The Coastal Barrier Resources Act

Harnessing the Power of Market Forces to Conserve America's Coasts and Save Taxpayers' Money

Division of Federal Program Activities
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Cover photos (clockwise from top left) from the South Florida Water Management District, Corel, National Oceanic and Atmospheric Administration, and SFWMD.

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Executive Summary

Coastal barriers provide many free services that are foundations of a strong economy and healthy environment. They create the back-bay water quality needed to support productive and lucrative fisheries, offer habitat for migratory birds and many at-risk plants and animals, and are also popular vacation destinations and a boon to local economies. Every year, millions of visitors flock to coastal barriers along the Gulf and Atlantic—from Galveston, Texas to Portland, Maine—to enjoy their beautiful beaches, unique dunes and wetlands, and biological diversity.

These characteristics make coastal barriers attractive places to build. Developing them, however, is risky business. Coastal barriers are the first land forms tropical storms strike; they must bear the full force of storm surges and hurricane winds. The constant pounding of waves keeps coastal barriers in flux, losing sand in some places and gaining it in others. Moreover, chronic erosion is a real and growing problem especially in the southeast, rendering development that appeared safe years ago vulnerable to storms today.

Aware of the risk and value of coastal barriers, Congress adopted the Coastal Barrier Resources Act (CBRA) in 1982. The Act is the essence of free-market natural resource conservation; it in no way regulates how people can develop their land, but transfers the full cost from Federal taxpayers to the individuals who choose to build. People can develop, but taxpayers won't pay. By limiting Federal subsidies and letting the market work, the Act seeks to conserve coastal habitat, keep people out of harm's way, and reduce "wasteful" Federal spending to develop—and rebuild again and again—places where storms often strike and chronic erosion is common. This is a classic example of how the Federal government can encourage conservation by simply getting out of the way.

The Act restricted spending within the John H. Chafee Coastal Barrier Resources System, named after the late Senator who was instrumental in shaping the law and a life-long champion of natural resource conservation. In 1982, the System included about 590,000 acres of undeveloped coastal barrier habitat along the Atlantic and Gulf coasts. The undeveloped status of System lands was an important underpinning of the law. The idea was to help steer new construction away from risky, environmentally sensitive places where development was not yet found, not to hurt existing communities where serious commitments of time and money had already been made. Congress

amended the Act in 1990, increasing the size of the System to about 1,326,000 acres and including coastal barriers along the Great Lakes, Puerto Rico, and the Virgin Islands.

Today, 20 years after President Ronald Reagan signed the Act into law, little is known about its precise impacts on taxpayers and development patterns. The Coastal Barrier Resources Reauthorization Act of 2000 directed the U.S. Fish and Wildlife Service to study the results of the law. We were asked to estimate how much money the Coastal Barrier Resources Act has saved taxpayers by restricting Federal spending for roads, wastewater systems, potable water supply, and disaster relief. This study meets this request and shows the market-based law has saved American taxpayers hundreds of millions of dollars, and will continue to save money as long as it exists. We were also asked to examine the Act's most important restriction: the National Flood Insurance Program. We describe the essential relationship between the Act and NFIP in the discussion section of this report.

Methods

Savings from Disaster Relief

To estimate the savings of disaster relief, we examined Federal spending for Presidentially declared disasters from 1988 through 1996. We estimated the Federal spending per developed acre in each disaster area with System units. We then multiplied the cost per acre by an estimate of the number of developed System acres in the disaster area. The product is the savings for the disaster. To estimate future savings, we multiplied the average savings per System acre from 1988 through 1996 by the number of System acres assumed to be developed in the future. This assumes future savings will be like past savings.

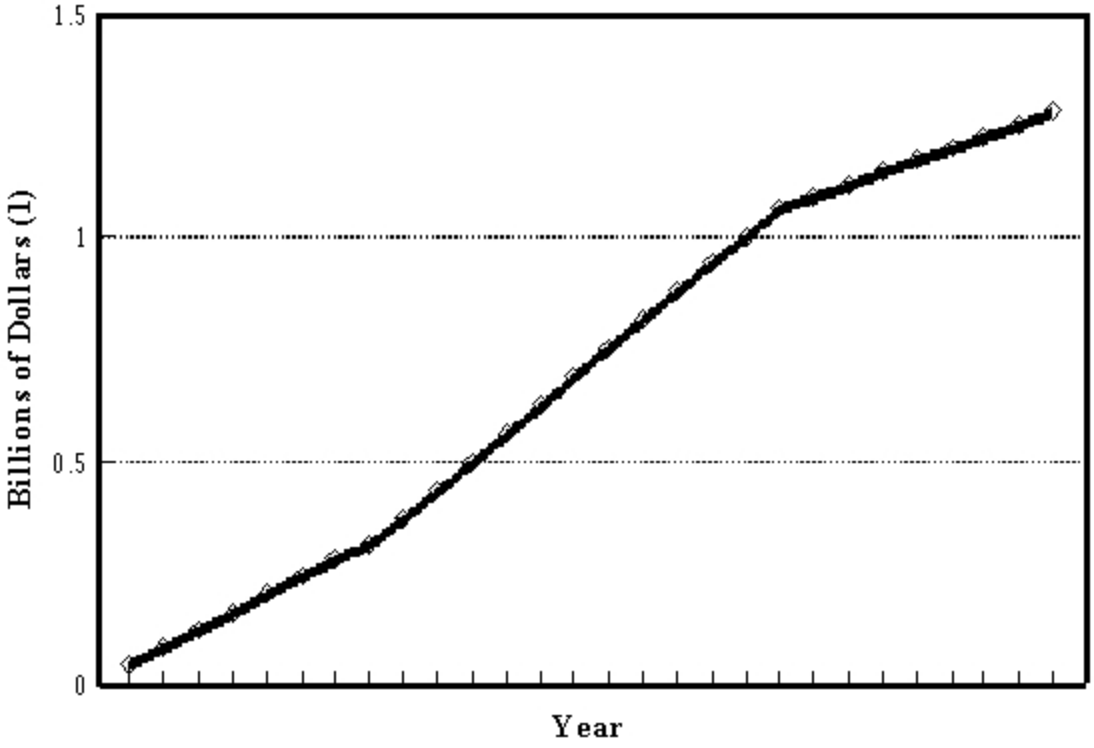
Savings from Infrastructure

We estimated the construction costs of roads, wastewater, and potable water for residential development. To calculate total costs, we multiplied the costs per acre for each type of infrastructure by an estimate of the number of developed System acres. We then estimated the Federal share of these costs through a number of sources, including legislation, government agencies, and other groups.

Results

The graph on the next page shows the cumulative Federal savings from 1983 through 2010. The savings from 1983 through 1996 was about $686,000,000, and the savings from 1997 through 2010 will be about $592,000,000. From 1983 through 2010, over $1,278,000,000 may be saved. In addition, the Act will continue to save Federal dollars as long as it exists. Another $200,000,000 of Stafford Act disaster relief may be saved by 2050.

Federal Savings from the Coastal Barrier Resources Act, 1983-2010



1. In 1996 dollars.

The savings estimated in this study is probably conservative for several reasons. First, the Federal programs Congress directed us to examine comprise but a fraction of the Federal programs, policies, and funding sources that promote, protect, and rebuild development along our coasts. For example, Federal funding for bridges and shoreline stabilization—beach nourishment, jetties, bulkheads, and other structural and non-structural mechanisms—are notable expenses we did not consider. Second, the methods we used to estimate Stafford Act savings assume the cost per developed acre in the entire disaster area is constant, but this is not generally the case. Coastal barriers often experience more damage from hurricanes and other coastal storms because they are made of sand and on the front lines of storm surge. Third, costs for infrastructure did not consider the geology of coastal barriers. It is more expensive to build in these places because they are unstable and flood prone. Fourth, we assumed no construction occurred on wetlands; if 14 percent of System wetlands were developed, the savings calculated in this study would double. Fifth, we only considered initial, on-site construction costs, but did not assess the costs of operating and maintaining infrastructure or connecting development to existing facilities.

Discussion

While it is clear the Act has saved taxpayers' money, it is less clear the Act's other objectives have been met. Congress reasoned the Act's restrictions on Federal funds would result in less development on risky and biologically rich coastal barriers. We know, however, that some System units have developed despite the Act's restrictions. For example, units in Bethany Beach, Delaware, North Topsail Beach, North Carolina, and Cape San Blas, Florida, have developed very much like nearby non-System areas.

