Proceedings of a Symposium

PREVENTING COASTAL FLOOD DISASTERS

The Role of the States and Federal Response

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PREFACE

These are the proceedings of the first national symposium devoted to an important topic--state programs to reduce coastal flood losses from hurricanes, tsunamis, winter storms and smaller floods. In 1983, private and public coastal flood losses may have already exceeded $1 billion, with flooding in Hawaii (Hurricane Iwa), California (eight winter storms), the Texas coast, Louisiana, and the Virgin Islands. Catastrophic losses will occur when a major hurricane again strikes the Atlantic or Gulf Coasts.

Cooperative state/federal coastal hazard management activities have expanded since state programs were last assessed in the handbook, Natural Hazard Management in Coastal Areas, prepared for the National Oceanic and Atmospheric Administration in 1976. This decade of experience has provided important insights into the workability of planning, mapping, regulations, evacuation, and educational approaches that could serve as the basis for strengthened state programs. Funding cuts in state budtets and in federal grants-in-aid and technical assistance this year threaten ongoing efforts as well as the prospects for improvement. There is a need not only for continued funding but also for a redirection in programs to reflect a greater need for technical expertise, participation by local communities in state-wide programs, understanding the viewpoints of special interests, and cooperation among all levels of government.

Progress in state programs and problems facing the states are discussed here. The first section of papers describes state policies and programs, ranging from specific descriptions of recovery from flooding to more philosophical reflection on the troubles presented by loopholes in state legislation. In recognition of recent federal concern with coastal barrier resources, one section is devoted to the management of barrier islands at both federal and state levels. Especially enlightening are the contributions from engineers, developers, architects and lawyers, and a report of a study by the Environmental Protection Agency of the impacts of a rise in sea level over the next several decades. Local programs are described, and certain aspects of federal policy as it pertains to coastal areas are analyzed. The last section presents the conclusions and recommendations of spirited panel discussions that took place during the meeting.

The Association of State Floodplain Managers is uniquely qualified to assess the status of public capability to cope with coastal flood hazards In convening the sympoisum and soliciting the contributions to this volume, the Association has drawn on its familiarity with the various state programs, the special problems that have surfaced, and the many success stories of disasters averted or successfully overcome. In short, this collection of papers represents an appraisal of the growing national experience in cooperatively using the valuable but dangerous coastal zone. It also raises serious questions about the future of such efforts in the face of budget cuts and the lack of a coherent federal policy to cooperate with and support state programs. Numerous recommendations are offered for state and federal actions to reduce future flood losses.

Gilbert F. White

October 15, 1983

FOREWORD

This two and one-half day symposium explored innovative approaches to reduce loss of life and the massive property losses resulting from major coastal storms. The potental for coastal flood disasters is increasing due to continuing, and in some instances, accelerated, development in coastal flood hazard areas, and reduced federal and state funding for coastal hazard mitigation activities. Reduced funding has been the result of state budget deficits, reallocation of hazard mitigation personnel to non-flood related activities and reductions in federal grants-in-aid in the Coastal Zone Management Program, FEMA State Assistance Program, and various other flood loss reduction programs. Can state hazard mitigation activities be continued at present levels or strengthened, despite these cutbacks? If so, how? What measures might the federal government take to cost-effectively support state programs not only through funding but also through improved disaster assistance and other measures?

Sixty-five speakers and panelists from twenty coastal states and four federal agencies were asked to address this important problem. They were joined by 100 symposium participants. All were asked to examine the problem from four perspectives:

1) What roles have states been playing in preventing coastal flood disasters and reducing flood losses? What approaches have been used?

2) What lessons have been learned about the pros and cons of these approaches?

3) What approaches are particularly innovative and cost-effective and why?

4) To what extent has the federal government encouraged or discouraged such efforts? How could federal programs be made more responsive to state needs in implementing such approaches?

Potential losses from a major coastal storm are now staggering. The last major coastal storm to strike the U.S. mainland, Hurricane Frederic, caused over $2 billion in losses in 1978. Tropical Storm Agnes caused over $3.5 billion in damages and damaged or destroyed over 300,000 structures in 1972. More than 7 million people now live within the 3,000 communities in the thirty-one states subject to hurricane and other coastal flooding. It has been estimated that a major hurricane striking the Eastern Seaboard could cause $7-12 billion in damages today.

Considerable public investment has already been made at federal, state, and local levels to reduce future loss of life and property including beach nourishment, groins, sea walls, evacuation planning, construction standards, beach setbacks, restrictions on barrier island development, relocation, education, and flood insurance. Approximately two million inland and coastal landowners have purchased federal flood insurance. The face value of this insurance is over $107 billion.

Although the potential for loss of life may have been reduced in the last decade, potential property losses have increased due to rapid construction in coastal communities. The costs of beach nourishment, groins and sea walls have escalated dramatically. In addition, during the last two years emphasis has been placed by the Reagan Administration upon greater responsibility by the states in planning and management of the nation's land and water resources, combined with cost sharing and cost recovery for water resources projects and cost-saving measures at all levels of government.

States are now playing an important role in mitigating coastal flood losses. However, effectiveness of state programs varies and many of the programs are threatened by federal cutbacks. In addition, some states have found federal programs inconsistent with state needs.

This symposium was designed to assess and strengthen state hazard mitigation approaches and to suggest how federal resources can best be used to support innovative and cost-effective programs and reduce potential disaster losses.

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The success of the symposium depended upon the help of cooperating organizations, particularly the Maryland Department of Natural Resources. Marguerite Whilden of the Maryland Water Resources Administration played a lead role in organizing the meeting. The help and guidance of Sarah Taylor, Director, Maryland Tidewater Administration and her staff, including Earl Bradley, Chris Zabawa, and Leila Holstein in designing and conducting the symposium including the field trip was invaluable. Many others contributed to the effort including Bob Cox of the Association of State Floodplain Managers Coastal Committee, Gary Magneusun of the Coastal States Organization, and Sharon Newsome of the National Wildlife Federation. Finally a great deal of credit is due to the Natural Hazards Research and Applications Information Center, and particularly Jacquelyn Monday for editing these proceedings and overseeing their publication.

Thank you all.

Jon Kusler

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EXECUTIVE SUMMARY

Strong state coastal flood loss reduction programs are the key to future loss reduction at federal and state levels, including protection of public safety and reduced private and public expenses for disaster assistance, flood insurance, relocation, and flood control works. In the last decade states have gained considerable experience about techniques to reduce coastal flood losses on barrier islands, beaches and other velocity zones and in back-lying areas subject to storm surge. Loss reduction measures have included improved warning systems and evacuation planning, mapping flood and erosion-prone areas, regulating construction, public education, relocation, and the control of public works in hazardous areas. Most state programs have been carried out in cooperation with local governments and federal agencies, with local governments assuming the primary role in regulation.

The principal state activity often has been helping the Federal Emergency Management Agency (FEMA) and communities implement zoning, building codes and subdivision regulations consistent with the standards of the National Flood Insurance Program (NFIP). States have established priorities for FEMA's mapping; distributed maps to communities and helped communities, landowners, and insurance agents interpret the maps; prepared guidebooks and manuals for community use; helped communities draft ordinances; and assisted in the administration of ordinances.

Funding support for these and other state activities has been provided by general state revenues and federal grants-in-aid from FEMA's disaster preparedness planning and state assistance programs and from the National Oceanic and Atmospheric Administration's Coastal Zone Management Program. Federal mapping and technical assistance have lent important support to state and local programs.

Cooperative federal/state/local approaches should be continued with modifications to reflect what has been learned about both workable and unworkable approaches. States may be expected to assume large financial responsibility; however, continued federal grants-in-aid, technical assistance and research are essential if state and local programs are to be strengthened.

Progress in individual state programs has been uneven because of several problems.

1. State program budgets and staffing have been limited. This has inhibited program development and implementation.

2. State enabling statutes have provided agencies with limited power. Only a few states directly regulate shoreline development. Where direct regulation does occur, it is usually limited to setback areas and wetlands.

3. There has been a dearth of maps of scale and accuracy sufficient for regulatory purposes, indicating 100-year flood elevations, wave action, and erosion zones. Neither are map data being stored adequately.

4. State disaster preparedness and response efforts often have been poorly coordinated with regulatory programs (usually

handled by another agency). State civil defense personnel usually have limited expertise in mitigation techniques except evacuation planning.

5. Coastal development pressures have been strong. It is difficult to convince private property owners and local governments to floodproof, relocate or otherwise mitigate potential flood losses because of their expectation that when a disaster occurs, beach erosion control and disaster assistance will be available at public expense.

6. Federal technical assistance to states and grants-in-aid have been fragmented and only partially responsive to state needs. Federal subsidies for flood control works and disaster assistance have encouraged or facilitated coastal development without individual mitigation measures.

State legislatures and agencies can strengthen their cooperative programs through appropriation of funds, amendment of enabling legislation where necessary, and redefining program priorities and new program initiatives. Some specific recommendations follow.

<u>State plans for barrier islands.</u> In cooperation with local governments, states should prepare hazard mitigation plans for developed and undeveloped barrier islands. These should address access and evacuation during a storm, erosion and island migration, protection of dunes and wetlands, post-disaster redevelopment and other relevant matters.

<u>Multi-objective state standards for hazard areas.</u> States should develop their own regulatory standards and guidelines rather than rely on minimum NFIP standards to meet multi-purpose land and water management goals. States should adopt or establish standards for local regulation of high hazard areas including setback lines, dune protection regulations, and minimum protection elevations for hazard areas on both barrier islands and mainland coasts.

<u>Monitoring local programs.</u> In cooperation with FEMA, states should systematically monitor local regulations with emphasis upon the most hazardous areas and those under the greatest development pressures.

<u>Vulnerability assessments.</u> In cooperation with local governments, states should prepare multi-hazard vulnerability assessments including inventories of structures and determinations of mitigation potential. These vulnerability assessments can serve as the basis for evacuation planning and for preparing mitigation plans for implementation both before and after floods.

<u>Training and education.</u> States should conduct state-specific training and education for lenders, developers, homeowners, building permit administrators, planners and others directly

involved in floodplain decision-making. These should cover such hazard mitigation techniques as interpretation of maps, floodproofing, hazard assessments, retrofitting existing structures, evacuation, erosion control, relocation, and dune reestablishment.

Selective mapping. In cooperation with FEMA and local governments, states should more specifically map such hazard areas as barrier islands, beaches, and those zones subject to combined erosion and flooding threats.

Disaster prevention and response fund. States should create their own "disaster prevention and response fund" to support state planning, regulating, and technical assistance efforts; provide funds for cost-sharing with the federal government and local governments in disaster assistance in the event of a disaster; provide funds for cost-sharing with the federal government and local governments for mapping and other mitigation measures; and provide funds for cost-sharing with landowners in retrofitting existing flood-damaged structures and beach erosion control devices.

Improved coordination. States should strengthen their clearinghouse and coordination functions for local, state and federal activities that affect floodplains and should encourage local packaging of grants-in-aid to serve multi-purpose goals.

Emphasis on mitigation approaches with safety factors. In their mitigation programs, states should emphasize flood loss reduction measures with long-term effectiveness and built-in safety factors. For example, it may be more cost-effective to acquire and relocate structures in a rapidly eroding beachfront area than to support repeated flood losses at public and private expense.

Setting priorities. States should more carefully focus their mapping, planning, regulations, education, and technical assistance on areas subject to the most severe flood hazards and development pressures.

Improved federal support of state programs can be achieved through the following means.

Reappraisal of total state/federal policy. FEMA, NOAA, the Corps, OMB and Congress should carry out a systematic reappraisal of state/federal policy in coastal hazard mitigation to guide new program initiatives and modifications in existing programs, including budget cuts. Such a reappraisal should be based on a careful analysis of what has and has not been working during the last decade.

This reappraisal should help remedy the present approach to coastal hazards, which had been described as "jury rig," even before the present piecemeal budget-cutting began.

Selective and revised mapping. FEMA should continue to selectively map coastal areas after disasters, especially those with changing conditions, and those that are under severe development pressures. This might be done on a cost-share basis. Such mapping should realistically reflect wave heights and erosion and should be at a scale adequate for state and local regulation.

Enhanced and more specific training and education. FEMA should enhance specific flood hazard training and education initiatives including its support of state-specific training and education.

Continued modification of insurance rates to reflect actual risks. FEMA should continue to revise its insurance rates to reflect actual risks. It should also increase its monitoring of community programs or, in the alternative, increase support for state monitoring.

Added incentives for private mitigation. FEMA, OMB, and Congress should provide stronger incentives for private and local mitigation measures through consistent federal policies like those mandated by the Coastal Barrier Resources Act. Such measures would involve consistent cost-sharing for structural and nonstructural mitigation measures including consistent federal subsidies for planning, regulations, training, flood control, insurance, disaster assistance, and grants for infrastructure. Tax credits (resembling energy tax credits) should be provided to encourage private mitigation measures such as retrofitting existing structures and relocation.

Assistance for state nonstructural loss reduction programs. FEMA, OMB, and Congress should continue to assist state hazard mitigation efforts through NOAA's Coastal Zone Management Program, FEMA's State Assistance Program, or other grants-in-aid. As with disaster assistance and flood control measures, hazard mitigation techniques such as mapping and public education cannot be accomplished on a one-shot basis. The coastline is constantly changing. New property owners, insurance agents and local government officials need new educational efforts each year.

States should be supported in what they do best: coordination; oversight of local programs; technical assistance; and tailoring of maps, regulations, acquisition, training and education, and other programs to state and local conditions. Congress may fund such efforts through general appropriations or by returning a portion of flood insurance proceeds to states and communities for mitigation (e.g., 20%). Congress could also enhance mitigation by requiring that a percentage (e.g., 15%) of disaster assistance funds be used for mitigation.

Continued research. FEMA, NSF, NOAA, the Corps and other agencies should continue research on coastal hazards and loss reduction techniques such as improved methods for predicting sea level rise and barrier island migration, the retrofitting of existing nonconforming structures, the use of "soft engineering" works for beach erosion control, improved mapping techniques for combined erosion and flooding areas, improved techniques for insurance rating to reflect actual hazards, determination of the efficiency of elevation and floodproofing techniques including a determination of the relative effectiveness during actual flood conditions, and improved techniques for monitoring and enforcing regulations.

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I. WELCOME AND OVERVIEW

WELCOME AND OVERVIEW

Jon A. Kusler, Esq.
Symposium Director

Goals of the Symposium

On behalf of the Association of State Floodplain Managers, our sponsors and other cooperating organizations, I welcome you to this symposium. We are pleased that so many of you could join us here in Ocean City to examine state and federal programs to prevent coastal flood disasters and reduce damage from smaller coastal storms.

This is a critical year for state programs. In the last decade states have gained considerable experience and expertise in reducing the potential for coastal flood disasters through evacuation planning, regulations, public education, relocation, flood control works and other measures. This experience could form the basis for future, more effective state/federal/local programs. But will state programs be strengthened or hold their own in light of severe budget cuts at all levels? Will the lessons learned about both workable and unworkable approaches be applied or will past errors be repeated?

We have gathered almost 150 representatives from state coastal zone management and floodplain management programs as well as federal agencies to discuss these questions and to suggest approaches for "doing more with less".

Our location in Ocean City will help keep our discussion specific. Ocean City was chosen for the symposium not only because it offers attractive conference facilities but also because it is located on a developed barrier island subject to erosion and flood hazards different in degree but not qualitatively from many other communities along the Eastern and Gulf Coasts. These dual attributes--attractive but hazardous--characterize much of the US coastline and are at the heart of a major dilemma in formulating coastal land use management policies: how can government permit reasonable development while protecting health and safety and preventing coastal landowners from shifting the costs of flooding to other landowners and units of government? How can government achieve the goal enunciated by the 1965 Presidentail Task Force on Floodplain Management: that those who occupy the floodplain be "responsible for the results of their own action"? (Task Force on Flood Control Policy, 1966).

A Growing Threat of Flood Disaster

The threat of coastal flood disasters with tens of billions of dollars in property losses and severe loss of life is increasing. It is only a matter of time before another hurricane makes landfall along the heavily populated Atlantic or Gulf Coasts. Even though Hurricane Carole devastated the North Atlantic Coast in 1954 and Hurricane Camille virtually destroyed development along a stretch of the Mississippi coast in 1969, due to intensive development during the last twenty years, property damage far exceeding that of the earlier storms may be expected. A quick moving storm occurring during the peak resort period could trap thousands of tourists on barrier islands and limited access areas like the Florida Keys.

More than six million people are exposed to hurricane storm surges along the Atlantic and Gulf Coasts (White et al., 1976). The population in this area is growing at a rate three to four times the national average, creating serious evacuation problems for barrier islands, the Florida Keys and other low lying areas. The average annual property loss due to hurricanes rose from $250 million during the 1951-1960 period to over $400 million in 1960-1970. One quarter of the shorefront in the United States (20,500 out of a total of 84,240 miles) is also subject to coastal erosion. Erosion is a critical problem along as many as 2,700 miles, predominantly in the Atlantic and Great Lakes states, and is particularly serious on barrier islands. As erosion occurs, the beach and wave velocity zone migrate shoreward, and structures that were formerly tens or hundreds of feet from the water are subjected to new risks from the storm surge and waves.

Hurricanes are the most severe of the coastal storms. They affect the entire Gulf and Atlantic Coasts although Texas, Louisiana and Florida are most vulnerable. Of the various types of coastal storms, hurricanes also pose the greatest threat to life. The typical hurricane system occurs between June and November. It has a diameter of 300 miles and wind speed exceeding 73 miles per hour. Gusts often exceed 100 miles per hour and may approach 200 miles per hour in a really severe storm. Most of the deaths from hurricanes result from the storm surge and waves although high winds, tornadoes and heavy rainfall also threaten life and cause property damage. The most serious loss of life in the United States occurred on

Galveston Island in 1900 when a hurricane demolished the city and killed 6,000 people.

"Northeasters" and other winter storms are a second major cause of coastal flooding in the Northeast and mid-Atlantic. Although winds are less intense than in a hurricane, winter storms may be massive in size, exceeding 1,000 miles in diameter. The storm surge may exceed ten feet. Storms often last for several days, destroying bulkheads and seawalls and causing severe erosion. A two-day northeaster with winds up to 90 miles per hour and a 14-foot storm surge devastated much of the New England coast in 1978. Over 2,000 homes were destroyed with another 9,000 damaged and 29 lives lost in Massachusetts alone. The "Ash Wednesday" northeaster of 1962 virtually destroyed the dune system from Virginia to New Jersey and levelled thousands of homes. A similar storm striking Ocean City and other heavily developed mid-Atlantic barrier islands now could cause hundreds of millions or billions of dollars in property damage.

Tsunamis are a third coastal flood hazard. Tsunamis are long period waves (10 to 20 minutes) set in motion by earthquakes or landslides. They are most common along the Hawaiian, Alaskan, and California coasts but can occur elsewhere. Tsunamis have repeatedly caused loss of life and property damage in such cities as Eureka, California and Hilo, Hawaii.

Land subsidence due to withdrawal of oil or water, or tectonic movements is a growing problem in some coastal areas such as Galveston. In Louisiana, subsidence is destroying wetlands and barrier islands and lowering the height of protective seawalls and levees that protect backlying areas. Subsidence is gradual but, like erosion and recession of the shoreline, can result in permanent flooding. Serious subsidence is occurring in areas of California, Florida, Texas and Louisiana. Rapid subsidence due to groundwater withdrawal in the Galveston area prompted the Texas legislature to adopt a statute controlling future extraction of groundwater. Oil wells in Long Beach, California have been repressurized to arrest rapid subsidence.

Why do major coastal storms cause such devastation? First, often when a major coastal storm occurs the storm surge and waves affect hundreds of miles of coast and may have an impact on hundreds of thousands of structures. This contrasts with inland storms (particularly in mountain areas), which often only affect smaller watershed areas. Combined coastal storm surge and wave elevations of 10 to 16 feet are common. Whole coastal communities may be flooded, not just low lying areas. Damage is often so extensive and serious that the emergency response capability of the local government is far exceeded.

Second, flooding from a major coastal storm occurs quickly, often with 24 hours or less of specific warning time in contrast with several days to several weeks of warning along major inland rivers such as the Mississippi. Evacuation may be a serious problem in heavily developed coastal areas. Traffic from mainland areas prevents evacuation from barrier island communities.

