with substantial protective value), or 4) 60 feet landward of the vegetation line (N.C. Rules T15A, Subch. 7H). Structures including more than 5,000 square feet of floor area or containing five or more residential units must be setback to the farthest of the following four distances: 1) 60 times the average annual erosion rate, 2) the crest of the primary dune, 3) the landward toe of the frontal dune, or 4) 120 feet landward of the permanent vegetation line. Where erosion rates exceed 3.5 feet per year, the setback line for large structures is set at 30 times the erosion rate plus 105 feet (N.C. Rules T15A, Subch. 7H). The more stringent setback rules for larger structures reflect the greater risk to loss of life and property that substantial developments pose and the legal, structural, and practical difficulty of relocating larger buildings (Association of State Floodplain Managers, 1988).

In 1981, the CRC liberalized the setback rules to allow construction of campgrounds, tennis courts, and other uses that do not require construction of substantial structures between the erosion setback line and the line of permanent vegetation (National Research Council, 1990). No development is allowed, however, seaward of the vegetation line. The 1981 regulations also permit single-family residences to be built on pre-existing lots that are not deep enough to meet the erosion setback requirements (N.C. Rules T15A, Subch. 7H). Structures built on these lots must, however, meet stringent construction standards, the 60-foot minimum setback requirement, and dune setback provisions. After the adoption of this rule, approximately 500 coastal lots remained unbuildable (Owens, 1985).

The DCM has used annual average erosion rates to establish and delineate setbacks for the entire coast. The vegetation line at a specific site, from which the predetermined setback is measured, is established after a landowner has applied for a development permit. Because building permits are valid for three years, the setback is not measured on site until the day construction begins (Association of State Floodplain Managers, 1988).

Coastal Erosion Delineation

To delineate oceanfront setbacks and define ocean hazard areas, the state's coastal regulatory program examines both long-term shoreline fluctuations and dramatic, short-term coastal changes. To estimate the long-term erosion rates that are used to set the erosion setbacks, the DCM determines rates of historical shoreline change using the Orthogonal Grid Mapping System developed by Robert Dolan of the University of Virginia (Association of State Floodplain Managers, 1988). In this system, U.S. Geological Survey topographic maps and low-altitude aerial photographs are enlarged to the same size with a projector or zoom transfer scope. The lines of high water and stable vegetation are traced from the photos onto the maps and then digitized onto a computer. To determine the long-term annual erosion rate along North Carolina's oceanfront, the DCM used photographs taken between 1937 and 1986. Investigators compared photographs taken from as many as 19 different time periods to as few as four (McCullough, 1988). Fluctuations for the entire North Carolina shoreline have now been mapped at 50-meter transect intervals. The state plans to update this data every five years.

Estimating short-term, storm-related erosion data has proven to be more difficult than calculating long-term trends (Owens, 1984). In 1979, the state initiated a study to project rates of erosion that would result from a 100-year storm. Because this data is less accurate than the long-term erosion rates, the 100-year storm information is not used to determine setback regulations. The DNR feels sufficiently confident in the storm-related data, however, to use them in delineating ocean hazard areas (Owens, 1984).

Local Planning

The Coastal Area Management Act mandates North Carolina's 20 coastal counties to prepare local land use plans under the guidance of the Coastal Management Program and in accordance with standards, objectives, and policies set by the CRC (Ch. 113, Sec. 106). The CRC defines the issues to be addressed and procedures followed in the planning process, but local governments make the substantive decisions (Owens, 1985). Municipalities have the option of preparing management plans, but are not required to do so. By 1985, all of the counties and 55 municipalities had adopted local plans (Godschalk et al., 1989). CAMA requires these plans to be updated every five years.

Regulations promulgated under CAMA require that the plans address current and future population and land use trends, as well as projected needs. The plans must also include policy statements regarding the land use issues likely to affect the community over the ensuing 10 years (Godschalk et al., 1989). Policy statements included in the plans must address resource protection, resource production and management, economic and community development, public participation, and storm hazard planning (Godschalk et al., 1989).

The current CAMA land use planning guidelines regarding storm hazard planning require localities to consider and include four primary components in their plans: 1) hazard maps and narrative descriptions of hazardous areas, 2) an inventory and analysis of existing structures and land uses in hazard areas, 3) descriptions of the risks and severity of damage and an estimate of monetary losses that might be sustained in hazard areas, and 4) hazard mitigation policies for public and private facilities in all hazard areas. The commission requires that the local plans include policies that specifically address the effects of erosion, high wind, flooding and wave action; structures and uses that do not conform to hazard mitigation policies; relocation of large commercial enterprises outside of hazard areas; and public acquisition of land in hazard areas. (Godschalk et al., 1989). Particularly important is the consideration of methods to ensure relocation of sewer lines, water lines, roads, and other public infrastructure outside of hazard areas (National Research Council, 1990).

Additional Approaches to Erosion Management

In 1978, the CRC prohibited the construction of permanent erosion control devices designed to protect structures built after 1978. The CRC extended this prohibition in 1985 to include construction of all new permanent oceanfront erosion control structures, including jetties, seawalls, breakwaters, and groins. Temporary measures, such as sand bags and beach nourishment, are still permitted (Association of State Floodplain Managers, 1988). The prohibition of erosion control devices may discourage new construction in eroding areas and encourage homeowners to relocate threatened structures instead of attempting to protect them in situ.

North Carolina also includes land acquisition among its oceanfront management tools. Acquisition became an important component of the North Carolina coastal program when the legislature adopted the 1981 beach access law, appropriating $1 million for shorefront acquisition. The legislation establishing the access program directed the DEHNR to give priority to acquisition of land that is considered inappropriate for permanent development (Godschalk et al., 1989). A tax credit program was also adopted to encourage donation of lands for beach access. Since that initial appropriation the state has spent an average of approximately $500,000 a year on the land acquisition program. There has been little connection, however, between the acquisition program and the state's hazard program, largely due to the lack of interest by owners of unbuildable property to sell or donate their property to the state (Owens, personal communication, 1990).

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Ohio

Introduction

Ohio's Lake Erie shoreline includes 45 miles of island lakeshore and 262 miles of mainland waterfront, characterized by high till bluffs, rocky shores, urban waterfronts, freshwater wetlands, and sandy beaches. Low, diked wetlands make up much of the western end of Ohio's lakeshore from the Michigan border to Point Clinton. East from Point Clinton to the mouth of Sandusky Bay carbonate bluffs characterize the coast. The shore along Sandusky Bay consists of low banks of till and glacial lake sediments and diked wetlands. Bay Point and Cedar Point spit stretch nine miles across the mouth of Sandusky Bay. Glacially deposited till bluffs border Lake Erie from Huron to Vermillion. From Vermillion to Lakewood there are 20- to 50-foot-high bluffs of shale locally capped by till. Bluffs of till and glacial lake sediments rise to heights of 60 feet along the remainder of Ohio's lakeshore (Jonathan Fuller, Ohio Division of Geological Survey, personal communication, August 1990).

The shores of Toledo and Cleveland—Ohio's major lakefront cities—have been heavily armored, extensively filled, and industrially developed. Many other parts of Ohio's Lake Erie shore, particularly its sandy barriers, support dense single-family residential development. East of Cleveland's suburbs, however, development is not continuous along the lakefront. The lakeshore in eastern Ohio is much less densely populated than the central and western parts of the lakeshore. Ohio's islands are all developed, some lightly and others heavily, with summer residences (Jonathan Fuller and Donald Guy, Ohio Division of Geological Survey, personal communication, August 1990).

Shore protection structures have been common along Ohio's Lake Erie waterfront for over 100 years. Large jetties were first built in the early 1800s, a period when Ohio's shoreline development was concentrated in the cities. Until the 1930s, the remainder of the shorefront area consisted of agricultural land and sparse residential development. By the 1970s, most of the shore's agricultural lands had been developed into residential communities. With this change in land use came an increase in construction of small, privately built shoreline stabilization structures, such as seawalls, breakwaters, groins, and revetments. Today more than 1,150 residential structures stand within 25 feet of Ohio's Lake Erie bluffline, and more than 3,600 shore protection structures are located along Ohio's lakeshore (Guy and Fuller, 1990).

After 20 years of above-normal levels, the water level in Lake Erie reached record highs in 1985 and 1986. Since then the lake level has returned to normal, declining approximately two feet. Severe shorefront erosion and flooding were associated with the high lake levels. In some areas, short-term lakefront recession rates were two to nine times greater than long-term recession rates (Guy and Fuller, 1990). Till bluffs receded as much as 10 feet per year, and shale bluffs receded more than 2.4 feet per year (Guy and Fuller, 1990). A survey made in 1988 found that approximately 50 miles of Ohio's lakeshore was critically eroding. A critically eroding shore is defined as a stretch of lakefront that was actively eroding in 1986, has historical (1938-73) recession rates exceeding 1.0 foot/year, and has houses within 30 feet of the bluff edge (Donald Guy, personal communication, August 1990).

Coastal Management Program

In 1988 Ohio enacted its first coastal management legislation. Senate Bill 70, which amended Ohio's Revised Code, initiated a comprehensive management program for Ohio's Lake Erie shore. Passage of this legislation should enable Ohio to be included in the federal Coastal Zone Management program. In the spring of 1991, Ohio's Coastal Management Program document was submitted to the federal program for review and approval.

Ohio's coastal act regulates activities within the coastal area of the state's eight lakeshore counties. The act defines the coastal area to include the waters of Lake Erie, islands within the lake, and land under and adjacent to the lake, including wetlands, beaches, and transitional areas. The coastal area extends landward to "include shorelands, the uses of which have a direct and significant impact on coastal waters" (Sec. 1506.01). The director of the Department of Natural Resources (DNR) has the authority to determine which shorelands should be included within the coastal area.

The act designates the DNR as the lead agency for development and implementation of Ohio's coastal management program (Sec. 1506.02). Preparation of a document that "describes the objectives, policies, standards and criteria of the coastal management program for guiding public and private uses of lands and waters in the coastal area" is among the DNR's primary responsibilities (Sec. 1506.01). Within the coastal area, all activities proposed or subject to approval by any state agency must be consistent with the policies set forth in this coastal management program document (Sec. 1506.03).

The coastal act instructs the DNR to delineate and regulate a "Lake Erie Erosion Hazard Area" (Sec. 1506.06). The erosion hazard area will include land that is anticipated to be lost due to shore erosion within a 30-year period. At least once every 10 years the DNR must review the delineation of the erosion hazard area. After preliminary identification of the erosion hazard area, the DNR must notify affected landholders and municipalities of the proposed designation and then hold public hearings. Before selling or transferring interests in land included within the erosion hazard area, the landowner must notify the potential buyer in writing that the land has been designated as such by the DNR (Sec. 1506.06)

Prior to building or redeveloping any permanent structure within the erosion hazard area, a permit authorizing construction must be received from the DNR (Sec. 1506.07). The DNR will only grant a building permit within an erosion hazard area if an existing erosion control structure will protect the proposed site for 30 years or if all three of the following criteria are met: 1) no reasonable, prudent, alternative site is available; 2) the structure or fixture will be movable or will be situated as far landward as applicable zoning resolutions or ordinances will permit; and 3) the person seeking authorization will suffer exceptional hardship if the authorization is not given (Sec. 1506.07). State permits are not required in municipalities or counties that have adopted a Lake Erie erosion hazard area resolution approved by the DNR.

Erosion Hazard Delineation Rules

At this writing, the DNR was drafting and revising erosion hazard area delineation rules. The proposed rules defined and set forth procedures for determining the landward extent of the erosion hazard area. Under the proposed rules, the erosion hazard area will extend inland from the most landward recession line for a distance equal to 30 times the annual recession rate (Proposed Rule 1501:6-10). The recession line used depends on the topography of the site and is defined to include, but is not limited to, a bluffline, the crest of a dune, the crest of a spit or barrier, the lakeward line of permanent vegetation in a wetland, or the top of a dike.

In addition to the 30-year distance based on the annual recession rate, the erosion hazard area incorporates a "stable slope allowance" and an "existing slope offset." The stable slope allowance, which is added to the 30-year erosion setback, is the "landward horizontal offset of the top of a bluff relative to its toe that is necessary to attain natural slope stability" (Proposed Rule 1501:6-10). This factor is a function of the height of the bluff and the shore material. The existing slope offset, which is subtracted from the erosion setback distance, is the offset provided by a slope where natural or artificial stabilization has taken place.

Erosion Mapping

Prior to enactment of the Coastal Management Act, the state DNR mapped historic recession lines for all of Ohio's Lake Erie coast. Using charts dating from the 1860s and photographs from the 1930s, 1950s, 1960s, and 1970s, the DNR plotted changes in the position of the lakeshore (Association of State Floodplain Managers, 1988). The location of bluffs, banks, and dune scarps were mapped, and average recession rates were determined. The DNR is now using aerial photographs taken in the spring of 1990 to update these recession rates and to designate the erosion hazard area (Donald Guy, personal communication, August 1990).

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Rhode Island

Introduction

Despite being the smallest state in the U.S., Rhode Island has a varied, 420-mile-long coastline that is extensively visited. Rhode Island's south shore, composed largely of sandy beaches, faces directly onto the Atlantic Ocean. Well-developed dune lines and fringe marshes are also common along Rhode Island's south shore. The state's oceanfront shoreline includes 27.3 miles of barrier beach, located primarily on barrier spits and bay barriers. The state's beaches are heavily used; on a sunny, summer weekend day, approximately 100,000 state residents and tens of thousands of people from out of state visit Rhode Island's beaches (Coastal Resources Management Program (CRMP), as amended, 1990, section 210.1).

Narragansett Bay and the islands lying within it dominate the eastern part of Rhode Island. The bay, with more than 350 miles of shoreline, occupies 7.3% of Rhode Island's total area (Wright and Sullivan, 1982). Marshes line over half of the bay shoreline, and a quarter of the shore has been stabilized with seawalls, revetments, and other erosion control devices. In particular, nearly all of the bay's northern shore, including Cranston, Providence, Pawtucket, and East Providence, is heavily armored. Rock cliffs, ledges, and narrow cobble and gravel beaches make up the remainder of the bay shore (Tippie, 1977).

Rhode Island's coast was not extensively developed until after the second World War, but by the early 1980s most of the readily developable waterfront had been subdivided (CRMP, Sec. 210). Nonetheless, 65% of Rhode Island's ocean-fronting barrier beaches remain undeveloped, as are most of the small barrier beaches bordering Narragansett Bay (CRMP, Sec. 210.2). Only one Rhode Island city, Newport, fronts directly on the ocean. The land bordering Narragansett Bay, especially the northern reaches, supports a much larger population than the south shore.

Nearly all of Rhode Island's coastal area lies below an elevation of 200 feet, making it vulnerable to hurricanes and northeasters (Kusler, 1983). The Army Corps of Engineers has been able to verify that 29 hurricanes struck Rhode Island between 1635 and 1980 (Wright and Sullivan, 1982), of which 13 occurred in this century. The Great 1938 Hurricane killed 19 people in Rhode Island and devastated the entire coastal area (Kusler, 1983). During this hurricane, the storm surge was more than 13 feet above mean high water and was topped by 10 foot waves (CRMP, Sec. 210).

In Rhode Island, most shore erosion occurs during severe storms. For example, some of the state's coastal bluffs have receded 30 feet during a single coastal storm. Because of the dearth of major storms in recent years, the low average erosion rates calculated for the last 30 years do not exemplify the norm (CRMP, Sec. 210.4). In general, the barrier beaches on the south shore and bluff areas on Block Island exhibit the highest erosion rates in the state (Tippie, 1977). In some stretches along the south shore average recession rates are as high as five feet per year (Tippie, 1977). Short stretches of shoreline bordering Narragansett Bay also exhibit high average annual erosion rates (Victor Parmentier, Rhode Island Division of Planning, letter of December 27, 1989).

Coastal Resources Management Council

In 1971 the Rhode Island Legislature created the Coastal Resources Management Council (CRMC) in one of the first state coastal management statutes, Title 46, Ch. 23, passed prior to the federal Coastal Zone Management Act of 1972. The Rhode Island statute mandates that state coastal policy is "to preserve, protect, develop, and where possible, restore the coastal resources of the state . . . through comprehensive and coordinated long range planning and management" (Chap. 23, Sec. 1). The Coastal Resources Management Council is the state's principal vehicle for managing uses within the coastal area. Rhode Island's policies pertaining to eroding shorelines are, therefore, included within this legislation and its regulations.

The legislature established the Coastal Resources Management Council as the state's coastal policy-making and regulatory body (23/2). This 16-member appointed group of state and local elected officials and members of the public has far reaching powers and duties. Its general planning and management responsibilities are to: 1) identify and evaluate the state's coastal resources; 2) determine current and potential uses of, and problems associated with, these resources; and 3) formulate and implement coastal resources management plans in which permitted uses, locations, and protection measures are identified (23/6). Specifically, the law authorizes the council to approve, reject, or modify any action or development undertaken below mean high water (23/6). Above mean high water, the law limits the council's authority to those powers necessary to implement the state's resource management programs. These powers include the regulation of "shoreline protection facilities and physiographic features and all directly associated contiguous areas which are necessary to preserve the integrity of such facility or features" (23/6). This authority enables the council to regulate construction on, and alteration of, dunes, coastal banks, wetlands, barrier beaches, and other coastal features.

Coastal Management Regulations

Policies and regulations pertaining to the CRMC were adopted in 1977 and were last amended in 1990. Under the regulations, construction and other major activities undertaken within coastal waters and on shoreline features require a permit from the council. The regulations define shoreline features to include: 1) coastal beaches and dunes; 2) barrier beaches; 3) coastal wetlands; 4) coastal bluffs, cliffs, and banks; 5) rocky shores; and 6) anthropogenic shorelines (CRMP, Sec. 100.1). The council also regulates activities within "contiguous areas," defined to include all land and water directly adjoining shoreline features and extending inland 200 feet from the landward border of the shoreline feature (Sec. 100.1).

If a proposed activity cannot meet the standards set by the regulations, the applicant may request a variance. Five criteria must be met to receive a variance: 1) the proposed activity must conform with the goals and policies of the Coastal Resources Management Program; 2) the proposed activity must not cause significant adverse environmental impacts; 3) the applicant must show that, due to site conditions, the permit requirements will cause undue hardship; 4) the proposed activity must be the minimum necessary to relieve undue hardship; and 5) the undue hardship must not be the result of the applicant's previous actions (Sec. 120).

Setbacks

The regulations specify a setback requirement for most activities undertaken in areas adjacent to shoreline features (CRMP, sec. 140). Development and other alterations must be set back at least 50 feet from the inland boundary of the most landward shoreline feature. The setback applies to five categories of activities: 1) filling, removal, or grading, except for an approved water-dependent activity; 2) residential buildings; 3) sewage disposal systems; 4) non-water-dependent industrial, commercial and public recreation structures; and 5) non-water-dependent transportation facilities (Sec. 140).

The council requires a larger setback on shoreline stretches designated as Critical Erosion Areas (sites receding at more than two feet per year). In these areas, the depth of the setback must be at least 30 times the annual erosion rate for structures with less than four dwelling units and 60 times the average annual erosion rate for all other structures (Sec. 140). Like the standard 50-foot setback, this setback is measured from the inland edge of the shoreline feature. In most areas, long-term average annual erosion rates are used to determine the appropriate setback distance. In receding areas where long-term erosion rates have not been calculated, as on Block Island, the council staff delineates the distance of the setback on a case-by-case basis. This setback distance is based on the available erosion data, existing site features, and the nature of the proposed activity (Kenneth Anderson, Coastal Resources Management Council, personal communication, July 1990).

The council can delineate a buffer zone that extends the distance of the erosion or the standard 50-foot setback line (Sec. 150). The council determines whether to require a buffer zone on a case-by-case basis, and the presence and extent of the buffer zone is tailored to specific site conditions and to the nature of the proposed activity. The buffer zone generally does not extend the setback beyond the 200-foot limit of "contiguous areas."

The regulations require that structures standing seaward of a setback line that are significantly damaged by coastal storms or erosion be relocated landward of the setback, to the extent possible. If more than 50% of the value of a structure is destroyed by natural coastal processes, reconstruction requires a new permit from the council (Sec. 300.14). If such a structure is standing seaward of the setback line, in most cases, it cannot be rebuilt at the same location. If less than 50% of a building's value is destroyed, reconstruction is considered standard maintenance, and the building need not be removed or relocated. No storms or erosion events severe enough to destroy 50% of a building's value have occurred since this regulation was adopted. The council has not, therefore, had to determine if any structures must be relocated or removed (Jeffrey Willis, Coastal Resources Management Council, personal communication, July 1990).

Water and Shoreline Classification

The types of activities permitted on or next to a shoreline feature depend on the designation the council has given to the water body adjacent to the site (Sec. 200). The council has classified the state's waters into six categories, based largely on the current use of the water and adjacent land. Type 1 includes those waters that abut undisturbed shorelines and land that is unsuitable for development due to wave action, flooding, or erosion. Type 2 waters adjoin areas dominated by low-intensity recreational and residential use (Sec. 200.2). Approximately 75% of Rhode Island's shoreline falls into one of these two categories. Type 3 waters are defined as "high intensity boating areas," where the abutting shoreline includes marinas or other water-dependent businesses (Sec. 200.3). Waters classified as Type 4 include large areas of open water that support commercial and recreational activities and that are adjacent to shorelines containing water-dependent commercial, industrial, or recreational activities (Sec. 200.4). Rhode Island's commercial and recreational harbors are classified as Type 5 waters and the state's industrial waterfronts and commercial navigation channels comprise the Type 6 waters (Sec. 200.5 and 200.6).

Prohibitions on development and permit requirements differ for land areas adjacent to each category of water, with the strictest regulations for land abutting Type 1 waters. For example, most construction and alteration is prohibited on shoreline features and undeveloped barrier beaches adjacent to Type 1 waters (CRMP, Table 1). Within and adjacent to Type 2 waters, construction of residential docks and shoreline protection structures requires a council permit, and all other construction is prohibited. Water-dependent commercial, recreational, and industrial structures are allowed on shoreline features adjacent to other categories of water if construction is for a designated priority use, the council has determined the proposed alternative is the most reasonable, and only minimum necessary alterations are undertaken (CRMP, Sec. 210.1).