Quite simply, where the economic incentive for development is extremely high, the Act's funding limitations can be overcome. Today, System units with significant development appear to be exceptions to the rule. As undeveloped coastal barrier lands become more scarce, however, market forces will overwhelm the Act's financial limitations in many other places. This reality underscores a vital point: *the Act works best when coupled with State and local actions to protect coastal barriers before the economic incentive for development surpasses the law's fiscal disincentive.*

Electronic Governance and Partnerships

Some State and local governments have followed Congress' lead and used their unique tools to bolster the Act's impact. These partnerships can make all the difference. As stated by Salvesen and Godschalk (1998), "Where State and local government actions and policies support the objectives of (the Act), little or no development occurred in the (System). The converse is also true." The Act can better meet its mandate when paired with appropriate State programs, local government zoning regulations, targeted land acquisition, long-term and voluntary conservation easements, or tax relief of some kind.

Texas, for example, prohibits State-backed windstorm insurance in the System, adding another layer of protection to the Act's free-market approach. On Dauphin Island in Alabama, the State's coastal construction control line coincides with the System boundary, and the local government has zoned the entire area for conservation and parkland (Salvesen and Godschalk, 1998). These complementary Federal, State, and local policies have steered development away from the island's west end.

The National Audubon Society, to illustrate another partnership, is buying System lands in North Carolina and will hold them in trust for fish and wildlife in perpetuity. The Act's limitations on Federal spending undoubtedly allowed Audubon's dollar to go much farther, purchasing coastal barrier lands at a comparatively low cost. When our partners augment the Act's market-based approach with their unique tools, all three of the Act's goals are realized: Federal tax dollars are saved, people do not build in the path of hurricanes, and intact habitat for beach enthusiasts, commercial and recreational fisheries, migratory birds, and other fish and wildlife endures.

We can do more to encourage these partnerships. The Internet and advances in electronic governance will be the cornerstones of this effort. The Act is a map-driven law, with limits on Federal spending in areas defined on maps approved by Congress and the Administration. By making the boundaries easily available in a GIS form, the Service could work with its partners to encourage more bundling of conservation programs to meet all of the Act's intentions. State and local governments could integrate Act boundaries into their planning tools and use them to help target their conservation efforts and get more for their money. Digital boundaries will also make other day-to-day activities more efficient. Interested citizens could easily access Act boundaries on the Internet instead of having to wait for official review. Federal agencies responding to a tropical storm or proposing to complete a new project could find out in seconds if the Act's restrictions apply.

The Coastal Barrier Resources Act is poised for a modernization process that expands electronic government, increases customer service, and builds upon the innovative tools used by our partners to conserve America's coasts.

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LIST OF ASSUMPTIONS

- The fastland portion of units in the John H. Chafee Coastal Barrier Resources System would have been completely developed 20 years after it was first designated by Congress.

- The rate of development is constant, with five percent of the fastland acreage developing per year in each county. The exceptions to this rule are counties with less than 400 acres of System fastland. The rate of development in these counties is 20 acres per year until all fastland acres are developed.

- The type of development in the System is residential and the density is five units per acre.

- The number of persons per household is 2.25.

- The lengths of roads, potable water supply lines, and wastewater lines are the same as those identified by the Real Estate Research Corporation in Costs of Sprawl: Environmental and Economic Costs of Residential Development Patterns at the Urban Fringe (1974). Other specifications for infrastructure were obtained from local government and private industry in Florida.

- The level of service for wastewater is 100 gallons per person per day.

- The level of service for potable water is 120 gallons per person per day.

- All wastewater receives secondary treatment based on specifications and cost estimates from the Environmental Protection Agency.

- All potable water receives treatment based on specifications and cost estimates from Culp/Weisner/Culp Engineers.

- The Federal share of road construction is 80 percent as outlined in the Intermodal Surface Transportation Efficiency Act.

- The Federal share of wastewater and potable water construction costs is 10 percent as estimated by the Water Infrastructure Network (2000).

- The amount of Stafford Act disaster relief per developed System acre would have been equal to the amount of disaster relief per developed acre in the State or Territory's entire disaster area.

- The average savings of Stafford Act disaster relief per developed System acre from 1988 through 1996 will characterize System acres from 1997 through 2010.

ACKNOWLEDGMENTS

The Division of Federal Program Activities relied on the economic expertise of many partners to complete this report. In particular, we would like to thank the U.S. Fish and Wildlife Service's Division of Economics for its time, effort, and thoughtful comments and guidance. We also thank the Environmental Protection Agency's Office of Water, the Federal Emergency Management Agency's Readiness, Response, and Recovery Directorate, and the Department of Transportation's Federal Highway Administration for their valuable input.

Introduction

Coastal barriers provide many free services that are foundations of a strong economy and healthy environment. They often help create the back-bay water conditions necessary to support productive and lucrative fisheries—the world class oyster beds of Apalachicola, Florida, are one example. In addition, these migrating strips of sand provide essential habitat for at-risk animals such as piping plovers and sea turtles, which spend a portion of every year on them. Coastal barriers are also popular vacation destinations and a boon to local economies; their beautiful beaches, unique dunes and wetlands, and biological diversity attract millions of visitors every year. Hilton Head, South Carolina, North Carolina's Outer Banks, and Galveston, Texas, are a few examples of popular coastal barrier holiday sites.

The services coastal barriers provide translate into real money for businesses both small and large, as well as tax revenue for local and State governments. The Pew Oceans Commission (2001) recently compiled a number of telling statistics about coastal barriers, other vital parts of the coast, and the fish and wildlife they nurture.

- Travel and tourism is our nation's largest employer and second largest contributor to the GDP, generating over $700 billion every year. Beaches are the leading destination, with coastal States earning 85 percent of all revenues. Approximately 180 million people recreate along our nation's coasts every year.

- More than 17 million Americans fish for fun along our coast each year, spending about $25 billion. In many places, recreational fishing generates more money than commercial fishing.

- Fish and mollusk (clams, oysters, and mussels) farming is booming in the U.S. The value of aquaculture increased from $45 million in 1974 to $978 million in 1998.

- Commercial and recreational fisheries support more than 1.3 million jobs. In 1998, the commercial fishing industry alone delivered 9.2 billion pounds of fish worth $3.1 billion to U.S. ports.

The economic power and natural beauty of coastal barriers make them attractive places to build. Developing coastal barriers, however, is a risky endeavor. Commonly found along the Atlantic and Gulf coasts, they are the first land forms storms strike; coastal barriers must bear the full force

of storm surges and hurricane winds. One strong storm can tear inlets in coastal barriers, completely reshaping them, wreaking havoc on development in the way, and threatening the lives of people trapped in the flooding. In fact, storm surge is the deadliest part of hurricanes and other tropical storms. David Jarvinen from the National Hurricane Center (2002) affirms this: "The greatest potential for loss of life related to a hurricane is from the storm surge." The consistent pounding of waves day after day and periodic severe storms keep coastal barriers in a state of flux, losing sand in some places and gaining it in others. In addition, chronic erosion is a real and increasing problem in many places, rendering development that appeared safe years ago vulnerable to storms today.

Hurricanes—Costly, Predictable, and Deadly

Tropical storm season occurs each year from June through November. Buildings on coastal barriers—and the people who live in them—face heightened risk from high winds and flooding during this time. The following examples begin to illustrate the effects of severe storms (National Hurricane Center, 2002).

- In 1995, Hurricane Opal made landfall near Pensacola Beach, Florida, as a Category 3 hurricane. The storm surge caused extensive damage from Pensacola Beach to Mexico Beach (a span of 120 miles), with a maximum storm tide of 24 feet. Damage estimates for Opal were near $3 billion.

- In 1989, Hurricane Hugo devastated the West Indies and southeastern United States, especially Charleston and Myrtle Beach in South Carolina. In total, Hugo was responsible for 60 deaths and about $7 billion in damage. Its storm surge was nearly 20 feet.

- Hurricane Camille of 1969—a Category 5 storm, the most powerful on the Saffir/Simpson Scale—had maximum winds of more than 200 miles per hour that devastated the Mississippi coast. The combination of winds, surges, and rainfall caused 256 deaths (including 143 along the Gulf coast) and $1.4 billion in damage.

