EVALUATION OF EROSION HAZARDS
SUMMARY

A Collaborative Project of

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FOREWORD

Mandated by Section 577 of the National Flood Insurance Reform Act of 1994 (Public Law 103-325), this independent report, *Evaluation of Erosion Hazards*, provides a much-needed and valuable assessment of coastal erosion and the resulting loss of property along our Nation's ocean and Great Lakes shorelines.

I commend the H. John Heinz III Center for Science, Economics and the Environment for its work and for delivering a thought-provoking set of findings, recommendations and policy options. The Center's multi-sector, nonpartisan approach drew experts from around the country to produce, as the Congress envisioned, an objective, science-based report.

One of the report's most sobering findings is that within the next 60 years approximately 25 percent of homes located within 500 feet of the coast (excluding those located in most urban centers) will fall victim to the effects of erosion. Erosion-induced losses to property owners during this time are expected to be half a billion dollars annually, an amount nearly equal to the risk of loss from coastal flooding. If coastal development continues unabated or if sea levels rise as some scientists are predicting, damages may be even higher.

Continued coastal erosion has made both coastal structures and ecosystems vulnerable to storms. An increase in the number and intensity of hurricanes making landfall along some of our most erosion-prone coastlines could dramatically affect those areas. Unfortunately, such an increase in storm activity is precisely what many leading experts are predicting over the next 20 years.

This report clearly lays out the hard choices facing the Congress and the Nation. It is now time – indeed it is past time – to renew the public dialogue about how we can lower the risks to life and property and reduce the costs to the Nation from the inevitable consequences of coastal erosion.

JAMES LEE WITT
Director
Federal Emergency Management Agency

Evaluation of Erosion Hazards
Summary

Driven by a rising sea level, large storms, flooding, and powerful ocean waves, erosion wears away the beaches and bluffs along the U.S. ocean and Great Lakes shorelines. Erosion undermines waterfront houses, businesses, and public facilities, eventually rendering them uninhabitable or unusable. By moving the shoreline inland, erosion also brings nearby structures ever closer to the water, often putting them at greater risk than either their owners or insurers recognize.

Over the next 60 years, erosion may claim one out of four houses within 500 feet of the U.S. shoreline. To the homeowners living within this narrow strip, the risk posed by erosion is comparable to the risk from flooding, especially in beach areas. The National Flood Insurance Program (NFIP), however, does not map erosion hazard areas to inform homeowners of the risk they face, nor does it directly incorporate erosion risks into its insurance ratemaking procedures. Both of these shortcomings can be remedied.

Congress debated erosion management legislation during the early 1990s, but could not reach agreement on a course of action. Deciding that more information was needed, Congress passed Section 577 of the National Flood Insurance Reform Act of 1994 (P.L. 103-325), which requested an analysis of a series of possible policy changes to address erosion hazards within federal programs.

This report, by The H. John Heinz III Center for Science, Economics and the Environment, is a response to that mandate. The goal of the study is to improve understanding of the impacts of erosion and erosion-related flooding on the NFIP, other federal programs, and coastal communities. The report makes two recommendations, shown in Box A.

Box A. Recommendations

Congress should instruct the Federal Emergency Management Agency to develop erosion hazard maps that display the location and extent of coastal areas subject to erosion. The erosion maps should be made widely available in both print and electronic formats.

Flood insurance rate maps do not inform current and prospective coastal property owners of erosion risks. Without such information, state and local decision makers and the general public are not fully aware of the coastal hazards they face, nor do they have this information available for land-use planning and erosion hazard mitigation. This expenditure is likely to be cost effective.

Congress should require the Federal Emergency Management Agency to include the cost of expected erosion losses when setting flood insurance rates along the coast.

Despite facing higher risk, homeowners in erosion-prone areas currently are paying the same amount for flood insurance as are policyholders in non-eroding areas. FEMA should incorporate the risk from erosion into the cost of insurance along the coasts. Otherwise, other NFIP policyholders or taxpayers will have to subsidize what is likely to become a substantial cost. Using maps such as those recommended above, rate increases could be confined to the highest-risk eroding regions. Alternatively, more modest rate increases could be spread across a larger "Coastal High Hazard Zone" that includes both the highest-risk flood and eroding regions.

Figure 1. Sample 60-year erosion hazard area map, South Bethany, Delaware

Notes:
This map shows the 60-year erosion hazard area (the land expected to be lost to erosion over the next 60 years). Structures inside the 60-year erosion hazard area are marked by a circle. Structures outside the 60-year erosion hazard area are marked by a square.