Third, severe threats to life as well as property losses are posed by the multiple hazards of a major storm. In addition to the storm surge, winds may exceed 100 miles per hour, and waves of five to 15 feet destroy all but the sturdiest structures. When a major coastal storm strikes, such as Hurricane Frederic in 1978, shoreline structures are destroyed, not just damaged.

Fourth, the immediate shoreline may be rendered permanently unusable. With inland flooding, rivers rise and fall, usually leaving the flooded land more or less intact. In contrast, coastal storms often cause 30 to 100 feet of erosion along the ocean front and in the back bay areas on barrier islands. Due to rising sea levels, the beaches and dunes will not be rebuilt at their old locations. Much of the Atlantic and Gulf Coasts, including most barrier islands, is retreating landward at an average rate of three to 30 feet per year. Efforts to artificially reconstruct beaches and eroded areas are very expensive and provide only a temporary solution (Kaufman and Pilkey, 1979).

Before 1970, few coastal structures were elevated or floodproofed. Since then, many new structures have been elevated, but most existing coastal structures (an estimated three million) are without flood protection.

Arguments are sometimes made that coastal flooding should be a state or local rather than a federal concern. But a major hurricane can affect dozens of states, damaging and disrupting regional communications, interrupting shipping and other commerce, damaging coastal industries and temporarily halting importation of strategic goods such as oil. For example, Tropical Storm Agnes in 1972 caused significant flood damage in

19 states. Billions of dollars in property damage and reduced income resulted in lowered federal tax revenues.

The federal government and the US populace, as a whole, have a greater financial stake in coastal flooding than ever before. Before 1968, Congress and the President exercised discretionary powers in authorizing disaster assistance programs and flood control measures to assist flood victims and reduce property losses. With the adoption of the National Flood Insurance Program (NFIP) in 1968, Congress for the first time legally obligated the federal government to pay flood victims for losses. This program has been heavily subsidized since its inception and continues to operate with a 60 to 80% federal subsidy for existing structures. The NFIP has become one of the largest financial and legal obligations of the federal government, with over two million policies in effect and total policy coverage exceeding $107 billion.

Flood insurance is now available in more than 17,000 communities participating in the NFIP. As indicated by Table 1, national flood insurance has become principally a coastal program. Although only 10% of the flood-prone communities of the US are located on coastal areas and only 11% of the communities eligible for flood insurance are located in coastal areas, coastal flood insurance policies account for 67% of the total policies. Seventy-two percent of the dollar coverage is in coastal areas and 57% of the total dollars paid for claims have been in coastal areas. In 1980, four coastal metropolitan areas (Galveston/Houston, New Orleans, Tampa/Fort Myers and Miami/Fort Lauderdale) alone accounted for 680,000 flood insurance policies, or 37.8% of the national total.

The federal financial stake in coastal disasters is not limited to flood insurance. Congress has also authorized a variety of individual and public disaster assistance grants-in-aid. Local governments depend more and more on federal subsidies for roads, sewers and water supply systems in floodplains and other areas. Such infrastructure is often damaged by flooding.

Federal coastal flood disaster assistance outlays since 1970 have exceeded $665 million. This total does not include massive low interest disaster assistance loans available from FHA and FDA. Once flooded or subject to erosion, property owners also pressure Congress, state

May 1, 1984

TABLE I

COASTAL FACT SHEET

NATIONAL FLOOD INSURANCE PROGRAM

Flood-Prone Communities

Coastal Communities (including Great Lakes)	2,058
Total Coastal and Inland Flood-Prone Communities in U.S.	20,359
Percentage of Coastal Communities/Total	10%

Communities Eligible for NFIP

Coastal Communities Eligible for NFIP	1,895
Total Coastal and Inland Communities Eligible for NFIP	17,432
Percentage of Eligible Coastal Communities/Total	11%

NFIP Policies

Coastal Policies	1,253,516
Total Policies	1,872,277
Percentage of Coastal Policies/Total	67%

NFIP Dollar Coverage

Coastal Policy Coverage	$77,369,774,400
Total Policy Coverage	$107,409,406,400
Coastal Coverage/Total	72%
Barrier Island Coverage	$10-15 billion
V-Zone Policies	
Post-FIRM	7,620
Total Policies	61,819

NFIP Claims Paid

Coastal Claims	146,251
Total Claims	277,908
Percentage of Coastal Claims/Total	53%
Dollars Paid on Coastal Claims	$632,578,621
Dollars Paid on Total Claims	$1,104,694,806
Percentage of Coastal Claims Dollars/Total	57%

Coastal Disaster Assistance Since 1970

(FEMA individual and public assistance)		$458,227,933.00
Hurricanes		$458,227,933.00
Typhoons		$44,490,464.00
Other		$163,005,945.00
	TOTAL	$665,724,342.00*

*Some non-flood damage

Data supplied by the Federal Emergency Management Agency.

legislatures and municipal governments for beach nourishment, sea walls, groins, revetments and other flood control measures.

The states' financial stake in coastal disasters is also growing. Congress now requires a 25% state or local cost-share for disaster assistance and flood control measures. State legislatures are being called upon to provide other types of disaster assistance and flood control measures as well as grants-in-aid to local governments for roads and other facilities.

Evolving State Programs

Until 1968, state coastal hazard mitigation activities were largely confined to construction or cost-sharing in beach erosion control works with the Corps and local governments. There was little direct state regulation of hazardous areas, standard-setting for local regulations, evacuation planning, relocation assistance or technical assistance to communities or landowners (White et al., 1976; Kusler, 1970, 1971, 1983; Bloomgren, 1981). Local flood hazard mitigation activities were also limited. Only a small number of local coastal communities had adopted regulations, undertaken evacuation planning or undertaken other hazard mitigation measures.

During the late 1960s and early 1970s many states adopted coastal zone management statutes which authorized either direct state regulation of certain coastal activities (e.g., industries in New Jersey) or authorized state standard-setting for local regulation of areas to serve hazard mitigation and other objectives (Bloomgren, 1981; Kusler, 1982). These new statutes were stimulated by the Coastal Zone Management Act of 1972 and by the National Flood Insurance Program.

Although most hazard mitigation efforts are now part of state coastal zone management programs (e.g., California, Massachusetts, North Carolina, Rhode Island), other efforts have been adopted as components of "shoreland" zoning (e.g., Michigan, Minnesota, Washington, Wisconsin), public safety and civil defense (e.g., Texas), floodplain management (e.g., Maryland, New York), beach protection (e.g., Delaware, Florida), or state/local planning programs (e.g., Oregon).

Most state efforts are in fact cooperative state/local programs with most of the implementation at the local level. However, whereas in inland areas many local governments have their own innovative flood hazard mitigation programs, only a handful of coastal governments have adopted strong floodplain management programs without state assistance (Kusler, 1982).

All states have assisted the Federal Emergency Management Agency to enroll communities in the National Flood Insurance Program through technical assistance, preparing model ordinances, evaluation and other activities. In some states this has been the principal coastal hazard mitigation activity. Other major state/local hazard mitigation activities during the last decade have included (see also Table 2):

1. Setback Lines. A number of states adopted building setback lines for serious erosion/flooding areas to reduce losses from waves and flooding and to protect dunes and beaches. Hawaii adopted a minimal, fixed setback. Florida adopted a variable setback based upon erosion and wave studies. Michigan adopted a varied erosion setback along Lake Michigan to provide 30 years of protection from erosion; North Carolina also adopted a setback line based upon erosion rates.

2. Elevation and Floodproofing Standards. Several states adopted elevation and floodproofing standards for structures. Massachusetts incorporated floodproofing standards in its state building code after a severe winter storm in 1978. Rhode Island incorporated elevation requirements into its permit requirements adopted pursuant to the Coastal Management Act of 1971. Wisconsin mandated that local governments require elevation of uses above the 100-year flood protection elevation for hazardous areas along Lake Michigan and Lake Superior. North Carolina also mandated that local governments require elevation or floodproofing of uses to the 100-year flood elevation.

3. Dune Protection Regulations. Maine adopted a statute requiring a state permit for alteration of dunes. In 1971 North Carolina required communities to adopt dune protection ordinances and has incorporated dune protection standards in its guidelines for local regulation of coastal areas under its Coastal Areas Management Act. The Florida setback law is intended, in part, to protect natural flood protective barriers.

4. Technical Assistance. All coastal states have provided some measure of technical assistance to local governments to help them adopt and administer coastal flood hazard mitigation ordinances pursuant to the National Flood Insurance Program or to state coastal zone management programs. NOAA's Coastal Zone Management Program and FEMA's State Assistance Program have been the major sources of funding for state technical assistance.

5. Training and Education. All coastal states have provided some level of training and education to local governments and private landowners in coastal hazards and mitigation approaches. Training and education efforts have included preparation of guidebooks and brochures, workshops and conferences, and small meetings. Most of the efforts have also been funded by the federal Coastal Zone Management Program or FEMA's State Assistance Program.

6. Grants to Local Governments. Many coastal states such as Maryland have provided grants-in-aid to local governments for planning and regulating coastal areas. The federal Coastal Zone Management Program has been the major source of this funding.

7. Mapping. A number of states have undertaken mapping of coastal flooding or combined flooding and erosion areas. Some of these are Michigan, Rhode Island, Massachusetts, Florida (setback lines), Wisconsin, Washington, and North Carolina. The Coastal Zone Management Program and FEMA's State Assistance Program have been the major sources of funding. Other states have not undertaken independent mapping, but have relied primarily on federal maps developed through FEMA's flood insurance studies.

8. Beach Erosion Control Projects. Many states have provided planning assistance to communities in the construction of beach erosion control works (e.g., Maryland, New York). Some states have also helped to fund erosion control and beach protection projects on a cost-sharing basis (e.g., Maryland). Federal aid from the U.S. Army Corps of Engineers has been the major source of funding for erosion control projects.

9. Warning Systems and Evacuation Planning. Hawaii has assisted counties in establishing tsunami warning systems. Many other states have cooperatively developed evacuation plans for tsunamis and hurricanes (e.g., Louisiana, Flordia, and Texas). These efforts have usually been undertaken cooperatively with FEMA, the U.S. Army Corps of Engineers or NOAA, which have provided total or partial funding support as well as technical assistance.

10. Disaster Preparedness Plan. Each coastal state has prepared a disaster preparedness plan with funding from the Federal Emergency Management Agency (Section 210 of the Disaster Preparedness Act of 1974). Most plans have a coastal storm element. These plans have focused primarily upon response to disasters although some mitigation planning has also been included.

11. Disaster Mitigation Plans. Several states (e.g., Louisiana) have prepared flood loss mitigation plans as a condition to receiving assistance under Section 406 of the Disaster Assistance Act of 1974.

12. Relocation of Structures. Several states have aided local governments or private landowners in relocating after a coastal flood disaster although these efforts were narrow in scope. Massachusetts acquired several properties in Scituate, Massachusetts to aid relocation efforts after the winter storm in 1978 caused severe damages. New Jersey aided communities in acquiring coastal properties through its "green acres" program after the Ash Wednesday Storm of 1962 destroyed much of the beachfront along the entire coast. Florida has purchased selected barrier island and beach properties as part of its Save Our Coast Program.

Implementation Problems

Implementation of state programs has been hindered by a variety of factors and only a few states have applied the full range of techniques. Major problems include (Kusler, 1982; Bloomgren, 1981):

1. Virtually all programs have suffered from small budgets and limited staff. Much of the funding has come from the federal government.
2. Agencies and their staffs have had inadequate expertise in such technical issues as floodproofing.
3. Flood and flood-related erosion data at adequate scale for regulatory proposes have been lacking for many areas.
4. Due to federal subsidies for beach erosion control works, flood insurance, and disaster assistance, it has been difficult to convince private landowners and local governments to undertake mitigation measures at their own expense.
5. FEMA's minimal construction standards for the National Flood Insurance Program which, until recently, failed to consider wave heights and still fail to consider erosion, have undermined some state programs (e.g., Massachusetts, Maine and Rhode Island).
6. Loss reduction approaches have focused almost entirely upon new construction with little effort to address the estimated three million existing structures in the coastal floodplains. Evacuation planning for these areas has reduced potential loss of life but not damage to structures.
7. Local development pressures have been strong and many local governments have been apathetic to loss reduction measures.
8. Federal grants-in-aid, mapping and technical assistance programs have been poorly coordinated and only partially responsive to state needs.

In 1979, one coastal hazards expert in the AIP Journal referred to federal/state policy as a "jury-rigged approach" to hazards management due

TABLE 2

STATE EFFORTS TO REDUCE COASTAL FLOOD LOSSES

This table highlights some of the more important state activities. It is based upon White (1976), Bloomgren (1981), Kusler (1982), and data supplied by NOAA's National Ocean Service.

State	Program Efforts
Alabama Hurricane flooding is serious along the entire 607-mile tidal shoreline. Hurricane Frederic caused over $1 billion in damages in 1978.	• The state adopted the Coastal Zone Development Act in 1976. • No state regulation of coastal floodplains; counties are specifically authorized to zone lands for flood insurance purposes.
Alaska Serious flooding and erosion occur along much of the 34,904 miles of bluff and low lying tidal shoreline due to winter storms and tsunamis. A tsunami in 1964 caused 103 deaths and $80 million in damage.	• The state adopted a Coastal Management Act in 1977. It has adopted guidelines for local regulations including guidelines for hazardous areas. Local permitting must be consistent with such guidelines. • The state has prepared community resource maps and guidelines with hazard elements. • The state has provided assistance to communities in adopting and administering regulations.
California Most of the 3,427 miles of tidal shoreline is bluff or cliff. Erosion is a serious problem along 1/5 of the coast. Winter storms and tsunamis are the major cause of flood damage. Eight winter storms in 1983 damaged 3,000 homes and 900 businesses. Crescent City has experienced 7 tsunamis since 1964.	• The state adopted a Coastal Zone Conservation Act in 1972 with a successor, the California Coastal Act in 1976. These acts authorized local regulation of coastal areas consistent with state standards. Hazard mitigation is one objective. • State guidelines for local regulations have been prepared.

State	Program Efforts
California (cont.)	* Technical assistance has been provided communities in establishing bluff setbacks and adopting regulations.
Connecticut The entire 618 miles of tidal shoreline is low-lying, highly developed and subject to hurricane and winter storm damage. The last major hurricane occurred in 1955 with $15 million in damage along the coast.	* The state directly regulates activities in coastal wetlands. * The state has inventoried coastal flood vulnerability including an investigation of coastal structures with potential for relocation.
Delaware The entire 381 miles of tidal shoreline is low-lying, intensively developed and subject to both flooding and erosion problems. The last devastating storm occurred in 1962, causing 7 deaths and $20 million in damages.	* The state directly regulates development in certain dune, beach and wetland areas pursuant to the Coastal Zone Act of 1971, Wetland Act of 1973 and Beach Preservation Act of 1972. * The state is developing storm evacuation plans for Lower Sussex County.
Florida The entire 8,426 miles of tidal shoreline is low-lying and subject to severe hurricane flooding. Development is intensive along much of the coast, including the Florida Keys. Evacuation is a major problem in the Keys, Miami, Tampa/St. Petersburg and other areas. Hurricane Betsy caused 80 deaths and $14 million in damage in 1965.	* The state in 1970 established a variable setback line program to protect dunes and control development in high hazard areas. However, most regulation of coastal areas is at the local level. * The state has provided technical assistance to communities in ordinance drafting, map interpretation, etc. * The state is preparing a hurricane evacuation plan and coastal mitigation plan. Major funding has been provided by the OCZM and FEMA. * The state has designated the Florida Keys as a critical area. * The state adopted a "Save Our Coast" program in 1981 by executive order including a $200 million bond issue for purchase of beaches and adjacent areas.

State	Program Efforts
<u>Georgia</u> The entire 2,344 miles of tidal shoreline, including many barrier islands, is low-lying and subject to hurricane damage. One-fifth of the coast is subject to erosion. Development on barrier islands has accelerated in recent years.	* The state directly regulates coastal wetlands and certain dune areas. * The state is developing local and regional evacuation plans for 8 coastal counties. * The state has provided technical assistance to local regulatory programs.
<u>Hawaii</u> Much of the 1,052 miles of tidal shoreline is subject to hurricane, tsunami, and winter storm damage. Development is intensive in some areas. A 1960 tsunami killed 61 and caused \$25 million in damage. Hurricane Iwa caused extensive damage in 1982.	* The state has adopted a hurricane warning system and evacuation plan. * The state has adopted an ocean setback. * The state has adopted a Land Use Zoning Program and a coastal zone management program.
<u>Illionis</u> Much of the 59 miles of Lake Michigan coast is highly developed bluff, subject to erosion.	* Regulation of coastal areas along Lake Michigan is at the local level. * The state has assisted communities in erosion control studies and floodplain regulation.
<u>Indiana</u> Much of the 45-mile Lake Michigan coast is highly developed and subject to bluff erosion and flooding from fluctuating lake levels.	* Regulation of coastal areas along Lake Michigan is at the local level.
<u>Louisiana</u> The entire 7,721 miles of tidal shoreline is low-lying and subject to severe hurricane flooding. Subsidence and erosion are problems. However, development is not intensive along the shoreline. In 1957 Hurricane Audrey killed 400 and caused \$200 million in damage.	* Regulation of coastal hazard areas is primarily at the parish level although state guidelines have been developed. * The state is developing vulnerability/loss studies and evacuation plans for an 8-parish area surrounding New Orleans with FEMA and state funding.

State	Program Efforts
Maine Much of the 3,498 miles of tidal shoreline is bluff or rocky headland. Flood and erosion areas are not extensive except south of Portland. Moderate damage was caused by the winter storm of 1978.	• Most coastal regulation is at the local level. However, the state has adopted a shorelands zoning act mandating local regulation consistent with state guidelines within 250 feet of the shore. In addition the state directly regulates certain coastal wetlands and dune areas and large-scale developments under its site location act. • The state has assisted local governments to adopt and administer regulations. • The state is preparing a hazardous areas handbook. • The state has provided funding assistance to 3-4 towns affected by the 1978 storm to develop flood hazard ordinances.
Maryland Most of the 3,300 miles of ocean and Chesapeake Bay tidal shoreline is low-lying and subject to damage from hurricanes and winter storms. Erosion is a problem. A northeaster in 1962 caused more than $1 million in damages. Tropical storm Agnes killed 17 and caused $134 million in damage to fishing and related industries on Chesapeake Bay.	• Regulation of most coastal hazard areas is at the local level; however, the state directly regulates coastal wetlands. • The state is preparing evacuation route maps for Ocean City. • The state is updating evacuation plans for other Chesapeake Bay counties. • The state is preparing postdisaster plans for Ocean City. • The state Coastal Zone Management Program has provided grants to coastal counties and has helped them assess erosion and prepare erosion damage mitigation plans. • The state is preparing a watershed management plan for Ocean City.

State	Program Efforts
Massachusetts Most of the 1,519 miles of tidal shoreline is low-lying and subject to both flooding and erosion damage (particularly serious on Cape Cod) from hurricanes and winter storms. A "northeaster" in 1978 destroyed 2,000 homes, damaged 9,000 others and caused 29 deaths.	• The Governor signed an Executive Order in August 1980 limiting development and public investments on barrier beaches. • Most coastal regulation is at the local level; however, the state regulates coastal wetlands. • The state has mapped and inventoried all barrier beaches. • The state is mapping shoreline changes and storm history impacts for western Cape Cod Bay. • The state purchased land in Scituate to permanently remove hazard-prone structures. • The state Coastal Zone Management Program has provided grants to communities to develop setback laws and floodplain zoning. • After the coastal storm of 1978, the state adopted flood mitigation provisions as part of the state building code. • The state issued a $5 million bond to acquire flood-damaged properties. • The state has adopted a "coastal floodproofing" program with a sliding scale of rebates after residential floodproofing has been completed.
Michigan Much of the 3,282 miles of Lake Michigan and Lake Superior shoreline is subject to erosion, some of it severe. Flooding due to fluctuating lake levels and storm waves is also a problem and caused $17.4 million in damages in 1951-52. Development is intensive in some areas.	• The state adopted a Shoreline Zoning Act in 1970 which requires that local governments regulate construction in erosion and flooding areas along Lake Michigan; direct state regulation is authorized in the event local governments fail to regulate consistent with state regulations. • The state directly regulates subdivision of flood hazard areas.