A Free-Market Approach to Coastal Barrier Conservation

Recognizing the risk of developing coastal barriers and their value to local economies and natural resources, Congress adopted the Coastal Barrier Resources Act (CBRA) in 1982. The Act is the essence of free-market natural resource conservation; it in no way regulates how people can develop their land, but transfers the full cost from Federal taxpayers to the individuals who choose to build. People can develop, but taxpayers won't pay. Federal subsidies and other programs—especially the National Flood Insurance Program—are central to the economic

viability of development in high-risk coastal areas. By limiting Federal subsidies and letting the market work, the Act seeks to conserve coastal habitat, keep people out of harm's way, and reduce "wasteful" Federal spending to develop—and rebuild again and again—places where storms often strike and chronic erosion is common.

President Ronald Reagan may have best articulated the Act's approach when he said "This legislation will enhance both wise natural resource conservation and fiscal responsibility. It will save American taxpayers millions of dollars while, at the same time, taking a major step forward in the conservation of our magnificent coastal resources. (The Act) will not prohibit a property owner from building on his property, and it will not impose Federally mandated duties on State or local governments. Instead, it simply adopts the sensible approach that risk associated with new private development in these sensitive areas should be borne by the private sector, not underwritten by the American taxpayer (1982)."

To make this vision work, the Act identified undeveloped coastal barriers along the Atlantic and Gulf coasts and included them in the John H. Chafee Coastal Barrier Resources System—named after the late Senator who was instrumental in shaping the law and a life-long champion of natural resource conservation. The "undeveloped" criterion is an important underpinning of the Act. Areas where significant development was already in place were not included in the System. The idea was to help steer new construction away from risky, environmentally sensitive places where development was not yet found, not to hurt existing communities where serious commitments of time and money had already been made. Undeveloped coastal barriers had a housing density of less than one unit per five acres of "fastland," or land that is considered developable; at least 0.25 miles of shoreline; and no access to potable water supply, roads, electricity, and a wastewater system.

Congress amended the Act in 1990, increasing the size of the System from roughly 590,000 to 1,326,000 acres, and including coastal barriers along the Great Lakes, Puerto Rico, and the Virgin Islands. Wetlands comprise the majority of System acres, and approximately 167,000 of the total are privately owned "fastland." Appendix A lists the fastland acreage in each State and Territory. The Act also affects another 1,838,000 acres of "Otherwise Protected Areas (OPAs)," which are coastal barriers protected by government or private groups. To discourage development of private inholdings, Federal flood insurance is prohibited in OPAs.

Today, 20 years after the Act was passed, little is known about the precise impacts of the law on taxpayers and development patterns. The Coastal Barrier Resources Reauthorization Act of 2000 directed the U.S. Fish and Wildlife Service to study the results of the law. In particular, we were asked to estimate how much money the Coastal Barrier Resources Act has saved taxpayers by restricting Federal spending for roads, wastewater systems, potable water supply, and disaster relief. This study meets this request and sheds some light on the Federal savings from the Act by considering two questions. How much money has the Act saved taxpayers since it was passed in 1982? How much money will it save taxpayers in the near future? We were also asked to

examine the Act's most important restriction: the National Flood Insurance Program. We describe the essential relationship between the Act and NFIP in the discussion section of this report.

The spending examined in this study comprises only a small fraction of the myriad Federal funding sources that encourage development along our nation's coasts. Federal funding for bridges and shoreline stabilization—beach nourishment, jetties, bulkheads, and other structural and non-structural mechanisms—are notable expenses not considered in this analysis. Savings in OPAs are not calculated in this study, in part because the acreage of privately owned inholdings is unknown, and also because Federal flood insurance is the only restriction in these areas.

We organized this study in three sections. The first describes the methods and assumptions we used to estimate taxpayer savings from the Act. Section two presents and explains the results. The final section provides a glimpse of other Federal programs that encourage development, and it also describes the critical relationship of NFIP to the Act. In addition, we briefly look to the future and explain how electronic governance and partnerships can help achieve all three of the Act's intentions. In closing, we briefly highlight opportunities where the Act's free-market approach could be used to meet other conservation, public safety, and fiscal goals. There are other ways the Federal government can encourage conservation simply by reducing its role and letting markets work unfettered.

Methods

Savings —1983-1996

Stafford Act Disaster Relief

After a Presidentially declared disaster, the Federal Emergency Management Agency provides money to help communities rebuild. Most Federal funding for disaster relief is prohibited in the John H. Chafee Coastal Barrier Resources System. Unlike the National Flood Insurance Program, communities located in disaster-prone areas like coastal barriers do not have to pay premiums to obtain relief. Federal taxes fund this assistance. By withholding disaster relief, Congress sought to discourage development by forcing people to bear the full financial risk of their actions.

FEMA monitors the amount of Federal dollars provided after disasters receive a Presidential declaration. Spending data are available by State and Territory for all declared disasters since 1988, the year the Robert T. Stafford Disaster Relief and Emergency Assistance Act was passed. Data are not available for selected geographic areas like coastal barriers. To estimate the savings of Stafford Act disaster relief, we used the methods summarized below. A more detailed explanation of our approach can be found in Appendix B.

FEMA provided total spending data for each Presidentially declared disaster in States and Territories with System units. Table 1 displays the Federal spending in each State and Territory we analyzed in this study. We contacted States and Territories to learn which counties were included in each disaster area. If a disaster did not affect a county with a System unit, it was not examined. When at least one System unit was included in the disaster area, we estimated the total amount of developed land in the area. The total expenditure for the storm was then divided by the developed acreage in the disaster area. The quotient is the cost per developed acre of the disaster. The following example illustrates this methodology.

> In 1996, Hurricane Fran damaged 51 counties in North Carolina. The number of developed acres in this area was 2,170,921. $400,061,602 of Stafford Act relief were provided after the hurricane. $400,061,602 divided by 2,170,921 acres equals about $184/developed acre.

Table 1: Stafford Act Expenditures Analyzed in Each State and Territory (1)

State/ Territory	Infrastructure Expenditures	Human Services Expenditures	Hazard Mitigation Expenditures	Administration Expenditures	Total Expenditures
Alabama	$39,819,380	$2,430,188	$6,779,904	$5,943,267	$54,972,740
Connecticut	$39,614,633	$2,092,940	$712,496	$2,098,326	$44,518,395
Delaware	$15,135,332	$0	$1,431,623	$437,778	$17,004,733
Florida	$1,020,328,836	$197,283,533	$55,382,824	$145,926,401	$1,418,921,594
Georgia	$28,830,776	$4,234,818	$2,051,854	$1,414,658	$36,532,106
Louisiana	$132,795,281	$97,558,979	$21,365,078	$20,947,845	$272,667,184
Maine	$24,697,588	$410,482	$3,654,949	$3,269,902	$32,032,921
Maryland	$34,520,842	$0	$1,687,688	$504,138	$36,712,668
Massachusetts	$123,198,795	$5,064,986	$14,545,573	$9,758,312	$152,567,666
Michigan	$5,564,727	$0	$983,009	$81,941	$6,629,677
Minnesota	$0	$0	$0	$0	$0
Mississippi	$15,961,924	$5,246,423	$1,937,077	$3,204,669	$26,350,093
New Jersey	$85,088,656	$6,051,946	$3,300,453	$9,917,347	$104,358,402
New York	$258,778,240	$8,496,049	$20,955,203	$21,469,380	$309,698,871
North Carolina	$271,252,313	$32,755,216	$87,273,451	$48,125,128	$439,406,107
Ohio	$7,520,139	$1,866,520	$1,456,750	$1,503,898	$12,347,308
Puerto Rico	$71,355,390	$696,079	$39,417,201	$41,181,240	$152,649,911
Rhode Island	$14,434,433	$0	$483,395	$870,038	$15,787,866
South Carolina	$304,329,704	$67,648,513	$14,715,853	$14,896,546	$401,590,615
Texas	$63,313,358	$65,238,925	$24,925,030	$17,615,416	$171,092,729
Virgin Islands	$137,437,730	$47,710,216	$55,116,020	$100,111,580	$340,375,546
Virginia	$24,732,083	$0	$3,452,544	$661,578	$28,846,206
Total	**$2,718,710,161**	**$544,785,814**	**$361,627,977**	**$449,939,387**	**$4,075,063,339**
Percent of Total	**67%**	**13%**	**9%**	**11%**	

Note and Source:

1. All data were obtained from the Federal Emergency Management Agency and are represented in 1996 dollars.

Federal Savings from Stafford Act Disaster Relief

The size of the System has changed over time. Disaster relief was first prohibited in October 1982. In November 1990, after the Act was amended, disaster relief was prohibited throughout the expanded System. Table 2 lists the acreage of System fastland in each State and Territory before and after the amendment. Appendix A presents the fastland acreage in the System by county and year.