Box B. Summary of Key Study Findings

- Within the first few hundred feet bordering the Nation's coasts, property owners face as large a risk of damage from erosion as they do from flooding. Information about the magnitude of this risk, which varies widely, is generally not available.
- Roughly 1,500 homes and the land on which they are built will be lost to erosion each year, on average, for the next several decades. Costs to coastal property owners will average $530 million per year. Additional beach nourishment or structural protection might lead to lower losses; additional development in the most erosion prone areas will lead to higher losses.
- At current enrollment levels, the National Flood Insurance Program will pay $80 million per year for erosion-related damage, about 5 percent of today's premiums. Total losses will rise with hoped-for enrollment increases.
- Today's property values within the areas most susceptible to coastal erosion have been lowered by a total of $3.3 billion to $4.8 billion nationwide as a result of erosion, a loss of about 10 percent.
- Most of the damage from erosion over the next 60 years will occur in low-lying areas also subject to the highest risk of flooding. Some additional damage will also occur along eroding coastal bluffs.
- Although certain types of erosion damage are not eligible under National Flood Insurance Program rules, most erosion-related losses sustained by policyholders is reimbursed by the program. However, erosion damage is not fully reflected in flood insurance rates; current rates are primarily based on flood risk alone. Thus erosion losses will be subsidized by policyholders in non-eroding areas or general taxpayers.
- To fully reflect risk, insurance rates in the highest risk coastal areas must be, on average, twice today's rates. Rate increases could be spread uniformly across the highest risk coastal areas or varied according to the risk of erosion-related damage. The rate increases needed to cover expected erosion losses can be designed to be acceptable to a majority of current policyholders, based on results of a mail survey.
- The cost of identifying, mapping, disseminating, and maintaining information on the erosion hazard nationwide is about $5 million per year. For comparison, if all currently empty lots in areas most susceptible to erosion are built on, damage from erosion would rise by roughly $100 million per year for the value of the structures alone. The cost effectiveness of mapping depends on how much the maps reduce development (and rebuilding) within eroding areas, but the investment is likely to be worthwhile.
- Development density in several of the high-risk coastal areas studied by The Heinz Center increased by more than 60 percent over the last 20 years. Roughly 15 percent of this increase appears attributable to the influence of the National Flood Insurance Program. However, the building standards and floodplain management requirements that are part of the program have reduced flood and erosion damage per structure by roughly 35 percent. Thus, for development after 1980, the program has lowered damage by about 25 percent below the level that would have occurred without the program.

The report also analyzes the economic impacts of erosion, presents a range of policy options, and evaluates the effectiveness of each option in reducing erosion losses. The key study findings are summarized in Box B. The policy options evaluated are listed in Box C.

The study was conducted in three phases. In phase 1, the Federal Emergency Management Agency contracted with state agencies to produce maps for 27 counties along U.S. coastlines. The maps included projections of how far inland the coastline may erode over the next 60 years and, where applicable, expected flood heights from a 1 percent chance ("100-year") storm today and in the future. A sample erosion hazard map is shown in Figure 1. The Heinz Center conducted phases 2 and 3, which included a field survey of over 10,000

FIGURE 2. In 1999 the National Park Service moved the Cape Hatteras lighthouse back 2,900 feet to a more stable position.

(Photo by Drew Wilson, The Virginia Pilot)

structures and analyses of the extent of erosion-related damage and options to address that damage.

This summary describes the nature of the coastal erosion hazard by region, the costs of erosion today and in the future, current federal and state policies in eroding areas, and a series of possible changes to the NFIP to better incorporate coastal erosion into the existing flood insurance program. The recommendations are discussed in greater detail at the conclusion of this executive summary.

The Coastal Erosion Hazard

The erosion hazard was dramatized recently by the predicament of the Cape Hatteras lighthouse in North Carolina. When constructed in 1870, the lighthouse was 1,500 feet from the shore. Protective measures to reduce the rate of beach erosion in front of the lighthouse provided a temporary solution, but, by late 1987, the lighthouse stood only 160 feet from the sea and was in danger of collapsing. In 1999, after several years of debate and lawsuits aimed at blocking a relocation, the National Park Service successfully moved the lighthouse back 2,900 feet at a cost of $9.8 million (see Figure 2).

Approximately 350,000 structures are located within 500 feet of the 10,000-mile open ocean and Great Lakes shorelines of the lower 48 states and Hawaii. This estimate does not include structures in the densest areas of large coastal cities, such as New York, Chicago, Los Angeles, and Miami, which are heavily protected against erosion.

Of these, about 87,000 homes are located on low-lying land or bluffs likely to erode into the ocean or the Great Lakes over the next 60 years. The breakdown by region is shown in Table I. Assuming no additional beach nourishment or structural protection, roughly 1,500 homes and the land on which they are built will be lost to erosion each year. An example of a house threatened by erosion is shown in Figure 3.

Box C. Policy Options Evaluated

The following nine options were evaluated. Options 1–5 are mutually exclusive; that is, only one can be chosen. Any of options 6–9 could be added to any of the other policy packages. Options 2–7 depend on the availability of detailed erosion hazard maps.

1. Maintain the status quo (i.e., no change in policy)
2. Erosion mapping and dissemination alone
3. Creation of a coastal high hazard zone, including both high flood and erosion zones
4. Mandatory erosion surcharge on flood insurance in erosion zones
5. Erosion surcharge combined with regulatory measures to reduce damages
6. Flood-related regulatory changes in erosion zones
7. Erosion insurance in bluff areas susceptible to erosion but not flooding
8. Relocation assistance and/or land acquisition
9. Shoreline protection measures (i.e., nour ishment, dune restoration, and structural measures)

Summary

Within the highest risk flood hazard areas ("V-zones") of the Atlantic and Gulf of Mexico coasts, the risk of damage from erosion is almost equal to, and added to, that from flooding. Much of the Pacific and Great Lakes shorelines are backed by steep cliffs or bluffs susceptible to erosion also.

The average annual erosion rate on the Atlantic coast is roughly 2 to 3 feet/year. States bordering the Gulf of Mexico have the nation's highest average annual erosion rates (6 feet/year). The rates vary greatly from location to location and year to year. A major storm can erode the coast inland 100 feet or more in a day. The coastline often accretes partway back over the next decade. Both the Atlantic and Gulf coasts are bordered by a chain of roughly 300 barrier islands, which are composed primarily of loose sand and are the most dynamic land masses along the open-ocean coast. Barrier island coastlines have been retreating landward for thousands of years in response to slowly rising sea levels.

FIGURE 3. As a result of erosion, this oceanfront house is now on the beach.