State	Program Efforts
Michigan (cont.)	* The state has developed erosion-recession rate maps for the Lake Michigan shore. * The state has prepared manuals and provided technical assistance to local governments in regulating flood and erosion areas.
Minnesota Most of the 206 miles of Lake Superior coast is rocky bluff and not heavily developed except in Duluth.	* The state adopted a special floodplain management act in 1969 that requires that flood-prone communities participate in the NFIP and adopt floodplain regulations. The state also adopted a Shoreland Zoning Act in 1973 requiring counties and cities to adopt regulations meeting state standards. * The state has adopted a building code for floodproofing and also adopted an administrative manual to aid implementation. * The state has adopted a model ordinance and technical assistance has been provided to communities. * The state has prepared a shoreland damage survey to determine recession rates.
Mississippi The entire 359 miles of tidal shoreline is low-lying and subject to severe hurricane flooding. Much of the coast is intensely developed. Erosion is a problem in some areas. Hurricane Camille killed 260 and caused $1.4 billion in damage in 1969.	* Regulation of most coastal hazard areas is at the local level; however, the state directly regulates certain coastal wetlands. * The state has completed evacuation plans for coastal areas.
New Hampshire The entire 131 miles of tidal shoreline is low-lying, intensely developed and subject to hurricane and winter storm damage.	* Most regulation of coastal areas is at the local level; however, the state directly regulates coastal wetlands.

State	Program Efforts
New Hampshire (cont.) Erosion is a problem along the entire coast. Moderate to severe damage occurred in the major winter storm of 1978.	* The state has assisted FEMA in preparation of flood-rate maps. * The state plans to help prepare evacuation plans for Seabrook Power Plant project.
New Jersey The entire 1,792 miles of tidal shoreline is subject to hurricane and winter storm damage with the 126 ocean front miles of barrier islands and beaches most susceptible. Virtually all of the coast, including barrier islands, is intensely developed and subject to erosion.	* The state is conducting a hurricane vulnerability study with \$200,000 in FEMA funding. * The state is coordinating with New Jersey State Police, Water Resources and FEMA to develop a coordinated approach to coastal storms. * The state regulates certain large-scale development under the Coastal Area Facility Review Act of 1973; it also regulates coastal wetlands. Most regulation of coastal areas is at the local level. * Under the Emergency Flood Control Board Act of 1978, the state is providing \$22 million in matching funds to local governments to construct flood control works and \$3 million for preparation of a statewide flood control master plan. * The state is conducting monitoring and enforcement meetings with all communities.
New York Much of the 2,380 miles of ocean, tidal river, barrier island and Lake Erie and Lake Ontario shoreline is subject to flooding and erosion. Hurricane Donna killed 36 in 1960.	* Regulation of most coastal floodplains is a local responsibility; however, the legislature has mandated local regulation of wetland and floodplain areas consistent with state standards. * The state has prepared guidelines and model ordinances for communities. * The state has assisted local communities in preparing plans for coastal erosion areas.

State	Program Efforts
North Carolina The entire 3,375 miles of tidal shoreline is low-lying and subject to hurricane damage. Winter storms are also a problem. Erosion is a problem along much of the coast, particularly on barrier islands and along the Outer Banks. The last major hurricanes were Donna in 1960 and Ginger in 1971.	* The state adopted a Coastal Area Management Act in 1974 with a strong emphasis upon management of flood areas. The Act mandates local planning of hazard areas and authorized the state to directly regulate areas if local governments fail to adopt and administer regulations meeting state standards for dunes, beaches, wave action areas, erosion areas and other hazard zones. Setback lines, dune protection regulations and broader flood hazard reduction measures have been adopted. * The state has developed evacuation plans for all coastal areas. * The state has prepared hazard maps for all areas. Existing maps are being refined with emphasis on ocean erosion rate maps. * The legislature is considering a full disclosure statute and tax incentive statute. * The state is preparing a prototype plan for postdisaster reconstruction for use by localities. * The state has adopted a limited acquisition program for high hazard properties. * The state is preparing a new statewide building code. * In 1971 the state adopted a statute requiring all barrier island communities to adopt sand dune ordinances.
Ohio Most of the 265 miles of Lake Erie Coast is subject to erosion. Some areas are also subject to flooding from eastern storms.	* Regulation is at the local level. * The state has developed model ordinances for use along erosion-bluff areas.

State	Program Efforts
Oregon Much of the 1,410 miles of tidal shoreline is subject to flooding and erosion. Winter storms and tsunamis are the major source of flooding. Winter floods in 1964 caused $8.3 million in damage in Tillamook County alone.	* The state adopted a comprehensive land use act in 1973 which requires that all local governments plan and adopt regulations consistent with goals and policies adopted by the State Land Conservation and Development Commission. These goals and policies have a hazard element which includes beaches, erosion areas and other hazard areas. The state may directly plan for and regulate areas if local governments fail to act. * The state has provided $24 million (statewide) to local governments to help them plan and implement the Comprehensive Land Use Act.
Pennsylvania Erosion is a severe problem along much of 60-mile Lake Erie coastline; tidal flooding of low-lying areas is a problem along the 60 miles of lower Delaware shores. The last major flood occurred in 1955.	* Regulation of hazard areas is a local responsibility. * Flood and erosion areas have been designated areas of particular concern.
Rhode Island The entire 384 miles of shoreline is low-lying, intensely developed and subject to hurricane and winter storm damage. Erosion is a problem along much of the coast. The entire coast was devastated by the 1938 hurricane which killed 19. In 1955, Hurricane Dianne caused $35 million in damage.	* Coastal regulation takes place at both state and local levels. The state has adopted a building code. In addition, the state adopted the Coastal Management Act of 1971 which authorizes the Coastal Resources Management Council to directly regulate development seaward of the mean high tide. * The state has prepared coastal erosion maps. * The state has conducted workshops for local officials and provided technical assistance to local governments.

State	Program Efforts
South Carolina The entire tidal shoreline of 2,876 miles is low-lying and subject to hurricane damage. Some of the coast, particularly barrier islands, is intensely developed. Critical erosion is presently occurring in many areas. The last major hurricane occurred in 1929. However 2,000 died in a pre-1900 storm.	• An evacuation plan has been developed for each county. • Regulation of coastal areas is primarily at the local level. • Local governments have been assisted in developing shoreline management plans including setback provisions and revised building codes. Critical areas have been designated for post-disaster planning.
Texas The entire 3,359 miles of Texas coast is low-lying and subject to hurricane damage. Some areas such as Galveston Island, where 6,000 lost their lives in 1900, are also subject to subsidence. Some, but not all, areas are intensely developed. Erosion is a serious problem along much of the coast. In 1961 Hurricane Carla killed 32 and caused $408 million in property damage.	• Regulation of coastal areas is at the local level. • Vulnerability studies have been completed for a 5-county area around Galveston. Initial work has begun in Beaumont/Port Arthur and the Port Aransas/Corpus Christi area. • An evacuation plan was developed for Galveston and for other areas. • Coastal construction workshops and legal issues workshops have been held. • The state has provided technical assistance to local governments in adopting and administering regulations.
Virginia Most of the 3,315 miles of open coast and Chesapeake shoreline is low-lying and subject to hurricane and winter storm damage. The last major winter storm occurred in 1962 when the dune system and much coastal development were severely damaged. An estimated $7.1 million in damage occurred at Chincoteague.	• Regulation of most coastal construction is at the local level; however, the state has adopted a State Building Code with a floodplain management element. In addition, it has mandated and established guidelines for local regulation of wetland areas. • The state has worked with localities and NOS to develop storm evacuation maps for the tidewater area, the eastern shore, and the western shore of the Chesapeake up to Northern Neck.

State	Program Efforts
Washington Much, but not all, of the 2,337 miles of tidal shoreline is low-lying and subject to winter storm damage and potential tsunami damage. Erosion is a severe problem along a portion of the coast. Development is intense in some areas.	• Regulation of coastal hazard areas is at the local level; however, in 1971 the state adopted a Shoreline Management Act which mandated local regulation of shoreline areas consistent with state standards. • The state has prepared an atlas of coastal erosion and flood hazard areas. • The state has provided technical assistance to local governments.
Wisconsin Much of the 620 miles of Lake Michigan and Lake Superior shore is bluff and subject to erosion damage. Low-lying areas are subject to flooding from fluctuating lake levels. Development is intensive in some areas.	• Regulation of Lake Michigan and Lake Superior coastal floodplains is at the local level; however, under the 1965 Water Resources Act the state mandates local regulation of flood hazard and shoreline areas (1,000 feet of lakes) consistent with state standards. • The state has provided model ordinances and technical assistance to communities. • The state has assisted communities in determining erosion rates and preparing erosion recession rate maps.

to the fragmented and only partially coordinated federal programs (Platt, 1979). Overall, since 1979, this fragmentation has continued and perhaps worsened due to program modification and budget cutting although there have also been some improvements such as the formation of federal post-disaster mitigation teams and the adoption by Congress of the Coastal Barrier Resources Act of 1982.

Principal federal/state programs in 1983 are the Coastal Zone Management Program (Department of Commerce), the National Flood Insurance Program (FEMA), FEMA's disaster preparedness planning program, the U.S. Army Corps of Engineers' erosion control and technical assistance programs, and the Department of Commerce's hurricane warning and evacuation mapping programs. The Flood Plain Management Executive Order, 11988, issued by President Carter in 1977, establishes a general federal policy for mitigation of flood losses including grants-in-aid to states. Each of the federal assistance programs has different goals and different state client groups.

The Coastal Zone Management Program, established by Congress in 1972, has been the major source of funds for state coastal resource planning programs including some planning of hazard areas, technical assistance, special state mapping and community grants-in-aid. The Coastal Zone Management Program is a geographically broad, multi-objective planning program but lacks specific hazard regulatory guidelines. Congress directed that state programs assess the effects of shoreline erosion and evaluate mitigation measures. State grants for the Coastal Zone Management Program exceeded $50 million in 1981 but have been reduced to less than half for 1982-83.

The National Flood Insurance Program contains regulatory guidelines but applies only to flood hazard areas and has relatively narrow flood loss reduction goals. Erosion is only partially addressed. The NFIP has worked primarily with state floodplain management programs. These are often located in an agency or division separated from the coastal zone management programs. The NFIP has included a major federal floodplain mapping effort for inland and coastal areas with funding approaching $50 million a year. States have assisted FEMA in establishing map priorities, enrolling communities in the NFIP, educating communities, and helping communities adopt and administer regulations.

Although it has been very important to the states, the NFIP has been primarily a federal/local program with limited state funding. Total yearly outlays for the State Assistance Program began at the $5 million level and have dropped.

The U.S. Army Corps of Engineers programs have not involved grants-in-aid to states but some grants have been made to private property owners for erosion control measures. The Corps conducts erosion surveys and erosion control studies and carries out beach protection projects. Primary clients are local governments and private property owners. But it has provided technical assistance to states and carried out mapping and research into coastal flooding and erosion.

FEMA's disaster preparedness program has provided grants-in-aid to states for preparedness planning. These grants have been made primarily to state civil defense agencies. Hurricane and storm preparedness has been an element in some but not all of these efforts. Generally civil defense planners have emphasized evacuation and immediate disaster response, but with little attention to reducing losses to housing and other structures.

Although each of these programs has played an important role, the National Flood Insurance Program has been the dominant coastal influence due to its central role in local hazard mitigation and massive mapping efforts. Problems with the National Flood Insurance Program have become, in a real sense, principal state and local problems.

1. Mapping efforts for the National Flood Insurance Program have sometimes been at too small a scale for state or local regulatory purposes. Until quite recently, maps have been available for only a portion of the coast. Nor have maps reflected wave heights. In some instances there have been serious problems with map accuracy and the methods used to estimate storm surge elevations and wave heights. Perhaps most frustrating from the perspective of the states is that FEMA has not considered erosion in these estimates.

2. Until recently, FEMA did not address wave elevations in establishing minimum construction standards. FEMA's regulations were, therefore, more lenient than some state regulations, and may have encouraged development at inadequate elevations.

3. FEMA's flood insurance rates have not reflected actual risks such as erosion and wave heights. This may have encouraged unwise development in some high hazard areas. For example, until recently, the tops of dunes were often placed by FEMA contractors in low hazard zones despite warnings by geologists

and hydrologists that beachfront dunes almost never survive major storms. FEMA is making an attempt to remedy this problem, but progress has been slow.

4. FEMA has made limited efforts to monitor community enforcement of floodplain regulations adopted for entry into the National Flood Insurance Program due in part to limitations on staff. Neither have sufficient funds been available to permit state monitoring except on a limited basis.

5. FEMA and other federal agencies have provided only limited assistance to facilitate acquisition and relocation of seriously threatened or damaged properties due again to minimal funding and staff.

A Crisis in Hazard Mitigation

Both the Carter and Reagan Administrations emphasized strengthened state roles in water resources management and hazard mitigation. Although federal agencies, including OMB, have shown interest in strengthened state roles, federal assistance to state efforts has already been cut and more cuts are proposed. Cuts have taken place in both direct federal aid such as technical assistance, mapping, and training and education and in grants-in-aid to states. Some significant reductions in support to states and communities include:

1. The capacity of the Federal Emergency Management Agency to provide technical assistance to states, communities and private landowners has been reduced dramatically in the last three years. FEMA's staff for dealing with flood issues has been reduced from approximately 380 full-time persons in Washington, D.C. and the regions in 1980 to 40 today. These people have been reassigned toxic wastes, evacuation planning for nuclear power plants, nuclear defense planning and other topics.

2. New FEMA training and education initiatives for flood hazard mitigation have been dramatically reduced in the last two years due to a shift in agency priorities.

3. FIA has proposed reduction or elimination of future federal flood mapping. FEMA's mapping program has been very expensive (more than one-half billion dollars spent to date) and not very satisfactory in meeting state needs. A modified and improved program is needed to satisfy state, local and insurance needs.

4. Funding for state coastal zone management programs, which are the source of most state coastal hazard mitigation efforts, has been dramatically reduced. Funding for 1982-1983 was approximately half of that for 1981 ($60 million). The Administration has proposed elimination of the project altogether.

5. Funding for FEMA's State Assistance Program has been cut from $5 million in 1979 to $3.2 million in 1984. Proposals have been made to abolish this program as well.

Curiously, these cuts are taking place at a time when the federal government professes to be improving its response capabilities to natural and human-caused disasters. It is consistent with the "new federalism" that states eventually assume greater responsibility for management of their own resources over time. But how much can or will they do during the most serious state and local revenue crises of the decade?

This issue is not simply one of states needing to cope with state problems. How are the mitigation requirements of the National Flood Insurance Program--a $125 billion program--to be monitored and enforced without federal personnel or state assistance? As noted above, this federal program offers strong incentives for coastal development (a subsidy of up to 80% continues for some properties) and virtually no federal technical assistance or mechanisms to insure compliance at this time. How also are the mitigation requirements of the Floodplain Management Executive Order, the Coastal Barrier Resources Act and the Disaster Relief Act of 1974 to be implemented and monitored with the limited federal staff and resources now available?

Need for a Reappraisal

Arguments that the federal government should reduce state grants-in-aid through the Coastal Zone Management Program, FEMA's State Assistance Program and other programs so that states will be forced to develop their own hazard mitigation capability would make more sense if federal subsidies were similarly reduced for flood insurance, flood control works, and disaster assistance loans. Funding cuts for mitigation without accompanying cuts in development subsidies offer little incentive for mitigation. OMB and FEMA have reduced federal subsidies and required state and local cost-sharing in federal disaster assistance (25/75) but this cost-share requirement still greatly favors loss bearing rather than loss prevention at state or local expense.

On the other hand, arguments that the federal government should simply provide more money to the states to improve hazard mitigation also oversimplify the problem. More money will not in itself insure improved cooperative state/federal/local hazard mitigation. A careful analysis of cooperative federal/state mitigation activities is needed, including technical assistance, flood control measures, mapping flood insurance, flood warnings, disaster assistance, acquisition and grants-in-aid. Program cuts so far appear to be guided more by the principle "let's cut to save money in our individual program" than "how can federal money be more effectively applied?"

Is it not time that FEMA, OMB, GAO, NSF or another agency consider the total picture of the federal, state and local programs related to the mitigation of coastal flood disasters, how they are funded, and the implication of budget cuts on overall mitigation including the implementation of ongoing federal programs? For example, I see little indication that any federal agency has considered the implications of simultaneous cuts in the two major sources of funds for state programs--the Coastal Zone Management Program and FEMA's State Assistance Program.

A reappraisal of total state/federal roles should build upon what has been learned during the last decade rather than simply continue present directions. For example, new directions in mapping are needed. What cooperative state/federal directions appear most productive?

1. States should, with federal support and cooperation, do what they do best:

   a. Coordinate federal/local programs such as disaster assistance and the National Flood Insurance Programs where federal staffing and resources are too limited to deal with 17,000 individual communities.

   b. Help FEMA provide oversight for the community floodplain management efforts.

   c. Help FEMA establish mapping priorities and tailor maps and data gathering to local special conditions such as "muddy bottoms" in Louisiana.

   d. Provide "state-specific" training and education to communities, bankers, lawyers, developers, private landowners, engineers and architects in the hazard specifics of state law.

   e. Provide assistance to communities on technical issues such as ordinance drafting and adoption, map interpretation, floodproofing, beach erosion control works, and postdisaster mitigation planning.

   f. Coordinate and help communities carry out evacuation planning and both pre and postdisaster mitigation planning.

g. Establish state building codes incorporating storm surge, wave, wind, erosion and other hazard mitigation requirements.

h. Directly regulate (in some instances) velocity zones, barrier islands and other high risk areas both before and after disasters where local units either fail to, or lack the expertise to, regulate such areas.

Congress and federal agencies should take the following actions to better support state/local hazard mitigation:

1. Continued Selective Mapping on a Cost-Share Basis. FEMA, the Corps and NOAA should undertake improved and selective mapping of coastal velocity zones and other hazard areas (perhaps on a cost-sharing basis with states) to better serve state and local regulatory and land management needs and to provide a more realistic assessment of risk so that insurance rates and land management approaches can better reflect this risk. Such mapping should address combined erosion and flooding problems.

2. Oversight for Local Programs. FEMA should, in cooperation with other federal agencies and states, develop improved techniques for evaluating community flood hazard mitigation measures including techniques for providing improved oversight of community regulations. Better coordination of flood insurance rates, disaster assistance, flood control measures and land use management is also needed to offer greater community and state incentives for hazard mitigation.

3. Research on Mitigation Measures. In cooperation with the Corps, NOAA and states, FEMA should develop a program to determine the effectiveness of mitigation measures, what measures work best in particular conditions and what are their relative costs and benefits. After flood events, damage surveys should be carried out for protected and unprotected structures to determine the effectiveness of mitigation measures and the accuracy of mapping approaches in predicting actual hazards.

4. Training and Education. FEMA, NOAA and other agencies should help fund and provide cooperatively with the states, enhanced training and education for local governments, landowners, bankers, lawyers, architects, engineers and other floodplain decisionmakers. This will not necessarily require new funding within FEMA, but it will require a shift in priorities. Such education should address the nature and severity of coastal hazards and mitigation measures such as construction practices, warning systems, floodproofing of existing buildings and postdisaster repair and response.

5. Multi-Agency Use of Personnel. FEMA, the Corps, NOAA and the states should cooperatively develop mechanisms for improved multi-agency use of federal, state and local experts in hazard mitigation including sharing of mitigation personnel among states both before and after disasters. Emergency

management personnel such as civil defense employees and police could be given training in flood loss mitigation.

6. Incentives for Local/Private Mitigation. Added incentives for local government and private sector mitigation of flood losses can take several forms. FEMA's effort to revise coastal flood insurance rates to reflect actual risk in V Zones should be continued and applied to other areas so that private landowners have a greater financial incentive to floodproof or relocate both prior to and after disasters. FEMA should also shift communities into the "regular" phase of the National Flood Insurance Program as soon as possible to reduce long-term subsidies for existing development although this shift should be accomplished carefully to prevent undermining of existing programs. Congress could help through income tax incentives including accelerated depreciation and tax credits for floodproofing. Congress should also place nonstructural measures on an equal funding and cost-sharing basis with structural measures.