As well as categorizing permitted uses based on water types, the regulations also set forth specific policies and restrictions on use for each kind of shoreline feature. Rhode Island's barrier beach policy, for example, is to preserve, protect, and restore undeveloped coastal barriers as conservation areas and storm buffers (Sec. 210.2). Correspondingly, new construction is prohibited on undeveloped barriers, except where the primary purpose of the project is protection, maintenance, restoration, or improvement as a conservation area or natural storm buffer. On developed barriers the state's policy is to ensure that new development and uses are undertaken in a manner that minimizes risk of storm damage and erosion. On all of Rhode Island's barriers, construction or expansion of new infrastructure and utilities is prohibited.

The state's policy for coastal cliffs, banks, and bluffs is to protect them from activities that may damage their value as sources of sediment and as storm buffers (Sec. 210.4). The council will not issue a permit, therefore, for a proposed activity that is likely to decrease the sediment supply and thereby increase erosion on nearby beaches. In bluff, cliff, and bank areas the council may choose to require that buffer zones be established to avoid further erosion. The council also encourages the use of nonstructural erosion control methods on these shoreline features.

Erosion Mapping

Historical rates of shoreline change have been established for all of Rhode Island, except for the coast of Block Island and the Upper Providence and Seekonk rivers. The council itself has not undertaken a comprehensive shoreline recession analysis, but rather has used data from independent studies to establish long-term erosion rates. The most extensive of these studies used aerial photographs dating from 1938 to 1975. Measurements were taken at 350-meter intervals. The council used the shoreline change rate data to calculate the erosion area setbacks, which are mapped at a 1:2,000 scale (Association of State Floodplain Managers, 1988; Saunders et al., 1990).

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South Carolina

The Physical Setting

South Carolina's 198-mile ocean coastline may be divided into three distinct physiographic areas. The northeastern 60 miles of shorefront consist of an unbroken stretch of mainland beach known as the Grand Strand, which extends from Little River Inlet, near the North Carolina border, to Winyah Bay in Georgetown. South of the strand lies the 20-mile wide Santee Delta, the largest deltaic complex on the U.S. Atlantic Coast. Below the delta lies a series of barrier and sea islands, totaling nearly 100 miles in length, interspersed with tidal rivers, inlets, and expanses of salt marsh (Federal Emergency Management Agency (FEMA), 1989). South Carolina's diverse and beautiful oceanfront yields substantial income for the state: two-thirds of the state's annual $3.75 billion tourist industry comes from tourism in the coastal region (South Carolina Coastal Council, 1987).

Nearly all of the Grand Strand and half of South Carolina's islands are developed, making up approximately half of the state's oceanfront. About 26 miles of this developed shoreline is eroding at rates greater than one foot per year, and 30 miles is eroding at slower rates. Approximately 10 miles of the state's developed shoreline is stable, and 22 miles is accreting (Kana, 1988).

The Grand Strand beach lies on a 100,000-year-old barrier formation (Kovacik and Winberry, 1987, p. 23). Despite its relative geologic stability, both long-term erosion and storm events threaten the large motels, hotels, and condominiums that line the strand. Long-term annual erosion rates determined for strand beaches range from five feet at Garden City to six inches along portions of Myrtle Beach (South Carolina Coastal Council, 1987). The Grand Strand is South Carolina's major resort and vacation area, hosting as many as 300,000 visitors during a peak summer weekend (Janiskee and Lovingood, 1987, p. 121). Because shoreline development is so dense on this narrow, low-lying strip of land, the potential for serious hurricane damage is high.

The Santee Delta, a highly unstable landform, experiences extreme rates of erosion. This erosion is due in part to the 1942 Santee-Cooper Diversion Project that diverted the Santee's sediment flow into the Cooper River Basin. In some areas, the shoreline has retreated nearly 900 feet during the past 40 years (Kovacik and Winberry, 1987, p. 23). Long-term

erosion rates calculated for locations within the delta area range from 1.2 feet to 31 feet per year. Some portions of this region are not, however, experiencing net long-term erosion, including Cape Romain, which is accreting at 1.2 feet per year (South Carolina Coastal Council, 1987). The entire delta area, from Winyah Bay to Dewees Island, is protected against development. Cape Romain and Yawkey National Wildlife refuges and lands of the South Carolina State Heritage Trust lie within this region. Because this part of the coast is largely protected and sparsely populated, erosion and hurricanes pose less of a threat to life and property than they do on the Grand Strand.

Waves, tidal action, and the prevailing currents constantly modify the islands lying in the southern half of South Carolina. Erosion and accretion rates among these islands vary substantially. Kiawah Island, for example, is accreting at nine feet per year, while Hunting Island is eroding at 28 feet per year (South Carolina Coastal Council, 1987). In addition to such gradual erosive forces, hurricanes can dramatically change these low-lying barriers, whose average elevations are less than 10 feet (National Research Council, 1990, Appendix F). Several of the islands were completely submerged by Hurricane Hugo's storm surge in September 1989. Some of South Carolina's islands, including Hilton Head and Kiawah, have been commercially developed by major land development firms. Others, such as Folly Island and Sullivan's Island, contain dense residential development that was designed and built by individuals. About half of the islands lying south of Charleston remain largely undeveloped (Gered Lennon, South Carolina Coastal Council staff geologist, personal communication, April 1990).

Tropical storms and hurricanes strike the South Carolina coast an average of once every four years (FEMA, 1989). From 1900 to 1982, South Carolina ranked fifth behind Florida, Texas, Louisiana, and North Carolina for number of direct hurricane strikes (Godschalk et al., 1989). Prior to Hurricane Hugo, South Carolina had been hit by only one Class IV (extreme) storm and no Class V (catastrophic) hurricanes. Hurricane Hugo, a Class IV hurricane, was the most severe storm to make landfall in South Carolina this century (FEMA, 1989). Preliminary studies indicate that during Hurricane Hugo, beach recession averaged over 100 feet (National Research Council, 1990, Appendix F). Many of South Carolina's protective dunes were completely leveled by the storm. The state quickly undertook a massive dune restoration program and has rebuilt dunes along most of the oceanfront that were damaged by Hurricane Hugo (Lennon, personal communication, April 1990).

The South Carolina Coastal Zone Management Act of 1977

South Carolina first addressed threats caused by coastal erosion in its 1977 Coastal Zone Management Act, Title 48 (CZMA). The development of a "comprehensive beach erosion and protection policy" (Ch. 39, Sec. 30) is among the goals to be implemented through the act. Although the act is largely concerned with general land use policies within the coastal zone, it addresses erosion both directly and indirectly.

The CZMA defines the coastal zone to include the eight counties bordering on tidal waters: Beaufort, Berkeley, Charleston, Colleton, Horry, Georgetown, Jasper, and Dorchester (the latter two border major estuaries, not the ocean) (39/10). "Critical areas" are defined in the act to comprise coastal waters, tidelands, beaches, and primary oceanfront sand dunes (39/10). The CZMA created the South Carolina Coastal Council, an 18-member appointive body, to develop, enforce, and administer the state's coastal management program (39/40 and 80). To conduct this program, the Coastal Council was charged to: 1) "inventory and designate areas of critical state concern within the coastal zone," 2) "establish broad guidelines on priority uses in critical areas," and 3) "conduct other studies and surveys as may be required, including the beach erosion control policy" (39/80).

To carry out the erosion policy, the council had to "identify critical erosion areas and evaluate the benefits and costs of erosion control structures" (39/120). Furthermore, the act gave the council the "authority to remove all erosion control structures which have an adverse effect on the public" (39/120). It also directed the council to coordinate beach and coastal erosion control among state and local governments (39/50).

The state Coastal Zone Management Act was held to be constitutional in *Carter v. S.C. Coastal Council* 314 S.E.2d 327 (1984).

The South Carolina Beachfront Management Act of 1988

To address coastal erosion directly, in 1988 the South Carolina legislature adopted the Beachfront Management Act (BMA). In passing this act, the legislature authorized the council to confront the problems posed by critically eroding beaches and to protect the coastal zone's beach/dune system (39/250). The BMA was enacted pursuant to a report by the South Carolina Blue Ribbon Committee on Beachfront Management (1987) that examined other states' experiences with coastal erosion management laws. In 1990 the act was substantially amended. On February 11, 1991, the BMA was held to be constitutional by the South Carolina Supreme Court in *Lucas v. South Carolina Coastal Council* 404 S.E.2d 895 (1991), but the

U.S. Supreme Court reversed and remanded the case for further review on June 29, 1992 (No. 91-453) (see discussion on page 119).

Under the BMA, the Coastal Council exercises direct permitting authority over new development in "critical areas." The definition of critical areas was amended in the BMA to include the "beach/dune system." The council also reviews permits granted by federal and other state agencies for consistency with council policies. In addition, FEMA has authorized the council to certify "structures subject to imminent collapse or subsidence" due to erosion for purposes of the Upton-Jones Amendment to the National Flood Insurance Act (42 USCA, Sec. 4013(c)).

The BMA states several legislative findings regarding the physical, economic, and ecological importance of South Carolina's beach/dune system. The act finds that "without adequate controls, development has been unwisely sited too close to the system" (39/250). Furthermore, the use of erosion control devices "has not proven effective . . . [and has] given a false sense of security to beachfront property owners" (39/250). The BMA also states that there is "no coordinated state policy for post storm emergency management of the beach/dune system [and] a long-range comprehensive beach management plan is needed for the entire South Carolina coast to protect and effectively manage the beach/dune system" (39/250).

The beach/dune policies listed in the BMA respond to these legislative findings and mandate the Coastal Council to remedy the problems outlined in the findings (39/130). These policies instruct the council to:

1) "protect, preserve, restore and enhance the beach/dune system,"
2) "create a comprehensive long-range beach management plan and require local comprehensive beach management plans . . . [that] include a gradual retreat from the system over a forty-year period,"
3) "severely restrict the use of hard erosion control devices,"
4) "encourage the use of erosion inhibiting techniques which do not adversely impact the long term well-being of the beach/dune system,"
5) "promote carefully planned nourishment,"
6) preserve and enhance "existing public access . . . of the beach,"
7) "involve local governments in long-range comprehensive planning and management of the beach/dune system," and
8) "establish procedures and guidelines for emergency management of the beach/dune system."

Coastal Construction Restrictions

The BMA defines the beach/dune system to include "all land from the mean high water mark . . . landward to the setback line" (39/270). The act, which applies to six coastal counties and 16 municipalities (Association of State Floodplain Managers, 1988), regulates construction on land in the beach/dune system within two zones: 1) "standard erosion zones," defined as segments of shoreline that are subject to essentially the same set of coastal processes; and 2) "inlet erosion zones," segments of shorelines along or adjacent to tidal inlets that are directly influenced by the inlet and its shoals (39/270).

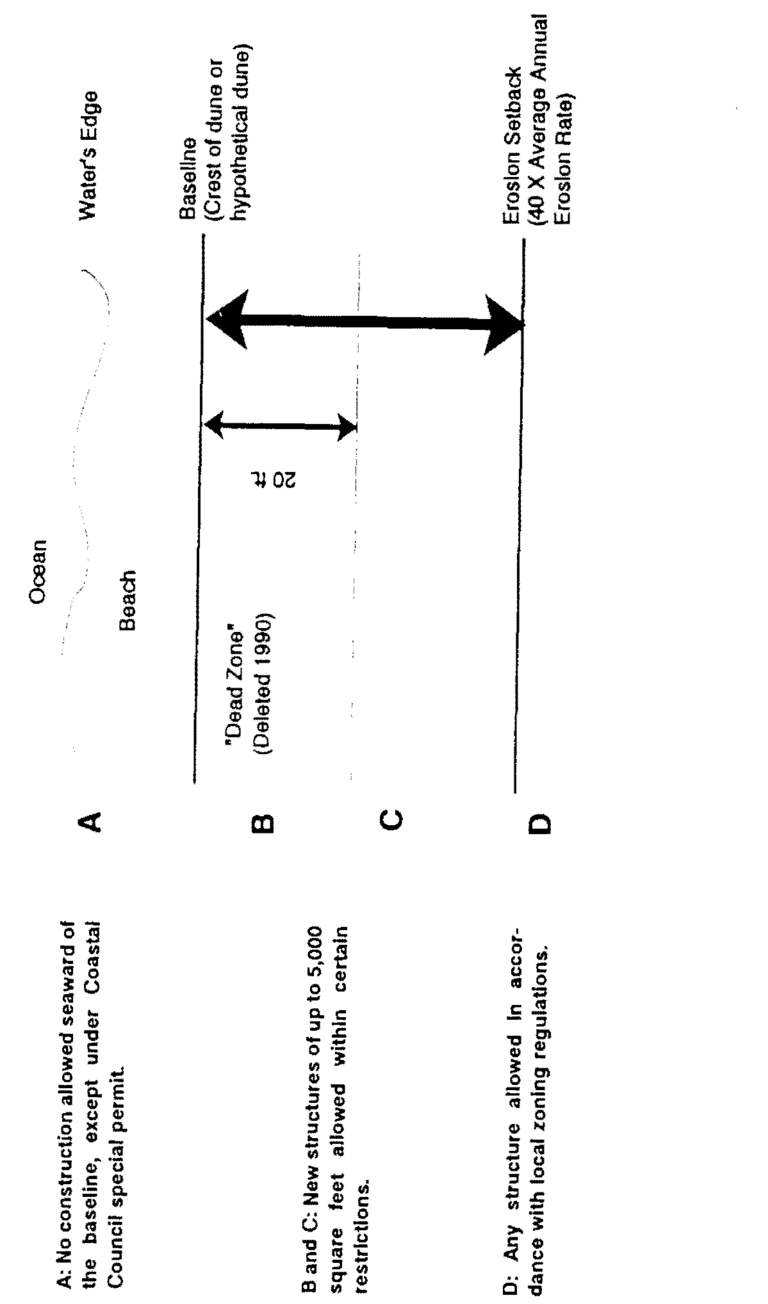
Within these zones, which include the entire oceanfront coastline, the council must establish baselines from which to measure erosion setbacks (39/280). In a standard erosion zone the baseline follows the crest of the primary dune or, where dunes have been altered, a hypothetical primary dune. The latter is determined by measuring representative, natural beach gradients seaward to a depth of five feet (mean sea level) to estimate where the primary dune would be located if the shoreline were not altered. For unstabilized inlet erosion zones, the baseline is defined as "the most landward point of erosion at any time during the past 40 years" (39/280).

The council delineates construction setback lines landward of, and parallel to, the appropriate baseline (39/280). The setback line is established at a distance equal to 40 times the average annual erosion rate. Prior to building a new habitable structure between the setback line and the baseline, the owner must certify to the council that construction meets the following conditions: 1) the structure does not exceed 5,000 square feet of heated space; 2) the building is located as far landward as practicable; 3) no erosion control structure is part of the building; and 4) the structure will not be built on primary dunes (39/290). New erosion control structures cannot be built seaward of the setback, except to protect an existing public highway (39/290). All other construction, except for swimming pools, requires a council permit. Landowners whose property development is restricted may petition the circuit court to determine whether a compensable taking of private property has occurred (39/290).

The law prohibits most construction seaward of the baseline. However, the council has the authority, under the 1990 amendment, to issue special permits for construction seaward of the baseline, but not on a primary dune or active beach (39/290). The act's rules and regulations make such a permit difficult to obtain. Only one special permit has been granted for a 2,500-square-foot house on the Isle of Palms on a site with over 200 feet between the street and the primary dune (Lennon, personal communication, December 1990).

Furthermore, destruction of any beach or dune vegetation seaward of the setback line is prohibited, unless there is no feasible alternative. In such cases, mitigation against destruction is required (39/310). Property deeds for parcels located partly or completely seaward of the setback line must contain a statement identifying the location of the land in relation to the setback line, baseline, and NFIP V zone; the local erosion rate; and locational coordinates (39/330).

Figure 3.2
South Carolina Beachfront Management Act
Regulatory Provisions



An existing habitable structure located seaward of the setback line or the baseline that is damaged by natural or human causes may be repaired (39/290). Existing structures "destroyed beyond repair by natural causes" may be rebuilt subject to the following limitations: 1) the total square footage of the rebuilt structure seaward of the setback line must be no greater than the square footage of the original structure seaward of the setback line, 2) the new structure has no greater linear footage along the coast than the original building, 3) the new building is no further seaward than the original structure, 4) the rebuilt structure is located behind the setback line or as far landward as possible, and 5) the structure is not built seaward of the baseline (39/290). The Coastal Council has not yet taken a firm position on whether a building bisected by a setback line is subject to the above limitations.

To be considered "destroyed beyond repair," two-thirds of a habitable structure's predisaster market value must be lost through damage (greater than the 50% criterion for "substantial damage" under the NFIP). Professional appraisers under contract to the state Coastal Council made this determination after Hurricane Hugo. The council devised a point system that appraisers use to measure extent of damage and determine if a structure is destroyed beyond repair:

Building Components	*% of Total Structure*
Foundations or Pilings	25
Exterior or interior load-bearing walls and beams	25
Roof system - joist	15
Electrical, plumbing, heating and air systems	10
Septic tank, drain fields, or sewer lines	10
Flooring	5
Doors and windows	5
Decks, porches, and stairs	5
Total	100%

Based on this system, a building is considered repairable even if only its waste-handling system and foundations or pilings remain intact (Beatley, 1990).

Erosion Mapping

The South Carolina Coastal Council uses aerial photos and maps to calculate historic rate of shoreline change for the state's oceanfront coastline. Data for some remote and undeveloped areas are sparse. Depending on the data available for particular areas, the council used maps dating as far back as 1859 and aerial photos from the 1930s up to the present. Shoreline change rates were determined at intervals ranging from 1,000 to 3,000 feet, depending on the presence of identifiable features. The resulting average, long-term erosion rates were then used to establish and map setbacks for the South Carolina shoreline. Setbacks and baselines are mapped on orthophoto maps at 1:100 scale. The council updates these erosion rates every five to 10 years (Association of State Floodplain Managers, 1988).

Beach Management Plans

Under the BMA, the council must develop a state-wide, long-range, comprehensive beach management plan and help local governments complete their own plans (39/320). The state's plan will include: 1) the development of a data base concerning the beach/dune system; 2) guidelines for beach nourishment and restoration, beach access, sand dune protection, habitat protection, and mitigation for construction seaward of the setback line; 3) recommendations for funding programs; and 4) development of a public education program on the beach/dune system (39/320).

Local governments are required to prepare comprehensive beach management plans and submit them to the council for approval (39/350). Beach profile and erosion rate data for erosion zones, an inventory of structures located seaward of the setback line, and an analysis of beach erosion control alternatives are among the elements that must be included in the local plans (39/350). If a local government fails to establish and enforce a local beach management plan within the prescribed time period, the council shall implement a plan for the community, and the local government will no longer be eligible to receive state funds for beach/dune protection, preservation, restoration, or enhancement (39/350).

The Lucas Decision

As mentioned above, the South Carolina Beachfront Management Act was held to be constitutional by the South Carolina Supreme Court in *Lucas v. S.C. Coastal Commission*, 404 S.E. 2d 895 (1991). This case involved an appeal by the Coastal Commission from a trial court decision that awarded the owner of two lots in a designated "inlet erosion zone" $1.2 million in taking damages for denial of a permit by the Coastal Council. The majority in the 3-2 state supreme court opinion emphasized that the plaintiff had not questioned the public necessity of the BMA, namely:

> that the beach/dunes area of South Carolina's shores is an extremely valuable public resource; that the erection of new construction, inter alia, contributes to the erosion and destruction of this public resource; and that discouraging new construction in close proximity to the beach/dune area is necessary to prevent a great public harm. (404 S.E. 2d, at 898).

According to the majority, the plaintiff had merely claimed that a regulation, no matter how valid, that deprived a landowner of "all economically viable use" of his property raised an obligation for the state to compensate the owner for the value of the land thereby lost. The court followed the majority opinion in *Keystone Bituminous Coal Assn. v. DeBenedictis* 107 S. Ct. 1232 (1987) and its own prior decision in *Carter v. South Carolina Coastal Council* 314 S.E. 2d 327 (1984) to deny a right for the landowner to be compensated where the regulation serves to prevent "a serious public harm." The majority quoted *Keystone* to the effect that "all property in this country is held under the implied obligation that the owner's use of it shall not be injurious to the community" (404 S.E. 2d, at 901, quoting 107 S.Ct. 1245). The dissent viewed the issue in terms of economic deprivation to the owner, whose expert appraiser had testified that the land was valueless under the BMA. Conceding that the 1990 amendments may retrieve the plaintiff's right to build, the dissent urged remand to the Coastal Council to grant a permit or pay compensation.

Although the state won, the owner appealed to the U.S. Supreme Court. On November 19, 1991, the latter announced that it would review the Lucas case with respect to the question presented: "Does land use regulation, pursuant to state's police power, require compensation under Constitution's Fifth Amendment if it totally eliminates value of private property?" (60 *Law Week* 3371). (Chief Justice Rehnquist authored the dissenting opinion in *Keystone* that the South Carolina court explicitly elected not to follow.)

On June 29, 1992, the U.S. Supreme Court announced its decision in the long-awaited land use case of *Lucas v. South Carolina Coastal Council* (112 S.Ct. 2886). By a 6-2-1 majority, the Court reversed and remanded the South Carolina Supreme Court decision.

The only issue before the Supreme Court was whether compensation was due to Lucas for his alleged "total loss of value" attributed to the Beachfront Management Act. Fearing affirmation of the state decision if the case were viewed by the Court as a referendum on the entire environmental movement, Lucas did not challenge the need for the South Carolina act. Nor did the Court suggest that coastal management and other environmental laws are necessarily unreasonable, even when they reduce property values. But where the value is essentially "destroyed" by

regulation, the majority felt that compensation should be paid. They hedged from an outright decision in his favor, however. They remanded the case to the state court to determine whether the Beachfront Management Act changed the "background nuisance and property law" of South Carolina, in which case compensation is due to Lucas.