TABLE I. Nationwide Estimate of Structures Susceptible to Erosion[a]

Variable	Atlantic Coast	Gulf of Mexico	Pacific Coast	Great Lakes	Total
Length of coastline					
Miles	2,300	2,000	1,600	3,600	9,500
Percentage of total	24%	21%	17%	38%	
Structures within 500 feet of shoreline					
Number	170,000	44,000	66,000	58,000	338,000
Percentage of total	50%	13%	20%	17%	
Structures within 60-year erosion hazard area (EHA)[b]					
Number	53,000	13,000	4,600	16,000	87,000
EHA structures as % of those within 500 feet of shoreline					
	31%	29%	7%	28%	
Structures within 60-year EHA assuming all open lots are filled					
Number	76,000	22,000	5,200	>16,000[c]	>120,000

[a] All estimates exclude structures in major urban areas. The analysis assumes these structures will be protected from the erosion hazard.

[b] The 60-year EHA is determined by multiplying local erosion rates by 60 years.

[c] Data on open lots not available in Great Lakes

FIGURE 4. Average Annual Erosion Rates (feet/year) within Counties studied in The Heinz Center's Evaluation of Erosion Hazards.

The Pacific coastline consists of narrow beaches backed by steep sea cliffs that are composed of crumbly sedimentary bedrock and are therefore unstable. In addition, the cliffs are heavily faulted and cracked, and the resulting breaks and joints are undermined easily by wave action. Cliff erosion is site specific and episodic. In some locations, the cliffs can retreat tens of feet at one time, whereas 50 to100 feet away, there is no retreat at all. As a result, long-term average annual erosion rates are usually less than 1 foot/year, but these low averages hide the true nature of large, episodic events. Similarly, along the shores of the Great Lakes, rates of bluff and dune erosion vary from near zero to tens of feet per year because of annual variability in wave climate and lake levels.

Costs of Erosion Today and in the Future

Property Losses and Insurance Payouts

Nationwide, erosion may be responsible for approximately $500 million in property loss to coastal property owners per year, including both damage to structures and loss of land. The breakdown by region is shown in Table II.

These conclusions are based on detailed field measurements and mail survey information collected on approximately 3 percent of the buildings located within 500 feet of the shore. The Heinz Center sent field survey teams to measure and photograph 11,450 structures in 18 counties. Additional information on these same structures was obtained from county assessor and similar offices, and detailed questionnaires mailed to the owners. Researchers intensively studied 120 miles of shoreline, or about 1 percent of the U.S. coastline outside of Alaska and Hawaii. The areas studied are shown in Figure 4 along with their typical erosion rates.

Not all of the $500 million in annual property loss will be covered by the NFIP, however. First, insurance does not cover loss of land. In addition, the NFIP limits coverage to $250,000 and many coastal houses are worth considerably more. Finally, results of The Heinz Center's mail survey indicate that roughly half the homeowners in high

TABLE II. Nationwide Estimates of Cost of Erosion: Average Annual Losses to Current Properties Within 60 Year EHA (in Millions of Dollars per Year)

Affected Entity	Atlantic Coast	Gulf of Mexico	Pacific Coast	Great Lakes	Total
Owners[a]					
	$320	$50	$110	$50	$530
Community[b]					
	$260	$50	$70	$30	$410
National Flood Insurance Fund[c], assuming 100% enrollment:					
	$130	$20	$10	$30	$200
National Flood Insurance Fund[c], assuming current enrollment					
	$70	$10	$1	$2	$80

[a] Loss of structure and land.

[b] Loss of structure and land, not including the "amenity value" of the oceanfront, which is transferred from owner to owner.

[c] Payments from the National Flood Insurance Fund are for damage to structures and contents only.

Data may not add to totals because of rounding.

TABLE III. Estimates of Cost of Erosion Along the Atlantic Coast: Variation in Average Annual Losses Through Time (in Millions of Dollars per Year)

Affected Entity	Within 30 Year EHA	30 to 60 Years from Today (Existing Structures Only)	30 to 60 Years from Today (Assuming All Lots Filled)[a]
Owners[b]			
	$200	$440	$630
Community[c]			
	$160	$360	$510
National Flood Insurance Fund[d], assuming 100% enrollment			
	$80	$180	$260
National Flood Insurance Fund[d], assuming current enrollment			
	$40	$90	$130

[a] Vacant lots are, on average, about 30 percent of total lots.

[b] Loss of structure and land.

[c] Loss of structure and land, not including the "amenity value" of the oceanfront, which is transferred from owner to owner.

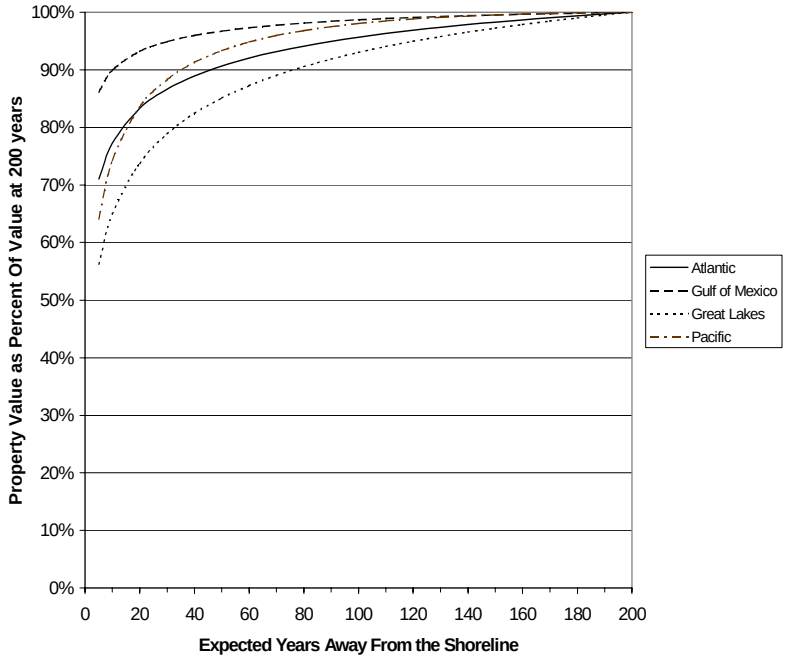
[d] Payments from the National Flood Insurance Fund are for damage to structures and contents only.