Recall that System units met criteria for "undeveloped" when they were created by the Act. In order to compute the savings from the law, it was necessary to estimate the amount of development that would have occurred in the System in the absence of the Act. This study assumes all fastland acres in the System would have been developed in 20 years. To achieve this, we assume a development rate five percent per year. For example, if 1,000 System acres were included in a county in 1982, then in 1983, 50 acres would be developed. After five years, 250 would be developed, and the entire 1,000 acres would be developed within 20 years. The exceptions to this rule are counties with less than 400 System acres. The development rate for these counties is assumed to be 20 acres per year. Tables 3 and 4 list our development assumptions for each State and Territory from 1983 through 1996. Appendix C provides this information for each county.

We multiplied the amount of System acres assumed to be developed in each disaster area by the total expenditure per developed acre for the disaster in the State or Territory. The product is the savings for the disaster. In essence, developed acres in the System are assumed to have the same cost per acre damage as the entire disaster area. Appendix D lists the savings for each disaster from 1988 through 1996. The following example illustrates this methodology.

> When Hurricane Fran struck North Carolina, we estimate 2,629 System acres would have been developed in the disaster area. 2,629 acres multiplied by $184/acre equals about $485,000. The savings from Hurricane Fran in North Carolina was $485,000.

Development Assistance

Various Federal programs subsidize or promote development. Examples of Federal incentives include home and small business loans, erosion control projects, and other infrastructure subsidies. This section considers Federal subsidies for roads, wastewater, and potable water.

To calculate savings in the System from infrastructure assistance, it was necessary to develop hypothetical development patterns. What will be the housing density? How many feet of roads are found in a development? What percentage of the costs does the Federal government pay? One helpful study is Costs of Sprawl (1974), which assessed the costs of development patterns with varying size and density. One of the development patterns considered a housing density of five units per acre, and discussions with local planning departments suggested this density

Table 2: Total Fastland Acres in the System in Each State and Territory (1)

State -- Territory	System Acres 10-18-82	System Acres 11-16-90
Alabama	2,940	5,699
Connecticut	333	943
Delaware	517	589
Florida	20,891	41,106
Georgia	5,126	5,069
Louisiana	4,518	8,626
Maine	486	1,191
Maryland	0	1,015
Massachusetts	3,872	7,509
Michigan	0	4,924
Minnesota	0	217
Mississippi	557	422
New Jersey	0	1,182
New York	1,131	10,488
North Carolina	8,610	8,009
Ohio	0	2,021
Puerto Rico	0	5,366
Rhode Island	1,058	1,739
South Carolina	4,379	10,216
Texas	47,024	47,834
Virgin Islands	0	636
Virginia	1,148	1,389
Wisconsin	0	614
Total=	**102,590**	**166,803**

Source:
1. Data were obtained from the U.S. Fish and Wildlife Service.

Table 3: Assumed Developed System Acres by State and Territory, 1983-1989 (1)

State -- Territory	Developed System Acres 1983 (2)	Developed System Acres 1984 (2)	Developed System Acres 1985 (2)	Developed System Acres 1986 (2)	Developed System Acres 1987 (2)	Developed System Acres 1988 (2)
Alabama	147	294	441	588	735	882
Connecticut	75	135	195	232	252	272
Delaware	40	80	120	160	200	280
Florida	1,198	2,382	3,536	4,631	5,709	6,763
Georgia	256	513	769	1,025	1,282	1,538
Louisiana	257	513	770	1,025	1,262	1,486
Maine	100	200	284	344	404	437
Maryland						
Massachusetts	221	439	656	873	1,091	1,294
Michigan						
Minnesota						
Mississippi	43	86	129	172	214	237
New Jersey						
New York	57	113	170	226	283	339
North Carolina	457	914	1,371	1,829	2,286	2,743
Ohio						
Puerto Rico						
Rhode Island	54	107	161	215	268	322
South Carolina	229	457	686	915	1,144	1,372
Texas	2,351	4,702	7,054	9,405	11,756	14,107
Virgin Islands						
Virginia	66	132	197	263	329	395
Wisconsin						
Total =	**5,551**	**11,068**	**16,540**	**21,903**	**27,214**	**32,467**

Notes and Source:

1. System acreage data were obtained from the U.S. Fish and Wildlife Service.

2. Developed System Acres assumes that the fastland System acres will be developed entirely in 20 years. The development rate is assumed to be constant, with five percent of the initial total System acres being developed per year. Counties with less than 400 System acres are assumed to develop at a rate of 20 acres per year until all fastland acres are developed.

Table 4: Assumed Developed System Acres by State and Territory, 1990-1996 (1)

State – Territory	Developed System Acres 1990 (2)	Developed System Acres 1991 (2)	Developed System Acres 1992 (2)	Developed System Acres 1993 (2)	Developed System Acres 1994 (2)	Developed System Acres 1995 (2)	Developed System Acres 1996 (2)
Alabama	1,176	1,461	1,746	2,031	2,316	2,601	2,886
Connecticut	312	352	409	451	493	535	577
Delaware	322	323	346	370	393	417	440
Florida	8,813	10,946	13,086	15,216	17,304	19,355	21,317
Georgia	2,051	2,304	2,557	2,811	3,064	3,318	3,571
Louisiana	1,919	2,254	2,696	3,138	3,580	4,022	4,451
Maine	477	584	674	754	834	914	980
Maryland		140	249	324	384	444	504
Massachusetts	1,689	2,078	2,463	2,849	3,234	3,607	3,973
Michigan		461	876	1,255	1,594	1,913	2,207
Minnesota		20	40	60	80	100	120
Mississippi	282	299	319	339	359	379	399
New Jersey		116	232	347	453	543	619
New York	452	1,045	1,606	2,133	2,659	3,185	3,711
North Carolina	3,604	3,193	3,599	3,994	4,380	4,765	5,151
Ohio		101	202	303	404	505	606
Puerto Rico		268	537	805	1,073	1,341	1,610
Rhode Island	429	516	603	690	777	864	951
South Carolina	1,830	2,341	2,851	3,362	3,873	4,384	4,895
Texas	18,809	20,419	22,794	25,157	27,520	29,860	32,165
Virgin Islands		60	113	153	193	233	273
Virginia	527	687	835	940	1,034	1,114	1,194
Wisconsin		80	160	240	318	367	407
Total =	**42,692**	**50,047**	**58,993**	**67,720**	**76,317**	**84,765**	**93,006**

Notes and Source:

1. System acreage data were obtained from the U.S. Fish and Wildlife Service.

2. Developed System Acres assumes that the fastland System acres will be developed entirely in 20 years. The development rate is assumed to be constant, with five percent of the initial total System acres being developed per year. Counties with less than 400 System acres are assumed to develop at a rate of 20 acres per year until all fastland acres are developed.

is fairly common on coastal barriers. In addition, we used some other assumptions in Costs of Sprawl such as the length of roads and utilities to help create our development patterns. Appendix B offers a detailed explanation of our methods.

Federal Savings from Roads

Although Costs of Sprawl provides reasonable estimates for the length of roads, other road specifications and cost estimates do not reflect current practices. We updated the study with information on arterial and collector roads found in Martin County, Florida's Subdivision Regulations (Martin County Code. Chapter 30.5, Section 30.5-19 to 30.5-60). Costs were obtained from the Martin County Engineering Department's 1994/1995 Annual Contract, which contains costs for projects the county will complete within the year. Table 5 lists the cost per acre of roads. A detailed explanation of our methods can be found in Appendix B.

As outlined in the Intermodal Surface Transportation Efficiency Act, we assume the Federal government pays 80 percent of road construction costs. Arterial and collector roads are evaluated in this study, but residential roads are not because the Federal government generally does not help fund them. The Federal savings for constructing roads is: (road cost per acre) x (total acres of developed System fastland from 1983 through 1996) x (80 percent). We understand this analysis provides a broad generalization that could vary dramatically from place to place. In some cases, the length of roads per acre may be much greater and the costs more significant. In others, no Federal funds may be used for collector roads, resulting in more modest Federal costs.