7. Continued Financial Support for State Mitigation. Congress, OMB, FEMA, NOAA and the other agencies should continue to provide financial assistance to states to support short- and long-term nonstructural loss reduction measures including planning, regulation, and relocation. As with disaster assistance and flood control measures, mitigation techniques such as regulation and mapping cannot be accomplished once and for all, or on a one-shot basis. Each time a disaster occurs mitigation activities are needed along with more traditional relief and recovery. Predisaster mitigation planning and regulation are keys to reduction of future losses.

   Federal financial assistance may take the form of Coastal Zone Management Program grants, State Assistance Program grants or new types of assistance. Whatever its form, this assistance must be channeled to those in state government with expertise in floodproofing, building setbacks, retrofitting of structures and similar technical subjects. Congress may wish to consider new funding strategies for these programs such as the return of a portion of flood insurance proceeds to the states or earmarking a portion of disaster assistance funds specifically for mitigation.

   It is reasonable for Congress, FEMA and OMB to expect states to bear a larger share of costs for programs with state and local benefits, but across-the-board cuts in the Coastal Zone Management Program and FEMA's grants-in-aid and technical assistance programs which are the key to implementation of the National Flood Insurance Program and other federal loss reduction programs make little sense.

In summary, strengthened--not weakened--state programs are needed to help meet the growing threat of coastal flood disasters, including potential federal fiscal liability. Considerable state experience in hazard mitigation has been gained in the last decade. This could form the basis for increasingly comprehensive and cost effective cooperative state/ federal/local programs. But will lessons be learned from existing efforts and will such programs ever be implemented? Diminished rather than increased hazard mitigation appears likely in the next several years unless state legislatures and Congress reverse the present trend. A thorough reappraisal of cooperative federal/state policy is needed and a renewed commitment to disaster and loss prevention goals. We have brought you together at this symposium to help begin this task. We hope the task will be completed by FEMA, OMB, the Corps, NOAA and Congress working cooperatively with the states.

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II. STATE POLICIES AND PROGRAMS

CAN AND WILL THE STATES INCREASE THEIR HAZARD MITIGATION EFFORTS?

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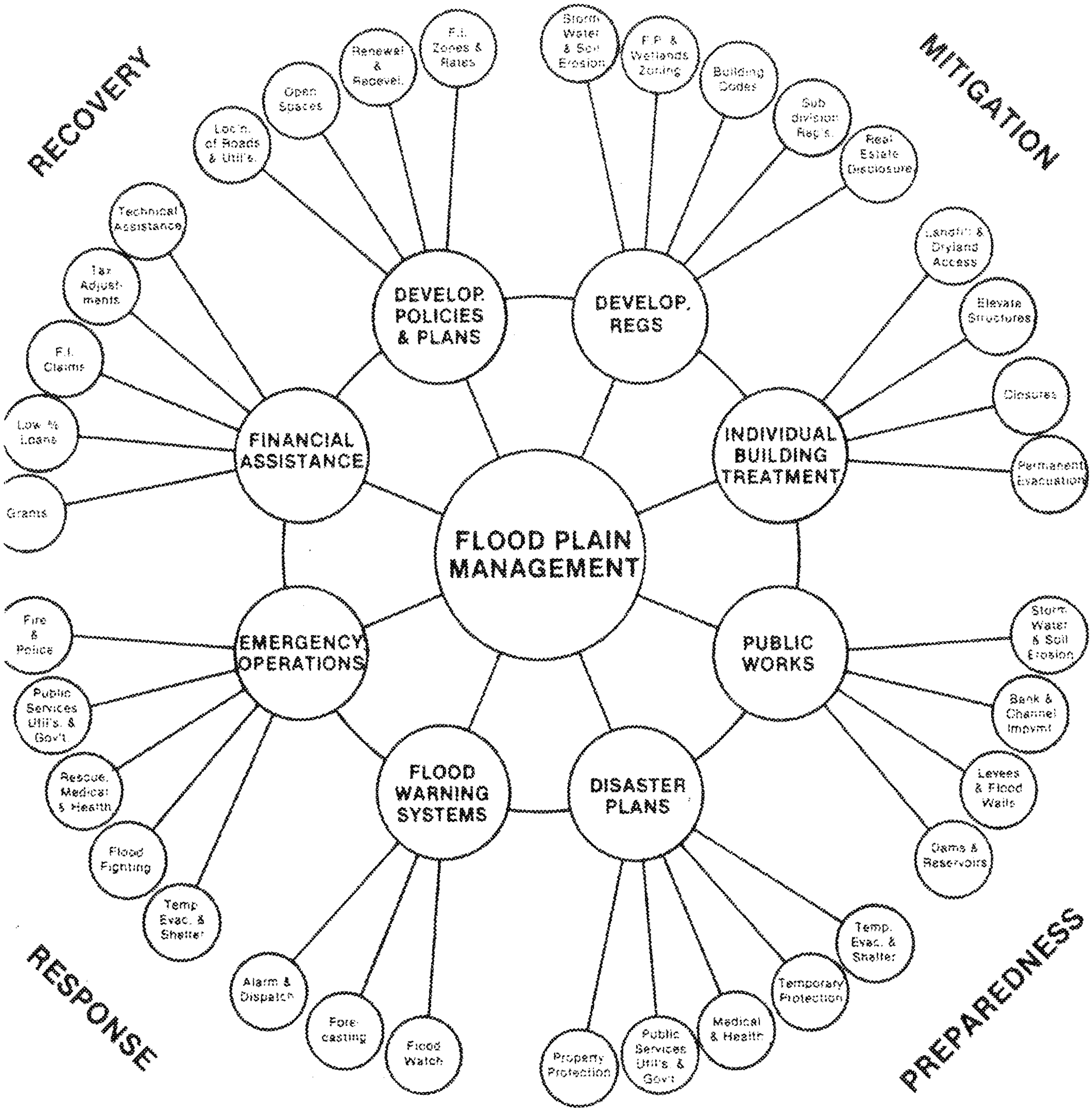
Coastal flood disasters occur with alarming frequency. Furthermore, while flood damages in riverine areas seem to be increasing at a reduced rate, damages in coastal areas seem to be increasing more rapidly. Efforts to guide development out of high hazard areas have been more successful in riverine than coastal areas. In riverine high hazard areas, (the floodway) structures are largely prohibited through state and local standards. However, in coastal high hazard areas (the velocity zone) structures are normally permitted, provided they are elevated. Only recently has this elevation requirement taken wave heights into account. Regulations have not addressed adequately specific problems like wave heights, dune loss and barrier islands.

Realizing reduced damages from flood disasters requires the combined efforts of local, state and federal agencies. Ways must be found to encourage the private sector to support mitigation efforts. Each of these efforts should address two major segments of flood hazard management programs:

1) Guiding new development.

2) Taking actions to reduce losses to existing development.

Local governments must play the key role in these efforts. There are many incentives for aggressive local action. Locals have a lot at stake because they rely on the natural values of coastal areas to attract housing, recreation, tourism and commerce. Improper construction resulting in high flood losses or the loss of attractive natural values adversely affects local economic and human environment interest. Local governments should take the lead in active planning, permit and mitigation programs. There are a number of tools to accomplish this including zoning, building codes, comprehensive planning, stormwater management, development regulations, public education, preparedness and evacuation planning, tax incentives, and public works. The chart demonstrates the broad spectrum of means available to communities and individuals. Local governments must get adequate technical assistance to be aware of, understand and



MEANS & TOOLS OF FLOOD PLAIN MANAGEMENT
Potential mitigation efforts if not properly directed
easily turn into aggravating forces.

Wisconsin Department of Natural Resou
May, 1983

successfully implement these approaches.

State governments must play a more active role in coastal areas than riverine areas. Coastal flood disasters tend to affect more of a state's population since people concentrate in coastal communities. Mitigation efforts such as evacuation planning, technical evaluations of wave heights, dune loss and erosion and mapping are more likely to exceed the ability or jurisdiction of local governments, and thereby require the attention of the states. States are in the best position to provide assistance to locals and act as a knowledgable link between unique local conditions and federal requirements. As a result, states can help local governments tailor their programs to their own unique conditions.

The state role includes the development of minimum regulatory standards tailored to state hazard conditions, assistance to local communities for regulatory planning and mapping, monitoring local government activity and sharing the costs of local efforts that contribute to mitigation in coastal areas. Special state programs also may be warranted in coastal areas. These might include

- State permit programs for coastal high hazard areas to regulate dunes, beaches, wetlands, recreation sites and areas subject to erosion and flooding;
- State wetland protection programs to preserve valuable fish and wildlife habitats, commercial fishing production, recreational opportunities and storage of flood waters;
- Special state building code requirements for coastal high hazard areas that take into account wave heights and also meet other structural requirements;
- Acquisition of valuable resource or recreational areas that coincide with coastal high hazard areas;
- Evacuation maps, warning systems and planning for coastal regions that incorporate multiple local jurisdictions;
- Identification and mapping of the coastal high hazard areas to include long-term recession and erosion;
- Adoption of state executive orders to insure that all state agency projects comply with the same standards required of private development.

There are two good reasons for states to play a more active role in reducing flood disasters. First, disasters cost states money. Those costs include direct payment of the non-federal share of disaster costs (25%), restoration of damaged state-owned facilities such as bridges, and assistance to local governments before and during the disaster for emergency preparedness, evacuation, and flood fighting. Economic losses include business income, dollars diverted to rehabilitation rather than new development, and a decreased tax base because people are unwilling to upgrade structures that are subject to repeated flooding.

Second, states are in the best position to assist local governments. They are closer to local government and better able to integrate many federal and state programs at the local level and help tailor local programs to local conditions. Many programs have special considerations for flood hazard areas. Examples are septic tank requirements; water and sewer projects; subdivision requirements, solid waste, water quality and other environmental programs; and state grants for mapping, management or mitigation in flood hazard areas.

Federal government involvement is essential in coastal areas. The majority of federal disaster costs are paid for floods in coastal areas. Most flood insurance policies are for coastal properties because that is where floods have been occurring and there are a great number of structures at risk. People with structures already there buy flood insurance due to floods. New developments are required to be insured and more new development is occurring in coastal areas than riverine areas. The federal role should include the establishment of national regulatory standards, mapping hazard areas, providing insurance, cost sharing of mitigation efforts and helping to build state capability.

With over 17,300 flood-prone communities in the nation, federal agencies cannot provide adequate assistance or monitoring of local governments. Tailoring maps and regulations is a task that must be done at the state level. To reduce flood losses, it makes sense to invest federal dollars to build better state programs. This concept is supported by Congress as demonstrated in the air and water quality and solid and hazardous waste programs.

Limitations on State Coastal Hazard Mitigation Efforts

By 1980, approximately 31 states had adopted statutes authorizing either direct state regulation of flood hazard areas or state standard setting for local regulation (Kusler, 1983). A number of those states have laws and programs that exceed the minimum standards of the National

Flood Insurance Program. The federal coastal program and FEMA's State Assistance Program help states preserve and enhance coastal values. Many of the 35 coastal states have developed their own programs to cope with coastal problems. Coastal erosion was specifically addressed by many states through such measures as erosion setback ordinances. Funding for the federal coastal zone program is ending, which will probably result in reduced effort at the state level.

Dollars are essential to state participation in coastal hazard mitigation. Those dollars come from the states themselves, the Coastal Zone Management Program and the State Assistance Program from FEMA. Every effort must be made to maintain an adequate overall level of funding. The coastal zone program and FEMA State Assistance Program must provide funding during the transition until the states can pick up some of these program costs themselves.

In addition to funding, coordinated policies are essential. Adequate training and education of state and local officials is a must, yet FEMA's programs do not meet this need. An overhaul of the FEMA training and education program may be needed to identify needs and priorities and establish the means to satisfy them. Particular emphasis must be placed on local training needs and a system to deliver that expertise through regions and states.

Other limitations on state programs are inadequate or fragmented statutory authority at the state level, conflicts between larger cities and state governments as well as between state and federal policies, lack of public awareness of coastal disasters and the problem of regulating existing uses in flood-prone areas.

Ways to Overcome These Limitations

- Coordinate the many ongoing efforts in coastal areas to maximize the ability to reduce coastal flood losses and increase mitigation activities. The Coastal Zone Program, the National Flood Insurance Program, wetlands preservation, disaster relief, civil defense, the Corps of Engineers Floodplain Management Service, and the activities of the Soil Conservation Service are just some of the programs that must share priorities, personnel and activities. Are we still spending tax dallars to rebuild or provide new infrastructure that results in more development in coastal high hazard areas? Are coastal programs and floodplain management programs properly integrated at the state level? The federal level? Are federally funded programs to nourish beaches or build structural work to protect coastal areas compatible with other programs to discourage development of such areas?

- Funding of these key programs must be adequate to make progress toward those goals and to provide a transition period during which states can come to assume an increased role. If the states lose coastal program or State Assistance Program funding, how many staff people will be lost? How will that loss hinder the ability of that state to reduce coastal flood losses for disaster relief or preserve coastal beaches? Have any federal agencies talked specifically with states to determine a logical transition period that is tied to the state's ability to fund its coastal program? Is there a residual national interest in coastal areas that requires a continuous federal investment for protection and enhancement? Have any incentive programs been developed to encourage greater state participation? If better state programs result in better local programs and a reduction in federal expenditures, that should provide a basis for incentive programs.

- Federal and state roles must be clarified to avoid duplication of effort and provide long-term guidance. The federal government should provide incentives and direction, including flood insurance, national regulatory standards, mapping, disaster assistance, public education and research. State governments should set standards tailored to special hazard conditions, technical assistance and training for local government personnel, and education of the public. The states must help local communities integrate the many elements of flood hazard management. All federal agencies must endeavor not to deal directly with locals, but to go through the state government to do so. To persist in justifying this direct involvement because a state is "weak" will only prepetuate the weakness and constrain program advances on a national scale.

- Training and education programs must place priority on training local and state officials to guide new development and undertake mitigation actions where there is existing development in high hazard areas. These programs should be aimed at key local officials and influential community leaders. This may require revamped training systems in federal agencies and the increased use of incentives to state and local participation.

- Federal programs must become better able to consider unique hazard conditions like coastal wave heights, coastal erosion, dunes, and barrier islands.

- The private sector must become more involved. Industries have a significant stake in losses due to floods, as do private homeowners. Acquisition of property by local or national conservation groups should place priority on coastal high hazard areas. Banks and insurance agents can be key links in directing development to reduce losses. Education, training and incentives are needed to foster increased private sector involvement.

- Nonstructural mitigation must be emcouraged by federal and state governments. Many local communities want to reduce flood losses to existing structures and have developed mitigation programs that meet many local goals including flood loss reduction, economic development, and housing stock improvement. In order to implement these programs, most local communities need some funding assistance through cost sharing. No federal program exists that is capable of assisting an adequate number of communities each year. The Corps of Engineers' programs are too complex and take too long to implement. There are significant obstacles in determining benefit/cost ratios. FEMA's 1362 program is grossly underfunded. The SCS PL-566 program has policy problems. There should be at least one federal program that is streamlined and adequately funded to assist in this effort.

. Some states, such as Louisiana and Maryland, are starting to share the costs of mitigation efforts. Other states need to pursue such initiatives. In addition, states must review and streamline statutory authority, increase training and education of locals and the public and work closely with locals to tailor regulations and mitigation programs to adequately address existing nonconforming uses in coastal high hazard areas.

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MANAGING DEVELOPMENT IN COASTAL HAZARD AREAS: STATE-FEDERAL RELATIONS

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Providing reasonable management of development in coastal high hazard areas has been a high priority for the State of North Carolina for the past ten years. With the adoption of strong new rules on this subject in 1979, North Carolina has been among the nation's leaders in implementing a comprehensive management program for oceanfront development. This experience has provided a number of lessons regarding the efficacy of various management techniques and the need for a more coordinated state-federal approach to this issue. This paper presents a state-level perspective on these issues and how hazard management programs can be improved.

Context for Coastal Hazards Management in North Carolina

The coastal hazards facing the oceanfront areas of North Carolina are typical of those facing East and Gulf Coast barrier islands (Clark et al., 1980). Long-term erosion is a reality for much of the state's 320 miles of ocean frontage (Dolan et al., 1979). Studies performed for the state's Office of Coastal Management indicate that almost 40% of the ocean shoreline has a long-term average annual erosion rate of three feet per year or higher. Given sea level rise and barrier island migration, these general erosion rates are likely to continue (Kaufman and Pilkey, 1979). However, future erosion rates at any individual site are likely to vary significantly.

Storm hazards are also a reality for most of the state's coast, with the outer banks being among the most vulnerable to hurricane threat in the country. Projections are that major hurricanes will make landfall in the state once every ten years and great hurricanes once every fifty years. These hurricanes will bring high winds, heavy rains, storm tides 10 to 15 feet above normal, and shoreline recession of 350 feet or more to the state. Extratropical depressions strike the state more frequently.

Most winters bring several damaging storms, which can on occasion be even more damaging than most hurricanes, as was the case with the Ash Wednesday Storm of 1962.

Inlet migration is another coastal hazard that is increasingly affecting development in the state (Langfelder et al., 1974). As safer areas are developed, more and more high density development is being proposed for dynamic inlet areas in North Carolina which had long been known for its low density, family-oriented small beach towns. Increasing demand for beach property has led to a proliferation of condominiums, time-sharing projects, and high-rise motels.

The coastal management structure was established in North Carolina with passage of the Coastal Area Management Act (CAMA) in 1974 (Heath, 1974; Schoenbaum, 1974). The CAMA establishes a Coastal Resources Commission (CRC) to designate critical environmental areas (termed "areas of environmental concern" or "AECs"), which specifically include hazard areas. The CRC oversees a regulatory program that requires a permit for all development in these designated areas. The law also requires mandatory land use planning, consistent with standards set by the CRC, to be undertaken by local governments in the coastal area. All twenty of the coastal counties and approximately fifty municipalities now have approved land use plans.

State Hazard Area Management Initiatives

The initial land use plans adopted by local governments pursuant to CAMA in 1975-76 and the original permit standards for AECs, which were first effective in 1978, addressed some hazards issues. The principal initiatives in this regard date from 1979 when major changes were initiated in the state permit standards and land use planning guidelines (Owens, 1981). The management framework that has been put into place in the 1979-83 period is among the strongest in the nation.

The regulatory program applies to those geographic areas designated as "ocean hazard" AECs by the Coastal Resources Commission. The ocean hazard system is composed of three parts. The first is the "ocean erodible area." This area runs from the mean low water a distance landward from the vegetation line equal to 30 times the long-term annual erosion rate plus the recession expected in a 100-year storm. The second is the "high hazard flood area." This area is defined as those open coast areas subject to wave action and flooding in a 100-year storm. The third component is the "inlet hazard area." This area is defined using statistical analysis of past inlet movement.

A key regulatory provision affecting development in these areas, and by far the most controversial regulation in the entire coastal management program, is the minimum oceanfront setback. This rule requires development to be located behind the furthest landward of four points: 1) thirty times the long-term annual erosion rate, measured from the vegetation line; 2) the crest of the "primary" dune (defined as the first dune with an elevation equal to the 100-year storm level plus 6 feet); 3) the landward toe of the frontal dune (defined as the first dune with sufficient height, continuity, configuration, and vegetation to offer protective value); or 4) sixty feet, measured from the vegetation line.

Only limited exceptions are allowed to this rule. Non-disruptive development that does not involve permanent substantial structures is allowed between the setback line and vegetation line. Allowable development includes clay parking areas, gazebos, tennis courts, campgrounds, and the like. This allows landowners a reasonable use of the land consistent with the inherent limitations of the natural hazards. No development is allowed seaward of the vegetation line. For preexisting lots that cannot meet the erosion rate and primary dune setbacks, a limited exception is allowed provided the 60-foot and frontal dune setbacks are observed. However, the size of such "grandfathered" structures is limited and additional construction standards must be met. The CRC is currently considering proposals to significantly increase the minimum setback requirement for large immovable structures.

There are several other key regulatory provisions that have been adopted under CAMA. No significant alteration of frontal or primary dunes is allowed. Construction standards closely modeled after federal requirements for floodplain ordinances under the flood insurance program have been adopted. Bulkheads and other shore hardening oceanfront erosion control structures are not allowed to protect development built after the setback rules were imposed in 1979. Such growth-inducing public facilities as roads, water supply and sewer systems are not allowed in hazard areas. Density limits apply in inlet hazard areas, preventing immovable structures from being located in these highly dynamic areas.