The *Lucas* case, if read carefully, need not be considered devastating either to coastal erosion management laws or to broader environmental regulatory programs. However, as Justice Blackmun warned in dissent, its impact will not be limited to its fairly narrow area of application—the "total taking" context. Politically, it will be invoked throughout the nation as a club over the heads of state and local officials to dissuade them from regulating private property. The case, in other words, may hover like a huge black cloud over the environmental management landscape in coming years.

(See further discussion of recovery from Hurricane Hugo in South Carolina in Chapter 5.)

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Texas

Introduction

Texas, with the third longest coast in the continental United States, has approximately 380 miles of shorefront along the Gulf of Mexico and about 1,000 miles of bay shoreline (General Land Office, 1990a and 1990b). Texas's Gulf Coast spans 15 counties and includes 365 miles of beach on elongated coastal barriers. Where barriers do not parallel the mainland shore, such as between Sabine Pass and High Island and Surfside and Brown Cedar Cut, large salt marshes border the Gulf. The extent of coastal vegetation and degree of dune stability decreases from north to south. North of Padre Island, for example, well-developed dunes and grassy vegetation are found on the shoreline. Within Padre Island National Seashore, however, the vegetation is sparse and dune fields are actively shifting. Along the most southerly part of the Texas shore, barren, saline, sand flats border the Gulf (Morton et al., 1983).

Significant development of Texas's coastal barriers did not occur until after the second World War. In the 1950s permanent causeways were constructed from the mainland to North and South Padre islands. During the 1970s, resort development concentrated on those two barriers, as well as on Galveston and Mustang islands. Today, many small communities are scattered along the Texas coast, but these four areas remain the points of major shoreline development (Morton et al., 1983). Seventy miles (18%) of Texas's Gulf shoreline is owned by the state and federal governments and is thereby protected from development (U.S. Army Corps of Engineers, 1981).

Texas's Gulf coast is highly vulnerable to hurricanes. Since 1880, 85 recorded hurricanes have affected Texas's shoreline. Texas's most disastrous hurricane, the Galveston Hurricane of 1900, caused more than 6,000 deaths (Morton et al., 1983). Today a massive seawall stands between Galveston and the Gulf. Galveston is the only large city located on the Texas coastline, and includes an extensive investment in oil refineries and chemical facilities (Jordan et al., 1984).

Approximately 60% of the Texas shore is eroding at rates ranging from one to 50 feet per year. About 10% of the coastline is eroding at more than five feet annually. Of the noneroding coastline, 33% is stable and 7% accreting. The West Beach area of Galveston Island (beyond the seawall), the upper coast from Sabine Pass to Rollover Pass, the Freeport area, Matagorda Peninsula, and South Padre Island exhibit the highest coastal erosion rates in the state (General Land Office, 1990a).

Special Committee on Coastline Rehabilitation

Texas is among the six coastal states that do not participate in the federal Coastal Zone Management program. Furthermore, Texas does not have a comprehensive shoreline management plan, and no single state agency is charged with regulating activities within the coastal region. For example, the state's General Land Office (GLO), the Bureau of Economic Geology at the University of Texas, and the state Soil and Water Conservation Board all address coastal erosion issues (General Land Office, 1990a).

In an attempt to redress the lack of comprehensive coastal erosion policy, the Texas Senate created the Special Committee on Coastline Rehabilitation (Senate Resolution 4, 1985). In the resolution the senate recognized that beach erosion is "causing serious financial loss to the coastal communities and the loss of a natural resource." The senate charged the special committee to examine problems created by coastal erosion in Texas and to recommend creative ways to alleviate these problems.

The special committee recommended that one state agency become the coordinating body for coastal issues (Special Committee on Texas Coastline Rehabilitation, 1989). Correspondingly, in 1989 the legislature amended the Natural Resources Code (section 33.052) to make the GLO the lead agency to coordinate and develop a long-term coastal management plan. Although the legislation directed the GLO to bring together all the appropriate state agencies to develop the plan, it did not change the powers or duties of the agencies. Each state agency, therefore, retained its individual coastal regulating and enforcing authority. The legislature also instructed the GLO to appoint an advisory committee to ensure that the public participate in preparation of the coastal management plan.

As a first step toward developing the plan, the GLO has prepared nine papers on coastal issues, including one on coastal erosion. These papers were then used to introduce the program at a series of public meetings. Although the public response has generally been positive, the legislature has not appropriated funds for development of the coastal management plan. Nonetheless, the GLO expected to complete a draft plan by the fall of 1990 (General Land Office, 1990d).

Open Beaches Act

The 1959 Open Beaches Act (Natural Resources Code, Chapter 61) legislatively affirmed existing state policy that allowed unrestricted access to the Gulf coastline and provided a means for enforcing this right of access (Cross, 1989). The act prohibits structures from being located on the beach by declaring that, through public trust and common law rights of access, the majority of Texas' Gulf beaches are open to the public (Ch. 61, Sec. 011). The beach in Texas is defined to have two components: 1) the "wet beach"—the area washed by the tides ending at the point of the mean high tide line, which is state-owned, and 2) the "dry beach"—the area from mean low tide to the natural line of vegetation. The dry beach is protected from encroachments if the public has acquired an easement under Texas common law principles. Such easements have been acquired on approximately 290 of Texas's 365 miles of Gulf beach (General Land Office, 1990b). The legislation does not pertain to beaches on islands or peninsulas that are inaccessible by public road or ferry (61/021).

The Open Beaches Act gives the attorney general the authority to require that structures stranded by coastal erosion on public beaches be moved landward of the vegetation line (61/018). This aspect of the act was tested in 1983 when severe erosion caused by Hurricane Alicia left approximately 300 structures standing seaward of the vegetation line on Galveston Island and other upper coast beaches (General Land Office, 1990b). After the hurricane, the attorney general instituted a policy that sets forth several prohibitions within the public beach area: 1) no construction of new structures, including bulkheads and seawalls; 2) no repair or reconstruction of any existing structures with more than 50% damage; and 3) no interferences on the ground level of existing houses sustaining less than 50% damage (Special Committee on Coastline Rehabilitation, 1989).

After Hurricane Alicia the attorney general's office filed suit against 17 landholders who owned structures that were left seaward of the vegetation line and who attempted to reconstruct these structures. The attorney general argued, and the court sustained his case, that the boundary of the public easement migrates landward to correspond to the movement of the natural vegetation line (Linda Secord, Texas Assistant Attorney General, personal communication, July 1990).

Dune Protection Act

Recognizing the storm-buffering capabilities of sand dunes, the legislature enacted the Texas Dune Protection Act of 1973 (Natural Resources Code, Ch. 63). The act allows certain coastal counties to establish dune protection ordinances in order to preserve sand dunes that "offer a defense against storm water and erosion" (63/011). The act pertains to Gulf coast counties north of the Mansfield Ship Channel that include a barrier island or peninsula. The legislature excluded counties located south of the ship channel because the dunes in that region ostensibly "do not afford significant protection to persons and property inland from this area" (63/001).

Eligible counties may establish a dune protection line up to 1,000 feet landward of the mean high tide line (63/012). Once a county has established such a line, a county permit is required for most activities seaward of the line. Livestock grazing, oil and gas production, and recreation other than use of a recreational vehicle are the only activities exempt from the permitting requirement (63/052). In deciding whether to grant a permit for a proposed activity, the county must determine whether the activity will "materially weaken the dune or reduce its effectiveness as a means of protection from the effects of high wind and water" (63/054). Of the 12 counties to which the act pertains, only Nueces and Brazoria counties have established dune protection lines (General Land Office, 1990c).

Erosion Mapping

Texas has quantified long-term annual erosion rates for the entire Texas Gulf coast and the state's major bays. The state used topographic maps dating from the mid-1800s to the 1930s, aerial photographs, and field surveys to calculate historic rates of shoreline change. Measurements were made at 5,000-foot intervals. The shoreline change data are updated approximately every 10 years. At present, the state does not use shoreline recession rates to regulate activities within the coastal zone (Association of State Floodplain Managers, 1988).

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4

The States Compared: Some Cross-Cutting Issues

by
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Introduction

The previous chapter expanded upon the data presented in Table 3.1 for selected states. As expected, the types of laws and agencies involved, geographic areas affected, and restrictions imposed differ significantly from one state to another. This may be viewed as a virtue of our federal system in which states may choose to regulate or not according to their own geographical and sociopolitical circumstances. A more pragmatic view, however, may suggest that the nation's eroding shorelines are managed inconsistently and even haphazardly from one state to another. Certain states with extensive eroding shorelines have sought to mitigate erosion losses through development restrictions (e.g., North and South Carolina, Florida, New York, Michigan, and Rhode Island). Other coastal states such as New Jersey, Massachusetts, Maryland and California (the latter two were not studied for this report) have extensive coastal zone and wetlands management programs that indirectly may influence development in eroding areas. Still others such as Texas and Virginia assemble technical data on erosion rates, but do little to restrict coastal development.

Evaluation of the effectiveness of the various state programs is difficult. Although several states have more than a decade of experience in administering their programs, regulations are frequently revised and are applied on a case-by-case basis. Unlike the minimum elevation requirements of the National Flood Insurance Program (NFIP), it is difficult to visually ascertain the horizontal displacement attributable to setback requirements, if any. Furthermore, few state programs have been tested

under conditions of actual coastal disaster. In the most prominent case to date, the South Carolina Beachfront Management Act of 1988 was amended after Hurricane Hugo to delete the statewide 20-foot minimum setback, or "dead zone" (see Chapter 5). As future storms demolish older coastal homes elsewhere, will even the most proactive state management programs be curtailed by political influence? (The NFIP elevation requirements apply to "substantially damaged" structures, but do not reflect erosion risks.)

Due to the comparative recency of most of the documented laws and the difficulty of making "with and without" estimates, we did not attempt to evaluate the effectiveness of state programs. Rather, the following discussion raises some cross-cutting issues that apply to any state program, existing or potential, that addresses coastal erosion management. This section is divided into the following headings: 1) legal and administrative framework, 2) delineation of erosion hazard areas, and 3) regulations within erosion hazard area restrictions.

Legal and Administrative Framework

The state programs summarized above differ widely in terms of 1) the type of legislative authority provided, if any; 2) the nature and functional scope of the responsible agency; and 3) the interaction of state and substate units of government.

Types of legislation fall into three categories:

1) erosion management laws,
2) coastal zone management laws with an erosion element, and
3) related resource management laws (e.g., wetlands).

Laws of the first type are relatively rare and recent, including only the New York Coastal Erosion Hazard Areas Act of 1981 and the South Carolina Beachfront Management Act of 1988 (amended in 1990). The New York law is unique in its complexity. It addresses two kinds of shorelines (ocean and Great Lakes) and two kinds of erosion zones (natural protective features and structural hazard areas), and is administered by two agencies—the Departments of Environmental Conservation and State. The South Carolina law, based on a blue ribbon committee review of several state programs, establishes a 40-year setback that is riddled with loopholes.

General coastal zone management (CZM) laws with erosion elements are the most prevalent among the states studied (primarily because they were selected for that reason). These include Florida, Rhode Island, North Carolina, Michigan, and Ohio. Except for Ohio, which only passed a coastal law in 1988, these state CZM programs date back about 20 years to the early period of the environmental movement and creation of the federal

Coastal Zone Management Act of 1972. Erosion, however, was not an immediate concern of either the federal act or its state counterparts. In each of those four states erosion was eventually addressed through 1) amendment of the original state coastal law (Florida and Michigan) leading to new regulations or 2) adoption of regulations pursuant to the original law (Rhode Island and North Carolina). In each case, the adoption and revision of regulations for erosion areas has proven to be arduous, controversial, and time-consuming. For example, Michigan, in February 1992, approved new regulations after a review process lasting three and a half years. (For a description of the equivalent process in North Carolina, see Owens, 1985, p. 326).

The third group of states included in our study—New Jersey, Massachusetts, and Texas—lack either specific or general coastal erosion legislation, but have other statutes that have been adapted (and perhaps stretched) to address erosion to some degree. The New Jersey Coastal Areas Facilities Review Act of 1973 purports to regulate coastal construction, but applies only to subdivisions of 25 or more units or commercial developments involving more than 300 parking places. Attempts to plug the loophole for smaller projects through "emergency regulations" have been struck down by the courts. Massachusetts relies chiefly upon its Wetlands Protection Act (WPA), which authorizes local conservation commissions to regulate development on beaches and dunes as well as traditional wetlands. Erosion hazards are reflected in WPA regulations, but do not require minimum setbacks. Texas—which has no comprehensive CZM law and does not participate in the federal CZM program—nevertheless has two statutes that relate to erosion: the Open Beaches Act of 1959 and the Dune Protection Act of 1973. The former prohibits building or rebuilding seaward of the vegetation line along much of the Texas Gulf Coast. The latter authorizes certain coastal counties to adopt dune protection lines up to 1,000 feet landward of mean high tide. Only two of the 12 eligible counties have so far utilized this authority.

Authority under the laws listed above is vested in a variety of agencies. Rhode Island, North Carolina, and South Carolina each have a state coastal commission or council, assisted by one or more administrative agencies, to administer their respective coastal laws. Michigan, Florida, New Jersey, Ohio, Massachusetts, and New York place their coastal programs within broader natural resource agencies. The latter two states, and perhaps others, have divided their programs among multiple agencies. In Massachusetts, coastal planning is conducted by the state Office of Coastal Zone Management, while administration of the Wetlands Protection Act is the function of the Department of Environmental Protection. In all cases except Texas, the lead coastal agency administers beach nourishment and shore protection permits. Texas has no coastal program, but in 1989 it designated the state General Land Office to take the lead in preparing a coastal plan.

The respective coastal laws vary in terms of the scope of authority and degree of discretion granted to administrative agencies. Generalization is difficult. The following summarizes how each state studied handles this issue:

Florida: The act explicitly requires Coastal Construction Control Lines (CCCLs) to be set, prohibits building seaward of the 30-year erosion line, and mandates the coastal building zone. It specifies how CCCLs will be defined and what exceptions to setbacks are allowed. However, the agency sets rules for determining the 30-year recession line and the Department of Natural Resources (DNR) has flexibility in coastal construction permitting.

Massachusetts: The Wetlands Protection Act spells out procedures for regulating use of wetlands (including beaches and dunes), but specific performance standards and guidelines are determined by administrative regulations.

Michigan: Under the Shorelands Protection and Management Act (SPMA), the Department of Natural Resources (DNR) has broad discretion. The SPMA itself is very short and most of the details are left for the agency to determine through regulations. Specifically, SPMA mandates that DNR determine "High Risk Areas," but it does not tell the agency how to do so. However, SPMA does instruct the DNR to enforce building setbacks.

New Jersey: Because the statutes regulating coastal development in New Jersey are very general, the agency's rules spell out most of the details pertaining to regulation within the coastal area. In particular, erosion hazard areas and setbacks were not mandated by the legislature, but were established through agency regulations. The agency's attempt to expand the coverage of CAFRA through emergency regulations, however, were judicially held invalid in 1991.

New York: Legislation clearly requires the Department of Environmental Conservation (DEC) to establish a 40-year setback in "structural hazard areas" and also sets forth state/county/local powers. This legislation did not, however, provide great detail on which activities should be permitted and when variances should be given.

North Carolina: The Coastal Commission and its supportive agency have broad discretion. The Coastal Area Management Act (CAMA) primarily sets policy and procedures for permitting, but the rules delineate the erosion hazard area and set forth specific erosion setback regulations. CAMA does not mandate an erosion setback.

Ohio: Legislation requires the Department of Natural Resources (DNR) to establish and regulate a 30-year erosion hazard setback area, but many details are left to the agency to determine through regulations.

Rhode Island: The 1971 act was quite general, leaving the details to be spelled out by regulation. The Coastal Resources Management Council, established under this legislation, has discretion in case-by-case regulation and permitting.

South Carolina: The Beachfront Management Act is very specific about setbacks, baselines, and exceptions. The act does, however, allow the Coastal Council discretion to grant special permits for construction seaward of the baseline.

Texas: Occasional litigation by the attorney general is the only management tool. There is no permitting process for building seaward of the vegetation line.

In terms of intergovernmental coordination, several states (Florida, North Carolina, South Carolina, New York, Michigan, and Ohio) require counties or municipalities to plan and regulate their coastal areas under state guidelines. Where no local program is approved, the state assumes direct control over such areas. Those states may reserve permitting authority at the state level over large scale or sensitive types of development. Rhode Island and New Jersey (as far as CAFRA applies) directly regulate coastal development at the state level. The Texas attorney general enforces the Open Beaches Act. Massachusetts relies upon local conservation commissions to enforce the Wetlands Protection Act, with a right of appeal by "aggrieved parties" to the state.

Erosion Hazard Area Delineation

Each of the 10 states examined for this study collect data on coastal erosion hazard rates, including Texas and Massachusetts, which do not have erosion setback requirements. Average annual erosion rates (AAERs) for specific segments of shorelines are used to some degree in each state that regulates erosion hazard areas. They use different methods of calculation, baselines from which setbacks are measured, and base number of years for minimum construction setbacks.

Florida has perhaps the nation's most geographically extensive and technically rigorous program of shoreline change measurement. AAERs are calculated from historical government surveys of mean high water dating from the 1800s to 1971 and from field survey profiles taken since 1971. For measuring recent shoreline change, the state uses over 3,400 concrete monuments placed at 1,000-foot intervals along the coast. These monuments are referenced to a system of larger monuments located farther inland. Beach and offshore profiles are measured from these monuments and are compared to historical surveys to determine AAERs, as well as used to set coastal construction control lines (CCCLs). The DNR also uses aerial photos flown during surveys to check field data and historical

aerials to check the accuracy of historic survey maps. The DNR has determined AAERs for 25% to 30% of the state on a county-by-county basis. An applicant's site survey is compared to the erosion rate data available for the site, and then the appropriate AAER is calculated. Generally, erosion risk areas are not mapped in advance of a specific development application.

The baseline for the CCCL is measured from the *mean high water line*. The 30-year erosion recession line is measured from the *seasonal high water line*. The seasonal high water line is a relationship that has no technical basis but was determined by the legislature in order to define the landward portion of the beach. It is based on the mean tide range and the elevation of mean high water.

North Carolina uses an Orthogonal Grid Mapping System to determine rates of shoreline change. U.S. Geological Survey (USGS) topographic maps and aerial photographs taken from 1937 to 1986 are enlarged to the same size, and the lines of high water and stable vegetation are digitized onto a computer. Photographs taken from as many as 19 and as few as four different time periods are compared. The agency develops data on the change in location of the shoreline and the vegetation line relative to a shore-parallel baseline. Shoreline changes for the entire ocean coastline have been mapped at 50-meter transect intervals and will be updated every five years.

Michigan superimposes current and historic aerial photos to determine the extent of bluff recession over 15 to 40 years. Recession rate transects have been measured from 100 to 750 feet apart. High-Risk Erosion Areas are designated where the AAER has exceeded one foot for at least 15 years. Such areas may be mapped for public informational purposes as far as 1,000 feet inland from the *bluffline*, which is the baseline. Proposed regulations expand the definition of bluffline to include areas with dunes. The new regulations would ensure that the baseline is always the landward edge of active erosion, regardless of site features.

New York calculates AAERs for the Great Lakes using hydrographic charts dating from 1875 to 1879 and 1979 aerial photographs. Generally, the baseline is the *landward limit of active erosion*. Erosion rates are measured at 200- to 400-foot intervals from the receding edge of the bluff, the rear dune toe, or the natural vegetation line. The DEC has not determined AAERs for the south shore of Long Island. All of Long Island is a "natural protective feature," so baselines and setbacks are based on the type of feature, not on erosion rates. For "structural hazard areas" (within which the 40-year setback applies), the baseline is the landward boundary of the most inland natural protective feature.

New Jersey calculates AAERs to determine setbacks on a site-by-site basis. National Ocean Service topography sheets, orthophotos, and color-infrared photos are used to determine the local historic recession rate. The data is entered into a metric mapping computer base that enables the Department of Environmental Protection's Division of Coastal Resources to plot any area on the coast and produce a long-term shoreline change map. Depending on the site, the setback is measured from the *crest of a coastal bluff, the dune crest, the first line of stable vegetation* or, in areas without dunes, *the landward edge of the beach* or the *eight-foot elevation line.*

The ***Rhode Island*** Coastal Council uses data from independent studies to establish AAERs. The most extensive of these studies compared aerial photos taken from 1938 to 1973. Measurements were taken at 350-meter intervals. The baseline is the *inland edge of the most landward shoreline feature*, which includes coastal beaches, dunes, barrier beaches, wetlands, bluffs, cliffs and banks, rocky shores, and existing anthropogenic shorelines.

South Carolina uses aerial photos from the 1930s to the present along with maps dating from 1859 to determine AAERs. In 1988 the South Carolina Coastal Council mapped the 40-year setback along the state's shorelines on orthophoto maps at a 1:100 scale. Shoreline change rates are determined at 1,000- to 3,000-foot intervals and will be updated every five to 10 years. For "standard erosion zones," the baseline is the *crest of the primary dune* or, where dunes have been altered, a *hypothetical dune* that is determined by measuring beach gradients to estimate where the dune would naturally be located. For "inlet erosion zones," the baseline is the most landward point of erosion in the past 40 years.

Ohio's new erosion management program uses hydrographic charts dating from the 1860s and photos taken in the 1930s, 1950s, 1960s, and 1970s. The program has mapped the location of bluffs, banks, and dune scarps and determined AAERs. The state is now updating this information with aerial photographs taken in the spring of 1990. In the proposed rules the baseline is the *most landward recession line*, which depends on the geography of the site and can be a bluffline, the crest of a dune, the crest of a spit or barrier, the lakeward line of permanent wetland vegetation, or the top of a dike.

Massachusetts uses a metric mapping system developed by Stephen Leatherman to document 140 years of shoreline change. This technique compares two or three historical shoreline maps to current maps and aerial photos. It also uses National Ocean Survey and USGS topographic maps, hydrographic maps, orthophotos, and aerial photos as supplementary sources of data. The state Coastal Zone Management (CZM) office has prepared 231 maps at a 1:5,000 scale that show the location of the shoreline at four different time periods. (This scale is too small for detailed shoreline land management however.)