Federal Savings from Wastewater and Potable Water

To estimate wastewater and potable water costs, we considered the capital costs of constructing treatment facilities along with the pipes and other systems needed to transport wastewater and potable water within a five unit per acre development. Pipe mix assumptions were derived from Costs of Sprawl and information provided by Kimley-Horn, a development consulting firm in south Florida. Costs and levels of service requirements were obtained from Kimley Horn, Martin County, and other sources. A detailed explanation of our methods is available in Appendix B.

To estimate the cost of wastewater treatment, we used an EPA (1980) document entitled Construction Costs for Municipal Wastewater Treatment Plants: 1973-1978. We used a study entitled Estimations of Small System Water Treatment Costs (Culp/Wesner/Culp Engineers, 1983) to estimate the cost per gallon per day of installed potable water treatment capacity. Tables 6 and 7 show the costs per acre of wastewater and potable water supply.

It is very difficult to generalize the Federal share of total wastewater and potable water spending along the coast. Various Federal agencies and programs provide some funds for infrastructure, and the amount given by each varies greatly (Congressional Research Service, 2002). One of the largest Federal sources of funding is the Environmental Protection Agency's State Revolving Loan Fund, which has programs for both wastewater and potable water supply. In fiscal year 2002, the Federal appropriation for the wastewater portion of SRF was $1.35 billion. The Federal appropriation for the potable water part was $825 million in the same year.

Table 5: Cost Per Acre of Roads (1)

	5 Units/Acre
Arterial	$1,905
Collector	$2,702
Clearing and Grubbing	$210
Seeding and Mulching	$92
Subtotal	$4,817
Profit, Overhead, and Engineering	$1,204

Total Per Acre Capital Cost --
Roads **$6,022**

Table 6: Cost Per Acre of Wastewater (1)

	5 Units/Acre
Pipeline	$4,636
Manholes	$900
Lift Stations	$975
Connection Cost	$563
Subtotal	$7,074
Profit, Overhead, and Engineering	$1,768
Treatment	$8,347

Total Per Acre Capital Cost --
Wastewater Infrastructure **$17,189**

Table 7: Cost Per Acre of Potable Water Supply (1)

	5 Units/Acre
Pipeline	$2,434
Hydrants	$286
Connection Cost	$725
Subtotal	$3,446
Profit, Overhead, and Engineering	$861
Treatment	$1,962

Total Per Acre Capital Cost --
Potable Water Supply **$6,270**

Notes:
1. All monetary values are represented in 1996 dollars.
Detailed versions of these tables with methods and sources can be found in Appendix B.

The Water Infrastructure Network (2000) estimated local versus Federal wastewater and potable water capital investments nationwide from 1980 to 1994. The Federal share of the total ranged from over 50 percent in 1980 to about 20 percent in each year from 1987 to 1994. WIN states "Federal contributions . . . have declined by 75 percent in real terms since 1980 and today represent only about 10 percent of total capital outlays for water and wastewater infrastructure."

For this study, we assume the Federal share of wastewater and potable water spending is 10 percent. We understand this number is a broad generalization that varies tremendously from place to place. In some cases, coastal areas may have developed with little or no Federal assistance, and in others the contribution may have been much greater. The Federal savings for constructing wastewater infrastructure is: (wastewater cost per acre) x (total acres of developed System fastland from 1983 through 1996) x (10 percent). The Federal savings for constructing potable water infrastructure is: (potable water cost per acre) x (total acres of developed System fastland from 1983 through 1996) x (10 percent).

Savings—1997-2010

This study assumes the System develops at a rate of five percent per county per year or 20 acres per county per year, whichever is greater. At this rate, System fastland will be completely developed in 2010. Table 8 lists our development assumptions from 1997 to 2010.

Stafford Act Disaster Relief

Future savings were estimated using the Stafford Act data examined in the previous section. After we computed the savings in each year, we calculated the average savings per developed System acre for each year from 1983 through 1996. We then averaged these figures, providing an average savings per developed acre per year over the entire period. This value was multiplied by the assumed number of developed System acres in each year from 1997 through 2010. The sum of each of the products is the estimated savings of disaster relief from 1997 through 2010.

Development Assistance

To estimate the future savings of development assistance, we used the costs per acre derived in the previous section. Each cost per acre was multiplied by the amount of development assumed to occur from 1997 through 2010. This study assumed 93,006 System acres were developed by 1996. The System includes a total of 166,803 fastland acres; with the development rate used in this study, an additional 73,796 acres (166,802.55 minus 93,006.21) will be developed from 1997 through 2010. The savings from 1997 through 2010 is 73,796 acres multiplied by the costs per acre and Federal shares presented in the previous section.

Table 8: Assumed Developed System Acres, 1997-2010 (1)

Developed System Acres 1997	Developed System Acres 1998	Developed System Acres 1999	Developed System Acres 2000	Developed System Acres 2001	Developed System Acres 2002	Developed System Acres 2003
101,123	109,114	116,995	124,752	132,430	139,756	143,326

Developed System Acres 2004	Developed System Acres 2005	Developed System Acres 2006	Developed System Acres 2007	Developed System Acres 2008	Developed System Acres 2009	Developed System Acres 2010
146,847	150,293	153,685	157,018	160,298	163,564	166,803

Notes and Sources:

1. System acreage data were obtained from the U.S. Fish and Wildlife Service. Developed System Acres can be found for each year by State and Territory in Appendix C.

2. Developed System Acres assumes that the fastland System acres will be developed entirely in 20 years. The development rate is assumed to be constant, with five percent of the initial total System acres being developed per year. Counties with less than 400 System acres are assumed to develop at a rate of 20 acres per year until all fastland acres are developed.

Results

Savings—1983-1996

From 1983 through 1996, the combined savings of Stafford Act disaster relief and development assistance is about $686,000,000. Federal savings for development assistance comprises about 97 percent of the total. Tables 9, 10, and 11 present the total savings from 1983 through 1996.

The total savings of Stafford Act disaster relief in the System is about $20,130,000. Table 12 shows the savings in each State and Territory since the Stafford Act was passed in 1988. From 1988 through 1996, the average savings per developed System acre is $32.47 (Table 13). The savings in Florida is about 40 percent of the total. A large portion of this savings, about $5,760,000, was from Hurricane Andrew. The next highest savings in Florida was $1,170,000 from Hurricane Opal. Appendix D lists calculations of savings from disasters by State, Territory, and year.

The Virgin Islands recorded the second highest savings from Stafford Act disaster relief. Almost $4,970,000 was saved, which is notable because the Virgin Islands were not included in the System until November 1990. Moreover, the Virgin Islands have 636 System fastland acres; only four other States and Territories have fewer. Together, the savings in Florida and the Virgin Islands comprises about 65 percent of the total.

New York, Texas, and Louisiana each had savings greater than $1,000,000, and five States and Puerto Rico had savings between $100,000 and $1,000,000. Ten States had savings between $0 and $100,000. Wisconsin and Minnesota had no savings because no Presidentially declared disaster struck the System between November 1990 and December 1996.

The savings for development assistance is about $666,000,000 (see Table 14). The Federal share for roads is about $448,000,000 and 67 percent of the total. The next greatest Federal share is about $160,000,000 for wastewater, followed by potable water at about $58,000,000. The Federal cost per developed acre is $7,163.

Table 9: Savings of Stafford Act Disaster Relief, 1988-1996 (1)

Federal Funds	Total Savings 5 Units/Acre
Stafford Act Disaster Relief, 1988-1996	$20,130,517

Stafford Act Disaster Relief -- Total Savings **$20,130,517**

Table 10: Savings of Development Assistance, 1983-1996 (1)

Federal Funds	Total Savings 5 Units/Acre
Development Assistance – Roads	$448,046,944
Develpment Assistance – Potable Water	$58,312,196
Development Assistance -- Wastewater	$159,867,367

Development Assistance – Total Savings **$666,226,507**

Table 11: Total Savings, 1983-1996 (1)

Federal Funds	Total Savings 5 Units/Acre
Development Assistance	$666,226,507
Stafford Act Disaster Relief	$20,130,517

Total = **$686,357,024**

Note:

1. All monetary values are represented in 1996 dollars.

Table 12: Stafford Act Savings by State and Territory and Year, 1988-1996 (1)