Data may not add to totals because of rounding.

erosion areas on the Atlantic and Gulf coasts currently purchase flood insurance, which to large extent covers erosion losses, as well. On the Pacific and Great Lakes coasts, where bluff erosion is a problem, 10 percent or fewer of at-risk houses are insured. Assuming that NFIP enrollment remains at present rates, the payout over the next few decades for erosion losses is likely to be roughly $80 million per year.

The breakdown by region is shown in Table II. Table III compares estimates of erosion along the Atlantic coast today to the higher losses projected decades into the future. Note that NFIP payments in

FIGURE 5. Effect of erosion hazard on typical coastal property value[a]



[a] Property value for otherwise identical waterfront houses, at the same distance from the water today, but with shores eroding at different rates.

TABLE IV. Estimated Economic Impacts of Erosion in 60-Year Erosion Hazard Areas Nationwide (in Millions of Dollars)

	Atlantic Coast	Gulf Coast	Great Lakes	Pacific Coast	Total
Loss in property value					
	$1,700–$2,700	$100–$200	$600–$900	$900–$1,000	$3,300–$4,800
Loss in property value, assuming all empty lots are filled					
	$2,500–$3,800	$200–$300	$900–$1,300[a]	$1000–$1,200	$4,600–$6,600

[a] Percentage of empty lots extrapolated from average of other regions.
The loss in property value represents depression in property price prior to any damage.
Data may not add to totals because of rounding.

erosion-prone areas over the last decade were *lower* than the losses projected in Tables II and III. Averaged over the last decade, premiums paid by owners of houses built after 1981 have been sufficient to cover losses, as required by law. However, as the shore erodes inland, damage to these structures will rise.

Property losses are just one of the many costs of shore erosion. A recent study by The Heinz Center (1999), *The Hidden Costs of Coastal Hazards*, emphasizes that many hidden or unreported costs related to coastal hazards are imposed on the business community, individuals, families and neighborhoods, public and private institutions, and

natural resources and the environment. Although that study focused on weather-related coastal hazards, such as hurricanes and other severe storms, erosion clearly influences the stability and condition of coastal property and beaches when such disasters strike a community.

Reduced Property Values

Research conducted by The Center's collaborators at The University of Georgia shows a strong relationship between house price and the number of years until the nearest shoreline is likely to erode and reach the house (determined by dividing the distance from the shore by the erosion rate). Houses close to a rapidly eroding shore are worth less today than otherwise identical houses that are close to shorelines that are relatively stable. The increased risk of damage is reflected in sales price. This relationship for typical waterfront properties – at the same distance from the water today, but with shores eroding at different rates – is shown in Figure 5.

TABLE V. Summary of Approaches to Erosion Management by Level of Response

Level of response	Approaches to erosion management
Individuals	• Protect private property through structural and non-structural measures • Comply with building codes and land use regulations
Communities, Local governments	• Establish and enforce building codes and land use regulations • Enforce NFIP building and floodplain management requirements • Participate in federal and non-federal shore protection projects
States	• Establish and enforce setback policies • Regulate the use of shoreline stabilization structures • Require disclosure of erosion hazards in real estate transactions • Participate in federal and non-federal shore protection projects
Federal agencies	• Provide flood insurance coverage (FEMA – NFIP) • Prohibit federal expenditures in designated coastal barriers (US FWS – Coastal Barrier Resources Act) • Provide disaster response and recovery assistance (FEMA) • Support state erosion management programs (NOAA – CZMA) • Participate in federal shore protection projects (US ACE)

Key:

CBRA	Coastal Barrier Resources Act
CZMA	Coastal Zone Management Act
FEMA	Federal Emergency Management Agency
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
US ACE	United States Army Corps of Engineers
US FWS	U.S. Fish and Wildlife Service

Along the Atlantic coast, a house that is 50 years from the shoreline is estimated to be worth about 90 percent of an identical house located 200 years from the shore; likewise, a house estimated to be within 10 to 20 years of an eroding shore is worth 80 percent of one located 200 years away. This varies somewhat from region to region, but the Atlantic coast results are typical.

By adding up these estimates across the 53,000 structures currently inside the 60-year erosion hazard area on the Atlantic Coast, The Heinz Center estimates a depression in today's property values to the owners of these homes of approximately $1.7 to 2.7 billion. (The 60-year erosion hazard area is the land expected to be lost to erosion over the next 60 years.) The estimated depression in property values for the 87,000 houses within the 60-year erosion hazard area nationwide is $3.3 to 4.8 billion. If houses are built on all the remaining empty lots within the 60-year erosion hazard area, then the loss in property value might total $4.6 to 6.6 billion. The breakdown by region is shown in Table IV.

Current Policies in Eroding Areas

Currently, erosion is addressed in a piecemeal manner by Federal, state, and local governments as well as private owners. These activities are summarized in Table V. Federal activities and programs include: the NFIP, which reimburses its policyholders for erosion losses; coastal engineering projects, such as beach nourishment, that help protect against erosion; funding and technical assistance to states; and purchase of coastal areas for public ownership. The Coastal Barrier Resources Act restricts federal expenditures, including flood insurance and disaster assistance, within designated Coastal Barrier Resources System Units. The system encompasses nearly 1.3 million acres and approximately 1,200 miles of shoreline.

Coastal Erosion and The National Flood Insurance Program

The National Flood Insurance Program was established in 1968 "to provide flood insurance in communities which adopt and adequately enforce floodplain management ordinances that meet minimum [program] requirements" (National Flood Insurance Act of 1968, P.L. 90-448).