In addition to these regulatory provisions, nonregulatory provisions play an important part in managing hazard area development in North Carolina. The local land use plans, which underwent comprehensive updates in 1980-81, are required to address hurricane evacuation, beach access, density, and other key issues on a community-wide basis (McElyea et al., 1982). New planning rules effective in 1983 require all local governments to undertake additional post-storm planning efforts as a part of their land use plans, including addressing storm hazard mitigation, post-storm recovery and rebuilding policies, and evacuation plans.

Land acquisition is also being used to address coastal problems in North Carolina. Although 48% of the state's oceanfront is already in public ownership, securing adequate beach access was becoming an increasing problem in North Carolina as in most other coastal states. Because of this, the General Assembly in 1981 enacted a new beach access statute, along with a $1 million appropriation for its initial implementation. This new program is explicitly tied to the hazards issues through a provision requiring priority to be given to the acquisitions of property that is both useful for access and unsuitable for the location of permanent substantial structures because of coastal hazards. Land acquisition is also being used selectively to implement overall resource management plans in key areas (Owens, 1980).

Education on coastal hazards is a critical part of the North Carolina management program. Slide shows, presentations, and articles have been used to make decision makers and the general public aware of the nature and extent of coastal hazards and the purposes of the management program. This broad understanding of the issues has proved to be essential to the political support of a controversial program.

Together, these various management efforts have been effective in reducing potential loss of life and property due to coastal hazards, in protecting the public beach area from encroachment by development or erosion control structures, and in reducing such public costs resulting from improperly sited development as disaster relief, flood insurance, infrastructure repair, and erosion control.

Much remains to be done at the state level. The General Assembly is now considering a proposal to require a simple coastal hazards disclosure to be made prior to any sale of property in an ocean hazard area. Another legislative proposal now being debated would create new tax credits to provide an incentive for the donation of hazardous coastal property to the state for land conservation, open space, or beach access use. Higher minimum setbacks for immovable structures, new land use plans for post-storm rebuilding, and closer attention to overall density levels on barrier islands are receiving close scrutiny in the state. Land acquisition and education campaigns are also being continued and expanded.

The Federal Contribution to Managing Hazard Area Development

A strong and effective state program for hazard area management is in place in North Carolina. Its effectiveness could be enhanced through the more closely coordinated application of federal programs dealing with hazard area development.

A number of federal programs have made a strong positive contribution to the North Carolina effort to manage development in coastal hazard areas (Holmes, 1980; Kuehn, 1981). Financial assistance for much of the work described above was provided through the Coastal Zone Management Act. FEMA funded much of the policy development work for the new post-storm policies. The incentives provided by the National Flood Insurance Program (NFIP) induced many local governments who would otherwise not have acted to adopt floodplain zoning ordinances to do so. Refuge, national seashore, and estuarine sanctuary programs have allowed for acquisition of hazardous lands.

Other federal programs have not had as salutary an effect. Federal funding of a large portion of the costs of disaster relief and structural erosion control projects has removed from local governments the responsibility of confronting the consequences of their land use decisions. When a local government can allow poorly sited development such as a high-rise hotel built too close to the ocean, enjoy tourism, sales and property tax benefits, and have the federal government assume most of the costs for dealing with the problems it generates (costs ranging from disaster relief to waste disposal to erosion control), the local government's incentive to more properly manage the development is clearly reduced. The recent changes in cost sharing for disaster relief improves this situation, as will the recently enacted Coastal Barrier Resources Act which limits future federal investments on undeveloped barrier islands. A major problem still remains since it is in developed areas that federal investments have their greatest impact.

Other problems stem from the failure more actively to coordinate federal and state policies. In North Carolina this is perhaps most clearly exemplified with the NFIP. While there are several instances of productive coordination of state coastal management efforts and the flood insurance program, such as the inclusion of improved construction standards in the state program, there are several areas in which coordination could be significantly improved. The state policy is to locate new development in as safe a location as possible and to deal with erosion and storm problems through nonstructural means. FEMA policies do not always support this stance, even though that program has the same general objectives as the state. For example, when the state was considering allowing modest development in some hazard areas, provided the risk was entirely privately borne and there was a waiver of any public financial assistance and cost whatsoever, the federal government advised the state that it could not honor a "no insurance" zone. This insistence that all permitted development is eligible for flood insurance prevented the injection of flexibility in hazard management.

A more serious problem in this respect has been the failure of the federal government to adopt an aggressive relocation program for imminently endangered oceanfront structures. Despite studies on the use of Section 1362 for relocation (FEMA, 1981) and experimental use of the "constructive total loss" concept to fund relocation, fewer than 20 threatened structures have been relocated in North Carolina. Given that even modest winter storms now demolish a number of structures, that a major storm would destroy thousands of structures, that erosion is constantly increasing the number of imminently threatened structures, and that relocation costs can be a fraction of the cost of total loss payments, the logic of an aggressive relocation program seems conclusive. The program is even more attractive when the benefits of public acquisition of the hazardous lots for open space and recreation are included. It would result in lower premiums for flood insurance policy holders, lower public costs to cover the catastrophic losses to the program when a major storm strikes, and improved public access to and use of the beaches. Governor Hunt and the CRC urged FEMA to implement such a program in North Carolina, but federal action has not been forthcoming.

Conclusion

Some of North Carolina's hazard area management efforts are extremely controversial. The economic values of the property and the recreational and aesthetic values of the coastline combine to make this an area about which people feel very strongly. Therefore any management effort must be based on technically sound and defensible data. A common understanding of the problems being addressed and the program's goals is also needed.

To be successful, a management program must employ the full range of available tools. Regulation, land use planning, land acquisition, public investments, and public education must all be employed in a coordinated fashion. When applied as a system each tool enhances the efficacy of the others.

Finally, there needs to be stronger coordination between state and federal programs. While the adoption of state coastal management programs with their federal consistency provisions has eliminated most of the more blatant conflicts, there remain a number of missed opportunities for more effective positive coordination of programs. Both state and federal management efforts would be more successful if their implementation were better coordinated.

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MANAGEMENT OPTIONS:
CAN WE PROTECT OUR NATURAL COASTAL BARRIERS?

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Introduction

Barrier islands are one of the most dynamic systems in nature. The engineer sees the system in a state of constant change, not equilibrium, and tries to modify the environment for personal desires. Most geologists, on the other hand, view shoreline and island changes over geologic time as a slowly evolving system in equilibrium with the oceanic processes it faces. Coastal zone managers understand these viewpoints and see the need to compromise between the two. They must come to grips with the potential for rapid, dramatic change in the system and assess the way in which those changes affect interactions between component parts such as dunes and wetlands. The coastal manager's daily decisions must account for short-term local impacts from development activity and determine the cumulative impacts individual projects have on maintaining the long-term integrity of the barrier island system.

This report examines the need to protect natural flood and erosion barriers and some regulatory tools state and local governments have used to protect these features. Two important barriers are worth discussion because of their physical capacity to reduce flood damage and the integral roles they perform within this dynamic coastal estuarine system. Those barriers, in their broadest categories, and dunelands and coastal wetlands.

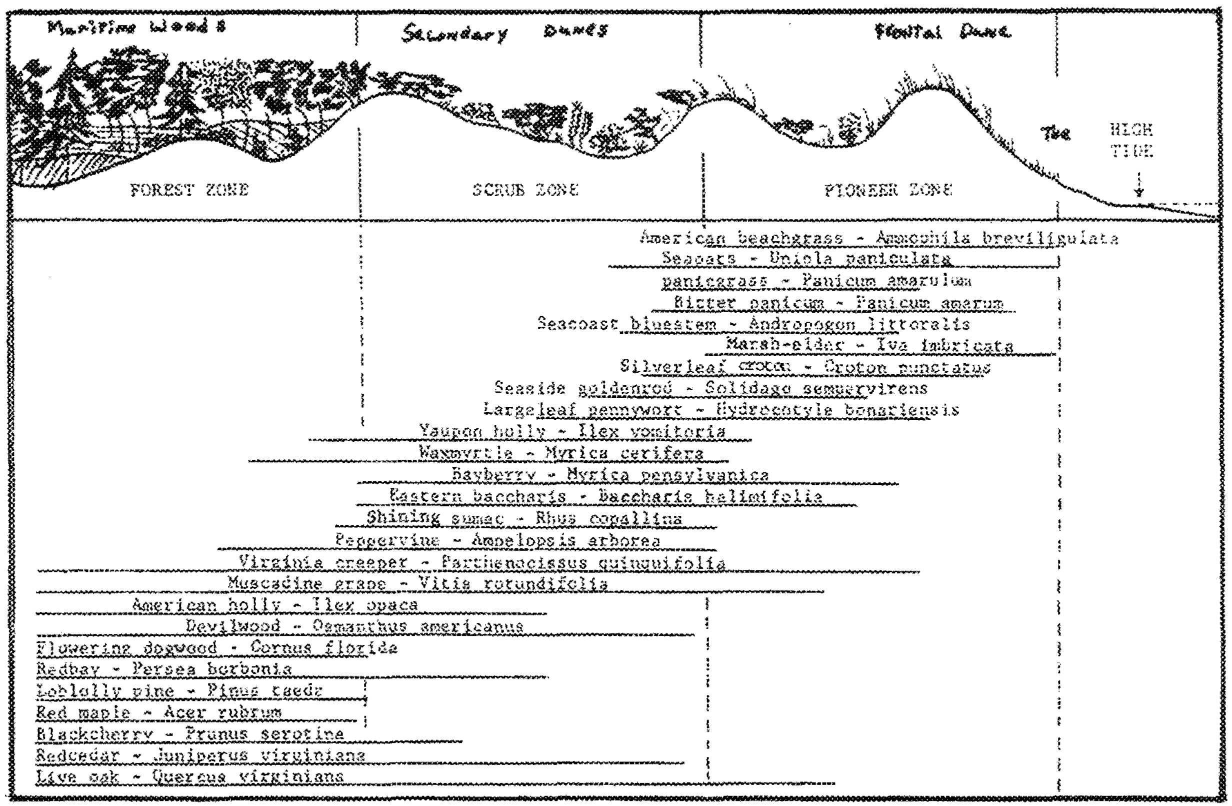
Dunelands

Coastal dunelands are keys to long-term barrier island stability since they act as temporary sand reservoirs for the erosive powers of storms. Dunelands include the active frontal dune area, the more stable, grassy, secondary dune area and back dune zones consisting primarily of maritime woodlands. The seaward edge of the duneland boundary is best described as at the toe of the dune, where stable, natural vegetation is found or where a distinct change in slope and elevation occurs next to the high tide "trashline". In areas subject to erosion, the toe of the dune corresponds to the erosion escarpment. These migrating mounds come and go according to availability of sand and direction of eolian (wind) transport and can be steep and narrow or extend completely across a barrier island for hundreds of yards.

For management purposes, it is useful to determine whether a dune is active and mobile or inactive and stable. Active dunes are still migrating with visible loss or gain of sand. They tend to be denuded or sparsely vegetated (see Figure 1) and are generally closer to the beaches and inlets. Stabilized dunes, on the other hand, are very well vegetated with climax dune vegetation (Graetz, 1973) and are found towards the interior of the islands. Often interior dunes form the backbone of the island and are vegetated by woody species.

Sand ridges normally are fairly continuous and run parallel to the beach front. In the "pioneer zone", dunes usually are smaller in height, more active and have daily interaction with diurnal tidal occurrences. For management purposes they are called the "frontal dunes". Frontal dunes with enough height and width and vegetative stability to exceed the 100-year base flood elevation (BFE) with adjustments for wave height are often called "primary dunes". Other distinct dune ridges that fall landward of these first barriers are called "secondary dunes". Those duneland areas which experience little or no ridge formation are commonly called "solitary dune mounds" and those areas where no dunes exist are either "overwash zones" due to flooding or "blowout" areas due to wind erosion.

The foreslope of the dune is more gradual and has grassy cover that can tolerate shifting sands and salt spray. The backslope or "dune slack" right behind the crest is more stable and amenable to woody plant growth. These maritime woodland areas represent the safest place to build on a barrier island and also perform basic functions such as lowering temperature extremes by shading, stabilizing the soil, nitrogen fixation, deposition of minerals in leaf litter humus and freshwater retention. On those eroding islands where maritime woodlands are near the beach, they serve as physical obstacles for storm surge.



A generalized cross section of the beach area on Bogue Bank, North Carolina.
Some common native plants with their zonal occurrence are included.

FIGURE 1

BEACH CROSS SECTION
(Graetz, 1973)

Thus, dunes and their vegetaiton interact to serve as physical barriers or buffers to climatic energies, particularly erosion. All of that sand held in storage beneath the grasses and woodlands must be forfeited in order to replenish beach materials that are either slowly eroded by normal high tide erosion or instantaneously removed by storms. In this manner, dunelands maintain their dynamic equilibrium and encourage the short-term stability of retreating shorelines. As the dunes erode, their sand is deposited in the nearshore section of the beach and shallow water sand bars. All of this displaced sand will aid in dissipating more wave energy and weaken the next storm attack (Pilkey, 1975).

Management Implications

Too often dunelands have been considered obstacles to development and nuisances to standardized building designs. The natural properties of dunes as physical barriers and their energy dissipation value have gone largely unnoticed. Even the close link between dune survivial and the vulnerable dune vegetation is not well recognized. Instead of building within the system and adapting structures and roads to dune topography, dunelands often have been leveled to provide cottages with a panoramic view. The result is the destruction of maritime woodlands due to salt spray, wind erosion and enhanced washover potential. Site preparation and construction activities also disrupt the fragile dune vegetation, resulting in destablization and blowouts (Alden et al., 1976). Buildings constructed on solid foundations or with "breakaway walls" act in much the same manner as groins along the beach with sand accumulating on the upwind side and erosion scour occurring to the downdrift side. Building too close to the ocean, on the fore slope or on the dune crest does not allow for the dune to migrate naturally and blowouts and slacks occur.

Foot and vehicular traffic across the dunes to the beach disrupts fragile dune vegetation. As few as one or two passes per week by a heavy vehicle or by 10 to 15 pedestrians per week along the same path will kill sensitive American beach grass or sea oats vegetation (Godfrey, 1972). Constant traffic to the beach will cause wide wind-swept gaps in dune formations and little healing can occur between tourist seasons.

Duneland Management Tools

The first duneland protection laws were coupled with trespassing regulations whereby no person could take or damage certain native barrier island plants. Sea oats and Atlantic white cedars were highly sought after on these sparsely populated barrier islands. Not until the hurricanes of the 1950s and 1960s had there been public sentiment to protect the dunelands. The earliest laws protected the frontal dunes.

Many local sand dune ordinances are essentially grading ordinances that require permits but containing little language to define "dune alteration". Often there exists no standardized enforcement procedure. Local ordinances often impose small civil or criminal penalties whose execution is cumbersome.

In 1971 North Carolina passed a law requiring all barrier island communities to adopt local sand dune ordinances. A key to the ordinances' success was language detailing precisely when an activity "materially weakens a dune". It is specified that a dune becomes weakened when a development activity 1) cuts into the dune foreslope, crest or backslope; 2) removes sand off the dune; and 3) needlessly damages dune vegetation. Some communities set up highly professional sand dune ordinance review boards who review detailed site layouts, while other towns established sand dune adjustment boards prone to granting variance requests.

Some of the more successful dune protection ordinances require site plans made up of topographic maps at no less than 4-foot contour intervals and require the applicant to stake the proposed placement of structures for public interest reviews. Other strong ordinances require that at least 35% of the lot's total square footage be left undisturbed, next to the dune. A few local ordinances prohibit new structures oceanward of frontal dunes and, at a minimum, be set 50 feet landward of the mean high water mark. Unfortunately, the untrained eye has a difficult time defining the mean high water mark and rear toe of frontal dunes. These inexact and sometimes arbitrary, definitions thus become points of contention between dune protection offices and applicants and between members of government review boards.

It is important to realize that common land use management tools may not be the best solution in a duneland environment. Traditional zoning, for example, relies on spatial separation to handle conflicting uses. This creates discrete zones of uniform use that may not necessarily conform to the processes occurring in the particular site. Simply platting lots and going through a subdivision review process does not usually take into consideration the ever-changing landforms and boundaries. Instead, most communities end up with prescriptive zoning rules, rigid subdivision regulations, city blocks at right angles to each other, and straight roads and utility easements, all creating static property boundaries in a dynamic coastal environment.

The experience in North Carolina suggests that it is best to derive a setback that, at a minimum, prohibits all permanent uses of the frontal dune area. This should be done with a floating setback, one which migrates landward with the toe of the dune or erosion escarpment. A larger storm recession line or hazard zone should be mapped and extended beyond the setback. This broad notice zone or permit zone should use strictly applied building and performance standards to provide for building in among the duneland features and to reduce potential flood damages. Mapping hazard zones and setbacks is good for public notice and general education, but they must be tied to a definition that can be reconstructed and measured in the field (see Figure 2).

Other duneland management tools that have been used successfully by local and state governments are

- sand dune zones overlain onto zoning maps;
- performance criteria in local subdivision regulations;
- planned unit development regulation;
- bonus and incentive zoning;
- dune protection criteria during A-95 reviews;
- criteria in sediment and erosion control laws; and
- public beach access acquisition programs.

Coastal Wetlands

As natural features that act as physical storm barriers, coastal wetlands can be divided into two categories, salt marshes and wooded swamps. Both types surround the edges of the lagoon estuary and both

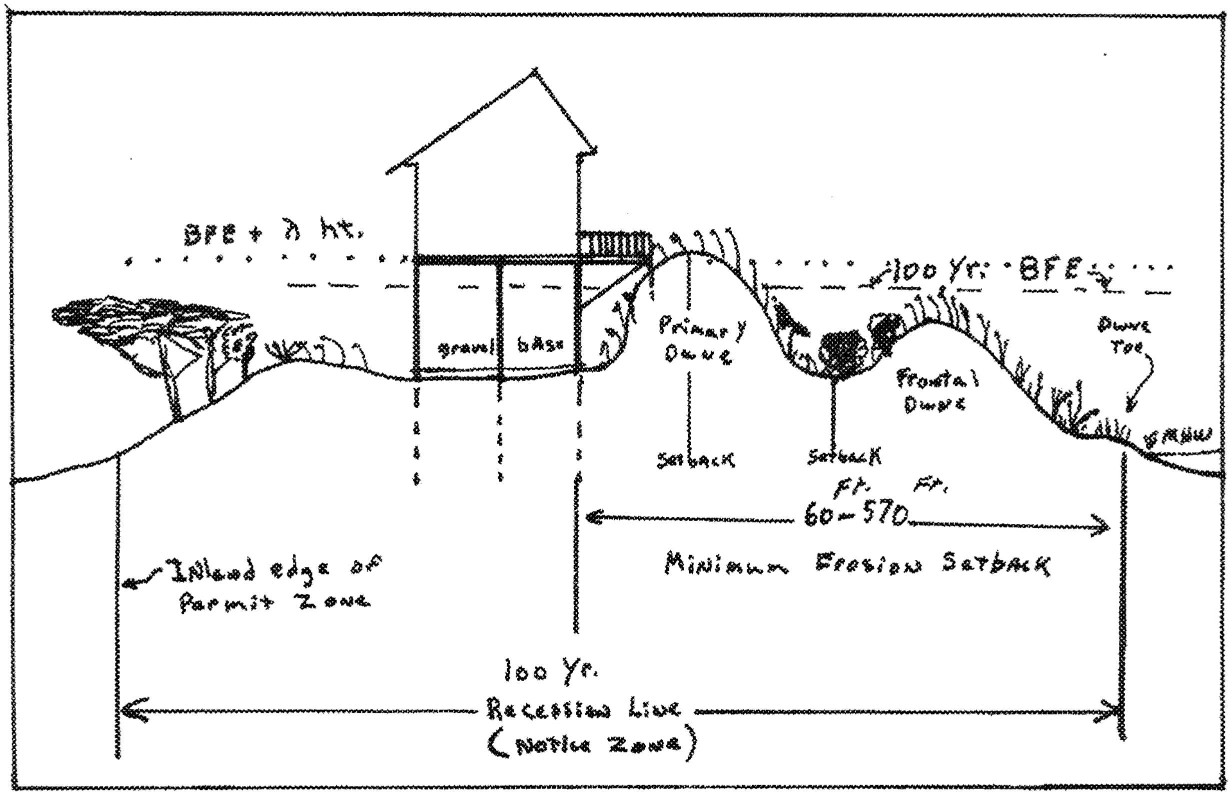


FIGURE 2

North Carolina's Setback Standards

help to protect adjacent flood-prone uplands.