State--Territory	Savings 1988	Savings 1989	Savings 1990	Savings 1991	Savings 1992	Savings 1993	Savings 1994	Savings 1995	Savings 1996
Alabama	$0	$0	$0	$0	$0	$0	$0	$129,008	$0
Connecticut	$0	$1,297	$0	$5,439	$8,488	$514	$0	$0	$5,712
Delaware	$0	$0	$0	$0	$4,992	$4,445	$17,720	$0	$10,523
Florida	$0	$0	$8,807	$0	$5,817,736	$204,956	$289,722	$1,742,287	$13,114
Georgia	$0	$0	$0	$0	$0	$35,862	$24,671	$0	$0
Louisiana	$0	$1,323	$0	$33,783	$419,896	$3,231	$0	$690,484	$0
Maine	$0	$1,851	$0	$29,487	$3,706	$2,869	$0	$0	$30,782
Maryland	$0	$0	$0	$0	$0	$2,895	$7,743	$0	$10,224
Massachusetts	$0	$0	$0	$310,896	$81,264	$3,396	$0	$0	$195,891
Michigan	$0	$0	$0	$0	$0	$0	$7,397	$0	$0
Minnesota	$0	$0	$0	$0	$0	$0	$0	$0	$0
Mississippi	$0	$0	$5,364	$7,721	$0	$0	$0	$13,743	$0
New Jersey	$0	$0	$0	$0	$60,494	$255	$0	$0	$45,251
New York	$0	$0	$0	$266,825	$643,852	$7,093	$0	$330,815	$423,288
North Carolina	$0	$0	$0	$0	$0	$10,809	$0	$0	$663,795
Ohio	$0	$0	$0	$0	$1,564	$0	$0	$718	$0
Puerto Rico	$0	$0	$0	$0	$31,456	$0	$0	$61,589	$382,292
Rhode Island	$0	$0	$0	$41,361	$0	$995	$0	$0	$14,548
South Carolina	$0	$324,867	$0	$0	$0	$0	$0	$0	$0
Texas	$35,439	$56,825	$59	$706,109	$0	$0	$834,854	$0	$0
Virgin Islands	$0	$0	$0	$0	$0	$0	$0	$4,738,650	$229,593
Virginia	$0	$0	$0	$0	$0	$0	$7,880	$0	$0
Wisconsin	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total =	**$35,439**	**$386,164**	**$14,231**	**$1,401,621**	**$7,073,449**	**$277,320**	**$1,189,988**	**$7,707,292**	**$2,045,014**

Note:

1. All monetary values are represented in 1996 dollars.

Table 13: Savings Per Developed System Acre of Stafford Act Disaster Relief, 1988-1996 (1)

	1988	1989	1990	1991	1992	1993	1994	1995	1996
Savings from CBRA	$35,439	$386,164	$14,231	$1,401,621	$7,073,449	$277,320	$1,189,988	$7,707,292	$2,045,014
Developed System Acres (2)	32,467	37,600	42,692	50,047	58,993	67,720	76,317	84,765	93,006
Savings/Developed System Acre	$1.09	$10.27	$0.33	$28.01	$119.90	$4.10	$15.59	$90.93	$21.99

Average Annual Savings/Developed System Acre (3) = $32.47

Notes:

1. All monetary values are represented in 1996 dollars.

2. Developed Affected Acres assumes that the all System fastland acres will be developed entirely in 20 years. The development rate is assumed to be constant, with five percent of the initial total System acres being developed per year. Counties with less than 400 affected acres are assumed to develop at a rate of 20 acres per year until all fastland acres are developed.

3. Average Annual Savings/Developed System Acre = (Savings/Developed System Acre, 1988-1996)/9 years.

Table 14: Savings of Development Assistance in the System, 1983-1996 (1)

	Fastland Acres (2)	Cost/Acre 5 Units/Acre	Total Cost 5 Units/Acre
Roads	93,006	$6,022	$560,058,680
Federal Share (3)			$448,046,944
Potable Water Supply	93,006	$6,270	$583,121,957
Federal Share (4)			$58,312,196
Wastewater	93,006	$17,189	$1,598,673,671
Federal Share (5)			$159,867,367
Total Federal Share			**$666,226,507**
Federal Share/Acre			**$7,163**

Notes and Sources:

1. All monetary values are represented in 1996 dollars.
2. It is assumed 93,006 total fastland acres in the System would have been developed by 1996.
3. The Federal share of road construction is assumed to be 80 percent as outlined in the Intermodal Surface Trasportation Efficiency Act.
4. The Federal share of potable water supply is assumed to be 10 percent as estimated by the Water Infrastructure Network.
5. The Federal share of wastewater is assumed to be 10 percent as estimated by the Water Infrastructure Network.

Savings—1997-2010

From 1997 through 2010, the combined savings of Stafford Act disaster relief and development assistance is about $592,000,000. Development assistance is the overwhelming majority at about 89 percent of the total. Table 15 presents the savings from 1997 to 2010.

The savings of Stafford Act disaster relief from 1997 through 2010 is about $64,000,000. Tables 16 and 17 present the savings of disaster relief from 1997 through 2010. The savings for development assistance is $529,000,000 for the period (see Table 18). The Federal savings for roads was the greatest, followed by wastewater and potable water, respectively. Roads and wastewater comprise about 91 percent of development assistance. The Federal cost of development assistance per developed acre is $7,163.

Savings—1983-2010

From 1983 through 2010, the combined savings of Stafford Act disaster relief and development assistance is about $1,279,000,000. Development assistance comprises about 93 percent of total savings. Tables 19 and 20 present our total savings estimates.

Perspective on Our Results

Stafford Act Disaster Relief

Savings of Stafford Act disaster relief can vary dramatically from year to year and place to place. Recall the savings from Hurricane Andrew is substantial; this is a function of the storm's small impact area, the intensity of the storm, the high level of structural damage, and the significant amount of System acreage in the area. If any one of these factors is different, the savings calculated in this study could be less significant.

The savings estimated in the System from the Stafford Act is probably conservative because we assume uniform damage across counties in the disaster area. In some cases, coastal barriers may not have been affected by a specific disaster; however, in many cases they were more damaged than inland locations. Hurricane Fran, for example, extensively damaged North Carolina's coastal barriers, suggesting the cost per developed acre was significantly higher than the $184 calculated in this study. To again illustrate this point, consider the following scenario. A tropical storm in Louisiana causes $100,000,000 in damages. Ten counties declared for disaster relief, two of which are on the coast. About 70 percent of the damages, however, occurred in the coastal counties. This method treats all counties in the disaster area equally when this is unlikely the case.

Table 15: Total Savings in the System, 1997-2010 (1)

	Total Savings 5 Units/Acre
Development Assistance	$528,621,478
Stafford Act Disaster Relief	$63,830,786

Total = **$592,452,264**

Note:

1. All monetary values are represented in 1996 dollars.

Table 16: Savings of Stafford Act Disaster Relief, 1997-2004 (1)

	Total 1997	Total 1998	Total 1999	Total 2000	Total 2001	Total 2002	Total 2003	Total 2004
Developed System Acres (2)	101,123	109,114	116,995	124,752	132,430	139,756	143,326	146,847
Stafford Act Disaster Relief (3)	$3,283,176	$3,542,622	$3,798,510	$4,050,357	$4,299,655	$4,537,494	$4,653,414	$4,767,705

Table 17: Savings of Stafford Act Disaster Relief, 2005-2010 (1)

	Total 2005	Total 2006	Total 2007	Total 2008	Total 2009	Total 2010		Total 1997-2010
Developed System Acres (2)	150,293	153,685	157,018	160,298	163,564	166,803		
Stafford Act Disaster Relief (3)	$4,879,593	$4,989,747	$5,097,961	$5,204,438	$5,310,491	$5,415,623		$63,830,786

Notes:

1. All monetary values are represented in 1996 dollars.

2. Developed Affected Acres assumes all System fastland acres will be developed entirely in 20 years. The development rate is assumed to be constant, with five percent of the initial total System acres being developed per year. Counties with less than 400 affected acres are assumed to develop at a rate of 20 acres per year until all fastland acres are developed.

3. Savings – Stafford Act Disaster Relief = Developed System Acres * $32.47. Recall from Table 13 that $32.47 is the Average Annual Savings of Stafford Act Disaster Relief/Developed System Acre.

Table 18: Savings of Development Assistance in the System, 1997-2010 (1)

	Fastland Acres(2)	Cost/Acre 5 Units/Acre	Total Cost 5 Units/Acre
Roads	73,796	$6,022	$444,381,969
Federal Share (3)			$355,505,575
Potable Water Supply	73,796	$6,270	$462,681,667
Federal Share (4)			$46,268,167
Wastewater	73,796	$17,189	$1,268,477,358
Federal Share (5)			$126,847,736
Total Federal Share			**$528,621,478**
Federal Share/Acre			**$7,163**

Notes and Sources:

1. All monetary values are represented in 1996 dollars.

2. It is assumed that 166,803 fastland acres in the System would have been developed by 2010.

3. The Federal share of road construction is assumed to be 80 percent as outlined in the Intermodal Surface Trasportation Efficiency Act.