Texas has used topographic maps dating from the mid-1800s to the 1930s, aerial photographs, and field surveys to calculate AAERs. Measurements were made at 5,000-foot intervals; data are to be updated every 10 years. There is no setback requirement except that no building is allowed seaward of the *mean low tide line!*

States differ as to how they utilize erosion data. Florida, North Carolina, and New Jersey do not map setbacks. Instead they apply local AAER data on a site-by-site basis as development applications arise.

By contrast, South Carolina has mapped the inhabited portions of its shoreline and has maps that display baseline and 40-year setback lines at a 1:100 scale. New York has mapped its Great Lakes shorelines at a 1:200 scale. Rhode Island also maps erosion hazard areas, but at a smaller scale of 1:2,000.

Regulations Within Erosion Hazard Areas

Within the delineated erosion hazard areas described above, several states administer some form of minimum setback for new or rebuilt construction, although terminology differs from state to state. Also, the exact significance of a setback varies from outright prohibition of new construction in Florida to allowing new homes of up to 5,000 square feet in South Carolina. Some states permit the location of readily movable structures within the setback zone. The North Carolina setback designation of 30 times the AAER for small structures and 60 times for large ones is utilized by several other states with some modifications. (The higher standard for larger structures is apparently based on the expectation that they will last twice as long or are more difficult to move.) The following summarizes some of the contrasts among state programs.

In ***Florida***, a DNR permit is required to build seaward of Coastal Construction Control Lines (CCCLs), and the builder must meet specific performance and siting requirements. Along eroding shorelines, however, no permit may be issued seaward of the 30-year AAER setback, regardless of where the CCCL lies. Within the Coastal Building Zone, which extends 1,500 feet landward of the CCCL on the mainland and 5,000 feet landward of the CCCL on barrier islands, special building code standards apply. Renovations or additions that alter the original foundation require a coastal construction permit. Thus, rebuilding can occur if the original foundation is not altered. If, however, more than 50% of a structure is destroyed, Coastal Building Code requirements must then be met, which invoke the coastal construction permitting process and thus require rebuilding landward of the 30-year setback line.

Within High-Risk Erosion Areas in ***Michigan***, 30-year setback lines are established for new construction, to which the Department of Natural Resources (DNR) adds 15 feet. The DNR is proposing to designate a "zone of imminent danger," which is 10 times the AAER (a 10-year erosion zone). Also, the DNR is proposing to require a 60-year setback for structures with more than five dwelling units and buildings with foundations larger than 3,500 feet (analogous to North Carolina). If 60% or more of a building's value is destroyed, the regulations for new, permanent structures apply. If the cost of repair is less than 60% of the value, an owner can rebuild seaward of the setback.

Since ***New Jersey***'s emergency amendments have been held invalid, the Department of Environmental Protection (DEP) only regulates construction of developments of more than 24 dwelling units and other major facilities under the Coastal Area Facility Review Act (CAFRA). A 60-year erosion setback applies for such developments. (The emergency amendments required structures containing one to four dwelling units to be built landward of a 30-year setback and other structures to be built beyond a 60-year setback.)

Within "natural protective feature areas" in ***New York***, most construction is prohibited. In "structural hazard areas," permanent structures are not permitted, but movable structures are allowed with a DEC permit. A permit is required to rebuild a structure with damage greater than 50% of its pre-storm value.

Within Ocean Hazard Areas in ***North Carolina***, an erosion setback is required and existing structures must conform to the Coastal and Flood Plain Construction Standards. Structures with less than five units and under 5,000 square feet must be constructed the farthest landward of the following: 1) 30 times the AAER, 2) beyond the crest of the primary dune, 3) beyond the landward toe of the frontal dune, or 4) 60 feet landward of the vegetation line. For larger structures, the minimum distances are doubled to 60 times the AAER and 120 feet beyond the vegetation line. *Unlike any other state, the 60 foot/120 foot minimum setback applies whether or not the shoreline is eroding.*

"Replacement" of structures seaward of the setback is not permitted but "repair" is exempted from permitting requirements. Neither the legislation or regulations define the destinction between repair and replacement. Generally, the DNR considers replacement to be more than 50% of the value of a structure.

Within the ***Ohio*** Lake Erie Erosion Hazard Area (30-year setback), a building permit is needed for all construction. The DNR can only grant a permit if an existing erosion control structure will protect the site for 30 years or if each of these criteria are met: 1) no reasonable, prudent alternative site is available; 2) the structure will be movable and located as far landward as possible; and 3) the applicant will suffer exceptional hardship if the permit is not granted. Proposed rules would require that the erosion hazard area incorporate a "stable slope allowance" and an "existing slope offset." The former, which is added to the setback distance, is the "landward horizontal offset of the top of a bluff relative to its toe that is necessary to attain natural slope stability." The former, which is subtracted from the setback, is the offset provided by a slope that has been naturally or artificially stabilized.

In Critical Erosion Areas, ***Rhode Island*** shorelines that are receding at more than two feet per year, a setback based on approximately 30 times the AAER is required for buildings with less than four units. For larger structures, the setback is doubled. (The regulations designate four erosion categories based on the AAER. For example, Category A areas have AAERs from 2 to 2.5 feet, with a 75-foot setback for small structures or a 150-foot setback for large buildings.) Where the AAER is less than two feet per year, development must be set back at least 50 feet. On a case-by-case basis, the Coastal Council may decide to add a buffer zone that extends the setback. If more than 50% of a structure's value is destroyed, reconstruction requires a council permit and will probably have to be rebuilt landward of the setback line.

South Carolina's Beachfront Management Act (BMA), as amended in 1990, establishes the most complex and probably most permissive requirements of any state erosion management law. It prohibits most kinds of construction seaward of the baseline, but allows special permits in certain cases. Within the 40-year setback zone landward of the baseline, the BMA allows building or rebuilding of homes of *up to 5,000 square feet in floor area*, as well as routine maintenance of seawalls and bulkheads and replacement of patios and swimming pools. Paradoxically, new seawalls are generally prohibited within the setback zone, although large homes are allowed.

Structures damaged less than two-thirds of predisaster value can be repaired. Structures damaged beyond that level must meet several standards:

1) square footage seaward of the baseline and total linear footage along the coast line must not be greater than for the original structure;
2) the new structure must be no further seaward than the original structure;
3) the new structure must be located behind the setback or as far landward as possible; and
4) the structure must be landward of the baseline.

In ***Texas***, building or rebuilding substantially damaged structures is prohibited under the Open Beaches Act from the mean low tide line to the natural line of vegetation or 200 feet, whichever is reached first. County dune protection ordinances can be applied to land up to 1,000 feet inland of mean high water, but only two counties have adopted them.

Three Great Lakes states—Michigan, Ohio, and New York—provide for *movable homes* to be placed within setback areas under certain circumstances. In ***Michigan***, if a property is too shallow to meet the setback requirement, the DNR may allow a movable structure lakeward of the setback line. Such an exception is granted only if 1) the waste-handling system is landward of the structure, 2) the structure is as far landward as possible, and 3) the building meets "proper engineering standards." In ***New York***, movable structures can be built in "structural hazard areas" if: 1) the structure does not have a permanent foundation and the temporary foundation is removed with the building, 2) no structure is placed within 25 feet of the landward limit of a bluff, 3) the structure must not place "excessive ground loading on a bluff," 4) the permit application includes a plan for landward relocation, and 5) the structure is removed before the receding edge erodes to within 10 feet of the structure. ***Ohio*** requires any building seaward of the 30-year recession line to be movable. It does not appear that these or other states require lot depths sufficient to accommodate landward relocation of structures.

Single family homes are exempted from setback requirements in several states. The ***Florida*** DNR can grant a coastal construction permit for a single-family dwelling seaward of the 30-year recession line if 1) the parcel was subdivided prior to the effective date of the amended act, 2) the landowner does not own another parcel adjacent to and landward of the proposed building parcel, and 3) the building will be located landward of the frontal dune and as far landward as possible. In ***Michigan***, there are exceptions for all structures, not just single-family buildings, on parcels established prior to High-Risk Erosion Area designation. The proposed regulations provide specific exceptions for single-family dwellings. In ***New Jersey***, construction of single-family dwellings on the coast is not currently regulated. In ***North Carolina***, single family residences can be constructed seaward of the setback on lots existing prior to June 1, 1969, within Ocean Erodible Areas (but not in Inlet Hazard Areas) if the structure 1) is located at least 60 feet landward of the vegetation line and as far landward as possible, 2) is not located on or in front of a frontal dune, and 3) meets specific building requirements. ***South Carolina*** allows homes of less than 5,000 square feet between the baseline and the setback.

Conclusion

The foregoing outlines a mosaic of laws, policies, and practices regarding the management of erosion hazard areas by the states studied. Most programs, even in the most experienced states such as North Carolina and Michigan, largely address prospective development, allowing existing homes to be "grandfathered" until they collapse. Except for the short-lived Michigan house moving program (described in Chapter 6), no state has attempted to encourage or subsidize voluntary relocation of structures from eroding coasts. Nor does public acquisition of areas suffering major erosion and flood damage play a significant or systematic role in state programs.

The assembly and analysis of historic shoreline change data is probably the strongest element of state erosion programs. All of the 10 states studied, including those without erosion management restrictions, have developed at least broad brush shoreline recession estimates. While the methodology and reliability of such data vary, they compose a useful starting point for a national erosion mapping program.

On the other hand, the adoption and enforcement of restrictions on coastal development is widely hampered by political caution. Coastal property owners tend to be affluent and well-connected. Unlike riverine floodplains, coastal property values tend to be very high despite flooding and erosion hazards. This may in fact be attributable in part to the perception of a federal "safety net" through the NFIP and shoreline stabilization projects. While demanding the continuation of federal economic benefits, property owners and their political supporters oppose public hazard area regulations as a "taking" of the value of their land without compensation (e.g., as alleged by the appellants in the Supreme Court review of *Lucas v. South Carolina Coastal Council*).

Nevertheless, several states have grasped the nettle of regulating further development along eroding shorelines. They have demonstrated the utility of states as laboratories of innovation in land use planning and have laid a foundation for the establishment of minimum federal standards under the National Flood Insurance Program, if pending legislation is finally adopted. Contrary to other areas of environmental management, such as water pollution control and surface mine reclamation, it is the states, or at least a few of them, that are leading the federal government reluctantly to confront the costs of erosion of the nation's coasts.

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5

Erosion as a Political Hazard: Folly Beach After Hugo

by
Timothy Beatley, Sandra Manter, and Rutherford H. Platt

Introduction

Folly Beach is an incorporated city on Folly Island, a coastal barrier on the Atlantic Coast of South Carolina (Figure 5.1).[1] The island lies to the immediate southwest of the mouth of Charleston Harbor and is just over 10 miles by road from downtown Charleston. The year-round population of Folly Beach is about 1,800, which rises to around 5,000 during the summer rental season, and as many as 14,000 people visit the island on summer weekends. Due to Folly Beach's proximity to Charleston, it has long been a popular, middle class destination for weekends, vacations, and retirement. An increasing number of the island's permanent population commute to jobs in the Charleston area.

Folly Beach is the oldest of the beach communities near Charleston; others include Sullivan's Island, Isle of Palms, and Kiawah Island. Prior to Hurricane Hugo, the oceanfront at Folly was lined with cottages dating back to the 1940s and 1950s. Most were built before modern standards of elevation and hurricane strengthening required by the National Flood

1. Portions of this chapter were previously published in R.H. Platt, T. Beatley, and H.C. Miller, "The Folly at Folly Beach and Other Failings of U.S. Coastal Erosion Policy," *Environment* 33 (9):6-9; 25-32. They are included here with permission from Heldref Publications.

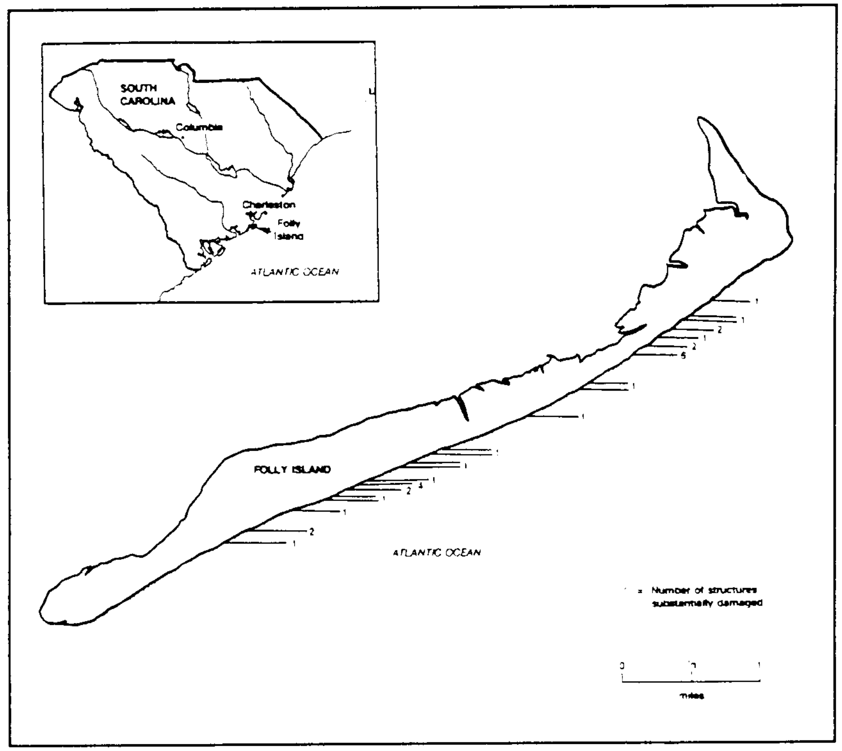

Figure 5.1. Locations and numbers of oceanfront structures on Folly Island, South Carolina, substantially damaged by Hurricane Hugo in September 1989. (Reproduced, by permission, from Platt, Beatley, and Miller, *Environment* 33. Copyright 1991 by Heldref Publications.)

Insurance Program came into effect. The high real estate values and lavish homes that characterize the newer, more opulent, Isle of Palms and Kiawah bypassed Folly Beach. The only large, high density structure at Folly is the Holiday Inn, located at the focal point of the community where the principal road from the mainland reaches the ocean. Public recreational access is limited to a small county park at the island's west end. Public walkovers (being restored since Hurricane Hugo) provide access to what is left of the beach, but in the absence of public parking lots, these primarily serve residents of Folly Beach. A former Coast Guard installation at the east end of the island is open and relatively unused, but swimming is dangerous due to high velocity inlet tides.

One reason for the relative (and peaceful) obscurity of Folly Beach is its chronic state of beach erosion, estimated to average up to four feet per year. According to the Coastal Council, although the island would erode naturally, most of its erosion is attributable to two five-mile-long jetties built along the navigational approach to Charleston Harbor at the end of the 19th Century. Because a southwesterly littoral drift exists at this location, sand has been blocked by the jetties from reaching Folly. A 1990 consultant report commissioned by the Charleston County Committee to Restore Folly Beach (1990), by Edge and Associates, Inc., estimated that the island shoreline is 810 feet landward of where it would be without the jetties and that the community has lost 545 acres of oceanfront real estate. (This estimate is disputed by staff of the state Coastal Council.) The report also asserts that the deepening of nearshore contours for navigational purposes has allowed larger waves to approach closer to the shore, aggravating erosion rates and increasing vulnerability.

A beach restoration program to renourish 5.5 miles of the Folly Island shoreline—at a total cost of $18 million—was approved by Congress before Hugo. The state has agreed to pay $2.5 million of that amount. Construction is scheduled to begin late in 1992. A sand transfer facility to move sand past the harbor jetties has been proposed to alleviate the need for frequent renourishment in the future.

Just before Hugo, Folly Beach was nearly beachless, at least at high tide. Much of the shore in front of the oceanfront cottages was lined with revetments of uneven height. Relict dunes were worn down and penetrated by informal access routes to the beach (Figures 5.2 and 5.3). Participants in a National Flood Insurance Program Conference held in Charleston in April 1989 visited Folly Beach to see the scene of the disaster waiting to happen.

Hurricane Hugo

It happened five months later on September 22, 1989. Hurricane Hugo originated as a tropical depression in the Eastern Atlantic around September 11. Its sustained wind velocities increased over the next week to about 120 knots (138 miles per hour) by the time it struck the Virgin Islands and Puerto Rico on September 18. Profound wind and flood damage were inflicted on those islands. After weakening as it crossed Puerto Rico, Hugo regained its 120-knot wind velocities and moved northwestward at approximately 36 knots. At 6 a.m. on September 21, the National Hurricane Center in Coral Gables, Florida, issued a hurricane warning for the southeastern U.S. coast from Fernandina Beach, Florida, to Cape Lookout, North Carolina. The governor of South Carolina declared a state of emergency and ordered the evacuation of all peninsulas, barrier islands, and beachfront property within the state, except Charleston. Voluntary evacuation had begun the day before. Including mainland residents who moved to safer locations, 264,500 people from eight counties were relocated by the time Hugo made landfall just north of Charleston Harbor in the

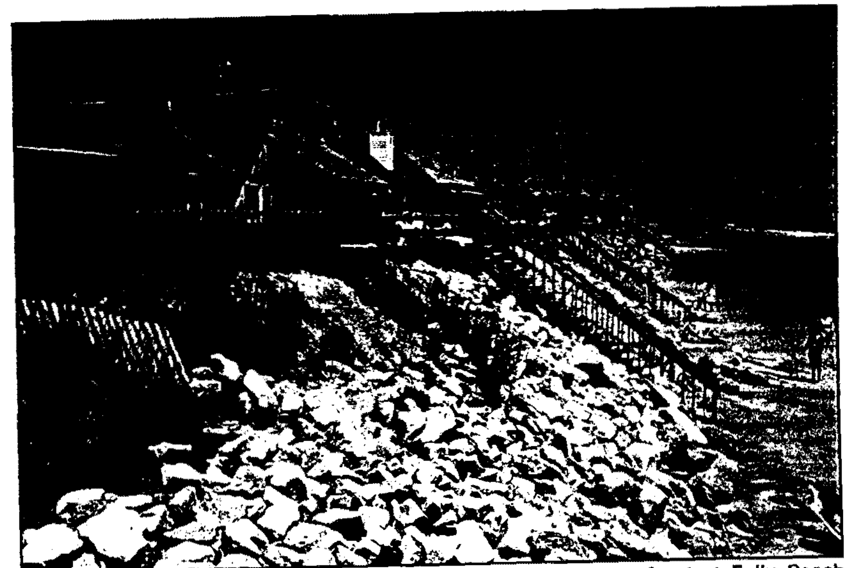

Figure 5.2. In March 1989, before Hurricane Hugo, the oceanfront at Folly Beach appeared to be armored against hurricane damage, but the entire beach was overwashed at high tide. (Photo by R. Platt.)

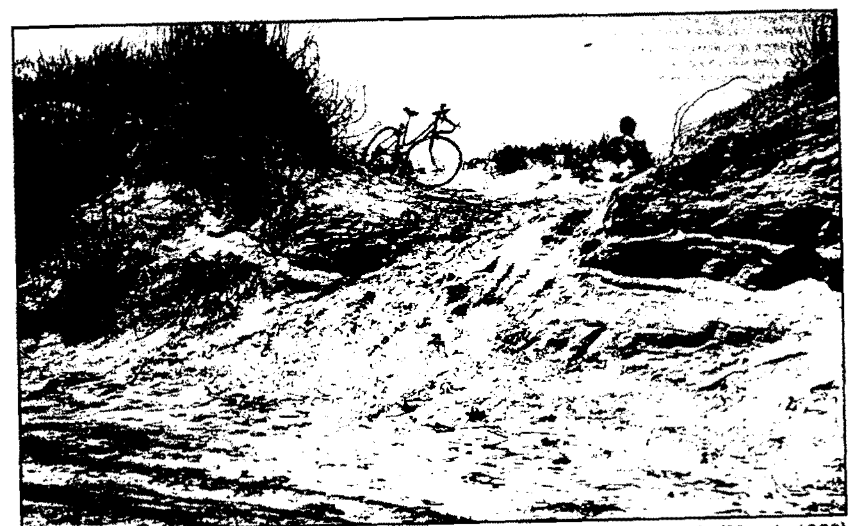

Figure 5.3. Informal access through residual dune line at Folly Beach (March 1989) opened up pathways for overwash by Hurricane Hugo's 15-foot storm surge. (Photo by R. Platt.)

early hours of September 22 (Federal Emergency Management Agency, 1989).

A category IV hurricane, Hugo was immensely destructive to both coastal and inland South Carolina. Its landfall coincided with high tide, and its storm surge of 13 to 17 feet above mean sea level swept over Folly Island and its neighbors to the northeast. Sustained winds at Folly Island were recorded at 78 knots (85 m.p.h.), with gusts to 100 knots (107 m.p.h.).

The single bridge connecting Sullivan's Island and Isle of Palms to the mainland was disabled. Fortunately, residents had already evacuated by that time. Inland, the hurricane toppled billions of board feet of forest and inflicted wind and flood damage upon hundreds of communities in South and North Carolina. Twenty-four of South Carolina's 46 counties were declared major disaster areas by President Bush, making them eligible for federal disaster assistance. Flood insurance claims were filed on about one-third of all policies in effect in South Carolina (15,739 claims out of 48,404 policies), yielding payments totaling about one-third of a billion dollars, or an average of $21,077 per policy (Miller, 1990, p. 23). Statewide, 20 persons died (most due to post-hurricane accidents), 60,000 were left homeless, 270,600 became temporarily unemployed, and about 54,000 registered for disaster assistance from the Federal Emergency Management Agency (1989).

Folly Beach's perilous balance at the edge of the sea and the age of its housing stock made the island's structures particularly susceptible to damage during Hugo (Figure 5.4 and 5.5). It was estimated that half of the island's 1,000 homes were damaged to some extent in the storm (*Evening Post*, September 16, 1990). Seawalls and relict dunes were generally overwashed and leveled. Even the sturdy concrete and steel bulkhead seaward of the Holiday Inn was badly damaged, although the hotel survived structurally despite a great deal of wind and water damage. The island's principal seafood restaurant and the pier on which it stood above the surf zone were swept away. A new inlet broke through the eastern part of the island, severing the only access road to that area by creating a 35-foot trench and destroying six homes in the washout area in the process.