Salt Marshes

The productivity of the estuarine system is supported by detritus (decayed plant material) and nutrients exported from the salt marshes. The amount of exportation and its importance to the system is variable from marsh to marsh, depending upon its frequency of inundation and the characteristics of the various plant species. Without salt marshes, the high productivity levels and complex food chains typically found in the estuaries could not be maintained.

Human beings benefit from this productivity when they fish, or hunt and gather shellfish from the estuary. Estuarine-dependent species of fish and shellfish such as menhaden, shrimp, flounder, oysters and crabs currently account for over 90% of North Carolina's commercial catch (CAMA, 1974). These salt marshes thus support a large number of commercial and recreational businesses along the coast.

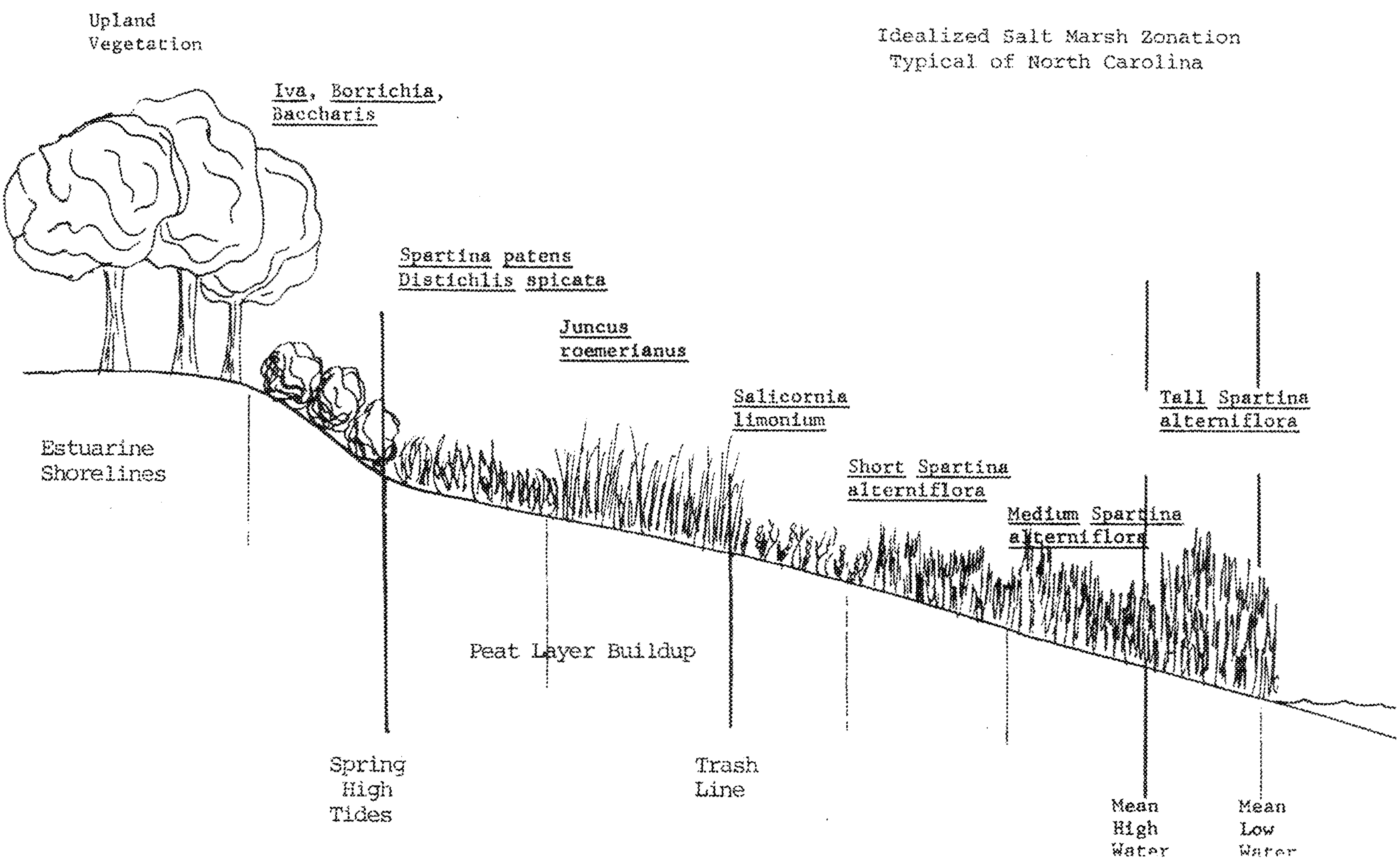
Marshlands also act as nutrient and sediment traps by slowing the water that flows over them and causing suspended organic and inorganic particles to settle out. In this manner, the nutrient storehouse is maintained and sediment harmful to marine organisms is removed. Pollutants and excessive nutrients are absorbed by the plants, thus providing an inexpensive water treatment service. Public awareness of the biological values of marshes has been one of the few success stories in environmental regulations. It is also generally recognized that salt marsh vegetation and its peat serve a function similar to the ocean berm and beach along estuarine shorelines. The plant stems and leaves tend to dissipate wave action, while the vast network of roots and rhizomes resists soil erosion. In this way, gradually sloping salt marshes serve as physical barriers against flood damage and retard estuarine shoreline erosion (see Figure 3).

Wooded Swamps

Coastal swamp forests make up half of the 5,885,000 acres of North Carolina's wetlands (Alden, 1976). Swamps are characterized by the type

FIGURE 3

Idealized Salt Marsh Zonation
Typical of North Carolina



of forest community that exists there, as opposed to other wetlands that have lower profile, more varied plant communities. The dominant hardwood tree serves to name the swamp forest type (i.e., cypress swamp, tupelo gum swamp), and three distinct types of swampland are recognized: swamp forests, river flood plain swamps, and pocosins. All three are found primarily within the coastal zone.

These three types of swampland have distinct roles to play in slowin down flood waters and regulating the water regimen. Unlike salt marshes, wooded swamps have little biological significance in the form of nutrient recycling and chemical absorption and sedimentation. However, their importance to hydrological cycles as natural mitigation to periodic flood occurrences is well-documented. Swamps have the unique ability to absorb flood waters when stream flow is high and slowly release it when stream flow is low.

Coastal Wetland Management Implications

Many of the potential uses of the wetlands are mutually exclusive and almost all uses to which a wetland is put by humans radically change the wetlands and eliminate natural roles it serves. Dredging and filling both limit the wetlands' abilities to function as natural barriers to flooding and erosion. Each human activity's relationship on both biologi and physical functions of wetlands must be determined by the coastal manager. In addition, most wetland areas are public trust lands, that is the public has acquired rights to them by prescription, custom, usage, and dedication. Most wetlands are "navigable in fact" during flooding conditions, and all have significant and long standing fishing resources which can help establish public rights to protect these areas.

The first goal of the coastal manager is to weed out those proposed uses that are typically found on high ground sites and are not water-dependent. The second is to establish a wetland protection program that balances the private individual's need for a given project against the loss of public resources. The third goal is to administer a wetland protection law that is easy to understand and is consistent in both daily decision making and enforcement.

Wetland Management Tools

All states have wetland protection ordinances, variously termed dredge and fill laws, wetland regulations, coastal regulations, and excavation or dumping ordinances. Some states have wetland boards, others have coastal commissions and councils. Many state programs are administe by local governments or by the state staff, and still others are administered through contractual arrangements with private consultants and universities. The common thread among all management techniques is the basing of wetland decisions on biological concerns. As a general rule, those wetlands subject to more tidal influences and higher salinity are afforded better protection. Those states with well-defined public trust doctrines better protect their wetland resources. The best tool for protecting wetlands in designated floodways has not yet been completely defined. Through a combination of regulatory tools, however, the protecti of the salt marshes has been highly successful and the protection of woode swamps is improving.

Other successful local and state techniques to protect wetlands are

- conservation and wetland zones in land use plans and on zoning maps;
- compliance decisions in subdivision regulations;
- bonus and incentive zoning;
- planned unit development regulations;
- local health regulations for septic tank placement;
- regulations pursuant to erosion and sediment control laws;
- wetland and soils criteria during A-95 review;
- preferential assessment of wetlands (use-value taxation).
- enforcement of local floodplain management ordinances;
- public and private acquisition programs; and
- public spending and capital programming policies.

Coordination With Federal Programs and Recommendations

The North Carolina experience has shown that effective coastal management requires the support of federal programs to keep pace with accelerated development pressures. As one public official put it "...we are all part-time captains fighting full-time generals", so federal assistance is alway helpful. The supportive federal programs are the Coastal Zone Management Program, the National Flood Insurance Program, and the Corps of Engineers' wetland regulations.

Coastal Zone Program Coordination

It is unfortunate that the present administration does not value state-federal coordination needed to combat common ills along the coasts. The once-close tie between the state program and the federal OCZM staff is being severed, and along with that comes the loss of the ever-importar "306 funding". It is hard to find fault with this federal program which helped 1) upgrade existing regulations; 2) required the development of difficult policies concerning future development; 3) provided implementati funding, planning grants and fisheries assistance programs; 4) supported states in tough federal consistency decisions against other federal agencies; and 5) provided 50% matching grants to acquire important estuarine sanctuaries. Needless to say, North Carolina would not have its unique and comprehensive coastal management program without the assistance of OCZM.

NFIP Coordination

FEMA does an admirable job in implementing the complicated NFIP when budget cuts are affecting everyone. However, it would be most helpful to both state and local coastal flood plain managers if FEMA personnel could make periodic site visits to see enforcement problems first hand and explain the ever-changing regulations to concerned citizens. It is frustrating for state program managers to try to answer valid, detailed questions from second-hand and sometimes outdated information.

One dune standard in the NFIP model ordinance should be evaluated. It states "...that local governments shall prohibit man-made alteration of sand dunes and mangrove stands within V1-V30 zones that would increase potential flood damage." This standard is too vague and needs more site-specific performance review language of the sort discussed above. In addition, it should not be limited to the narrow V zones but also include the broader A zones. In North Carolina FEMA's contract engineers are remapping all V zones to incorporate the state's updated erosion data. It is hoped that protective duneland features as well as actuarial rates for structures thus will be afforded more realistic treatment. Recently the state Coastal Resources Commission (CRC) unanimously passed a resoluti urging federal authorities to use flood insurance funds to relocate insure oceanfront structures which are in imminent danger of being destroyed. The CRC pointed out that this policy would prevent the destruction of the buildings, reduce public costs and place the vacated lands in public ownership for beach access. This resolution was sent to Governor Hunt, FEMA and the North Carolina Congressional Delegation.

Corps of Engineers Coordination

Wetlands in North Carolina are protected by two state regulations, the Dredge and Fill Law of 1969 and the Coastal Area Management Act of 1974, and by two federal laws implemented by the Corps. Authority for dredge and fill regulation is granted to the Corps of Engineers in Section 10 of the Rivers and Harbors Act of 1899 and through Section 404 of the Federal Water Pollution Control Act of 1972. In order to coordinate four overlapping and cumbersome wetland laws, state and federal staffs have developed one of the best jointly implemented wetland programs in the nation. A few of its highly successful coordination techniques are

- Joint applications requiring the same information, same sketches and the same degree of detail and completeness;
- Joint onsite visits with applicants during the pre-application phase and joint visits with contractors during post-permit phases;
- Sharing information among all state and federal review agencies in a standardized format known as a "field investigation report";
- Bimonthly enforcement conferences among all seven state and four federal review agencies to discuss administrative details, regulation changes, permits and legal actions;
- The "CAMA General Permit" whereby all federal review agency comment and permit conditions are given to the state coastal management staff for inclusion in the state coastal permit. This general perm relieves the Corps of duplicating review efforts of coastal projects within 20 designated coastal counties. State wetland laws are very strong in these brackish water areas and the CAMA

general permit allows the Corps staff to concentrate on inland freshwater 404 wetlands where state protection is weaker; and

. More general permit language that allows the rapid approval of those common water-oriented projects that have little or no direct or cumulative negative impact on wetlands. These state and federal general permits alleviate a lot of red tape, promote good will and have encouraged the protection of wetlands through standardized implementation and enforcement. Some of the more common general permits that have been developed cover the installation of piers, docks, mooring pilings, boathouses, wooden groins, riprap revetments, boat ramps and residential bulkheads.

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MONITORING AND ENFORCEMENT OF NATIONAL FLOOD INSURANCE PROGRAM REGULATIONS IN NEW JERSEY COASTAL AND BARRIER ISLAND MUNICIPALITIES

Clark Gilman
New Jersey Division of Water Resources

Of New Jersey's 567 municipalities, 542 participate in the National Flood Insurance Program (NFIP). Sixty of these are located along the Atlantic Ocean or Raritan Bay shoreline. According to the Federal Emergency Management Agency (FEMA) on October 1, 1982, 52,147 policies and $3,407,990,500 worth of flood insurance had been purchased within these 60 coastal and barrier island municipalities. This amounts to 60.6% of the total number of policies and 70.7% of all the flood insurance coverage in force in New Jersey.

An additional 47 municipalities lie along the shores of Delaware Bay, Great Bay, Barnegat Bay and other tidal estuaries and rivers. Most of these municipalities are less developed and less vulnerable to damage caused by coastal storm surge. Twelve municipalities also lie along Newark Bay and New York harbor. These 12, though subject to tidal flooding, will not be further considered here because of their unique nature and the status of development there.

Prior to October 1980 a minimum amount of monitoring and enforcement activity had taken place in New Jersey. The major emphasis had been on contracting for and undertaking flood insurance and flood plain delineation studies of various rivers and streams that flow through non-coastal municipalities. The few Community Assistance and Program Evaluation (CAPE) meetings that did take place were scheduled with carefully selected municipalities by the Federal Emergency Management Agency (FEMA) Region II staff members, to fulfill the quota set for New Jersey. This effort was neither adequate nor did it provide an accurate assessment of the level of enforcement of NFIP regulations and standards. However, with the limited amount of time and personnel available it was the best that could be expected.

Under the initial phase of the State Assistance Program (SAP) of the NFIP, the State Division of Water Resources, Bureau of Flood Plain Management agreed to meet with representatives of each New Jersey municipality participating in the NFIP. This was am ambitious goal considering that at the time 542 New Jersey municipalities were participating and there were no trained flood plain management specialists available to begin the arduous task.

Though New Jersey's State Assistance Program officially began on October 1, 1982 the two individuals designated to meet with the local officals could not be transferred and trained for this work until the end of the year. Considering this, the fact that 406 CAPE meetings were held during the first year of the program is remarkable.

The municipalities located within the coastal counties of Middlesex, Monmouth, Ocean, Atlantic and Cape May were assigned to one specialist who met with representatives of each of the 60 coastal and barrier island municipalities during the first year of the SAP. All but six of the 60 were participating in the regular phase of the NFIP and of the 54 participating in the regular phase of the program 46 had identified zones of coastal high hazard within them. During 1980 each of the municipalities participating in the emergency program were under detailed study. Wave height analyses, to be used to revise existing Flood Insurance Studies (FIS) and Flood Insurance Rate Maps (FIRM) by adding wave heights to base flood elevations, were in progress for the municipalities for which coastal high hazard areas had not been previously identified. Wave height analyses of all 60 coastal and barrier island municipalities have now been completed and each municipality either has amended or is in the process of amending its Flood Damage Prevention (FDP) Ordinance. The SAP staff assisted FEMA and each of these municipalities by reviewing amended FDP ordinances.

Initial CAPE meetings with representatives of regular phase municipalities, held primarily with building inspectors and construction officials, indicated that most of these municipalities were familiar with the program and were enforcing appropriate FDP Ordinances. Record-keeping required by the NFIP was, however, sloppy to nonexistent. A special form was prepared by the SAP staff and given to appropriate community representatives to assist them with their record keeping. It further became apparent that while economic conditions had effectively stopped all construction in other municipalities throughout the state, in coastal communities it was proceeding unimpeded by high interest rates and tight money.

Two adjacent barrier island municipalities were found to be flagrantl violating their own FDP Ordinances by not properly enforcing V-zone construction standards. Specifically, they were requiring only elevation of the lowest floor and not the bottom of the lowest structural member to the base flood elevation in the identified V zone. Reconnaissance, however, revealed that each of these municipalities was protected by continuous manmade wave barriers that had not been considered when the V-zone boundary had been identified. The SAP staff assisted these municipalities by collecting plans of the wave protection structures, conducting supplemental field surveys and calculations and forwarding these data to FEMA with a request that wave height analyses of these municipalities and three adjacent ones where V-zone boundary revision had been promised, be expedited. These studies were undertaken and completed during 1982 only because the data submitted made it possible to conduct them without expenditures for new surveys and mapping.

Detailed CAPE meetings with the six barrier island municipalities located on Long Beach Island during February and March of 1983 have recently disclosed questionable building practices, nonuniform insurance policy rating, and a general state of confusion caused by new insurance guidelines and revised mapping incorporating wave heights. As a direct result of this, the CAPE process is being broadened to include lenders, real estate agents and insurance agents. More detailed field surveys of new structures are also obviously needed and a considerable amount of time will be required to explain the revised Flood Insurance Studies, which include wave height analysis, and insurance guidelines to those who are affected by them.

It is quite apparent that staffing of the FEMA regional office is not adequate to effectively monitor NFIP standards enforcement. If this work is to be accomplished in Region II it will therefore have to be undertaken by SAP staff members. Funding of the SAP is therefore of utmost importance if NFIP goals are to be achieved.

EFFECTIVENESS OF COASTAL REGULATIONS

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Coastal Regulations and Existing Development in New Jersey

The public interest in the coast that led Congress to pass the Coast‹ Zone Management Act in 1972, also led the New Jersey Legislature to enact a wetlands act in 1970 and an act regulating major coastal development in 1973. These two laws formed the legal authority for the bay and ocean shore segment of New Jersey's Coastal Management Program, which received federal approval in 1978. New Jersey also used a reinterpreted 1914 Waterfront Development Law to gain federal approval for its program for the entire coast, including river waterfronts, in 1980.

The state makes decisions under these three laws using a set of coastal resource and development policies that have been adopted as administrative rules. Those policies are among the most specific in any coastal state. They include special area policies discouraging development on beaches, dunes, erosion hazard areas, and other sites along the natural edge of water.

This set of laws and policies is the envy of planners in many coastal states. New Jersey's Coastal Management Program was cited as one of the best three in the nation by The New York Times. Yet the state's major coastal law, the Coastal Area Facility Review Act (CAFRA), gives the state permit authority only for housing developments of 25 or more units. The Act also limits the state's review of commercial facilities to those generating more than 300 parking spaces.

At the time the Act was passed in 1973, the New Jersey shore had already been extensively rebuilt from the damage caused by the most recen major coastal storm, which occurred in March, 1962. As a result, much of the ocean shorefront that remained undeveloped was in sufficiently small pockets that developers could build below the 25-unit threshold of CAFRA. Moreover, as the reality of CAFRA and the policies under which its decisions would be made became more widely publicized, a 24-unit development phenomenon began to spread throughout the New Jersey coast.

While CAFRA only gives the state regulatory authority over major developments, it gives that power for a large geographic area that extends from a minimum of several thousand feet to up to 24 miles inland from the ocean. The strange result is that New Jersey's Coastal Management Program has the power to require, and in fact has required, that housing projects located 20 miles from the ocean be redesigned to lower density and provide a buffer from environmentally sensitive areas while the program has been powerless to prevent developers from destroying oceanfront dunes to build one, five or 24 new houses.

This is the program the Department of Commerce approved for New Jersey under the federal Coastal Zone Management Act. The program has many strengths, but dramatically limiting future storm damage is not yet among them. This provision of CAFRA actually helps developments larger than 24 units get built near the shore as well. The Department of Environmental Protection, which administers the law, is well aware that a developer proposing 35 or 40 units who is denied a CAFRA permit may go ahead and build 24 of those units. The Department is then faced with the choice of trying to modify the project through permit conditions and allow it to go ahead, or to deny it and lose all control over a 24-unit project.