4. The Federal share of potable water supply is assumed to be 10 percent as estimated by the Water Infrastructure Network.

5. The Federal share of wastewater is assumed to be 10 percent as estimated by the Water Infrastructure Network.

Table 19: Total Savings in the System, 1983-1996 (1)

	Total Savings 5 Units/Acre
Development Assistance	$666,226,507
Stafford Act Disaster Relief	$20,130,517

Total = $686,357,024

Table 20: Total Savings in the System, 1997-2010 (1)

	Total Savings 5 Units/Acre
Development Assistance	$528,621,478
Stafford Act Disaster Relief	$63,830,786

Total = $592,452,264

Total Combined Savings 1983-2010 = $1,278,809,288

Federal Savings/Acre (2) = $7,667

Note:

1. All monetary values are represented in 1996 dollars.

2. Federal Savings/Acre = (Total Combined Savings 1983-2010)/(166,802.55 Acres).

Another related problem is found within individual counties. Assume, for example, that one coastal county in North Carolina was declared a disaster area and received $3,000,000 of relief in 1996. The greatest losses occurred near the coast, especially to roads that were inundated by storm surge. The methods used in this study would have diluted the cost per acre significantly, because the entire developed acreage in the county would have been the denominator, rather than the actual acreage of the flooded area. If the developed area in the county is 50,000 acres, the cost per developed acre calculated in this study would have been $3,000,000 divided by 50,000 acres, or $60 per acre. If the actual flooded area was 1,000 acres, the cost per acre was really $3,000.

On the other hand, however, our methods tended to overestimate the savings in one way. We used statewide estimates of developed land to estimate the amount of developed land in disaster areas. The problem with this is disaster areas generally include a high number of coastal counties with a high proportion of State populations and related development. This suggests our estimates were too low for many of the disaster areas. In such cases, the expenditures in the disaster area were divided by a denominator that was too small, inflating the cost per acre estimates.

Our methods also assume no Stafford Act dollars were spent in the System (with a few minor exceptions). Some parts of the System could have been developed before the Act was adopted, and this development could be eligible for disaster relief. Recall, however, that the initial threshold for including land in the System was either a density of less than one structure per five acres of fastland or access to roads, potable water, wastewater, and electricity. Federal spending is probably not significant because of this threshold.

Development Assistance

The Federal costs calculated for development assistance may also be conservative. The cost factors we used did not consider the geology of coastal barriers, and constructing infrastructure in sandy soils requires more reinforcement. However, this study did not consider less costly forms of treatment such as septic tanks, which tended to inflate the estimates.

Another problem is the calculations for roads, potable water supply, and wastewater consider only on-site construction costs; they do not include the costs of connecting new infrastructure to existing infrastructure. For example, a new subdivision development on a coastal barrier may require that one mile of road be constructed to connect it to existing transportation routes. Water lines and wastewater pipes would also have to be extended over that distance. The costs of this can be high, and the savings could be substantial if the infrastructure passes through land in the System. In addition, we did not calculate the costs for maintaining infrastructure. These costs are significant over time, especially in areas like coastal barriers where costs are probably higher than in less dynamic areas.

Other Considerations

The development rate we used in this study is an estimate; it is unknown if the System would have developed in 20 years. Some areas probably would have developed sooner, and others may not have developed at all. It is clear, however, that many parts of the Atlantic and Gulf coasts are growing rapidly today, and much faster than inland areas. For example, between 1991 and 1994 the number of new housing units permitted in Florida's coastal counties increased from 70,938 to 100,415 (Bureau of Economic and Business Research, 1996). In comparison, the number of permits in non-coastal counties decreased from 24,436 to 14,718.

Moreover, development pressure is expected to increase along the coast. As stated by the National Oceanic and Atmospheric Administration (1998), "coastal areas are the most developed in the nation. This narrow fringe comprising 17 percent of the contiguous U.S. land area is home to more than 53 percent of the nation's population. Further, this coastal population is increasing by 3,600 people per day, giving a projected total increase of 27 million people between now and 2015." It is reasonable to suggest the coastline will continue to grow disproportionately, although the precise rate of development and the variance among counties, States, and Territories are unknown.

Another important point about our methods is we assumed development occurred only on fastland, which is mostly uplands. The acreage of wetlands in the System is significantly greater. Although wetlands are protected by a number of Federal, State, and local laws and regulations, some probably would be filled over time, suggesting the savings we calculated is conservative. For example, if we assumed 14 percent of System wetlands were developed, the savings would double. This is undoubtedly a high estimate but it sheds light on possible additional savings not captured in this study.

Yet another important consideration is we only estimated the savings from 1983 through 2010. Assuming that the Coastal Barrier Resources Act endures, savings will increase every time a storm strikes. Recall this study estimated a Stafford Act savings of $5,000,000 in 2010, the year the System is assumed to be built out. If future Stafford Act expenditures are similar to those from 1983 through 1996, then about $5,000,000 will be saved every year after 2010. Another $200,000,000 could be saved by 2050.

A shortcoming of this study is its rather narrow focus; we only examined a few of the many Federal programs that promote development. A complete analysis of all Federal programs would undoubtedly yield significantly greater savings. Some of these programs are introduced in the next section.

Discussion

This study posed two questions. First, how much money has the Act saved Federal taxpayers since it was ratified? Second, how much money will the Act save taxpayers in the near future? This study estimates that $686,000,000 was saved from 1983 through 1996, and projects a combined savings of $1,279,000,000 by 2010. Several observations follow.

This study estimated the savings from a few Federal programs by the Coastal Barrier Resources Act. While the estimate is substantial, a complete analysis of all Federal funds available for development and disaster relief would yield much greater amounts. Funding for bridge construction, beach nourishment, and other types of erosion control is significant, and Federal outlays for these activities may increase in the future as erosion threatens development. Table 21 lists examples of Federal programs not examined in this study that are prohibited by the Act.

Table 21: Examples of Federal Assistance Prohibited by the Act

Agency	Type of Assistance
Farm Service Agency	Community Facility Loans
	Business/Industry Loans
	Rural Housing Loans
Small Business Administration	Small Business Loans
	Disaster Assistance Loans
U.S. Army Corps of Engineers	Beach Nourishment and Erosion Control
	Dredging Ship Canals
Federal Highway Administration	Funding for Bridges
Rural Electrification Administration	Electrical Systems Loans

Source:

U.S. General Accounting Office, 1992. Coastal Barriers: Development Occurring Despite Prohibitions Against Federal Assistance. Washington, DC: General Accounting Office.

The National Flood Insurance Program

One Federal program restricted by the Act probably yields no Federal taxpayer savings, yet it is without a doubt the most important deterrent to development in the System. The National Flood Insurance Program, a part of FEMA, offers insurance to communities that adopt a series of flood management protocols. NFIP works closely with local and State governments to ensure at-risk development is properly elevated and constructed with flood-resistant materials. Citizens within communities that adopt the provisions can acquire flood insurance through NFIP, which generally offers policies below private-market rates.

By law, NFIP is expected to base its rates on sound, risk-based market analyses. In other words, the program is required to be self-sufficient, with income from policy holders exceeding expenses. NFIP meets this requirement most of the time. In years it does not, the shortfalls are primarily caused by old structures that were grandfathered into the program before risk-based floodplain mapping and rating were completed in 1983. NFIP is exploring ways to eliminate these periodic shortfalls.

A significant portion of System lands falls within NFIP's V and A zones, which are the flood areas with the highest risks. NFIP charges its highest premiums in these zones, reflecting the risk-based accounting strategy mandated by law. Through NFIP, an owner with a single family home in a V zone can acquire $250,000 worth of structural coverage, and another $100,000 worth of coverage for furniture and other belongings, for about $1,000 to $1,500 per year. Private-market premiums dwarf NFIP's rates; anecdotal evidence suggests yearly premiums through a bank such as Lloyd's of London range anywhere from $2,500 to $7,500. Moreover, unlike NFIP, private-market insurance is often encumbered by high deductibles and can be canceled with little warning. Private market flood insurance is far more costly and insecure, and some coastal barriers are so risky that insurance companies will not offer flood insurance for any price. Most mortgages in high-risk areas require flood insurance as a safety net, therefore undeveloped coastal barriers that are uninsurable by both the private sector and Federal government will likely remain undeveloped.