The program has three objectives:

- Identify flood risks and disseminate this information to the public, lenders, insurance and real estate agents, and state and local governments;
- assure the purchase of sufficient insurance and the enrollment of adequate numbers of communities and individuals to curtail the expansion of federal disaster relief and flood control programs; and
- encourage wise use of the floodplain through mitigation requirements and activities in communities that wish to obtain federally backed flood insurance.

Erosion is not well addressed by the current NFIP. Although certain types of erosion-related damage are not reimbursable under program rules, the NFIP appears to pay for most erosion-related damage claims in low-lying areas. A survey of insurance agents by The Heinz Center found no case where policy holders failed to submit a claim, or the program denied a claim, because of erosion. However, current insurance rates do not reflect the magnitude of the erosion risk faced by any individual policyholder. Thus, future claims by homeowners in erosion-prone areas will have to be subsidized by others. Moreover, because current flood maps do not incorporate erosion risk, they are not only incomplete but also misleading to users.

The next section presents a comprehensive series of policy options to remedy these shortcomings. The Heinz Center's recommendations are presented at the conclusion of this summary.

Policy Options

Nine policy options, or packages of options, were developed and analyzed. Options 1–5 are meant to be mutually exclusive; that is, only one can be chosen. These are ordered roughly from least to most extensive policy intervention. Any of options 6–9 could be added to any of the other policy packages. Options 2–7 depend on the availability of detailed erosion hazard maps. Each option is summarized and evaluated below.

To help sort through the nine options, The Heinz Center constructed a series of evaluation criteria that reflect possible goals for changes to the flood program. The criteria are as follows:

- Will the public be better informed about the risks of living on the coast?
- Does the change help alleviate economic hardships from erosion damages that do occur?
- Is the program fairer?
  - Will insurance rates more closely reflect risk?
  - Are additional restrictions imposed on property owners?
- Does the change lead to reduced damage to structures?
  - Does it avert damage to structures not yet built?
  - Does it help reduce damage to existing structures?
- Does the change lead to other desirable outcomes, such as environmental benefits or enhanced opportunities for recreation?
- Is the change cost effective for affected individuals?

Option 1. Maintain the Status Quo

Nineteen of 30 coastal states currently incorporate erosion risks into the approval process for new construction close to the shoreline. The erosion management activities undertaken by states and communities are summarized in Box D. However, information about erosion risks is spotty, and both the information and its usage are inconsistent from state to state. Although the NFIP appears to reimburse most erosion-related damage in low-lying areas, current insurance rates do not reflect the variation in risk among policyholders. Thus, claims by homeowners in erosion-prone areas will have to be subsidized by policyholders in non-eroding areas. The regulatory components of the NFIP have reduced damage from flooding but are less successful with respect to erosion.

Option 2. Erosion Mapping and Dissemination Alone

The preparation of maps displaying the location and extent of areas subject to erosion would be the simplest and least intrusive change to the NFIP. The maps, if made widely available, would help to better inform the public about the risks of living along the coast. Erosion mapping is also a requisite component of options 3 through 7. FEMA estimates that a nationwide erosion hazard mapping program would cost $44 million. Assuming that a map is useful for 10 years, annual costs would be roughly $5 million per year. Depending on the region, if such maps discourage more than 2 to 7 percent of development on currently empty lots within the 60-year erosion hazard area, the investment will be worthwhile.

Erosion is a highly variable process, thus the maps would reflect only a statistical "best guess" of how much the shore might erode over the next several decades. Furthermore, the maps would be based on data from historical maps and aerial photographs—data that can be sparse and difficult to interpret. Nevertheless, such information is extremely helpful to many types of users of flood insurance rate maps.

Option 3. Creation of a Coastal High Hazard Zone, including both High Flood and Erosion Risks

FEMA could establish a single "coastal high hazard zone" encompassing the current highest-risk flood zone (the “V-zone”) and any additional areas highly

Box D. Present Status of Erosion Management at the State and Community Levels

Thirty states and five territories border the U.S. coastline. States have adopted land-use plans, regulations, building standards, and other programs for addressing coastal storms, floods, and erosion. Particularly since the passage of the 1972 Coastal Zone Management Act (P.L. 92-583), coastal states have been central players in the management of coastal resources and shorefront areas.

State-level responses to erosion range from doing nothing to restricting the use of hard structures and enforcing erosion-rate based setbacks (e.g., North Carolina), to providing loans and grants to stabilize the shoreline through cliff-hardening (e.g., the Maryland side of the Chesapeake Bay). Nineteen of 30 coastal states currently incorporate erosion risks into the approval process for new construction close to the shoreline. However, information about erosion risks is spotty, and both the information and how it is used is inconsistent from region to region.

Generally, states have delegated their land-use authorities to local governments. Therefore, the National Flood Insurance Program requires each community to adopt floodplain management requirements, including performance standards for new construction and substantial improvements to existing buildings located in special flood hazard areas on the Flood Insurance Rate Maps.

Communities or local governments address coastal erosion problems by developing and enforcing local ordinances to guide decisions on land use, zoning, subdivision practices, building standards, hazard mitigation, and management of public beach areas. Through the Community Rating System (a flood insurance rating and community inspection program), policyholders receive reductions in their premiums if the community implements floodplain management activities that exceed the National Flood Insurance Program's minimum requirements.

As part of this study, The Heinz Center conducted case studies of community responses to coastal erosion (Chapter 4 and Appendix F). These examples show how communities may react to policy changes at the federal level and how their concerns might be addressed.

susceptible to erosion. Insurance rates would increase to reflect both risks. On the Atlantic and Gulf coasts, the combined region would be roughly 15 percent larger than the current high-hazard V-zone.