In New Jersey, all development needs the approval of the local municipality. Those projects that need state approval under CAFRA or another environmental statute must receive that approval in addition to the local approval. The municipalities, therefore, have the power on their own to prevent inappropriate shorefront development. They rarely do so, however, due to two factors. First, New Jersey municipalities are largely financially dependent on the revenues they generate internally from property taxes. They thus have a large incentive to increase their ratable base whenever possible, and property near their ocean shorefront is usually considered their major developable asset. Second, municipal officials are often afraid of being charged with the taking of private property, and becoming liable to pay landowners for depriving them of the use of their land.

The effect of this set of regulations on future flood losses is small. New development is being designed and built with more concern for floodproofing as a result of developer initiative, municipal regulatio compliance with federal flood insurance standards and, where it applies, state regulation. But the location of new development is, for the most part, not taking potential storm damage into account. The extent to which losses will be lessened is dependent on the extent to which floodproofing techniques work. Experience from other states that have been subject to recent major storms shows that reliance on such techniques alone is not sufficient.

Do State Coastal Regulations Address the Right Issues?

Despite the fact that there is an insufficient appreciation of the extent or implications of the rising sea level, the policies of most state coastal programs are aimed in the right direction. If all new shorefront development in New Jersey followed the adopted policies of the New Jersey Coastal Management Program, the development would be sensibly located and designed. Unfortunately, however, those policies become increasingly irrelevant at the oceanfront in New Jersey and most other northeastern states with developed shorelines. Even if New Jersey suddenly obtained the power to impose these policies on all new shorefront development, there are only several hundred vacant building lots on the entire 137-mile New Jersey ocean shorefront. This compares with more than 54,000 housing units approved throughout the coast under CAFRA since 1973.

The issue which must then be addressed is how the states should prepare to respond to future coastal storms so that the mistakes of the past will not be repeated. This is an issue with which New Jersey is currently grappling. Three years ago, the state Department of Environmental Protection proposed a strict regulatory law that would have prohibited any shorefront development that was more than 50% destroyed by a coastal storm from being rebuilt in that location. That bill received criticism from throughout the state and was eventually withdrawn by its legislative sponsor.

New Jersey is now addressing the issue in several less heavy-handed approaches. The state approved a grant from its federal Coastal Zone Management Act grant to prepare a voluntary post-storm plan for a local government. The plan assesses where storm damage is likely to occur and where municipal plans and ordinances should be changed to prevent or limit reconstruction. Because that plan has just now been completed and i being reviewed by the municipality, it is too soon to see the extent to which its recommendations will be heeded by the local governing bodies, or the extent to which it can serve as a model approach for other shorefront towns.

New Jersey has also received a grant from the Federal Emergency Management Agency to prepare a storm evacuation plan, and to analyze how to direct government assistance immediately after a storm. One of the most exciting aspects of this new study is that it is being jointly administered by the State Police and two parts of the Department of Environmental Protection so that, for the first time, a coastal regulatory and planning program may be integrated with the Civil Defense aspects of post-storm recovery.

Non-regulatory Techniques

A major program of education is necessary to alert potential shorefront residents as well as officials at all levels of government to the inevitability of major coastal storms and the damage they pose. New Jersey has not had a major storm in over 20 years so that few people are around who remember what it was like to have lives lost, millions of dollars of property destroyed and New Jersey's largest tourist-attracting barrier island cut into thirds. Some of those who do remember tend to romanticize the storm in a way that makes it sound like an exciting event one would not want to miss. As a result, the shore is developed and redeveloped as much as government regulations allow.

Last winter a seawall in the northern part of New Jersey's ocean shore was damaged by storms. The seawall separates a state highway from the ocean, with virtually no beach to serve as a buffer. After the damage occurred, the local municipality asked that the governor declare the town a disaster area. Although subsequent analysis determined that the problem could be repaired for approximately $50,000, it was notable that when the author inspected the seawall at the time the disaster request was stil pending, carpenters were working across the street to build 23 houses. Apparently no one involved in investing in the 23-unit project felt that the presence of a possible disaster area 50 feet away was going to affect the marketing of these housing units. Moreover, the local officials who felt so threatened, and legitimately so, by any crack in the seawall were either unable or unwilling to use their zoning board or planning board to avoid adding 23 housing units to the potential victims from future storm damage to the seawall.

In addition to education, coastal states should work to develop dunes, nourish beaches, and acquire shorefront areas whenever possible. Acquisition is, of course, the most difficult of the three techniques. In addition to the expense involved, it poses the dilemma of suggesting to states that they purchase the most heavily threatened areas--those areas most likely to be underwater in five or ten years. It is easy to question whether that is a useful expenditure of public money.

Construction and repair of structural shore protection projects will continue to be necessary in New Jersey and other developed shorefront areas. While it is important not to oversell the effectiveness of such structures, it is also important to recognize situations in which they can be of benefit. Investment in shore protection programs is a gamble, but such assistance should not be withheld merely to penalize shorefront areas for past inappropriate building.

The Federal Government and the Overall Effectiveness of Coastal Regulations

The first objective of the federal government should be to bring federal flood insurance premiums to actuarial rates. This should be coupled with the non-renewal of insurance to cover sites heavily destroyed by coastal storms.

In undeveloped areas, the spending prohibitions imposed by the Coastal Barrier Resources Act seem to be an effective technique. It comes as a surprise to many people, however, to realize that this much-heralded act includes no areas within New Jersey. It would be useful to extend the act so that currently developed areas that become heavily damaged by coastal storms can be added to the definition of "undeveloped" and thereby become covered under the act.

Finally, Congress should enact an outer continental shelf revenue-sharing The bill would allow coastal states to continue to look for answers to coastal storm hazard mitigation and to continue to work to direct post-storm federal and state involvement in rebuilding so that the potential damage from future storms is reduced.

Conclusion

In New Jersey, at least, coastal barrier islands have traditionally been looked at from two different perspectives. On the one hand, many people look at the development along the ocean shore and then look for opportunities to be part of it. Then they look for structures they believe will protect them from hurricanes. They seek to build on any vacant area near the shore and they seek increasing amounts of state and federal assistance to try to create wider beaches and shore protection structures to protect their investments.

Others see the shore as an area just waiting for the next storm. They work to see that as little public money as possible is spent protecting these poorly located developments, that no new development is added, and that the shore is left largely undeveloped after future storms.

There is a third perspective offered by a group formed in New Jersey specifically to oppose the dune bill mentioned above. This view recognize that coastal storms are inevitable, but holds that the expense involved in rebuilding after major storms is more than met by the benefit provided by shorefront development between storms. This is a more honest approach than many that have been expressed, and it can be helpful in assessing conflicting policies about the future of the shore.

The Jersey shore was heavily damaged by the storm of March 1962, for example, yet was able to rebuild sufficiently to accommodate millions of tourists in the summer of 1962 and was almost back to normal by 1963. By 1970, the shore was as intensely developed as it had been before the storm, and today it is much more intensely developed than ever before. This group argues that the benefits accrued to New Jersey residents and millions of others who have visited the New Jersey shore in the last 20 years, stayed in quest houses and motels, eaten in restaurants and driven on roads all located near the ocean, are worth whatever costs everyone will have to pay to rebuild after the next hurricane.

It is hard to calculate the dollars involved in making this kind of assessment, but at least it does recognize both that the coastal storms are inevitable and that people are attracted not only to relatively natural sites such as Island Beach State Park in New Jersey or Cape Cod National Seashore in Massachusetts, but also to heavily developed, shorefront towns and their facilities. A useful analysis would be an assessment of how much public money is actually invested to rebuild after each major coastal storm. If federal flood insurance rates were changed to increase private risk and accountability, if coastal development was kept away from dunes and other storm-prone areas and if the buildings that do go up were designed to be relatively floodproof, would the resulting lowered public investment in the shore be worthwhile?

After New Jersey's last major coastal storm in March 1962, then-Governor Richard J. Hughes commented,

> "I think it is certain that we will recover from the latest disaster and we will make a good recovery. But unless we consider future activity only in terms of lasting protection against future disasters, we stand to suffer again and again loss of life and property.
>
> We must learn that nature has provided its own means of accommodating high waters, high tides and other accommodations of natural forces which periodically destroy what man has created. We have learned once again through this sobering experience in March that nature will exact a heavy toll from those who insist upon encroaching on areas which are intended as natural shock absorbers for nature's tremendous destructive forces. If we would develop such areas with a sense of caution and respect for the oddities of nature, we would then have substantially lessened the risk of the kind of destruction that we have just experienced."

THE STATE OF FLORIDA

"SAVE OUR COAST PROGRAM"

Howard Glassman

State Coordinator, National Flood Insurance Program

Florida Department of Community Affiars

The State of Florida's "Save Our Coast" program is a statewide effort to protect and preserve the state's coastal resources. Enacted in September, 1981 by an executive order of Governor Bob Graham and the Florida Cabinet, this program was designed to redirect the state's land acquisition funds and natural resource legislation. The executive order called for emphasizing coastal barriers in land acquisition programs, for discriminate application of state and federal development, and for encouraging greater state review of local management in coastal areas.

Implementation of the Save Our Coast Program includes four major elements:

1. a $200 million bond issue to purchase beaches and adjacent areas;
2. the completion of various state and federal projects such as beach renourishment;
3. the issuance of Executive Order 81-105, which requires that executive agencies consider the impacts of their programs upon coastal barriers; and
4. the development of a comprehensive legislative program to improve resource management and hazard mitigation.

Thus far the Save Our Coast Program has been successful due to the Governor's and the Cabinet's commitment to provide ample funding and to specify agency responsibilities. After the 1981 executive order, the Governor and the Cabinet approved the first $50 million increment of bond proceeds. They also directed the Department of Natural Resources to assume the primary responsibility for program administration.

The Department of Natural Resources presently administers a program for acquisition of outdoor recreation lands under the Outdoor Recreation and Conservation Act of 1963 (Chapter 375, Florida Statutes). The Act provides for a Land Acquistion Trust Fund that is the primary source of funds for acquiring state park properties. The trust fund and the State Constitution authorize the issuance of revenue bonds to acquire lands for outdoor recreation and to retire the bonds with monies from the Land Acquisition Trust Fund. Documentary stamp tax revenue accounts for over half the receipts of the Land Acquisition Trust Fund.

With that legislative framework in place, it was then possible to alter the emphasis of the Land Acquisition Trust Fund and use Chapter 375 and the Rules of the Department of Natural Resources (Chapter 16D-10) to implement the Save Our Coast acquisition program. Because of the escalating costs of coastal properties, the September 1981 resolution adopted by the Governor and the Cabinet directs that bond funds generated for the Save Our Coasts Programs be used "for the accelerated purchase of sensitive coastal barrier areas over the next two years."

So far over $25 million has been committed to the acquisition of specific coastal properties. These include a 208-acre parcel with over one mile of beachfront in northwest Florida, and two oceanfront parcels in southeast Florida that are surrounded by large urban areas. Proposed sites include a 400-acre barrier island in southwest Florida and a 50 to 60-acre site in northeast Florida.

The Department of Natural Resources has enacted rules based upon both quantitative and qualitative factors to determine site selection. Such considerations as need, suitability, urgency and availability are used to evaluate the proposed parcel. The Governor and Cabinet also directed the department to give higher priority to proposed acquisitions that include a local government financial contribution and a willingness by the local government to maintain and manage the future site. Recreation use potential is evaluated according to a quantitative formula that incorporates measures of the need for additional beach recreation facilities, population and growth pressures, and the length and depth of beach properties.

Another aspect of the land acquisition program is the Governor's and the Cabinet's interest in purchasing sites susceptible to repeated erosion or physical alteration. Two parcels soon to be submitted for coas consideration contain single-family residential structures as well as commercial land uses.

While the land acquisition portion of the Save Our Coast Program has been most visible statewide, other efforts to improve existing coastal protection legislation are being actively pursued. An Interagency Management Committee (IMC) was established by the Governor and the Cabinet to help guide the state coastal management program. This committee, composed primarily of representatives of agencies that manage coastal areas, was directed by the Governor to implement the overall objectives of the Save Our Coast Program by establishing the necessary legislation and administrative procedures.

Following several months of work, the IMC developed four bills that were introduced during the 1982 legislative session. However, a variety of factors, including legislative priorities and inadequate lead time, combined to prevent the passage of any of the Save Our Coast bills. Sponsors of those measures eagerly awaited the current (1983) session, scheduled to adjourn June 6, 1983. This legislative session has been marked by a resurgence of interest in environmental and coastal protection issues unequalled in the State of Florida since 1972. One bill, to establish more specific coastal protection requirements, would be an amendment to the Local Government Comprehensive Planning Act of 1975. It would encourage a stronger state role in the review and approval of coastal zone protection elements.

The Coastal Barrier Bill proposes to discourage development and construction on undeveloped barrier islands by prohibiting the expenditure of state funds for the construction of utilities and public services. This bill would also establish a twelve-hour evacuation standard, and further emphasize the National Flood Insurance Program.

The most significant aspect of the Save Our Coast Program has been its ability to use and simplify the existing land acquisition programs and Florida statutes. With these two essential components already in place, the Governor and Cabinet were able to redirect and improve current statewide activities to move the state's environmental programs in a new direction.

MICHIGAN'S HIGH RISK EROSION AREAS PROGRAM

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Since 1970, the Michigan Department of Natural Resources has been developing, implementing and enforcing a program to improve citizen perception of Great Lakes erosion hazards. High water levels on the Great Lakes in the early 1950s contributed to millions of dollars worth of property damage. After extremely low water levels in the early 1960s created a popular belief that "we will never see high water again", the lake levels increased in the late 60s to century-high levels in the early 1970s, and damages once again soared. In response, the Michigan Legislature passed the Shorelands Protection and Management Act.

Even though the Legislature found it politically beneficial to support this environmental statute during the "Earth Day" era, it was slow to provide funding. Michigan has over 3,200 miles of Great Lakes shores including nearly 1,000 miles on islands. Seventy-five percent of Michigan's shorelands are erodable shore types. Because of the magnitude of the problem and the lack of state fiscal responsibility toward the new statute, the Department of Natural Resources was forced to develop an extensive second-order survey approach. Since the Shorelands Protection and Management Act was passed, all studies and implementation have been conducted with federal funds. Since 1973, that funding has been provided through the federal Coastal Zone Management Act.

Initial assessments were conducted by Department of Natural Resources employees surveying the entire mainland shore and many islands, recording ten physical parameters and classifying erosion as none, slight, moderate and high. Later, resurveys rated each area of shore as being subject to slight or high erosion. It should be noted that these surveys were done during the highest water period of the century, and that an area exhibitin active erosion during that period was identified as a short-term erosion area. The subsequent procedure of determining which areas represented long-term erosion problems largely became a process of elimination.

The next and the most time-consuming step in Michigan's program is the determination of the historic rate of bluff recession. High risk erosion areas are those areas found to be eroding at a long-term average of one foot or more per year. Michigan measures the historic retreat of the bluff over a period to 15 to 40 years using historic and modern aerial photography. The policy is to measure the longest reliable time span available as the most reasonable model on which to project future erosion losses. The recession rates are measured by determining photographic scale on site, viewing the shore to determine the present bluffline, and using a zoom transfer scope to measure the bluffline lost over time. Initial recession rates were measured from 100 to 1,320 feet apart depending on the recession rate variability. Later studies use a spacing of 100 to about 700 feet apart. The more intense measurement actually requires only minor increases in effort. Within a continuous length of shore, recession rates of similar magnitude are grouped and an average is determined. The group average and recession rate variability are considered to determine the minimum required setback for permanent structures to protect them from shoreland recession for a period of 30 years as required in the administrative rules.

All affected property owners are invited to a meeting. Follow-up information is provided to those who do not attend. Informal reviews precede formal designation of high risk erosion areas. Formal designation are hand delivered or sent by certified mail. Formal appeals have occurre in fewer than ½ of one percent of designations. Administrative hearings have concluded all appeals to date, although Circuit Court action is possible. A strong technical base combined with every reasonable effort to meet and assist the affected property owners has insured the success of Michigan's high risk erosion area program.

Completion of the formal designation process establishes a state permit requirement to review construction of all permanent structures on the designated properties. All properties with sufficient depth must meet the setback requirement. Owners whose property has insufficient depth to meet the setback may erect or install a movable structure in lieu of the total setback requirement. Failing the movable structure criteria requires the installation of shore protection certified by a professional engineer as being designed and constructed to meet Great Lakes standards before a portion of the setback will be waived. To discourage reliance on structural shore protection and to avoid the taking issue, this option is included only after all setback and movable structures options have been exhausted.

The high risk erosion area program has formed a close association with local building code enforcers to ensure local permits are not issued prior to state approval. This local cooperation has enabled Michigan to conduct its Great Lakes erosion program with a minimum of enforcement problems.

Local units of government have the option to adopt shoreland zoning under the Shorelands Protection and Management Act. To ensure compliance with minimum state standards, ordinances and amendments must be reviewed and approved by the Michigan Department of Natural Resources. If approved the state ceases all permit review in that community and periodically monitors local performance.

To date, Michigan has formally designated 210 miles of high risk erosion area shoreline involving 5,500 property ownerships. Program completion will include approximately 300 shoreland miles in Michigan. The program has affected the location of about $8-10 million worth of permanent structures. The implementation cost of the program has been about $125,000 per year.

A large part of the program has evolved toward providing technical assistance to property owners in managing their shorelands. Changing perceptions of the causes of water level changes, the proper design of shore protection, the management of property to reduce wind erosion, and the control of pedestrian and vehicular traffic are constantly necessary. In addition, ground water seepage, sewage effluent and stormwater management have been incorporated into the assistance program. At least 24 different publications dealing with some facet of Great Lakes erosion have been distributed widely. Thirteen publications are currently available. In addition, when time and budget permit site inspections, analysis and recommendations to individual property owners with erosion problems or concerns are made. Although specific engineered solutions are not designed for the homeowners, the obvious, often overlooked practical solution and design deficiencies (such as lack of toe protection on a bulkhead) are pointed out to help ensure the property owner's success. Unfortunately, the assistance provided by the Department of Natural Resources has been severely constrained by budget cuts.

The success of Michigan's program has been attributable to:

1. An open process that allows local official and property owner involvement and comment at several stages in the designation and regulation process.

2. The changing of property owner's perception of erosion--both its causes and solutions. Many of the mysteries have been replaced by facts. To be sure, there are still nonbelievers; many people think the U.S. Army Corps of Engineers maintains water levels to promote shipping interests. However these people are now the minority. The smart property owner is more often perceived as the one who was prudent enough to build far back from the erosion hazard and not the one with a home perched on the edge of the bluff.

3. The combined program of setback requirements and technical assistance has been well received. Both are necessary and effective in preventing disastrous land use patterns from developing. Efforts at technical assistance have been most rewarding.

4. A properly designed program can use something less than first order surveys to set erosion setback requirements.

Shortcomings in the program lie in two areas:

1. Thirty year setbacks are too short. In the Great Lakes region, the average life expectancy for a new single family home has been determined to be between 66-75 years. Setbacks need to be increased to at least 40 years of protection as a step in the right direction. The result of creating more severe setback requirements, of course, will produce more substandard lots and perhaps reduce program acceptance. However, with a program that allows variances on substandard lots, these pitfalls should be acceptable.

2. No set of regulations can cover all possible cases. Situations arise in which rules permit construction, yet scientific reasoning leads to the conclusion that the property is too hazardous for development. A small fund enabling the state to purchase these hazardous building sites is necessary to avoid creation of future disasters.

Michigan's experience has yielded the following recommendations:

1. Do not fund shore protection.

2. Permitting agencies should be more concerned with the potential adverse impacts of shore protection, especially the expansion of shore protection into undeveloped shorelands.

3. Recession rate data must be periodically updated to reflect changes in shore protection efforts, water levels on the Great Lakes, and the effects of storms.

4. Because erosion is not an insurable risk, the erosion provisions of the National Flood Insurance Act of 1968, as amended, should be repealed. FEMA's current interpretation of those provisions makes Great Lakes erosion losses uncovered and yet policies are

still sold and premiums collected. FEMA's action is inexcusable and the erosion provisions of the program are grossly misrepresented.

5. The new federalism of the current administration can only succeed if the states are economically capable of absorbing programs. That can only happen during the best of times. These are not the best of times. There is enough national interest in erosion loss to justify federal assistance to states to implement state erosion plans.