Recovery from Hugo

Damage assessment after a natural disaster is an immediate and controversial necessity. In South Carolina, the rebuilding of coastal structures was governed by two thresholds of damage severity, one federal and the other established by the state Beachfront Management Act. Under the National Flood Insurance Program (NFIP), structures damaged more than 50% of pre-storm value would have to be elevated above the estimated 100-year-flood level plus wave heights (like new construction). Under the state BMA, structures damaged more than two-thirds of pre-storm value (damaged beyond repair) could not be reconstructed at all in the 20-foot-

Figure 5.4. Post-Hugo devastation at Folly Beach, March 1990. (Photo by R. Platt.)

Figure 5.5. This house on the Isle of Palms was moved landward off its foundation by Hurricane Hugo. (Photo by R. Platt.)

wide "dead zone" or seaward of it. (See discussion of BMA in Chapter 3). Damage assessments, however, were liberally interpreted in favor of the property owner, with each building component evaluated separately as a percentage of the whole. Under the state's point system, survival of the foundations or pilings counted as 25%, and a septic system counted as 10%. Thus, the house could be swept away but still not be "damaged beyond repair" if those appurtenances remained. Damage assessment was conducted by South Carolina Coastal Council staff and was assisted by professional engineering firms under contract from other parts of the state and FEMA representatives.

The results of damage assessment for shoreline development at Folly Beach are summarized in Table 5.1. Of 290 oceanfront structures, 85 were declared more than 50% damaged under the NFIP. Of those, 38 were found to be damaged beyond repair under the state BMA, of which 31 were in the dead zone; thus, while virtually every beachfront structure was damaged, only 31, or 11%, of them were ineligible for reconstruction due to the dead zone requirement, although at least 55 other structures would have to be elevated to meet NFIP requirements. Statewide, 159 structures were classified as nonrebuildable in their existing locations due to the BMA dead zone setback (Beatley, 1990, p. 3).

Table 5.1
Extent of Damage to Oceanfront Structures in Folly Beach, South Carolina

Total Oceanfront Lots at Folly Beach	310
Total Developed Oceanfront Lots	290
Total in "Dead Zone"	96
Damaged Beyond Repair	31
Exceeding 50% Damage	79
Other	17
Total Within 40 Year Setback (including Dead Zone)	259
Damaged Beyond Repair	38
Exceeding 50% Damage	85
Other	136

Sources: 1. South Carolina Coastal Council orthophotos (pre-Hugo).
2. Aerial Photography (post-Hugo).

The politics of erosion soon swept away even this meager incentive to retreat. In July 1990, under heavy pressure from storm victims, the South

Carolina legislature amended the Beachfront Management Act to eliminate the 20-foot "dead zone" along the entire state shoreline. It retained the 40-year setback for structures of more than 5,000 square feet in floor area, but it exempted Folly Beach from even this minimal setback requirement. Both the setback and the restriction on the rebuilding of seawalls were eliminated for jurisdictions where "the erosion of beaches . . . is attributed to a federally authorized navigation project" (BMA, Secs. 48-39-290(E) and 48-39-300), including one built in 1898! With this amendment, the BMA lost any influence over the rebuilding of the shoreline at Folly Beach.

The actual process of rebuilding the oceanfront at Folly Beach has been gradual. By August 1990, 10 months after Hugo, only 10 building permits had been issued by the town for front row structures. Many owners were evidently waiting for legislative action on eliminating the dead zone and for the outcomes of the *Lucas* case and some 75 other lawsuits filed against the state. Others were delayed by septic system problems. By October 1990, 21 oceanfront structures had been rebuilt or repaired. The NFIP elevation requirements were enforced: all 85 oceanfront structures damaged more than 50% will be required to be elevated to the base flood level plus wave heights if they are rebuilt, according to the Folly Beach building inspector. (Many of the 204 oceanfront homes damaged less than that threshold were already elevated.) Individual lot owners have replaced seawalls in front of their lots, while others remain unprotected and are overwashed at high tide (Figures 5.6 and 5.7).

Landward relocation under the amended Beachfront Management Act is required only to the extent that rebuilt structures must be moved "landward of the setback line or, if not possible, as far landward as possible, *considering local zoning and parking regulations*" (emphasis added—new language in the 1990 amendments). Thus, if an erosion setback would cause a rebuilt structure to violate minimum street setbacks for amenity and parking, the latter shall prevail. This reflects an inadequate recognition of the purpose of the erosion setback. Only two of the 21 structures rebuilt as of October 1990 were moved landward on the same lots. Sixteen were in approximately the same horizontal position, and three were actually rebuilt slightly seaward. Even though house movers were required to elevate rebuilt houses, the displacement achieved in most cases was vertical but not horizontal (Figure 5.8).

Although the city building inspector sought to have structures placed landward as far as possible on each lot (in accordance with the BMA), most oceanfront lots were simply too small to permit much landward displacement without encroaching on the minimum zoning and parking setbacks on the street side. In a few cases, owners of eroded lots were granted variances from compliance with the 10-foot-minimum, street side setback. Relocating the street itself further landward was apparently not an option

Figure 5.6. Six months after Hugo (March 1990), rebuilt homes stand at the water's edge behind makeshift private revetments. The structure in the foreground is elevated to NFIP standards, but no setback was imposed by state or federal authorities. The Holiday Inn stands on artificial fill in the distance. (Photo by R. Platt.)

Figure 5.7. Twenty months after Hugo (May 1991), the Folly Beach shoreline is a patchwork of bulkheaded building sites and vanishing vacant lots. (Photo by R. Platt.)

Figure 5.8. House-movers lifted many houses upward and sideways, but not usually landward from eroding shorelines. (Photo by R. Platt.)

due to a continuous second row of houses on the landward side of the street.

State septic system regulations proved to be more significant as impediments to reconstruction than erosion or zoning regulations. Only the small commercial district of Folly Beach has a public sewer system. The remainder of the island is dependent upon individual septic systems. Hurricane Hugo uncovered and damaged about 164 of the systems on the island, of which 29 were completely destroyed and 37 severely damaged, according to the South Carolina Department of Health and Environmental Control (DHEC). The DHEC required that septic systems be restored before the city could issue occupancy permits. The department's Minimum Site Conditions, which may not be waived by variance, require that:

> The area of the lot or plot of ground where the individual sewage treatment and disposal systems is to be installed shall be of sufficient size so that no part of the system will be: (a) within five (5) linear feet of a building or property line or under a building, driveway, or parking area; [or] . . . (c) within fifty (50) linear feet of the mean high water elevation (tidal waters) (South Carolina Department of Health and Environmental Control Regulation 61-56).

The DHEC has allowed homeowners to place septic fields on back-filled material, thereby lessening the impact of erosion on reconstruction. The Folly Beach building inspector stated that most lots that had septic systems prior to the storm will be able to rebuild those systems (Gil Samonds, Folly Beach building inspector, personal communication, May 1991).

As of May 1991, an effort was underway to secure a public sewer system for Folly Beach's oceanfront property. Funding for the $1.7 million system was being sought from the state with uncertain prospects. Presumably a public sewer system would facilitate further intensification of development along both sides of Folly Beach's shore road.

In terms of flood insurance, three months before Hugo (June 30, 1989), 694 NFIP policies were in effect in Folly Beach, with a total coverage value of $48,675,000. NFIP claims were filed on 647 of those policies, of which 73 pertained to substantially damaged structures (more than 50%) and surprisingly only 26 pertained to oceanfront homes. The latter, however, accounted for over one-third ($1,092,125 out of $2,970,645) of total claims dollars paid at Folly Beach. The average payment on the Folly Beach oceanfront was $42,000, as compared with the state average of $21,000. If half (145) of the shorefront homes at Folly Beach had been insured and received an average flood insurance payment of $42,000 each, those claims would have totaled $6 million. Yet, there is no federal, state, or local legal impediment (other than possible septic field problems) that would prevent those homes from being rebuilt *in situ* at probably much higher value, and those homes would still be eligible for flood insurance if elevated. In fact, there was little increase in NFIP premiums at Folly Beach after Hugo. As of May 24, 1991, there were 716 policies in effect, with coverage totaling $56,238,000 (Cindy Keegan, Federal Emergency Management Agency, personal communication, July 12, 1991).

In May 1991, a visual survey of the 85 substantially damaged shorefront structures on Folly Island revealed the following status:

Table 5.2
Status of Reconstruction on Folly Beach Oceanfront (May 1991)

Replaced/Rebuilt	30
Under construction	3
Vacant lot	50
Unrepaired structure	2
Total	85

This data, of course, only refers to the 85 out of 290 oceanfront structures officially designated as damaged by more than 50%, applying the

standards discussed earlier. Most of the remaining 204 first-row structures were also damaged to some extent, of which an undetermined but substantial number were rebuilt or in process of repair as of May 1991.

Despite Hugo, the real estate market at Folly Beach remained strong in the year following the storm. At first, several properties were sold at distress prices, but within months prices rose above their pre-Hugo levels (Table 5.3).

Table 5.3
Folly Beach Real Estate Activity, First Six Months of 1989 and 1990

Units Sold		Average Selling Price		% Increase
1989	1990	1989	1990	
5	14	$78,010	$81,501	4.5

The Fred P. Holland Agency, which handles most of the real estate transactions in Folly Beach, indicated that in 1990 they sold beachfront lots, which were on the market for approximately $50,000 before Hugo, for $62,000 to $82,000. O'Shaunessy Realty quoted a price for a beachfront lot with a modest house at $150,000. Realtors cited the replacement of older, modest homes with more expensive oceanfront dwellings as a factor for this market increase. Given the expense of elevating on pilings and constructing a private seawall, rebuilt homes on the oceanfront tend to be larger, more "trendy," and certainly more expensive than what they replaced. This then enhances the market values of other similarly situated lots. The total value of property at risk from future hurricanes and erosion, therefore, will be considerably greater after Hugo than before (even after correcting for inflation).

Conclusion

Folly Beach built itself to the ocean's edge, despite ongoing erosion fostered in part by the Charleston Harbor jetties and by natural coastal barrier processes. Hurricane Hugo inflicted a terrible toll upon the community's housing stock, its public and private infrastructure, and its citizens. Yet the city is in the process of rebuilding itself in more costly form at the water's edge, despite its recent bitter experience and the certainty of future disasters. It has been exempted from both the minimum 40-year setback for new or substantially rebuilt structures and the ban on seawalls in the 1990 amendments to the South Carolina Beachfront Management Act. Landward relocation has been virtually nonexistent in tion process, even though some 50 vacant lots on the landward side of the shore road are identifiable in aerial photographs.

The Folly Beach shoreline is ragged—private seawalls jut into the surf in front of expensive homes while adjoining lots are overwashed nearly to the shore road at high tide (Figure 5.7). The large percentage of non-rebuilt, substantially damaged structures (51 out of 86) is not the result of a deliberate public policy at any level of government. Rather, it appears to be due to a combination of factors, such as 1) uncertainty about the beach nourishment project, 2) uncertainty about the outcome of the *Lucas* case and other pending litigation, 3) economic recession, and 4) difficulty in obtaining financing. A number of shorefront lots such as the one in Figure 5.7 are for sale despite obvious inundation: their owners expect rescue of their investments through the federal renourishment project and state-funded sewer system, if those come to pass.

The shore road of Folly Beach, like its counterparts in other coastal communities, reveals a truism of oceanfront development and redevelopment in the 1990s: the primary motive is rental income and resale profit, not personal use on a year-round basis. Real estate agent signs line both sides of the shore road and few indications of off-season occupancy were visible in May 1991. While inland Folly Beach remains largely an owner-occupied community, at least during part of the year, the oceanfront, with its dramatic, towering, contemporary homes that defy erosion with costly seawalls, is a landscape of speculation. It reflects capitalist pursuit of financial gain as facilitated by public tax policies, infrastructure subsidies, potential beach restoration, federal flood insurance policies that ignore erosion hazards, and an outright exemption from the state Beachfront Management Act. Folly Beach epitomizes the nature of erosion as a political hazard.

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6

Michigan's Emergency Home Moving Program

by
Brenda G. Mathenia

Introduction

At various times in Michigan history, the hazards and costs of unwise development along Michigan shorelines have been clearly demonstrated. Shore erosion is a major problem along the Michigan coastline, as property owners and developers have discovered through the loss of land, structures, and money.

Shore erosion in Michigan is strongly influenced by lake level (Horvath, Jannereth, and Shafer, 1989). The primary factor that determines lake levels is the hydrologic cycle (Quinn, p. 5). The hydrologic cycle includes both water coming into the system, such as precipitation on lake surfaces and run-off from precipitation on land, as well as water leaving the system, such as evaporation off the lake surface and outflows through connecting channels. The imbalance between inflow and outflow causes lake levels either to rise or fall. The magnitude of hydrologic variables vary with the seasons, typically resulting in more inflow in the spring and more outflow during the fall and winter. One other important factor in the hydrologic cycle, which plays a major role in the unpredictability of high and low lake levels, is that the effects of heavy rain or of a dry season are not immediately evident. Events that cause lake levels to rise generally predate the visible changes by as much as a year. Because of the lag time in cause and effect, it is very difficult to predict the exact impact an extremely wet or extremely dry season may have on lake levels (Quinn, 1989).

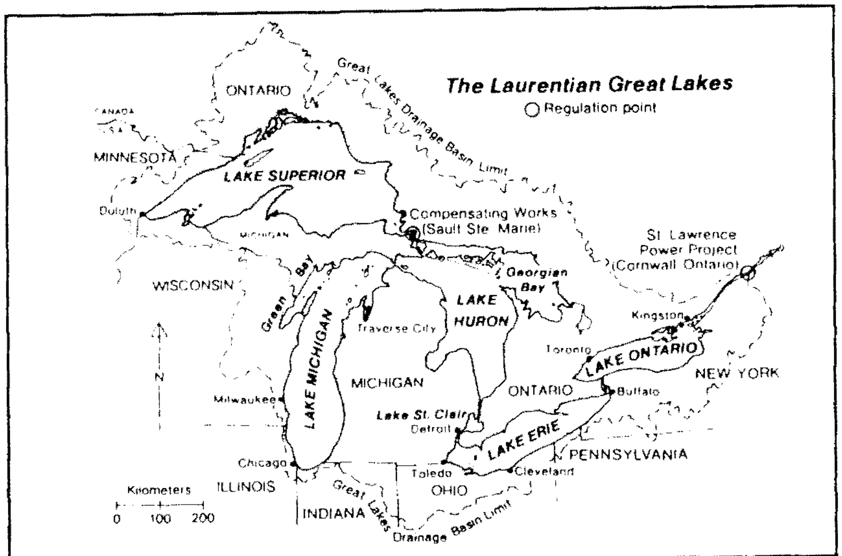

Figure 6.1. The Great Lakes system. (*Source:* Quinn, 1989.)

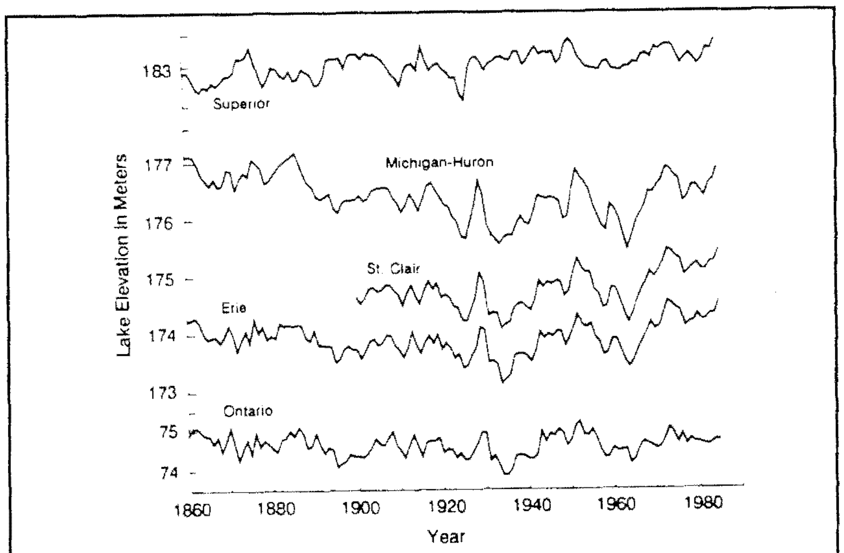

Figure 6.2 Great Lakes mean annual water levels. (*Source:* Quinn, 1989.)

Shore erosion problems become critical when high lake levels submerge beaches, which normally function to protect the adjoining, highly erodible upland area. Raised above the beaches, wave forces can work directly on the lowest part of bluffs and dunes, resulting in rapid erosion (U.S. Army Corps of Engineers, 1978). High water levels on the Great Lakes are cyclical, following a system of highs and lows correspondent to time of year, localized weather conditions, and climatic changes (Figures 6.1 and 6.2).

In the early 1950s, high water levels on the Great Lakes caused millions of dollars worth of damage to Michigan shoreline properties. During subsequent low water years, many homes were built too close to the bluffline of the Great Lakes. When high water levels returned in the late 1960s, damage to homes and businesses occurred once again. The most recent high water period occurred in 1985 and 1986 when "Lakes Michigan-Huron reached a May 1985 monthly mean level two inches above the previous May record set in 1973. Record high water levels were also established in 1985 on Lake St. Clair and on Lake Erie" (Hilmes, 1985, pp. 40-41).

Damage caused by erosion can be extremely costly for both the affected property owners and the general public. When severe storms caused extensive erosion damage in the past, the public absorbed part of the loss through disaster assistance, disaster loans, and repairs to public facilities (Michigan Department of Natural Resources, 1987). For example, the high water period of 1951-52 caused an estimated loss of $61 million per year. A U.S. Army Corp of Engineers study indicated that, "during the high water period of 1972-76, an estimated $170 million was spent on private shoreline protection structures, while $231 million of property (land and structures) loss occurred" (Meadows, 1988). Unfortunately, there are no specific figures available that tell us the number of homes lost to erosion damage or the amount of property and monetary losses during the 1985-86 high-water period.

As was evident from the great amount of shore erosion damage that occurred, attempts to stabilize bluffs through shore protection measures were not effective in protecting structures located along the lakes. "The impact of high lake levels on a specific property is governed largely by two basic factors: bluff/shore composition and building setback" (Rasid, 1989). Bluff/shore composition is a factor that provides little in the way of options. A major portion of the most densely developed areas along the Michigan coastline are composed of unconsolidated bluffs, windblown and vegetated dunes, and sandy beaches (Sommers, 1984). These areas are highly susceptible to shore erosion.

Building setback, the other major factor affecting the impact of high lake levels on property, is entirely within the realm of human control. Building setback, if it had been regulated in the past as it is now, could have saved the state and property owners millions of dollars in lost property as well as an immeasurable amount of personal trauma. Through increased setback requirements as well as better enforcement of existing regulations along the Great Lakes shoreline future erosion-induced damage can be decreased and perhaps completely eliminated.

In July 1985, Michigan's Governor James Blanchard announced the creation of the Emergency Home Moving Program (EHMP). This program, as initiated in 1985 and reauthorized in 1987, was created to provide financial assistance to homeowners by providing interest rate subsidies or grants to assist in relocating their homes away from eroding shores.

The EHMP sought to encourage a nonstructural approach to dealing with the erosion hazard while providing prompt assistance to homeowners whose homes were immediately threatened by shore erosion damage. It took a long-term view toward the problem of shore erosion and related damage in two important ways. First, relocation, which is done generally only once in the life of a home, is usually cheaper in the long run than the cost of construction and maintenance of erosion-control structures. Second, unlike many types of disaster assistance, the program did not wait until damage had occurred to offer aid to homeowners. Instead, Michigan offered loans for relocation or protection of homes that were in "imminent danger" of collapse from bluff erosion (Center for the Great Lakes, 1988). The three main objectives of the program can be summarized as follows:

1) to establish a program that would effectively eliminate the natural hazard threat to the home,
2) to provide financial assistance to homeowners threatened by extremely high Great Lakes water levels, and
3) to create and administer a program that would accomplish the first two objectives in the most expeditious manner possible (Michigan Department of Natural Resources, 1987).

The program was funded through unspent monies in the Michigan share of the U.S. Army Corps of Engineers Advance Measure Program. The loan program was open to any homeowner living in a community that was not already participating in that program (Governor's Office, 1985).

Section 64 of Michigan Public Act 108 (1985) appropriated $2 million to "be made available for low or no interest loans to move homes along the Great Lakes in imminent danger of destruction by shoreline erosion" (Governor's Office, 1987). The total appropriated amount was designated for homeowner assistance; none was available to cover DNR administrative costs. Existing staff, who were funded by Coastal Zone Management monies, redirected their efforts from other duties to administer the emergency program (Michigan Department of Natural Resources, 1987).

In July 1987, an additional $500,000 was approved for the reauthorization of the program, which had expired in 1986. The 1987 program incorporated improvements suggested by DNR staff that offered the

property owner more options and greater protection than the original version.

Eligibility Requirements

The EHMP provided a 3% interest rate subsidy to eligible homeowners on loans of up to $25,000 from lending institutions.[1] The subsidy was provided directly to lending institutions in the form of a lump-sum payment from the Department of Natural Resources. The subsidy was applied directly to the loan principal, thereby essentially reducing the interest rate by 3% over the life of the loan. This approach was selected so that if the loan was paid back early the borrower would still get the full benefit of the subsidy. Under the 1987 program, a one-time grant was made to those who either did not want to borrow money or could not obtain a loan from a qualified lender. This allowed for greater flexibility and program accessibility for more people.

The owner of any residential building that was in imminent danger of destruction by Great Lakes shoreline erosion within the next 12 months was eligible to participate. Eligibility was determined by DNR field staff, who conducted an on-site inspection to assess the following factors:

1) proximity of the structure to the active edge of erosion, generally 35 feet or less. This was changed to 45 feet in the 1987 program to provide assistance to more people.
2) slope of the bluff face.
3) height of the bluff.
4) composition of bluff material.
5) presence, condition, and effectiveness of existing shore protection structures.