If Congress directs FEMA to increase insurance rates to fully cover expected erosion damage, rates in the new area would rise a fixed amount between $.90 and $1.00/year per $100 of coverage. This is in addition to current rates that vary by flood risk. Under this option, all policyholders share the costs of erosion damage equally.

One advantage of this option is that it contains the cost of erosion to within the coastal high hazard zone, thus eliminating future subsidies from other NFIP policyholders (such as inland homeowners). Because it also requires erosion hazard mapping (discussed in option 2), the public will be better informed about the risks of living along the coast.

The main disadvantage of this option is that it does not bring insurance rates fully into line with the risk faced by individual homeowners within the coastal high hazard zone. Thus, policyholders in low erosion areas will still be subsidizing those located within more erosion-prone ones.

Option 4. Mandatory Erosion Surcharge on Flood Insurance in Erosion Zones

Many homeowners pay insurance rates far lower than is necessary to cover the risks caused by both flooding and erosion. Thus, either other NFIP policyholders or taxpayers will subsidize future erosion damages. Congress could direct FEMA to impose an erosion surcharge on current flood policies in erosion-prone areas to cover the additional risks and thus reduce the subsidy. The surcharge would have to be mandatory because the flood program already pays for most losses from erosion (in low-lying areas), and few policyholders would be likely to pay extra for erosion coverage that they get free of charge today. Moreover, it is not practical to distinguish between damage from flooding alone and that from erosion-related flooding.

This option would help bring insurance rates closer in line with expected damage and like the previous two options, would help better inform the public about the risks of living along the coast. Fairness is one of the most compelling reasons in favor of a mandatory erosion surcharge.

Option 5. Erosion Surcharge Combined with Regulatory Measures to Reduce Damages

Under the NFIP, flood insurance is offered to individuals on the condition that the community adopts regulations to reduce future damage. Following this model, other measures—such as setback requirements or building code changes—could be required in erosion-prone areas as a condition of allowing residents to remain eligible for combined flood and erosion insurance. NFIP elevation and related floodproofing requirements have been effective at reducing flood damage (see Box E) but are not as effective for reducing erosion damage.

Mandatory setbacks determine how close to the shoreline structures can be built or rebuilt. FEMA could follow one or more of the approaches taken by state coastal zone management programs in establishing setbacks. Nineteen of 30 coastal states have setbacks or land use controls in place along the coast (see Box D). Seven states establish setback distances based on expected years from the shoreline. Typical setbacks are 30 years for houses and 60 years for larger structures. The remainder specify a fixed setback distance in feet from the shoreline, typically between 25 feet to 100 feet. Alternatively, the two approaches may be combined (i.e., no development within 50 feet or within the 30-year EHA) to provide an additional safety margin.

FEMA could also require communities to adopt building code changes to reduce the impacts of erosion-related damages. For example, structures could be designed so that they could be moved and relocated more easily in the event that an eroding shore gets too close. Removal of a structure that ends up within, for example, the 10-year erosion line could be required.

A key issue associated with this option is whether Congress decides that the public benefits of setback requirements or mandatory removal of structures outweigh the potential hardship from imposing restrictions on how individuals may use their land. Congress could follow a different path if there is hesitancy to assign additional regulatory responsibilities to states and localities. It might simply choose to deny insurance—for both flooding and erosion—to new structures in the highest-risk erosion zones. Building in these areas would not be prohibited, but the owners of new structures would not be eligible for federal flood insurance or disaster assistance grants or loans. This is similar to the approach followed in the Coastal Barrier Resources Act.

Option 6. Flood-related Regulatory Changes in Erosion Zones

Erosion not only causes damage directly, but also, over time, increases the risk from flooding. The likelihood of damage could be lowered somewhat if communities were directed to apply building standards appropriate to the flood conditions

expected several decades from now. Newly constructed houses, or houses rebuilt after substantial damage, that are located in flood zones also susceptible to erosion, could be required to meet building standards with an added margin of safety based on the anticipated erosion of the coast.

Building in some additional flood resistance is cheaper during the design and building phases than it is after a structure has been built. However, we were not able to ascertain how large a margin of safety would be cost effective.

Option 7. Erosion Insurance in Bluff Areas Susceptible to Erosion but not Flooding

Although many houses on bluffs overlooking the coast are subject to erosion damage, homeowners

Box E. Effects of Erosion Risk, Flood Risk, and Flood Insurance on Development

The Heinz Center study evaluated some of the effects of the National Flood Insurance Program, which has never been fully assessed. A team of researchers at The George Washington University reconstructed 35-year development histories of 120 blocks of homes within seven of the counties inventoried. Four of the counties were on the Atlantic coast, two were on the Gulf of Mexico, and one on the Pacific coast.

Within these counties, development density more than doubled over the 35 years. With such overall growth as background, the researchers used statistical regression methods to examine whether the amount of land developed in each block was related to the risk of erosion; the risk of flooding; as well as other factors, such as whether it was a waterfront block. The research team also explored whether the availability of flood insurance affected the density of development.

Just as erosion affects property prices, so, too, does it affect the density of development. For blocks within the front (ocean-side) half of the 60-year erosion hazard area, the closer the block was to the ocean in years, the lower the development density. Outside the 60-year erosion hazard area, the closer the block was to the ocean in years, the more rapid the development.

The research team also found that flood risk affects the density of development. In the absence of insurance and other programs to reduce flood risk, development density would be about 25 percent lower in the highest-risk zones than in areas less susceptible to damage from coastal flooding. After the adoption of the National Flood Insurance Program, development density was roughly 15 percent lower in areas now classified as highest risk than in other areas. Thus, it appears that although development density is still lower than average in high-risk flood areas, the difference is smaller than it was before the program.