As the agency charged with implementing the Act, the U.S. Fish and Wildlife Service has first-hand experience with NFIP and its impact on development in the System. Without question, NFIP is the most controversial restriction. This is because flood insurance is a cost that is paid in full each year by individual households. For example, if an NFIP policy in the V zone is $1,500 per year and private-market insurance is $5,500 per year, a land owner in the System will have to pay $4,000 more per year than a land owner outside of the System. Over a 30-year mortgage, the total difference is $120,000. In the most risky places, land owners may be unable to find private flood insurance even for this exuberant price. Other restrictions on Federal funding, such as infrastructure subsidies and beach nourishment, can be overcome by pooling resources within communities and State government. This is not the case with flood insurance—homeowners are on their own.

Realizing All of Congress' Intentions

The Act sought to transfer the full cost of development from Federal taxpayers to the people who choose to develop risky and valuable coastal habitats. It is clear the Act has saved Federal funds that promote, protect, and rebuild development. Moreover, the Act will continue to save money as long as it exists.

It is less clear the Act's other objectives have been met, at least to the same degree. Recall the intent of the Act was to (1) keep people out of harm's way, (2) reduce "wasteful" Federal expenditures, and (3) protect wildlife and their habitats. Congress reasoned the Act's restrictions on Federal money would result in less development.

The Act's impact on development rates and patterns is unclear. We know some System units have developed despite restrictions on spending. For example, System units in Bethany Beach, Delaware, North Topsail Beach, North Carolina, and Cape San Blas, Florida, have developed very much like nearby non-System areas. Where the economic incentive for development is extremely high, the Act's funding limitations can become irrelevant. When owners can earn $4,000 and up per month by renting their homes to beach goers during peak season, even the high cost of private flood insurance can be overcome.

Today, System units with significant development appear to be exceptions to the rule. As undeveloped coastal barrier lands become more scarce, however, market forces will overwhelm the Act's financial limitations in many other places. This reality underscores a vital point: *the Act works best when coupled with State and local actions to protect coastal barriers before the economic incentive for development surpasses the law's fiscal disincentive.*

Not surprisingly, System units with significant development are also the most controversial. As erosion encroaches upon this development, local and State government and the private sector are faced with the financial burden of protecting structures without Federal help. Moreover, after tropical storms strike, FEMA can offer little assistance to redevelop, but nearby areas outside of the System can receive a wide array of relief. These problems will only become more severe should predictions of sea level rise come to pass. Controversy is also found in places actively seeking to develop coastal barriers. Local governments attempting to spur new home and business construction are at a disadvantage because Federal flood insurance is unavailable and the Federal share of infrastructure costs must be found elsewhere.

Twenty years after the Act was passed, these realities still cause a consistent stream of questions and controversy. In hopes of receiving Federal funds, people scrutinize the procedures that created the System and sometimes seek a Congressional change. Pressure to eliminate or reduce the Act's restrictions on spending will only increase as more System acres develop and erosion takes its toll. This pressure and controversy, however, show the approach taken by Congress and the Administration in 1982 is working. The free-market strategy directs the costs of development away from Federal taxpayers to those who choose build.

It is true that development has occurred in some System units despite the Act's restrictions. It is also possible the restrictions on spending cause System lands to develop differently than non-System lands. For example, wealthy people may be able to bear the full financial burden, while middle-class people may not. It is conceivable that higher density developments may be built to reduce the marginal cost of purchasing private flood insurance. It is also possible the Act is merely postponing development that will occur after similar, unaffected property is developed.

All of these plausible scenarios shed light on new research topics. Future studies should assess the amount and type of development that have occurred in coastal barriers within—and outside—the System. One such study by Salvesen and Godschalk (1998) found "parcels in CBRS units were less likely to be developed than parcels in non-CBRS areas within the same coastal barrier. Only 19 percent of the CBRS parcels sampled were developed compared to 36 percent of the non-CBRS parcels." More comparisons of this sort should make it possible to determine the degree to which the Act has met all of its intentions.

The Future Is Electronic Governance and Partnerships

Partnering the Act with other conservation tools can help attain Congress' full vision. The Act should be viewed as one item in the conservation toolbox that works best when complemented by other approaches. Today, the Act uses financial disincentives to discourage development. We know when market forces are great, development occurs despite restrictions on Federal spending. Some State and local governments have followed Congress' lead and used their unique tools to bolster the Act's impact. This can make all the difference. As stated by Salvesen and Godschalk (1998), "Where State and local government actions and policies support the objectives of (the Act), little or no development occurred in the (System). The converse is also true."

The Act could better meet its mandate if paired with appropriate State programs, local government zoning regulations, targeted land acquisition, long-term and voluntary conservation easements, or tax relief of some kind. Texas, for example, prohibits State-backed windstorm insurance in the System, adding another layer of protection to the Act's free-market approach. On Dauphin Island in Alabama, State and local policies have reinforced the Act's goals. The State's coastal construction control line coincides with the System boundary, and Dauphin Island has zoned the entire area for conservation and parkland (Salvesen and Godschalk, 1998). These complementary Federal, State, and local policies have helped steer development away from this at-risk area.

In addition, the restrictions on Federal spending may make land owners in the System more willing to sell their property or obtain an easement. Therefore, State and local conservation programs may get more for their money by targeting their efforts in the System. The National Audubon Society, to illustrate another partnership, is buying System lands in North Carolina and will hold them in trust for fish and wildlife in perpetuity. The Act's limitations on Federal spending undoubtedly allowed Audubon's dollar to go much farther, purchasing coastal barrier lands at a comparatively low cost. When our partners augment the Act's market-based approach

with their unique tools, all three of the Act's goals are realized: Federal tax dollars are saved, people do not build in the path of hurricanes, and intact habitat for beach enthusiasts, commercial and recreational fisheries, migratory birds, and other fish and wildlife endures.

We can do more to foster cooperative approaches. The way to encourage these partnerships is by fully integrating the Act into local and State management tools. The Internet and advances in electronic governance can help meet this goal. The Act is a map-driven law, with limits on Federal spending in areas defined on maps approved by Congress and the Administration. In the last decade, geographic information systems have become widespread and immensely valuable tools for urban planning and resource conservation. During this transition, local governments have asked the Service to provide digital Act boundaries they can fold into their property tax appraiser and long-term planning data bases.

The Service is not currently positioned to meet this need. Transforming existing maps will take time and money, but electronic governance is clearly the future for the Act. By making the boundaries easily available in a GIS form, the Service could work with its partners to encourage more bundling of conservation tools to meet all of Congress' intentions. Digital boundaries will also make other day-to-day activities more efficient. Interested citizens could easily access Act boundaries on the Internet instead of having to wait for official review. Federal agencies responding to a tropical storm or proposing to complete a new project could find out in seconds if the Act's restrictions apply. This map-driven law is poised for a modernization process that expands electronic government, increases customer service, and builds upon the innovative tools used by our partners to conserve America's coasts.

Other Applications for Free-Market Conservation

The Coastal Barrier Resources Act is a classic example of how the Federal government can encourage conservation simply by getting out of the way. This laissez-faire, free-market approach—rather unique within the Federal government's cadre of natural resource laws—may have other applications in disaster management. Land use decision-making is firmly situated at the local level in the United States; Federal agencies cannot tell people what to do with their property. Withholding Federal funds, however, is squarely on the table for consideration. For example, Federal funds and programs could be minimized across a gamut of high-risk locations, from earthquake fault zones to the 50-year riverine floodplain. Clearly, the Federal government cannot turn its back on development in place today. When disasters strike, the government has a real role to play to help communities get back on their feet. It may be wise, however, to take Act's tack, designating areas where little or no development exists and restricting Federal funding henceforth.

This strategy has other important applications for natural resource conservation. Federal taxpayers may choose, for example, not to subsidize development in places with tremendous national value such as large, biologically important, and connected tracts of habitat. Land acquisition, conservation easements, and other programs are effective long-term conservation

tools, but each requires the government to spend limited taxpayer dollars—dollars sought after by many different interests for a variety of needs. The Act's market-based approach should be another high-profile item in the conservation toolbox. It has the benefit of encouraging conservation while saving money. The free-market message from taxpayers would be clear: You can build there but we won't pay.

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