The subsidized interest loan covered relocation of the building, utility hookups, septic system relocation, and proper disposal of the old foundation and septic system. The purchase of additional property was also eligible if needed for relocation. This is more permissive than the very limited Upton-Jones Amendment under the National Flood Insurance Program (NFIP).

To receive the subsidy, a homeowner must have met the following conditions:

1) The building must have been moved landward at least 45 feet. If the property was within a designated High Risk Erosion Area under the Shorelands Protection and Management Act, it had to be moved to

1. The following is taken from the Michigan DNR *Final Report* and *Final Report Update*, unless otherwise noted.

the minimum required setback or 45 feet from its former location, whichever was greater.

2) All construction materials, including the old foundation and septic system, had to be removed and properly disposed of or reused as part of the moving operation.
3) The building had to be relocated within 90 days of the date of the loan.

Shore protection structures were funded only when no other option was available to the property owner. The EHMP was designed to provide a nonstructural response to erosion so that the need for additional shore protection would be minimal. Erosion control structures (i.e., groins, revetments, and sea walls) are disfavored in Michigan shoreline policy because they are generally temporary in nature: repair and reconstruction are needed on a timely basis in order for them to function properly. Moreover, they are often responsible for erosion occurring on adjacent property and further damage to beaches.

The DNR approved shore protection based on the home's construction, movability, and site characteristics. Such determinations were made under the following criteria:

1) Those houses with slab foundations, concrete block walls, extensive brick or stone work, or large unusual shapes were deemed immovable.
2) The site had to have sufficient depth to allow relocation to the 30-year-minimum required setback in designated High Risk Erosion Areas and at least 45 feet in other areas.
3) The site had to be accessible to heavy moving equipment and have acceptable terrain for the actual structure relocation.

If the building certified in imminent danger could not meet the DNR setback requirement for relocation, the property owner had two options:

1) The owner could have used all or a portion of the subsidized loan to purchase additional property. The threatened building was to be located on the additional property within 90 days of the date of the loan.
2) The owner could have used the subsidized loan to finance approved shore protection. The shore protection had to be certified by a professional engineer as able to withstand a 20-year storm at the site. The proposed shore protection had to be accepted by the Michigan Department of Natural Resources and permitted by the U.S. Army Corps of Engineers and the DNR, if necessary.

Administration

Due to the urgency of the danger to structures that most homeowners faced in 1985-87, the EHMP was designed to be as responsive and efficient as possible. This required rapid response times and a minimum of paperwork. Applications were processed verbally from property owners over the telephone. Transmittal to field staff was also done by phone to save time. All applications were logged and tracked with a personal computer file management program, which allowed staff to find out where an application was in the process at any point in time and to rapidly follow up on site inspections. Many applicants had their property inspected within a week. Most applicants received notification of eligibility within two to three weeks.

To keep the paperwork to a minimum, DNR staff developed simple forms for both applicants and lending institutions. Both the application and the form to be completed by banks were a single page. Many applicants completed the process without phoning the DNR office after submitting the initial application. In spite of these efforts, however, the staff spent a great deal of time on the phone with both lending institutions and applicants explaining the program and dealing with individual concerns.

Basically, the program was run with two staff and one supervisor from the Shorelands Management Unit of the DNR Land and Water Management Division. Site visits were shared by field and central office staff. During those visits, staff provided technical assistance to many shoreline property owners, whether or not they participated in the program.

Program Activity

Of the 273 applications received between August 1985 and February 1987 (the initial phase), 199 were determined to be potentially eligible for state assistance. Many of the original 199 applicants dropped out of the program for various reasons or failed to meet deadlines established for continued eligibility. Some of the applications, when reviewed by DNR personnel, were found to be ineligible due to absence of "imminent danger." Sixty-five relocation projects were certified as eligible, and of those, 62 were funded. Fifteen shore protection projects were eligible, and eight were funded. In the 1985 program, 70 payments were authorized and delivered for both relocation and construction of shore protection devices. The total amount paid out to lenders through March of 1987 was $266,809.67, with an average payment of $3,705.69.

During the 1987 phase of the program, applications were accepted from August 15, 1987, through December 15, 1987 (four months). Eligible property owners were required to submit project cost estimates by March 31, 1988. All requests for payments had to be in by July 31, 1988.

Forty-eight applications were received, and 25 of those were declared eligible for funds. Only six of the 25 eligible applicants completed all requirements of the program and received payment. Four houses were relocated, one applicant built shore protection, and another property owner used the funds to demolish the existing structure so that he could rebuild on his lot. Since the 1987 program provided the option of a lump-sum grant, three of the six recipients received grants of $3,500 (or up to half of the cost, up to a maximum of $7,000). A total of $23,920.64 was paid out during this phase of the program, with the average payment being $3,986.77.

Case Studies

The following are three case studies of actual experiences under the EHMP. The names of the property owners have been changed to protect their privacy.

Case 1 - A Premature Move

John and Helen James of Warren, Michigan, own a vacation cottage located on the shore of Lake Huron at Grandview Beach, in Michigan's Sanilac County. The Michigan Department of Natural Resources received the Jameses' application for assistance through the Emergency Home Moving Program on August 18, 1987. The Jameses learned of the program through a neighbor in Sanilac County, who was also relocating his home. They also heard of the program through several articles in the newspaper and by calling the Department of Natural Resources directly to find out more details.

At the time of application, the cottage was a mere 13 feet from the active edge of erosion. The Jameses' neighbor had also relocated his home back from the edge of the bluff and cautioned the Jameses not to wait much longer before taking some action to protect their cottage. A note included in the application material on the James property explained: "lost ten feet of adjacent shoreline in a storm in winter of 1986. This, plus the difficulty of contracting a mover prior to any more storms, prompted us to not wait any longer to have it moved, since our building was only 13 feet from the active edge of erosion." The Jameses initiated moving their cottage in the summer of 1987. Ample room existed to relocate the home back from the bluff, since the Jameses' lot was 271 feet deep. They wanted to move the house back 180 feet from the bluff edge.

On September 15, 1987, EHMP staff notified the Jameses that their cottage was indeed in imminent danger of destruction from shoreline erosion and noted that, at the time of application, the home had already been relocated approximately 115 feet from the bluff crest. The letter

stated that they were "eligible for a subsidy under the EHMP. However, any work completed prior to August 17, 1987 will not be eligible."

Due to their home's proximity to the active edge of erosion, the Jameses relocated their home before that date. Unfortunately the guidelines set up to manage the second phase of the EHMP established that any work done prior to August 17 would be ineligible for consideration when calculating the subsidy for relocation. Because of these rules, the owners could not count any of the costs they had incurred. The only costs that were eligible for subsidy were those acquired for removing the old foundation and hooking up the new septic system.

The owners submitted receipts and canceled checks to the DNR that totaled $11,140.51. The grant option they chose provided up to 50% of eligible costs up to a maximum grant of $3,500. On June 16, 1988, DNR staff authorized payment of $1,235.52.

The Jameses felt that while the application procedures were straight forward and simple, the program was not advertised well enough, and many people did not know what to do. They also felt that the requirement that the work be done after August 17, 1987, was not fair to those homeowners who had taken an initiative to relocate, save their homes, and preserve the coastline. Because they were "on top of things" and had initiated and completed most of the work prior to the start date of the second phase of the program, they felt penalized for acting responsibly. John James mentioned that it would have been more equitable if some sort of "grandfather" clause had been worked into the program to assist people like he and his wife, who had done the work during the high water period when danger of erosion was greatest. He felt eligibility should have been retroactive back through the time of high risk.

He also expressed a sense of frustration with the way the program was managed. The Jameses had taken great pains to remove an old foundation in order to conform to program guidelines that required complete removal of old foundations and septic tanks. Although they were careful to fully comply, a neighbor to the north had a septic tank ready to fall over the crest of the bluff and land on the beach. No special action was taken to ensure proper removal of that tank.

James mentioned that several neighbors utilized the Upton-Jones Amendment to the National Flood Insurance Program to have their homes condemned and receive claim money to help them rebuild in a new location. While it is not clear whether this was an option the Jameses could have pursued, they seemed to be uninformed about the amendment. With more information, the entire process of relocating their cottage could have been less burdensome. Since their home was moved prior to the adoption of Upton-Jones, it is likely that they would not have been eligible for benefits under that program.

Case 2 - Combining State and Federal Benefits

On November 3, 1987, Samuel Lewis, a resident of Illinois, applied for assistance through the EHMP to relocate his Lake Michigan vacation home in St. Joseph, Michigan, in Berrien County. Lewis learned of the Emergency Home Moving Program through a DNR direct mailing that informed lakefront property owners of the program.

At the time of application, the foundation of the house was 52 feet from the active edge of erosion. His lot was approximately 500 feet deep and he intended to move the house approximately 300 feet back on the lot.

There was an old steel sea wall on the property that was no longer effective. The height of the bluff was approximately 150 feet, with a near vertical slope. The bluff soil consisted mainly of highly erodible sand. A special note was made concerning the "extremely unstable" condition of the bluff at the time of application. Lewis reported that he "had lost approximately 50 feet of bluff since the first of the year and he was expecting to lose an additional amount by spring, even with the lower lake levels."

On November 6, 1987, a field check was made to verify conditions of the application. The application was certified as eligible for assistance under EHMP on December 12, 1987. In order to be eligible, the DNR required Lewis to move his house to a point on the lot at least 130 feet from the crest. This determination came from the recommended setback established through the High-Risk Erosion Area (HREA) program run by the DNR. Lewis' lot is located within an HREA with average annual erosion rates high enough to warrant 130-foot setbacks. (Of course, if the short-term rate of 50 feet per year continued, the structure would be destroyed in three years in its new location.)

Lewis was able to relocate his home a full 300 feet from its former position, placing approximately 350 feet of property between the structure and the active edge of erosion. After relocation, Lewis reported that he had lost an additional 30 feet of lakeside property to continued erosion. This situation reinforces the need for the substantial setbacks requirements of the Emergency Home Moving Program.

For Lewis, the application process was easy and the DNR staff were "extremely helpful" in expediting the process. Lewis stated that, while he would have moved his home regardless of the EHMP, this program was the impetus for him taking action in 1987.

He received one cost estimate from a homemover in southwest Michigan for $16,000.00, which included moving the house and garage intact, digging the basement, placing the home, and back-filling. Invoices provided by Lewis show that the actual moving of the home and complete excavation of the property cost $17,190.00. Block and concrete work on the relocated home cost an additional $11,051.30. Lewis reported that the total cost of relocating his home came to $28,241.30.

Lewis obtained a loan of $30,000 at 9% interest to relocate his home. The EHMP interest subsidy covered the first $25,000 of the loan. As a result, Lewis had a reduced interest rate of 6% on the first $25,000 of funds borrowed to relocate his home. On June 20, 1988, a subsidy payment of $6,371.69 was authorized and applied directly to the principal of the loan, effectively reducing the interest on the entire loan.

Lewis was also able to collect a claim on his flood insurance policy via the Upton-Jones Amendment to the National Flood Insurance Program. While dollar figures related to the claim are not available, Lewis did describe the claim against his flood insurance as a long and arduous process, but a step in the right direction.

Case 3 - Benefit of a Deep Lot

Betty Randolph of Evanston, Illinois, is the owner of a vacation home in Grand Haven, Michigan, along the Lake Michigan shoreline in Ottawa County. The Michigan Department of Natural Resources received her application for assistance through the EHMP on August 21, 1987. At that time, the house was located three to four feet from the active edge of erosion. The lot on which the house is located was approximately 500 feet deep. There was also a smaller guest cottage on the same lot. Randolph applied for assistance to build shore protection because she did not want to demolish the smaller cottage in order to relocate the other house.

On September 11, 1987, DNR staff notified Randolph that building shore protection was not an eligible expense, but that she would be eligible for financial assistance if she were to relocate the endangered home at least 70 feet from the active edge of erosion. The 70-foot setback was required because the lot was located within a High-Risk Erosion Area. The shore protection option was ruled ineligible in this case because Randolph's lot was deep enough to accommodate relocation.

On March 29, 1988, the DNR informed Randolph of the recently enacted Upton-Jones Amendment to the National Flood Insurance Program and suggested that this amendment might provide additional funds to assist in the relocation or demolition of her endangered home. The Federal Insurance Administration approved her eligibility for Upton-Jones benefits on July 29, 1988.

Estimates of the cost to relocate Randolph's home included $14,600 for the moving and reconnection of the house and garage, excavation, and tree removal. Construction of a full basement for the relocated home and the pouring of a four-inch garage floor were estimated to cost $11,472, and an additional $471 was included for construction of a front porch floor.

Randolph received money from both the Upton-Jones amendment to the Flood Insurance Program and a subsidy through the EHMP. Without the assistance of both programs, she would not have been able to relocate. In the end, she demolished the smaller guest cottage and relocated her home

170 feet back from the crest of the bluff. Randolph was able to secure a loan of $25,000 at a rate of 10.75%. The EHMP subsidy resulted in a reduced interest rate of 7.75% on the money borrowed to save her home.

According to Randolph, the Emergency Home Moving Program was a "lifesaver" and the application process was quite easy and efficient, something she attributes to the staff of the DNR. Randolph had the most difficulty securing the loan that allowed her to utilize the subsidy payment the state was offering. From her point of view, that was the most troubling aspect of the program. Without the loan, she could not have saved her home, and without the help of the state of Michigan and the NFIP, she would not have been able to manage the debt she would have had to incur to move the home.

On September 8, 1988, a subsidy payment of $5,813.43 was authorized, and the amount was applied directly to the principal of the $25,000 loan. In 1991, her home sat 170 feet from the edge of the bluff, and her property had experienced no additional erosion losses since the relocation.

Conclusion

Although limited in duration and caseload, the Michigan Emergency Home Moving Program was an important experiment in fostering retreat from eroding shorelines. While the federal government provided some of the funding (U.S. Army Corps of Engineers), the state initiated and administered the entire program. The program assisted 68 homeowners (62 in the first phase and six in the second) in saving their homes from almost certain collapse.

The effects of the EHMP extended well beyond those immediate beneficiaries. Michigan DNR staff held property owner workshops in several locations along the shoreline, and many people received advice and technical assistance. Presumably the general public better recognized and understood the physical nature of shoreline erosion as a result of the DNR's outreach efforts. The EHMP demonstrated the value of dealing with natural hazards in a proactive and nonstructural manner. The encouragement of a long-term nonstructural approach (i.e., relocation) was an important goal. By helping property owners protect their homes before storm damage occurred, costs for repair of flooded or collapsed buildings were avoided, and the total cost of the emergency program was held down. Homeowners could make decisions to relocate a building or build a shoreline structure while there was still time to consider alternatives and develop adequate project designs (Center for the Great Lakes, 1988).

By acting before disaster struck, and by insisting that approved projects provide long-term solutions to erosion hazard problems, the Emergency Home Moving Program helped reduce total costs for both homeowners and the state of Michigan.

The Michigan EHMP also served in part as a model for the Upton-Jones Amendment to the National Flood Insurance Program (Sec. 544 of the 1987 Housing and Community Development Act of 1987) that was cosponsored in Congress by Michigan Representative Fred Upton. (Relocation, however, has not fared well when compared with demolition of erosion-threatened structures under the Upton-Jones Amendment.)

With lower lake levels, the immediate threat of bluff collapse appeared to lessen, and the Michigan program therefore was allowed to lapse. Its brief but promising experience, however, provides a useful precedent for the initiation of relocation subsidies elsewhere.

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7

On The Brink: Coastal Location and Relocation Choices

by
H. Crane Miller

Introduction

Sea level is rising and the American shoreline is retreating. We face economic and environmental realities that leave us two choices: (1) plan a strategic retreat now, or (2) undertake a vastly expensive program of armoring the coastline and, as required, retreating through a series of unpredictable disasters.[1]

The opening lines of the "National Strategy for Beach Preservation" are but one of many calls for retreat from the eroding shorelines of America. Yet in their survey of mitigation practices in coastal localities, Godschalk, Brower, and Beatley found that only nine of 403 coastal communities surveyed (or 2.2%) had building relocation programs, although on a scale of five, relocation rated 3.3 for average effectiveness.[2]

One tentative response toward a strategy of retreat from the shorelines is the Upton-Jones Amendment,[3] which authorizes relocation or demolition benefits under the National Flood Insurance Program for structures imminently threatened with collapse from erosion. Godschalk, Brower, and Beatley completed their survey prior to enactment of the Upton-Jones Amendment, before the financial benefits of that law became available. Although relocation is little used when the full cost must be borne by property owners, what would happen if costs were partially reimbursed through insurance or other means?

On August 28, 1989, the National Research Council Committee on Coastal Erosion Zone Management stated that implementation of the loss prevention provisions of Upton-Jones had been "very limited."[4] At that time, 188 coastal claims had been filed under Upton-Jones, and of those approved, 14 were for relocation and 60 were for demolition. After Hurricane Hugo, the North Carolina Department of Natural Resources and Community Development, Division of Coastal Management (DCM) identified and gave preliminarily designation to 515 structures in Brunswick County that were threatened by imminent collapse and met the criteria of the Upton-Jones Amendment.

Despite increased activity under Upton-Jones as a result of Hurricane Hugo, very few houses were relocated. When owners chose to receive Upton-Jones benefits, about two out of three opted for demolition over relocation. After nearly three years of the program, strikingly few property owners have even taken advantage of the benefits. This chapter explores some reasons why relocation is used so little and places particular emphasis on choices made by property owners.

The author conducted two case studies—one in Brunswick County, North Carolina, in the communities of Ocean Isle Beach, Holden Beach, and Long Beach, and the second on Fire Island, New York, in the communities of Saltaire, Fair Harbor, Dunewood, and Lonelyville. The project required gathering tax, property ownership, property rental, permit, and Upton-Jones certification information, where appropriate. In addition, interviews were conducted with federal, state, and local officials; property owners whose homes were threatened by coastal erosion; realtors; insurance agents; and others involved with management and development in the coastal zone. The results of the two studies are described below.

Settings

Brunswick County, North Carolina

Brunswick County is the southeasternmost county in North Carolina, bordering South Carolina on its south and New Hanover County to the east and northeast. The towns of Long Beach, Holden Beach, and Ocean Isle Beach are on barrier islands that are separated from the mainland by wetlands, bays, and the Intracoastal Waterway. The towns are separated from each other by Lockwoods Folly Inlet and Shallotte Inlet. The islands are typical of coastal barriers along the middle and south Atlantic coast—low-lying, sandy, geologically recent, and fronted by beaches on their seaward side and wetlands on their landward side.

Storm and erosion hazards. Each coastal barrier is vulnerable to flooding and storm surge, long-term erosion, and storm scour. Northeasters in March 1988 and March 1989 and Hurricane Hugo in September 1989 caused flooding and extensive erosion, which greatly exceeded the average

annual erosion rates of two to four feet[5]. In one case, on the eastern end of Ocean Isle Beach, strong evidence indicates that in the last three years erosion of 80 feet or more per year occurred due to the natural processes of Shallotte Inlet and the three storms.

Encouraged by DCM and concerned that Congress might not renew Upton-Jones when the law expired on September 30, 1989, Brunswick County owners and their agents filed 493 applications for certification of threat of imminent collapse. Often, agents filed applications on behalf of owners before they were notified in order to preserve owners' rights under Upton-Jones. This occurred because there was so little time between Hurricane Hugo (September 21) and the approaching expiration of the legislation (September 30).

Over half of the applications in Brunswick County were withdrawn before certification inspection; a very high percentage of the remainder opted not to proceed once they analyzed the costs and benefits they would incur under Upton-Jones. In the end, not a single owner voluntarily chose to relocate or demolish his or her property under Upton-Jones; the few who did were not permitted by regulation to rebuild on their lots.

Development. The communities' primary building stock consists mainly of single-family dwellings, with some condominiums and commercial buildings, along the oceanfront. Despite moderate density, with five to 10 dwelling units per acre, their oceanfronts had few undeveloped lots. The second, third, and fourth tiers of Ocean Isle Beach and Holden Beach have many developable lots that are potentially available if owners choose to relocate. Long Beach is somewhat more developed than the other two communities, but still has some lots available for relocation or new development. Vehicle access to the three towns is via bridges or causeways over the Intracoastal Waterway and coastal wetlands.

Fire Island, New York

Fire Island is part of the barrier complex roughly parallel to the southern mainland coast of Long Island and separated from the mainland by bays, lagoons, and salt marshes. The total barrier complex is about 73 miles long, running from Southampton to the Nassau County/Queens boundary. The barrier complex consists of four islands—Long Beach, Jones Beach, Fire Island, and Westhampton Beach—which were shaped primarily by marine deposition. Five artificially maintained tidal inlets separate the barrier islands—East Rockaway, Jones, Fire Island, Moriches, and Shinnecock. Three interconnected tidal lagoons separate the barriers from the mainland—Great South Bay (111 square miles), Moriches Bay (16 square miles), and Shinnecock Bay (15 square miles).

The barriers are low-lying, geologically recent, and have sandy, unconsolidated soils. They range in width from one-tenths of a mile to one mile and are reshaped continually by waves, winds, and currents. On the western portion of the barriers, beach widths range from 100 to 500 feet. Sand dunes rise as high as 30 feet in some places, but generally range from level with the beach to 12 feet high. They tend to have steep wind- and wave-eroded slopes or scarps on the seaward side and gentle slopes on the landward side, often with beach grass or other vegetation helping to stabilize them.

According to Sanders and Kumar,[6] the present barrier complex formed about 7,500 years ago and migrated as a unit about 1.25 miles inland, keeping pace with sea level rise following the last ice age.