Although development density has increased, flood damage may be lower than it would have been if the National Flood Insurance Program had never been enacted, because of the program's floodplain management and building code requirements. Structures built after the program's building requirements went into effect in 1981 are expected to sustain significantly less damage during floods than are older structures built prior to the program. Overall, the net damage to "post-1981" structures is about 25 percent lower than it would have been if the new development had occurred at the lower densities, but higher rates of damage per structure, that would have occurred without the program.

in these areas typically have not purchased flood insurance. Only 10 percent or fewer of the susceptible structures in the bluff areas of the Great Lakes and Pacific coasts are covered, even though annual erosion damages in these areas may exceed $100 million per year. Coverage may be low in bluff areas because the National Flood Insurance Act limits coverage of erosion damage to that "caused by waves or currents of waters exceeding anticipated cyclical levels." Hence, there may be a greater likelihood of a claim being rejected in bluff areas than in low-lying areas. Insurance specifically covering erosion risks in bluff areas would be more consistent with the actual problems in these areas.

Any extension of erosion insurance into bluff areas would need to be pursued with caution, to make sure it did not encourage development in eroding areas. The NFIP appears to have contributed modestly to the increase in low-lying coastal areas, but because of the success of building standards, overall flood damage is lower than it would have been without the program (See Box E). Building standard changes are not likely to be as effective for lowering erosion damage, thus the overall effect of extending insurance to bluffs is unclear. Nevertheless, this option would serve to reduce the hardship if and when damage does occur.

Option 8. Relocation Assistance and/or Land Acquisition

The Heinz Center estimates that roughly 10,000 structures are within the estimated 10-year erosion zone closest to the shore. A program of relocation assistance and/or land acquisition could encourage removal of these high-risk structures before they are destroyed. Such a program might make the most sense if linked to some of the regulatory options under Option 5, such as revocation of insurance once a structure enters the 10-year erosion zone, unless the structure is relocated. Buyouts, or acquisition of property, already are used by many states and the federal government as a risk-reduction strategy. Under the rules for buyouts funded by the Federal Emergency Management Agency, the land purchased is deeded permanently as open space. Acquisition offers a way to permanently reduce or eliminate susceptibility to flood damage in the highest-risk areas. It also can be used to achieve important community and environmental protection goals, such as public beach access and preservation of open space and wildlife habitat.

This option has not been used extensively because of the high costs of coastal property. Mandatory programs also would provoke objections from private landowners. A previous attempt to encourage removal and relocation of threatened structures—the Upton-Jones Program, which existed from 1987 to 1994–was suspended because of limited usage and unintended outcomes. A relocation program, if pursued, would have to be carefully designed to avoid the shortcomings of the Upton-Jones Program.

Option 9. Shoreline Protection Measures (Nourishment, Dune Restoration, and Structural Measures)

Like relocation, shoreline protection is one of the few options that can reduce damage to existing structures. Interest in shoreline protection measures by current property owners is clear, especially in areas with a high density of existing structures and limited shoreline. Protective measures include beach nourishment, dune restoration, and armoring of the shoreline with hard structures. Individuals, communities, and states already build many such projects. Protection measures such as dune restoration are likely to lead to environmental improvements. However, hard structural measures, such as groins, bulkheads, and rip-rap, can have negative impacts on the physical and aesthetic characteristics of beaches by reducing beach width, disrupting sand supplies, and limiting recreational use of the beach.

The U.S. Army Corps of Engineers spent about $880 million between 1950 and 1993 (in 1993 dollars) on beach nourishment of about 200 miles of coast. Continued maintenance and

renourishment costs roughly $300,000/year per mile of coast. However, expected annual erosion damage exceeds nourishment costs in only one of the 10 Atlantic and Gulf coast counties in The Heinz Center sample. Thus, nourishment of additional stretches of the coast, if desired at all, will only pass a benefit-cost test for federal funding in limited, high-density areas. Shoreline protection measures can augment, but are not substitutes for, other options.

Recommendations

Based on the analyses presented in this report, The Heinz Center recommends that Congress take, at minimum, the following two actions. The Heinz Center believes that these two recommendations provide significant benefits, are cost effective, and are acceptable across most of the political spectrum. The other options we presented will lower damage or alleviate economic hardship should damage occur. Congress should consider the advantages and disadvantages of these options within the framework of existing Federal, State, and local programs.

Congress should instruct the Federal Emergency Management Agency to develop erosion hazard maps that display the location and extent of coastal areas subject to erosion. The erosion maps should be made widely available in both print and electronic formats.

Flood insurance rate maps do not inform current and prospective coastal property owners of erosion risks. The omission is substantial. Averaged over the highest hazard flood zone, the risk of erosion-related damage to structures is roughly equal to the risk of flood damage. Thus, the current maps, which show only flood hazards, are misleading.

Without accurate information on erosion, state and local decision makers and the general public will not be fully aware of the coastal hazards they face, nor will they be able to make use of this information for land-use planning and erosion hazard mitigation.

Congress should require the Federal Emergency Management Agency to include the cost of expected erosion losses when setting flood insurance rates along the coast.

Despite facing higher risk, homeowners in erosion-prone areas currently are paying the same amount for flood insurance as are policyholders in non-eroding areas. FEMA should incorporate the additional risk from erosion into the determination of actuarial rates in high-hazard coastal regions. This will eliminate the need for subsidies from other NFIP policyholders or taxpayers to cover expected erosion losses.

Erosion risk can be incorporated in several ways. The simplest is to combine the highest hazard flood zones and erosion hazard areas into a "Coastal High-Hazard Zone." Erosion risk would be shared equally among all policyholders in the new combined zone. Alternatively, FEMA could charge rates based on a refined risk classification that separately distinguishes erosion and flood risks. Only those policyholders in erosion hazard areas (about one-third of the coastal high-hazard zone) would be charged an erosion surcharge.