> The barriers are extremely unstable, subject to drastic alteration as a result of storm events and net westward movement as a result of long-shore transport. The position and number of south shore tidal inlets have changed frequently within the historic past in part due to catastrophic storms that have cut new inlets through the barrier islands. Some of these inlets have filled naturally due to the rapid movement of large volumes of littoral drift from the east to west along the shore, others have been maintained through channel dredging and jetty construction.[7]

Storm and erosion hazards. Hurricanes and other coastal storms are a very real threat to Long Island. The probability that at least one tropical storm will strike within any given 10-year period ranges from 85% to 96%. The probability of a hurricane affecting Long Island in the same period ranges from 50% to 80%. On average, severe storms strike Long Island three times per century.[8]

Surge and storm waves from the 1938 hurricane breached most of the dunes on Fire Island that were less than 16 feet high and lowered the dune profile to five to eight feet. Dunes 18 feet or higher were generally left in place.[9] The western end of Fire Island probably escaped even greater damage than would have occurred if the eye of the hurricane had passed 20 to 30 miles west.

Extratropical storms (northeasters) affecting the Long Island coast have an 80% chance of occurring annually. While generally producing fewer wind damages, northeasters can persist through many tide cycles and cause severe erosion. The March 1962 northeast storm caused waves of up to 20 to 30 feet high and $16 million in damages from the Jones to Fire Island Inlets.[10]

While the frequency of hurricanes and northeasters striking Long Island is smaller than along the Gulf coast, in the 100-year period from 1886 to 1986, eight hurricanes passed over or near Long Island, and 15 northeasters struck the region. In 1981 Neumann and Pryslak calculated that, in an area that includes western Suffolk County and Nassau County, the expected number of tropical storms and hurricanes per 100 years is 19, of which seven are hurricanes.[11] In any given 10-year period, they

estimated a probability of at least one tropical storm was 85% and at least one hurricane was 50%.[12]

The long-term average annual erosion rate in the area is two to three feet per year. Owners are highly aware of the potential for storm-caused erosion and scour. Many commented on the effects of the winter storms of 1978 from which the beach has still not completely recovered. Every homeowner interviewed carried the maximum flood insurance available ($185,000). However, not one was aware of the Upton-Jones Amendment, and very few expressed any interest in it once it was explained to them.

Development. Developments on Fire Island range from the Robert Moses State Park on the west end to Fire Island National Seashore to Smith Point County Park on the east end. These include recreational, educational, wilderness, and natural areas. In addition, there are 17 small communities with moderate density (5-10 dwelling units per acre) that consist primarily of single-family, largely seasonal, residential development. A ferry and private boats provide access to the island. Vehicle use is strictly limited by permit, while boardwalks provide foot, bicycle, and wagon access.

Home Ownership on Coastal Barriers

The results of this study and others[13] indicate that owners generally buy oceanfront property with knowledge of the risks and the history of storms and other hazards in the area. People buy on the oceanfront because they "want to be there," find the risks acceptable, and often would locate there if flood and wind insurance were not available. In addition, they are far more likely than their riverine counterparts to rebuild in the same location if a disaster destroys their home.[14]

Home ownership on Brunswick County barriers. When the addresses of houses offered for rent for the 1990 season were compared with the addresses of houses that had been certified as threatened with imminent collapse under the Upton-Jones Amendment, it was discovered that a high percentage of owners of certified homes had decided against relocation or demolition. Also, those who either relocated or demolished their homes were from the east end of Ocean Isle Beach. Rates of erosion were considerably higher than those officially published by the state. Owners of identified houses certified by the state and located on the east end of the island were contacted by telephone.

Each owner stated that he or she had purchased the property for personal or family use and not primarily for investment purposes. Several expressed a strong love for the location or the house itself, a desire to be on the oceanfront, or an appreciation of the view, sunsets, the wetlands, or particular seasons of the year. Each respondent showed a high level of awareness of the interplay between risk, insurance, property values, rental income, and other factors affecting the economic value of the property.

Storm risk awareness. All but one owner indicated that he or she was aware of the risks of owning oceanfront property, including storms, flooding, and erosion. Respondents bought their property despite the risks, and none would voluntarily relocate because of them. The one respondent who was unaware of the risks stated that he and his partner were first-time oceanfront property owners. They made the purchase expecting to hold the property for a long time. Neither had any prior knowledge of the risks and were not warned by anyone about them. Erosion from Hugo extended beneath their house, scoured out their septic system, and left insufficient land on the lot to place a new septic system. The health department refused to grant a permit for a septic system, effectively forcing them off the lot.

Insurance coverage. Each owner carried high amounts of flood, wind, and homeowners' insurance. Each also stated that they carried enough insurance to cover their investment and most other losses they might incur. Each was aware he or she might lose the property under circumstances that were not reimbursable by insurance, especially flood insurance, but most considered that possibility small.

Property value—affordability of new lots. While almost all oceanfront lots in the three communities had been developed, many developable lots remained in the second row and landward. Most of the oceanfront owners had explored purchase of another lot because their property was threatened by erosion. Prices ranged from $65,000 to $80,000 for lots in the second row and from $40,000 to $55,000 in the third and fourth rows. Only one of those interviewed currently owned a second vacant lot to which he or she could relocate the house. All but one of the others stated that they could not afford another lot or that it was not economic for them to buy another one. Local real estate agents corroborated the range of lot values.

Regulations and decision-making. Among those who had either relocated their houses before or after enactment of the Upton-Jones Amendment, or had demolished their homes or applied for demolition benefits under the Upton-Jones Amendment, all had done so because they were forced to by state or local setback or health department septic system regulations. None had done so voluntarily to avoid the risk or to protect their investment.

A corollary to this finding was that if storm surge did not destroy the building or erosion did not undermine the foundation or septic system, and if state, town, or county governments issued permits to effect repairs, all owners chose to repair, no matter how close to the house erosion was certified or perceived to have come.

Property rentals. Each owner in the study rented his or her property to others. According to town officials, between 80% and 90% of the properties in the community are rented. Properties were generally rented by the week; owners typically reported renting 10 to 12 weeks per year, with some renting for brief periods in the spring and fall. One owner reported that he rents his house between 20 and 30 weeks per year. Gross annual rental income for oceanfront properties (before taxes and expenses) typically ranged from $8,000 to $16,000 per year.

In contrast to ownership patterns found on Fire Island and described below, for most of the owners rental income was probably a decisive factor in whether they could afford the property. Rental income in these cases permitted them to own and enjoy the property while covering their mortgage, maintenance, taxes, and other expenses. Only one owner, who purchased the home after Hurricane Hugo, stated that he knew the risk, could afford to lose the house, and did not rely on rental income.

All owners were well aware that their oceanfront location provided the highest rentals obtainable. If they moved to the second, third, or fourth row off the beach, they uniformly estimated that their rental income would be reduced nearly 50%. These estimates proved to be accurate when compared to rents charged for those rows.

The author's study of nearly 300 houses offered through four real estate agents showed that rents varied considerably by age and condition of the house, by the number of bedrooms and number of people who could be accommodated, and by location, among other factors. Despite those variables, the average rental rates of houses on the oceanfront was nearly double those of houses in the second row, and higher still than those in the third and fourth rows. Three-, four-, and five-bedroom houses made up nearly 80% of the sample. Average rental rates of houses in the second row were almost 47% lower than those of oceanfront houses; rates for houses in the third and fourth rows were approximately 55% lower than those on the oceanfront. As summarized in Table 7.1, rental houses are categorized by the number of bedrooms and, therefore, capacity.

The finances of retreat. Although each interviewed owner seriously contemplated relocation or demolition, these choices were considered last resort. With varying degrees of formality, a notably uniform analysis emerged from the owners' stories. A composite of those stories follows.

> When the state certified my house, I took the next step and contacted my insurance agent, who had an adjuster come out . . . What triggered it for me was the adjuster's valuation of the house. The house is new, built in 1987. Turned out that the "value of the building" under Upton-Jones was the actual cash value. That was the smallest of the three or four ways they determined what benefits I should be offered. Before Hugo I had a market value of about

Table 7.1
1990 House Rentals—Ocean Isle Beach, North Carolina

Number Bedrooms		Oceanfront	Second Row	Third Row
7	Average (No.)[1]	$1,357 (3)	$1,095 (1)	
	% Difference[2]	19.3%		
	Rent[3] Range/Week	$1,225-$1,495		
6	Average (No.)	$1,521 (24)	$1,045 (7)	$795 (1)
	% Difference	31.3%	23.9%	
	Rent Range/Week	$1,085-$2,100	$625-$1,600	
5	Average (No.)	$1,439 (50)	$748 (2)	$475 (1)
	% Difference	48.0%	36.5%	
	Rent Range/Week	$500-$2,250	$595-$900	
4	Average (No.)	$1,016 (43)	$646 (45)	$553 (38)
	% Difference	36.4%	14.4%	
	Rent Range/Week	$520-$2,395	$450-$950	$395-$750
3	Average (No.)	$921 (28)	$406 (17)	$508 (11)
	% Difference	55.9%	-25.1%	
	Rent Range/Week	$535-$2,075	$310-$595	$450-$560
2	Average (No.)	$425 (11)	$361 (10)	$383 (3)
	% Difference	15.1%	-6.1%	
	Rent Range/Week	$350-$520	$225-$535	$325-$415
1	Average (No.)	$447 (3)		
	% Difference			
	Rent Range/Week	$315-$525		

1. The average rental per week and the number of houses in each sample (in parentheses).
2. The percentage difference between average weekly rental rates of houses in one row (e.g., the oceanfront) and the next row landward (e.g., the second row). For example, a seven-bedroom oceanfront home would rent for an average of 19.8% more than a seven-bedroom home in the second row of houses.
3. The highest and lowest rental rates per week found in that group.

Source: Compiled by H. Crane Miller from rental brochures from Ocean Isle Beach, North Carolina.

$175,000. After Hugo the adjuster valued the house at $80,000 and I would lose the land value. Once the state certified the property as threatened with collapse, it became almost unsalable because banks wouldn't mortgage it.

I had already looked into the purchase of another lot and found that I would have to pay at least $40,000 for a lot in the third or fourth row, and if I bought there my rental income would go down about 50% from what I'm getting now. I could get a maximum of $32,000 under Upton-Jones [40% of the value of the house], which probably would cover my immediate relocation expenses, clean up, and site preparation. Then I'm left with a $68,000 mortgage on the original property plus at least $40,000 (probably closer to $50,000) to purchase a new lot and make improvements on the house. As it is, I generally have a $1,000 to $2,000 a year loss for tax purposes. Last year the loss was over $4,000 because of repairs I had to make after Hugo that weren't covered by insurance. Because depreciation does not require an actual cash outlay, I normally have a slightly positive cash flow from the property. Where I am, my costs are covered and I get to enjoy the property. But if I relocate, that turns around. If I could refinance the $68,000 mortgage and 100% of the new lot cost at $40,000, I would carry a $108,000 mortgage and would add $5,000 a year to my principal and interest costs. My rental income would go down from $1,400 per week to $750 per week, and instead of $18,000 or $19,000 per year in rent, I would have $10,500. Even if my total expenses remained the same or just slightly higher, I would have a $14,000 a year loss for tax purposes, and an actual cash loss of nearly $10,000. I can't afford it.

So relocation is out. Demolition would at least allow me to recover more than moving it. While this was happening, Congress extended Upton-Jones for two more years, and I took another look at my situation. I figured that if I keep my application under Upton-Jones open, I might get another two seasons of use and rent out of the building before having to fish or cut bait under Upton-Jones. If the house was wiped out in a storm, I would be fully covered by wind and flood insurance. By filling in with sand or putting in sand bags, I'm pretty sure I can keep normal erosion away from the house for that time. As long as I am grandfathered under the state setback law and don't have to rebuild, and as long as my septic system remains covered and functions, I'm in good shape. It doesn't make sense for me to move the house or demolish it now. Keeping it, using it, and keeping an eye on what happens seems to be a good risk.

You asked earlier what the federal taxes on the place looked like. Here's what I reported in 1989:

	Gross rental income	$18,800	
Less:	Repairs	2,800	
	Commission	3,000	[agent's fee @ 16% of rent]
	Insurance	1,400	
	Interest	6,800	
	Equipment	150	[replace appliances]
	Supplies	250	
	Taxes	900	
	Utilities	2,000	
	Depreciation	5,000	
	Transportation	700	
	Total Expenses	$23,000	
	Income minus Expenses	-$4,200	

As you can see, depreciation is the only expense that wasn't actual cash out of pocket. Take that amount ($5,000) out of the expenses, and add $1,300 in principal payments on the mortgage that are not included in the expense deduction, and my actual cash outlay was $500 greater than my rental income. To me, that is a break-even position. My family and I get to use the property for short periods during the most beautiful times of year, the spring and fall, and the property pretty much pays for itself. Cover it with flood insurance and add benefits under Upton-Jones, and I have a nearly risk-free investment.

But look what would have happened if I had relocated. The picture is very different, though the expenses in a normal year would only be slightly higher.

Deduct the depreciation and add nearly $1,700 in principal payments I would make, and I would have actual cash outlays of $10,600 more than my rental income. Under those circumstances, relocation isn't for me.

	Gross rental income	$10,500	
Less:	Repairs	1,000	
	Commission	1,680	[agent's fee @ 16% of rent]
	Insurance	1,400	
	Interest	11,300	
	Equipment	150	[replace appliance]
	Supplies	250	
	Taxes	900	
	Utilities	2,000	
	Depreciation	5,000	
	Transportation	700	
	Total Expenses	$24,380	
	Income minus Expenses	-$13,880	

As noted earlier, the story is a composite of several owners' circumstances and closely approximates the financial and tax considerations related to newer homes or homes that have substantial mortgages. Owners who built in the '60s and '70s frequently reported that they had low mortgages outstanding or none at all, and that they had fully depreciated their homes for tax purposes. Rental rates for these properties tended to be lower than those for newer properties, so the net effect was similar to that reported above—break even or slight loss in most cases—although some said they had a positive net cash flow that they would lose if they chose to relocate.

Property tax effects of erosion and relocation. After any major storm that erodes the coast, Brunswick County reassesses real property values. The county tax administrator's office had completed reassessment in the three towns after this study began, and their results (shown in Table 7.2) are one indication of the property tax effects of erosion.

The assessed values shown for Brunswick County's report of May 29, 1990, were adjusted after accounting for decreased values attributable to Hurricane Hugo. The tax administrator's office attributed the following decreases to Hugo before making adjustments to assessed property values:

Table 7.2
Real Property Tax Assessment Values Before and After Hurricane Hugo

Long Beach, North Carolina

	Pre-Hugo Values ($)	Post-Hugo Values ($) (5/29/90)	Difference ($)
Number of Records	9,831	9,996	+165
Land Value	171,860,290	162,747,110	-9,113,180
Building Value	165,063,240	165,254,810	+191,570
Outbuilding Value	6,616,970	6,627,860	+10,890
Totals	343,550,331	334,639,776	-8,910,555

Holden Beach, North Carolina

	Pre-Hugo Values ($)	Post-Hugo Values ($) (5/29/90)	Difference ($)
Number of Records	3,015	3,016	+1
Land Value	131,170,410	130,951,970	-218,440
Building Value	85,385,070	86,016,030	+630,960
Outbuilding Value	4,199,110	4,153,770	-45,340
Totals	220,757,605	221,124,786	+367,181

Ocean Isle Beach, North Carolina

	Pre-Hugo Values ($)	Post-Hugo Values ($) (5/29/90)	Difference ($)
Number of Records	3,081	3,080	-1
Land Value	170,714,020	169,656,370	-1,057,650
Building Value	119,900,990	120,009,530	+108,540
Outbuilding Value	4,490,440	4,538,530	+48,090
Totals	295,108,531	294,207,510	-910,021

Total Change in Assessed Values

	Land Value ($)	Total Value ($)
Long Beach	-9,113,180	-8,910,720
Holden Beach	-218,440	+367,180
Ocean Isle Beach	-1,057,650	-910,020
Net Changes in Assessed Values Attributed to Hugo	-10,389,270	-9,453,560

Source: Brunswick County, North Carolina, Office of the Tax Administrator, June 1990.

As corrected in the county's May 29 report, the net values reflect the repairs, reconstruction, and new building that have gone on in the towns since the storm. The increase in building and outbuilding (decks, walkways, gazebos, etc.) values is normal after a storm, resulting from an infusion of insurance, savings, loans, and new capital funds.

As oceanfront lots erode in Brunswick County, the tax administrator's office reduces the land value to 50% of the market value as long as a structure remains on the lot. This policy recognizes that if the house were destroyed in a storm, the owner could not comply with the Coastal Area Management Act and local setback regulations and would thus not be allowed to rebuild. Once a structure is demolished or removed, the assessed value of the land drops to 10% of market value, but no greater than $5,000.

Tax officials to whom the author spoke said that there had been so few relocations that a change in total assessed values was barely measurable. In one case reported by an owner, the relocated property increased in value. Before relocation, the assessed value of the original land had been reduced to 50%, and the depreciated value of the house (i.e., replacement value less depreciation) had substantially decreased. After relocation, the owner improved the house to bring it up to construction code requirements and to add improvements the owner wanted. The net effect was an increase in assessed value. Any such increase in assessed value will tend to result from improvements to the house, because the county's policy is to tax interior lots at their full value.

Demolition, on the other hand, causes the assessed lot value to drop to 10% (or a maximum of $5,000), and all value attributable to the structure is lost. While more demolition than relocation had taken place, the county did not measure the impact, perhaps because new construction more than offset the losses due to demolition.

Home Ownership on Fire Island

In family-oriented Fire Island communities such as Saltaire, Fair Harbor, Dunewood, and Lonelyville, the psychology of homeownership is perhaps the most important factor explaining why people buy properties at risk to storm and erosion hazards. Many property owners in the Dune District work and live in New York City. Invariably those who live there spoke of their personal and family need to get out of the noise and pressure of the city into a very different environment.

Why is Fire Island preferred for recreation over other areas? Answers were strikingly uniform: sand, sea, sun, surf, sanity, and sans auto. There are no paved roads in these communities. Lateral access to the communities from Robert Moses State Park, for instance, is by four-wheel-drive vehicle over the beach. Vehicle permits are severely restricted by the communities and given predominantly to maintenance and similar service vehicles. Once in the community, travel is by foot or bicycle. People arriving by ferry in Saltaire find homeowners' wagons cable-locked to racks, used to carry owners' belongings over the boardwalks to their homes.

Several owners described the ferry ride as a decompression from the pressures of the city—the beginning of a quiet that pervades physically and emotionally. All spoke of the quiet of the communities—there is almost no vehicle traffic, and the communities have a "walking quality." For some an important factor is an environment in which young children can be raised without fear for their safety from traffic.

The Fire Island communities are a relief valve for city dwellers, a total change from city life during the work week. Although these communities are within 50 miles of New York, several owners commented on a strong feeling of isolation, of remoteness, insulated from the commercialization and development of the mainland. A common statement was, "I feel like I am a thousand miles away from the city." Others who do not live in New York placed less emphasis on a desperate need to get out of the city and spoke of their fondness for the area, the ocean, the beaches, and the different community atmosphere.

"Community," "a family of neighbors," and "our true home," were factors for some owners and were usually contrasted with high-rise living in the city. One owner chose to buy his oceanfront property in Fair Harbor as a first home while renting in the city. Unable to afford to buy both properties, he stated that he had more of a sense of homeownership, community, and relief from stress at his Fire Island home than in the city. For him and most others, this was important.

The psychology of ownership was also evident in the use of the properties. In contrast to the communities the author studied in North Carolina where owners rent 80% to 90% of the homes, 80% to 90% of the owners in the communities studied on Fire Island do not rent their properties. All but two of the owners interviewed reserve their house for their exclusive use. Many mentioned that they bought the house for their family's use and recreation, that recouping costs through rents was not important to them, and that they had not bought for resale.

One owner who rents stated that he did so to cover the cost of taxes. By renting for one month, he defrayed in whole or part his $6,000 tax bill. A second owner rented the house immediately behind his oceanfront property. Anticipating coastal erosion and the possibility that he might have to retreat from the sea, he had purchased a second "reserve" lot, available for his family's use if necessary. Meanwhile, he rents the house for the months of April through October to a group of renters who have returned annually for many years. This owner stated that the house was a major, important factor in his life. He and his family use the property heavily, and he has taken long-range measures to preserve it. He said that he has no plans of ever selling the property.

Ownership patterns suggest community stability—among those interviewed, properties had been owned from 10 to 30 years. Real estate brokers corroborated this ownership pattern, noting that owners offer relatively few properties for sale in any given year.

Storm risk awareness. All owners interviewed were aware of the storm, flood, wind, and erosion hazards to which their properties were exposed. All stated that they carried the maximum flood insurance available ($185,000), and most had wind insurance under the New York Property Insurance Underwriters Association FAIR Plan. Several had already retrofitted their homes for wind resistance to qualify for renewed wind insurance; others stated that contractors would retrofit their homes in the fall.

Erosion risk awareness. Each owner was aware of the threat of erosion. Several had owned their present properties when two northeasters struck within a short time of each other in the winter of 1978. One owner estimated that storm tides and waves in those storms scoured 30 feet of dunes, which were once level with the deck of her house. Hurricane Gloria in 1985, which struck Long Island at low tide, appears to have built up portions of the beaches along Fire Island. Storms since then have stripped part of the upper sand on the beaches. Since 1985 there has been some natural rebuilding of the dunes, and the back beaches have been relatively stable. On many reaches from Fair Harbor to Lonelyville, there are dune scarps as high as six feet, some of which are behind the first pilings supporting house decks.

Erosion protection programs. Aerial photographs of the shore show a scalloping effect along the shore and waves breaking offshore at regular distances from the beach. The scalloping effect suggests a series of erosional nodes offshore at fairly regular intervals; breaking waves suggest shallows probably caused by sandbars that break incoming waves. Based on observed effects and the comments of Fire Island National Seashore (FINS) Geomorphologist James Allen, the author concludes that the groins at Ocean Beach have little or no effect on erosion from Lonelyville west through Saltaire. Other natural dynamics appear to be the cause of erosion in that reach.

The owners reported that from Saltaire to Lonelyville there have been no federal, state, or local government beach renourishment or inlet sand bypassing programs, nor government-funded structural measures to control erosion in that reach. Members of the communities have installed sand fencing annually that, under National Park Service regulations, is not to extend seaward of the general trend of natural dunes. The Park Service has permitted some beach scraping of the upper layers of sand, apparently on the theories that the amount removed by scraping is trivial to what would be moved in a storm and that the scraping would have no adverse effect on Park Service lands.