Discussion of Recommendations

Given the magnitude of the risk posed by coastal erosion and the misleading nature of the current "flood only" coastal hazard maps, FEMA should be directed to prepare maps of erosion risks of at least the quality of current flood maps. Ideally, these maps should display both risks and be made available in both paper and electronic forms.

FEMA estimates such maps, covering 12,500 miles of U.S. ocean and Great Lakes shoreline of greatest concern, would cost approximately $44 million—less than $5 million per year over their expected 10-year useful life. While it is difficult to estimate the effect such information would have on future development decisions, the effect would not have to be large to justify the costs. If the availability of erosion maps lowers future damage by just a

few percent, the savings would exceed the costs. Alternative federal erosion-related expenditures are unlikely to be more cost-effective. For example, spending an equivalent amount on beach nourishment would protect roughly another 10 miles of shoreline. And though these funds could be used to further improve existing flood maps, far less information about erosion—a risk about equal to flood in coastal regions—is available.

In addition to the use of erosion maps by individual homeowners and communities, FEMA must have them if they are to include the costs of erosion losses when setting coastal insurance rates. As presented earlier (Table II), FEMA's liability for erosion losses is likely to average $80 million per year without any further development in erosion-prone areas. If erosion hazards are not adequately factored into current flood insurance rates, losses will have to be subsidized by other NFIP policyholders or taxpayers. Losses of this level are a small fraction of the total earned premiums collected nationwide (currently about $1.3 billion per year), but within coastal regions, the percentage is substantial.

Table VI includes estimates of insurance rate increases from several alternative ways to charge policy holders for the cost of erosion damage. By spreading the costs over a newly created Coastal High Hazard Zone, rates for all policy holders in both High Hazard Flood Zones (V-zones) and the 60-year Erosion Hazard Area will rise roughly $.90/year per $100 of coverage. If Congress chooses to extend subsidies to some existing structures (similar to the current flood insurance program, which subsidizes many houses built prior to 1981), those structures would pay increases of about $.35/year per $100 of coverage.

If rate increases are confined to only those structures in the 60-year erosion hazard area, rates would have to rise by roughly $2.45/year per $100 of coverage to fully cover expected losses. Again, if Congress chooses to subsidize some (or all) current policyholders, following the percentages used elsewhere under the program would lead to rate increases of roughly $1.00/year per $100 of coverage.

TABLE VI. Insurance Rate Increases[a]

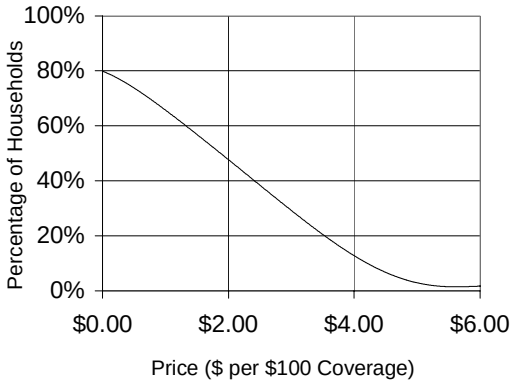
	High Hazard Flood Zone, Not EHA[b]	Erosion Hazard Area	Subsidized Rate
Combined Flood and Erosion Coastal High Hazard Zone	$0.90	$0.90	$0.35
Single Zone Erosion Hazard Area			
0- to 60-year EHA	No increase	$2.45	$0.95
Two Zone Erosion Hazard Area For New Structures			
0- to 20-year EHA	No increase	$11.40	N.A.[c]
20- to 60-year EHA	No increase	$1.75	N.A.

[a] Surcharges are given in dollars per year per $100 of coverage for a 1-4 family residence. Rates for new structures and post-1981 structures are calculated to be revenue neutral within each zone. Assumptions: Federal Insurance Administration (FIA) pays for 85 percent of damage (remainder is wind damage paid for by private insurers); interest rate is 3 percent; FIA overhead is 35 percent; subsidized structures pay 38 percent of post-81 rates.

[b] Erosion hazard area

[c] Not applicable

FIGURE 6. Percentage of households willing to voluntarily purchase erosion policies.



Congress may prefer to treat future construction differently. Unlike the owners of existing houses, builders of new homes can choose where to locate. Congress can give builders of new homes an incentive to build further back from the shoreline within eroding areas by charging higher rates closer to the shore and lower rates further inland. Rate increases are shown for two zones, 0-20 and 20-60 years. Note that rates in the zone closest to the shoreline would have to rise to $11.40/year per $100 of coverage—over 10 percent of the value of the house each year. Rate increases in the zone set back from the shoreline could then be held to a much more modest rate, $1.75/year per $100 of coverage.

The Heinz Center's mail survey of homeowners found that about half of flood policyholders would be willing to buy optional erosion insurance at a cost less than $1-$2/year per $100 of coverage (see Figure 6). However, at rates exceeding $5/year per $100 of coverage, voluntary participation would be quite low. Thus, most of the rate increases shown in Table VI seem within the range of public acceptability. While the rate increase for new construction closest to the shore may at first appear unreasonably high, to many homeowners it may still be preferable to such alternatives as denial of insurance, or outright bans on construction, for such risky locations. Other options for subdividing the erosion hazard area are described in chapter 6 of the report.

About The Heinz Center

The H. John Heinz III Center for Science, Economics and the Environment, a non-profit institution, furthers the work of Senator John Heinz by improving the scientific and economic foundation for environmental policy. The Heinz Center's distinctive contribution is to foster collaboration among industry, environmental organizations, government, and academia. Each of these sectors plays an important role in solving environmental problems, and each must participate in developing robust solutions. The Heinz Center provides an institutionalized venue for these sectors to work together on an array of diverse environmental and natural resource problems.

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Copies of *Evaluation of Erosion Hazards* are available by contacting The Federal Emergency Management Agency. The report is also online at http://www.heinzctr.org

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