Some community groups also plant beach grass to help stabilize the dunes. The total volume of sand collected and moved by these community efforts appeared to be somewhat small. They would provide only modest protection in a northeaster or in a hurricane (perhaps measured in minutes

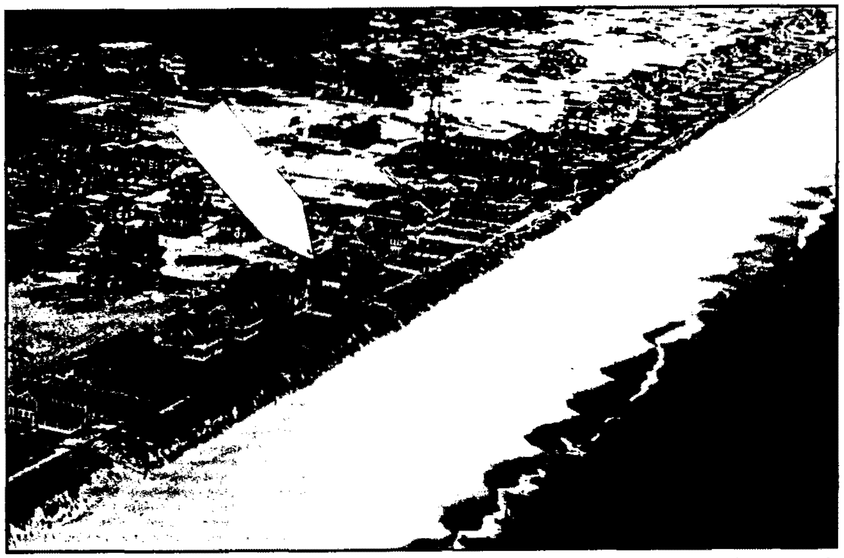

Figure 7.1(a). Aerial photo of Point O'Woods on Fire Island, circa 1938. Note beach dunes and boardwalk seaward of oceanfront row of houses. House indicated is pictured in 7.1(b) and (c). (Photo courtesy of R. Platt.)

Figure 7.1(b). Same house in 1970. House is now partly on the beach. Dunes, boardwalk, and most neighboring houses along the oceanfront are gone. (Photo by R. Platt.)

Figure 7.1 (c). By 1987, the dune line has receded behind the house, leaving it entirely on the beach. House was washed away on October 31, 1991. (Photo by R. Platt.)

of protection). Thus, oceanfront properties in the area remain vulnerable to long-term erosion and storm scour, and the residents know it. One owner stated that every fall he leaves feeling that he may never see the house again.

Oceanfront property owners. Fire Island development is a classic interplay of private property interests working both with and against public coastal management and regulatory practices, environmental and natural hazards, planning and policy goals, and constitutional limitations on governmental roles.

The zoning regulations and general management plan of the Fire Island National Seashore have maintained the low- to moderate-density, predominantly single-family development that existed before the seashore was established. Having precluded commercial and residential development on the lands owned by the federal government, whatever growth has occurred has been within the confines of the 17 communities. Developable land is now at a premium. Residential development in the 17 communities on the island is near the saturation point and has taken place in the face of known storm and erosion risks.

Except one owner who purchased a lot immediately landward of his oceanfront property, the owners interviewed said that relocation was not a realistic option for them. There is simply no site available on which to relocate. About 95% of the buildable land in the communities is already developed.

There are few options available to owners on Fire Island. They can stay where they are or sell and move elsewhere. The clear and dominant choice they make is to remain where they are and assume whatever financial and other risks not covered by insurance. The conditions (environmental, psychological, and otherwise) attracting property owners to Fire Island existed well before federal programs were enacted to reduce losses from flooding, erosion, and other natural hazards.

There is strong indication in the interviews for this study, as well as in the literature,[16] that oceanfront owners generally buy with a knowledge of the risk and awareness of the history of storms and other hazards in the area. People buy on the oceanfront because they "want to be there," find the risk acceptable, and often would locate there whether flood and wind insurance were available. Besides, they are far more likely than their riverine counterparts to rebuild in the same location after destruction of their home in a disaster.[16]

Regulatory and planning regime. The legislation establishing the Fire Island National Seashore authorized limited development within the existing 17 communities on Fire Island. The legislation did not contemplate phasing out existing developments, but continuing the residential and limited commercial uses subject to the recreation, conservation, and management goals of the Seashore. The principal regulatory body within the Seashore to reduce losses from flooding and erosion is the Dune District. When a comparison is made of the definitions of the FINS Dune District and the New York State Coastal Erosion Hazard Area, the two overlap a little. Any problems relating to the overlapping yet different areas of jurisdiction can be resolved if the parties wish, for the laws are basically congruent.

These laws permit development in their respective hazard zones, subject to regulatory restrictions. They differ about the threshold for denying permits to rebuild following damage. Similarly, building codes, regulations of the National Flood Insurance Program, and the wind resistance guidelines of the New York Property Insurance Underwriters Association address building requirements for strength and elevation, not *where* development takes place (that is, location upon a building site), with minor exceptions not used for this study.

The Long Island Regional Planning Board's Proposed Long Island South Shore Hazard Management Program[17] has added heat to the debate over development and land use management on Fire Island. This proposal establishes a 35-year planning period, acknowledging the probability that during this period Long Island will be struck by a major, catastrophic storm, and recommends that:

> when private structures located within the Coastal High Risk Zone [defined as V zones on Flood Insurance Rate Maps and the Coastal Erosion Hazard Area identified by the New York Department of Environmental Conservation, plus the Jones Beach, Fire Island, and Westhampton Beach barrier islands and the Southampton barrier spit] are damaged to a level greater than 50% of their replacement value due to either severe storm occurrence or long-term shoreline erosion, action should be taken to prohibit redevelopment in those locations and configurations that would result in recurring public costs to cover repeated damages or threaten the integrity of the barrier islands. Should regulation and other actions . . . fail to prevent redevelopment, government should acquire the damaged structures and private property as a last resort.[18]

If the regulatory portion of the recommendation is adopted, the proposal would be a major step beyond any regulations presently in force. Besides, this portion of the recommendation might be challenged under the 5th and 14th Amendments to the Constitution of the United States on the "taking" issue. If a storm or other hazard destroyed or damaged more than 50% of a building's replacement value, but there is sufficient land remaining on a lot to comply with zoning regulations, variances, and health regulations, prohibiting rebuilding could constitute a taking without just compensation under the 5th Amendment. If so, government acquisition of the property would be required to prevent rebuilding, a cost that could be prohibitively expensive given current and projected oceanfront property values.

Life at the Brink—A Rationale

The amenities of an oceanfront location—view, easy access to the beach, water recreation, nearby wetlands, peace and quiet—seem to meet deeply felt emotional needs of people who own property there. The case studies, observations throughout the coastal area, and the literature all suggest that most oceanfront property owners have to be forced off their property by nature after it destroys the land and its buildability.

Those who have no intention of moving unless a natural catastrophe makes their land unbuildable tend to find no incentive to relocate or demolish their houses under the Upton-Jones Amendment, or any other program or rationale for that matter. The desire to "be there," tenaciously holding on to property at the brink, may relate less to the house than to the land itself. From the owner's perspective the house can be replaced as long as enough land remains to build upon.

The experience of Brunswick County suggests that owners tend to consider relocation and demolition as options of last resort, options exercised primarily when an owner will not be allowed to repair or rebuild under setback, septic system condemnation, or other regulations. Under such circumstances most owners opt to stay:

1) in hopes that the beach will build back or that action will be taken to renourish or otherwise protect the beach and adjacent property;
2) to continue to enjoy the property and ocean ambience as long as possible; and
3) to continue to receive higher rental income than would be had if they moved or relocated off the oceanfront.

When choosing between relocation and demolition, more owners of rental properties decide to demolish than relocate their houses. The factors that encourage this choice are: 1) the cost of a new lot on which to relocate; 2) their ability or willingness to service new debt in addition to any old debt they may have; 3) probable reduction in rental income if they relocate to lots off the oceanfront; 4) high flood, wind, and other insurance coverage that substantially reduces the financial risk of a storm destroying or substantially damaging a structure; and 5) demolition benefits up to 110% of the value of the house under the Upton-Jones Amendment.

Brunswick County's experience also suggests that the heavy influx of claims feared by FEMA officials and others under the Upton-Jones Amendment may not happen while both property owners and local governments attempt to mitigate beach and home losses through beach renourishment, erosion control devices, and other means before resorting to relocation and demolition.

Most local government management, the most prevalent regulatory techniques (e.g., construction codes, zoning), and most public disaster assistance and infrastructure investments also support preservation of threatened property on site. For example, following Hurricane Hugo, federal, state, and local governments spent funds in the Brunswick County communities studied to build berms along the shore to protect against further damage expected from astronomical high tides. Besides, in at least one town the local government accelerated the extension of its sewer system to oceanfront homes that experienced heavy erosion during Hugo. The effect was to permit some homes that could not or might not have been able to reinstall septic systems to remain in place without being subjected to relocation or demolition.

Seasonally based localities such as those in Brunswick County and on Fire Island depend heavily upon real estate sales and rentals, tourism, and real property tax receipts for their economies. In many seaside communities, the oceanfront properties are the highest value properties in the community (both market value and tax-assessed value) and often carry a high percentage of the local tax base when compared to the space they occupy. Thus, local governments have strong financial incentives to permit their oceanfront owners to stay in place as long as possible.

The nominal intent of Congress under the Upton-Jones Amendment is to encourage voluntary, anticipatory action by owners to remove structures threatened by erosion and to provide benefits before the structures are damaged by flooding or erosion. The results of the studies suggest that the incentives of the Upton-Jones Amendment generally will not induce voluntary, anticipatory action by owners and are insufficient to overcome individual, market, and regulatory incentives for oceanfront owners to remain in place. This occurs for the following reasons:

- The psychological value of oceanfront property ownership is in no way compensated under any program, yet may be one of the most important factors in owners' decision making.
- Loss of rental income and added costs for land are not fully offset nor compensated by the relocation benefits available under Upton-Jones; continued rental income is a strong incentive for owners to accept the risks of remaining on the property.
- Benefits for demolition are potentially greater than those for relocation, but will not compensate for loss of land value.
- Continued availability of flood insurance reduces the owners' risks of remaining.
- Measures by local, state, or federal agencies, such as renourishing beaches, building berms, otherwise mitigating the effects of erosion, or installing sewer lines to overcome septic system limitations, bolster owners' perceptions of acceptable risk.
- Elevation of buildings above the 100-year flood level and embedment of piling foundations below erosion and scour depths reduce the threat of imminent collapse from erosion, even as erosion extends beneath houses.

Thus, as written at the time of this study, the Upton-Jones Amendment had insufficient market incentives and regulatory teeth to induce widespread, voluntary, anticipatory relocation by oceanfront owners.

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13. See, e.g., Miller, H.C., 1975, "Coastal Flood Plain Management and the National Flood Insurance Program: A Case Study of Three Rhode Island Communities," *Environmental Comment,* Urban Land Institute, Washington, D.C.

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Miller, H.D., 1980, *Barrier Island Development Near Four National Seashores,* U.S. Council on Environmental Quality, Washington, D.C.

14. See Miller, H.C., 1977, *Coastal Flood Hazards and the National Flood Insurance Program*, pp. 21-31, Federal Insurance Administration, Department of Housing and Urban Development, Washington, D.C.

15. See, for example, Miller, H.C., 1975, "Coastal Flood Plain Management and the National Flood Insurance Program: A Case Study of Three Rhode Island Communities," *Environmental Comment*, Urban Land Institute, Washington, D.C.

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8

Conclusions and Recommendations

The question posed rhetorically in the title of this study—Has retreat sounded?—must be answered with a qualified negative. Despite all the lip service paid to the need to retreat from eroding shorelines, past perceptions and building practices remain solidly entrenched along most of the nation's developed coasts. Furthermore, retreat as a hypothetical response to coastal erosion losses is obstructed by an array of governmental incentives for not relocating, including federal flood insurance; beach nourishment and shore stabilization programs; subsidies for roads, bridges, and sewer and water systems; rapid depreciation of rental properties; casualty loss deductions; and zoning requirements for minimum lot and streetside setbacks.

One qualification to this assessment is the elevation of newer or rebuilt residential structures on pilings in accordance with the base flood elevation standards of the National Flood Insurance Program. But while elevation reduces damage due to storm surges and waves, it does not address the recession of shorelines toward and beneath such structures. As H. Crane Miller reported in Chapter 7, the higher rental income and federal tax write-offs obtainable from oceanfront locations motivate owners to stay put and maximize short-term income rather than relocate landward. It is foreseeable that elevation on sturdy pilings will gradually leave many such structures stranded in the surf zone, uninhabitable due to loss of septic systems and street access. Also, flood insurance will cease for structures seaward of the mean high tide line. In time, such buildings will become opulent derelicts—tax delinquent obstructions within the intertidal zone—and public safety hazards requiring removal at public expense.

The other qualification is the increasing prevalence of state erosion management restrictions on building along eroding shorelines, as discussed in Chapters 3 and 4. Such measures reflect a commitment in certain states to require new and rebuilt construction to retreat—somewhat—from eroding shorelines. But the potential value of such measures as now utilized is likely to be undercut by several factors.

First, state-imposed setbacks, where they exist, are generally *too narrow in relation to the life expectancy of modern structures*. The North Carolina standard of 30 years of the average annual erosion rate (AAER) for smaller structures and 60 years for larger ones has become a rule of thumb for several other states and was proposed as a minimum federal standard under S. 1650. But if such a standard were uniformly applied to all new dwellings built in 1972 (when the federal Coastal Zone Management Act was adopted), they would now theoretically have only 10 years left and would soon be exposed to high risk of undermining and flooding. The useful life of shorefront homes is certainly longer than 30 years, and setbacks should be established accordingly. (The National Research Council Committee on Coastal Erosion Zone Management, in its 1990 report, recommended a 50-year/100-year standard for small and large structures, respectively.)

Second, existing standards provide *little or no margin of error* to account for catastrophic storms, which is when much of the average annual erosion actually occurs. For example, on October 31, 1991, bluffs along the south shore of Nantucket Island in Massachusetts experienced an entire year's average erosion in one day, namely six feet (*Philadelphia Inquirer*, 1992). The estimation of average erosion rates based on historical shoreline change data, while necessary and expedient, is scarcely an exact science. Particularly along bluff shorelines where erosion is irreversible, estimates should incorporate a margin of error reflecting the possibility of greater than expected erosion losses. (Michigan adds 15 feet to its 30-year setbacks for this reason.) On ocean shorelines, minimum setbacks should reflect the possibility of faster rates of erosion due to accelerated sea level rise (National Research Council, 1987).

Third, *minimum setbacks, where required, tend to be the maximum distance of retreat* in building practice. In a study of 87 permits issued under the North Carolina Coastal Area Management Act between 1979 and 1981, it was reported that 49% were situated at or very close to the minimum 30-year setback, and 97% would be within reach of long-term erosion during their hypothetical 70-year average lifetime. Even where lot depths were sufficient for a greater than minimum voluntary setback, three-quarters of the buildings sampled were plotted with more space used for setback on the street side than on the ocean side (Stutts, Siderelis, and Rogers, 1985).

Fourth, *minimum setbacks may be riddled with loopholes and may be terminated or waived in the event of catastrophic coastal damage*. In South

Carolina, for example, homes of up to 5,000 square feet may be built within the 40-year setback zone landward of the baseline. The entire setback was eliminated for the city of Folly Beach after Hurricane Hugo, as was the 20-foot minimum setback ("dead zone") for the entire state through amendments to the Beachfront Management Act in 1990 (see Chapter 5).

Fifth, the application of current elevation and/or setback requirements to the rebuilding of existing structures depends upon a *determination of the level of damage incurred.* Under the National Flood Insurance Program (NFIP) and many state programs, new standards apply when a structure is "substantially damaged" (i.e., by more than 50% of its preflood value, excluding the value of its lot). This is a notoriously subjective determination often made by local building inspectors. Sympathy for victims may override long-term hazard mitigation goals. Even where standards for calculating levels of damage are specified, they may be favorable to the restoration of the status quo. In South Carolina, survival of a foundation or pilings alone counts as 25%, and a septic system counts as 10% of preflood value. After Hugo struck Folly Beach with a storm surge of 13-17 feet, only 85 out of 290 structures on the oceanfront were designated as substantially damaged. Some were in fact spared greater damage due to elevation; others were perhaps treated generously in the assessment process. (Even the 85 substantially damaged structures may be rebuilt without a minimum setback under South Carolina's Beachfront Management Act).

Sixth, inadequate standards for rebuilding after a disaster set the stage for *repeated losses to the same properties* (and often repetitive claims under the NFIP). For instance, at Pegotty Beach in Scituate, Massachusetts, the October 31, 1991, Halloween Storm destroyed, among others, five houses that had been rebuilt to NFIP standards after being substantially damaged in the February 1978 northeaster (*Boston Globe*, 1991). Between January 1, 1978, and October 31, 1987, nearly 78,000 repetitive losses in coastal communities were incurred under the National Flood Insurance Program, of which 3,002 were in coastal high hazard zones (V zones) and 15,126 were on the Great Lakes shorelines (General Accounting Office, 1988, Table 3.2).

Therefore, there is reason for skepticism regarding the efficacy of the present limited and piecemeal approaches to erosion management through the individual states. Some states clearly stand out as leaders (e.g., North Carolina, Florida, New York, and Michigan), but even those programs are subject to most of the flaws listed above. Other states, such as New Jersey and Texas, are far more limited in their extent of state intervention in coastal development.

Meanwhile, the federal government so far has no standards for mitigating erosion hazards but continues to insure against erosion losses and fund occasional beach nourishment or shoreline protection projects according to the whims of the political process. Such projects only delay the

inevitable along eroding coasts at great expense. Such expense may be justified or unavoidable along heavily urbanized coasts, but even there, repetitive beach nourishment, as at Ocean City, Maryland, may be fiscally onerous, especially during a recession.

One must conclude that despite encouraging signs, retreat as a national strategy in response to coastal erosion has not yet sounded. The question logically follows: what more do we need to do to accomplish a meaningful level of reduction of coastal erosion and flood losses? What follows are some concluding thoughts and recommendations.

Federal Government

1) Establish by presidential Executive Order and/or act of Congress that retreat from eroding shorelines will be the national policy of the United States and that federal funding for *in situ* protection will be authorized only: a) where cost-effective, b) where retreat is not feasible, c) with at least a 50% nonfederal matching cost share, and d) with provision for enhanced public access to beaches and coastal waters.
2) Ensure through federal review that any implemented shoreline stabilization or inlet maintenance project be designed to minimize environmental harm and downdrift erosion (e.g., provide sand transfer facilities and avoid deep water disposal of sand dredged from inlets).
3) Revise federal tax code to: a) eliminate casualty loss deduction for owners of investment properties damaged by coastal flooding and/or erosion (excluding personally occupied principal residences), b) eliminate depreciation tax shelter for seasonal rental properties wherever located, and c) provide tax credit or deductibility for specified expenses incurred in relocating erosion-threatened structures landward.
4) Specify that natural hazard mitigation plans prepared under Section 409 of the Stafford Act (P.L. 100-707) for coastal areas must include plans for the relocation of structures, where feasible, from eroding shorelines.
5) Amend the National Flood Insurance Program as proposed in H.R. 1236 and S. 1650 to: a) incorporate erosion data on flood insurance rate maps (FIRMs), b) establish standards for minimum setbacks along eroding coasts, c) limit future NFIP coverage for structures in the 10-year AAER zone of imminent collapse, and d) limit repetitive claims on the same property in the absence of mitigative actions.
6) Designate Special Area Management Plans (SAMPs) under Section 303(3) of the federal Coastal Zone Management Act to encourage state, municipal, and private cooperation in developing innovative

plans for coastal land use and redevelopment along eroding shorelines.

State Governments

7) Continue to expand and refine data gathering, analysis, and, where justified, mapping of shoreline change rates.
8) Prohibit any new construction seaward or lakeward of minimum setback (i.e., 30-year AAER or greater), except nonresidential structures dependent upon direct water access.
9) Require any new structures seaward of the 100-year AAER line to be readily movable, whether they are elevated or not.
10) Establish interest subsidy programs to encourage voluntary landward relocation of structures similar to the Michigan Emergency Home Moving Program (see Chapter 6).
11) Identify "substantially damaged" structures through nonlocal damage appraisers, and apply minimum setbacks to all such structures. (Required elevation will presumably diminish as distance from water increases.)
12) Acquire fee-simple or easement interests in eroding coastal shorelines to enhance public access, environmental rehabilitation, restoration of natural coastal processes and to avoid future costs of shoreline stabilization and removal of abandoned and damaged structures. (Oregon and California excel in this approach).
13) Promote public awareness and understanding of coastal geology and ecology through education programs, video productions, "coastweeks," and interpretive coastal tours. (Many states already conduct these types of projects under the federal Coastal Zone Management Program and its state counterparts.)

Counties and Municipalities

14) Establish local minimum setbacks from eroding shorelines using the best available shoreline change data.
15) For new subdivision plats, require waterfront lot depths sufficient to accommodate landward relocation of movable structures within 100-year AAER line (see recommendation 9).
16) For new nonmovable structures (e.g., hotels and condominiums), establish minimum 100-year AAER setbacks with waterside open space usable for patios, pools, or other nonenclosed amenities.
17) Encourage location or relocation of structures away from eroding shorelines through the use of planned unit developments, cluster zoning, or transfer of development rights.

18) Initiate legal action against updrift sources of artificial shoreline erosion if identifiable, whether within or outside the jurisdiction of the county or municipality.
19) Relax minimum streetside setbacks for structures on pre-existing lots to facilitate landward relocation (parking may be accommodated underneath elevated structures).
20) After a coastal disaster, replan location of streets and utilities to facilitate landward redevelopment of community. (Section 404 hazard mitigation grants under the Stafford Act may be available to fund 50% of the costs of such measures).

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