CALIFORNIA COASTAL STORMS

JANUARY - MARCH, 1983

A.J. Brown

California Department of Water Resources

Introduction

During the winter of 1983 (January-March), eight major storms were identified (see Table 1), causing significant damage along the California coast.

TABLE 1

Comparison of Winter Storms - California

Comparisons	January-March 1983	January-March 1980-82
Number of storms	8	15
Mean significant height	18 ft.	14 ft.
Mean period of peak energy	19.5 sec.	14 sec.
Maximum significant wave height	24 ft.	18 ft.
Maximum wave height	36 ft.	27 ft.
Peak periods	17.22 sec.	17 sec.

Wave energy is proportional to the square of the wave height, so a 2-fold increase in wave height will yield a 4-fold increase in wave energy at the shore.

1983 peak waves contained about 80 percent more energy than the biggest ones in the previous 3 years.

The major causes of such coastal storm damages are tides and wave action.

During this past spring, astronomical tides were very large, ranging about 10 feet. With a slowing of the California current, there was a general rise of sea level of about 8 inches along the coast, and strong winds probably elevated the surface by another foot. At Mission Bay, near San Diego the largest waves seen in 8 years were registered. Higher winter tides this century at San Diego will be December 2, 1990 and January 19, 1992. On March 8, 1993 the tide will be the highest this century and higher than any San Diego will see until the year 3384.

The overall weather pattern along the West Coast from the late 1940s to the late 1970s could be characterized as a stable or calm period. Some scientists regard this 30-year period as an anomaly, and since 1976, it has become increasingly apparent that the "stable" period is over. Weather patterns are returning to unpredictability and extreme variability.

Those 30 years also were the years of greatest population growth and the heaviest and most precarious oceanside development. Not much attention was paid during this time to warnings that developments should not be built on water-front cliffsides and beachfronts, so close to the ocean's powerful force. As a result, the many miles of coastal development are characterized by the closeness of buildings, dense packing, and the proximity to shoreline.

Discussion

Storm Damage

Approximately 75% of the damage to California occurred in coastal counties. The greatest amount of public damage was to state parks and recreational areas in Los Angeles and San Diego counties. About 40% of California's coast is publicly owned. The greatest amount of private damage was structural damage to homes in Santa Cruz, Orange, and Los Angeles Counties. All along the coast, approximately 3,000 homes and 900 businesses suffered damage: 27 homes and 12 businesses were completely destroyed.

The sequence of damage along a beach is as follows. As tide level, wind speed, and storm duration increases, large waves break closer to shore, berms are lost, and eroded sand is transported offshore. Waves reach further inland, erode beach cliffs, and damage coastal property. With a succession of large storms, more and more sand is transported offshore, delaying the beach rebuilding process, and having a more destructive influence on the beach profile. Thus, not only severity but also the succession of storms are important factors in storm damage.

Loss of beach sand is another factor in coastal storm damage. Beaches are being deprived of their primary source of sand, rivers, because just about every river has been dammed. Systematic erosion over the past 30 years has been masked in part by accidental and artificial preservation and restoration brought about by dredging sand in the creation of harbors--dumping it on the beach simply to get rid of it. There are few places left to put a good harbor, so beaches have lost another major source of sand.

The distance the beach retreated as a result of the '83 storms this year was considerably greater than anticipated. Structures were damaged where beaches were narrow, or where the shoreline was oriented toward the direction of wave attack. Even buildings which had been protected by rip-rap were damaged. The 1983 storms against the California Coast demonstrated the vulnerability of structures located too close to the water's edge, such as the San Onofre nuclear power plant in San Diego County. Not unexpectedly, the winter storms resulted in damage to several different types of structures including the Ft. Arena Pier near Monterey, Rincon Pier near Carpenteria, Paradise Cove at Malibu, the Santa Monica Pier, and the San Clemente Pier in Orange County. There was significant damage to the seawall at Big Rock Beach, Malibu. The Pajaro Dunes near Santa Cruz experienced 20 to 40 feet of bluff recession. Scouring in front of and behind houses was particularly severe in the Malibu Colony, as was flanking of houses and between bulkheads.

The Del Mar (San Diego) Beach profile was reduced 10 to 15 vertical feet as sand was transported off-shore to bars. Cliff erosion was a problem at Laguna, Solano Beach, and La Jolla. Coastal highways were damaged and subsequently closed at Big Sur.

Coastal Protection

Several factors that contribute to the conflict between accelerating coastal development and ongoing coastal erosion are the desirability of oceanfront property, the progressive erosion of buffer zones, the fact that structures are being undercut and encroached upon, more frequent large storms, and increased street runoff, landscape watering, and septic tank leach fields.

Seacliff erosion is the dominant process occurring along 86% of California's coastline. The other 14% has year-around beaches that serve to buffer the cliffs. The seacliffs are experiencing either intermittent or continual wave attack, and the critical factors in their susceptibility are resistance of the seacliff material, presence or absence of a protective beach, and exposure to wave attack.

Shoreline Protection

The most common types of shoreline stabilization structures are rip-rap, revetments, seawalls, bulkheads, longard tubes, and dunes. Emergency placement of protective works during winter storms is a common occurrence, but it effectively eliminates a thorough consideration of the ongoing shoreline processes, the economic effects of the works, or their environmental impact. Rip-rap is often placed at the base of the seacliff in an attempt to control erosion. It can be an effective buffer to wave attack. Rip-rap is not without its problems, however. It must be large enough to remain stable if placed on the beach. Winter scour can remove underlying sand so that if it is placed discontinuously, erosion progresses around and behind the rip-rap. It can sometimes become a missile, damaging structures: during this year's storms, boulders and drifting logs acted as battering rams against houses. Rip-rap, as a form of shore protection, has a high visibility and is often considered the first option by shorefront residents, but it alters the natural shoreline, reducing its recreational and aesthetic value, and creating access problems.

The Longard Tube at Stinson Beach was too small to significantly affect the uprush of large, long-period waves. At Del Mar the tube did not prevent any of the erosion it was supposed to prevent. Parts of the tube were undermined and it dropped as much as six feet.

Houses built on pilings have a longer useful life than those built on ground elevations. The advantages of pilings are that they protect from wave overwash and flooding; they cause less interference with the dune-building process; and they permit homes built landward of a high dune to have a view of the sea.

As with many geologic hazards we cannot, either as individuals or as a society, afford complete protection from the infrequent large events whether they be earthquakes, floods, or storms. Eight times in 58 years seawalls and bulkheads in the Sea Cliff area have been partially destroyed. Yet the structures continue to be rebuilt at public expense. It is reasonable to conclude this area is part of the active coastal zone and will continue to experience high energy storms. After storms in 1978 and 1981, $2.65 million was spent for seawall repairs at Sea Cliff State Beach Park, including roads and facilities. These funds were expended to serve the needs of a projected 850,00 visitor-days per year, including

26 camping sites for recreational vehicles.

One of the first emergency measures attempted after the storms this spring was the creation of artificial dunes to provide temporary local protection to exposed facilities. Bulldozed dunes generally are not very effective. Their position reflects the shape and location of the facility being protected, not the dune's natural equilibrium configuration and location. Artificial dunes are usually too low, too narrow, too close to water's edge, not stabilized by vegetation, not well-packed, and easily removed by wind and waves. Bulldozed dunes are useful, however, for cosmetic cover and protection against vandalism for other protective structures such as sand bag dikes or Longard Tubes. Bulldozed dunes should not be created as a permanent alternative to natural dunes.

Shoreline Management

Too often developers fail to recognize that the dunes, like the beaches in front of them, are dynamic features subject to cycles of erosion and deposition, and so structures are built too close to the water. It is easy to overlook the significance of past storms when siting new facilities. Long periods without major storms contribute to a lowered awareness of the erosion hazard and a lax attitude toward the siting of coastal structures.

High dunes can protect against overwash, even if the seaward portions of the dunes are attacked and erosion occurs. Lots in areas with high dunes may still be flooded as a result of water entering the property from adjacent locations of low dunes where washover occurred. The high dunes need to be continuous to serve as a barrier to overwash and flooding.

Even a small dune will provide limited protection. At Stinson Beach the small dune protected several houses, but they were eventually exposed through progressive erosion. The dune could not achieve adequate size because it could not migrate inland, and it was destroyed in place.

There was considerable damage in developed areas where pre-storm beaches were not wide enough to allow for the formation of a dune. At Oxnard and Ventura, the beach provided some protection and damage was less severe, but the houses were located right where the dune would be under natural conditions.

Certain aspects of the recent storms were significant in demonstrating the value of dunes as a future option for protection of the California coast:

- High continous-crest dunes provide protection against wave overwash.
- Letting natural dunes develop would establish a more landward line of buildings and a criterion which can be used to site structures.
- Dunes located close to the water and those not allowed to migrate can be rapidly eroded and destroyed in place, allowing damage to buildings placed too close to the beach.
- Besides overwash protection, natural dunes provide recreation space, esthetic and habitat values, and horizontal (longshore) access.

A shoreline management program designed to reduce damages from future storms should consider the following:

- Do not allow fixed facilities on the beach.
- Reevaluate the "string line" concept that allows new construction close to water if buildings already exist there.
- Prohibit activities that result in destruction of the dune.
- Restore the dune if it is damaged.
- Do not interfere with the natural transfer of sand to the dune.
- Minimize traffic on the dune--provide walkovers.
- Actively promote and support dune-building programs.
- Place new construction inland of active dunes, or landward of the zone in which dunes could form, if not yet present.
- Communities and shorefront residents should be encouraged to use dunes as a means of shore protection.

In active coastal areas, whether backbeach, dune, or retreating seacliff, there are the same two problems as with riverine flooding which need immediate attention: prevent new construction and regulate poststorm reconstruction, rather than continuing to publicly subsidize recurrent destruction of beachfront properties.

Conclusion

Coastal land-use controls should be based on:

- A realistic assessment of geologic processes and economic factors, not simply a continuation of past practices and sympathetic emergency disaster relief.
- Accepting the concept that erosion, storms, floods, earthquakes, and landslides are natural processes and not "acts of God".

- Instituting local policies that will control new development; and developing performance standards that eventually will allow the community to retrofit itself to its geology.

In the long term these actions will greatly reduce public expenditures and subsidy, by reducing existing programs such as disaster relief, low-interest loans, higher insurance rates, and protection of poorly placed public facilities and utilities.

MASSACHUSETTS' COASTAL FLOODPLAIN MANAGEMENT POLICY

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Introduction

The long history of development on the Massachusetts coast includes considerable experience with coastal storms and disasters (U.S. Army Corps of Engineers, 1978). Only recently, following the 1978 approval of the state's coastal zone management program (Office of Coastal Zone Management, 1978), has a comprehensive coastal floodplain management policy been developed. These policies recognize that past attempts to protect the shore from flooding and erosion have proved expensive and often futile as well as environmentally detrimental. Development activity on coastal floodplains, however, continues to expose a greater number of individuals and their property to serious storm damage. A management program for addressing these problems must consider many factors including land use and storm damage history, geology, economic conditions, political institutions and legal and regulatory issues.

In Massachusetts, the policy framework for coastal floodplains addresses coastal hazard issues for two related but different situations: undeveloped coastal floodplains and developed, altered coastal floodplains. Undeveloped floodplains often remain subject to sustained development pressures regardless of the hazards involved. Management strategies for these areas in Massachusetts focus on preserving as much of the unaltered floodplain as possible. Developed floodplains, despite sometimes extensive alterations, remain susceptible to storm flooding and erosion. A management strategy for these areas requires a multifaceted approach. This paper discusses the current policy framework for both developed and undeveloped coastal floodplains in Massachusetts including a description of a coastal hazards information base, management policy, management consideration for undeveloped and developed coastal floodplains and future management issues.

Coastal Hazards Data Base

Effective management of coastal hazard areas requires a comprehensive information base. Data concerning physical coastal processes as well as socioeconomic factors are needed for policy and regulatory decision making and must be regularly updated and expanded, especially for areas where chronic storm damage occurs. In Massachusetts information about coastal physical processes and coastal geomorphology includes flood maps, reports, and wave height studies; barrier beach inventory maps; wetland aerial orthophoto maps; shoreline change maps; and shoreline processes reports. Federal National Wetland Inventory maps, undeveloped barrier beach maps, shoreline processes studies and nautical charts are also available. These data are used to assess the susceptibility of development in coastal floodplains to erosion, storm overwash, and the formation of tidal inlets.

Information on the location and density of housing, utilities, coastal engineering structures, demographic profiles, transportation links or other factors that relate to land use characteristics of floodplains is important for storm preparedness and recovery planning. Public opinion sampling is also important. In Massachusetts, for example, the opinions of property owners within the velocity zones of all coastal communities were assessed concerning the individual's property, flood experience, perception of flood hazard and preferences for flood damage reduction measures.

Management Policy

In the past, public policy concerning coastal hazards has been largely to plan and fund projects for structural shoreline protection. Only recently, with the approval of the state's coastal zone management plan in 1978, has this policy been modified to consider other techniques to control storm losses including land use regulations, building codes, nonstructural erosion control measures and land acquisition. The CZM plan provides a comprehensive set of policies concerning coastal hazards, which is intended to protect existing natural storm buffers, encourage the use of nonstructural alternatives for coastal erosion problems, restore previously impaired natural buffers, prevent development that could exacerbate existing hazards and implement limited structural solutions only in those situations where the need for structural protection is unquestioned. In 1980, gubernatorial Executive Order No. 181 further clarified the policy framework for managing barrier beaches (Governor of Massachusetts, 1980), especially as it relates to state funds. For example, the Order directs that the state acquisition of barrier beaches be made a priority. The Order assigns the highest priority for use of disaster assistance funds to relocate willing sellers from storm damaged barrier beach areas. Finally, state and federal monies for construction projects are not to be used to encourage growth and development on barrier beaches.

State policy also directs agencies to provide technical assistance to local communities for hazard area zoning and mitigation of erosion problems. Increased public awareness is also an important policy objective expecially in a state where most land use decisions are made by the communities. Reducing future storm losses as well as redirecting public policy depends in large part on the political support of an informed citizenry.

Management Considerations For Undeveloped Floodplains

The goal of managing undeveloped floodplains in Massachusetts is to protect and preserve existing natural storm buffers including beaches, dunes, barrier beaches and coastal banks. While many of these coastal resources have been altered or eliminated by development, unaltered areas remain. The long-term benefit of avoiding storm damage costs and loss of life is dramatically illustrated after each major storm in those areas where the natural features of the coastal floodplain remain relatively intact. Protecting undeveloped coastal floodplains in Massachusetts involves several approaches.

Regulations

The Wetlands Act (M.G.L. ch. 131, §40), and its implementing regulations control activities on land subject to tidal action and coastal storm flows. The coastal wetland regulations (310 CMR 10.00 - 10.36) define and describe the significance of the various coastal features (e.g., beaches or dunes) and the performance standards which activities in these areas must meet. For example, a recent state administrative decision denied a permit for the construction of a single-family house on a barrier beach based on the likelihood of the septic system being exposed and overwashed by storm waves. Efforts to stabilize the movement of the barrier landform were considered likely to have serious adverse effects on the overall storm buffering capacity of the barrier.

The Wetlands Restriction Act Program (M.G.L. ch. 130, 105) prescribes permitted and prohibited activities in critical coastal areas such as dunes, beaches and barrier beaches by placing a restriction order on the deeds of all affected landowners. Any large-scale alteration of these resources is prohibited, including projects that would change tidal flow patterns or obstruct the movement of sediment. All restricted wetlands greater than ½ acre in area are identified and delineated on aerial orthophotographs.

The federal Coastal Zone Management Act of 1972 provided coastal states with the opportunity to develop comprehensive management plans for their coasts. States with approved coastal management programs review projects involving federal funding or permitting or other federal actions within the coastal zone to ensure that these actions are consistent with state coastal policy (M.G.L. ch. 21A and 301 CMR 20.00 - 20.99). For example, in Massachusetts the Governor's Executive Order No. 181 on Barrier Beaches has precluded the use of any state or federal funds for the construction of a water supply and distribution system on Plum Island, a large barrier island located on the north shore of Massachusetts. This decision reflects the state's concern with increased growth and development in this hazard-prone area.

Acquisition

Twenty-two percent of the Massachusetts coast is protected from future development through ownership by public and private conservation agencies. Public acquisition of coastal floodplains is one of the most effective techniques to reduce future storm damage losses while providing increased open space, recreation and public access opportunities. In Massachusetts, both direct state appropriation as well as bond authorizations are used to acquire coastal floodplains. Communities acquire these areas directly or with assistance (up to 80%) from several state programs. Communities have adopted subdivision bylaws that require that developers of large parcels restrict a percentage of that land for recreation or open space use. Communities can also consider agreements with willing landowners for allowing the community the right of first refusal for oceanfront property. A landowner may be willing to sell land to the community at a price lower than the property's fair market value in return for a tax deduction equivalent to the difference.

Several private organizations have acquired by purchase, gift or restriction, barrier beach property in Massachusetts for conservation purposes. These organizations can also occasionally negotiate acquisitions to avoid the time-consuming public acquisition process.

In the past, Massachusetts has worked with the federal government to transfer surplus federal lands in coastal hazard areas to the state for recreation and conservation purposes. Recently, Massachusetts cooperated with the U.S. Department of Interior in identifying 39 undeveloped coastal barrier units within the state in response to the Coastal Barrier Resources Act.

Management Consideration For Developed Floodplains

Serious management problems still prevail on the developed coastal floodplains of Massachusetts. Many of these developed areas are heavily populated and subdivided into very small building lots with minimal setbacks and little space between residences. Although engineered structures are sometimes present, these areas (especially barrier beaches) remain susceptible to storm flooding and erosion.

The management objective for developed coastal floodplain areas in Massachusetts is to reduce future storm losses. The policy also seeks to shift some of the burden of storm damage to those whose presence in the floodplain creates the losses. A variety of management considerations are required for developed floodplains because of a complex set of factors including historic land use, flooding and erosion hazards, natural resource characteristics, costs and ownership. Examples of some of these management considerations follow.

Storm Preparation Planning

Most Massachusetts communities do not have comprehensive coastal storm evacuation plans. Existing storm preparedness program guidelines include warning, evacuation, and recovery plans which can help reduce the potential loss of life and property on developed coastal floodplains. An educational program is also an essential part of storm preparation. Owners of flood-prone property are the primary target of this program, especially the newer or seasonal residents who have not experienced a major storm.

Acquisition

Public acquisition of storm-damaged properties is an effective alternative to the repeated repair or reconstruction of property in flood-prone areas. Following a major northeaster in Massachusetts in 1978, the state and Federal Emergency Management Agency worked together to implement the FEMA 1362 program. This program allows FEMA to purchase property from willing sellers where insured buildings have been damaged more than 50% in a single year or at least 25% in three storms over a five year period. As one of the first applications of this program in the nation, ten properties destroyed in the 1978 northeaster were adquired on Peggotty and Egypt Beaches in Scituate, Massachusetts. Once these properties were acquired by FEMA, they were given to the state for leasing to the town. This experience offers several recommendations for future 1362 acquisitions. First, a discretionary emergency action fund should be used to acquire destroyed properties, including non-contiguous parcels, early in the post-disaster phase rather than years after the storm. A general management plan for these acquired parcels should be prepared before the storm. Debris removal procedures must be defined well in advance.

Massachusetts is presently considering an agreement between the Commonwealth and FEMA under which FEMA covers the acquisition and pre-acqusition costs of acquiring storm-damaged properties. Massachusetts is also studying the need to develop a state-funded program for acquiring storm-damaged properties which can complement the FEMA 1362 program.

Land Use Regulations

The regulation of development activities on coastal floodplains in Massachusetts now includes more stringent standards for building and rebuilding strutures. Communities participating in the National Flood Insurance Program must adopt floodplain management building codes which meet minimum standards. Within the A zone all new development and substantial improvements of residential structures must have the lowest floor above the 100-year base flood elevation. Within V zones all new development and substantial improvements must be elevated on pilings or columns so that the lowest portion of the lowest floor is above the 100-year base flood elevation. In the past, one problem with this standard was that the V-zone elevation underestimated flood water elevation because it did not account for wave heights. FEMA is now calculating wave heights for most Massachusetts communities. Another problem associated with the V zones is that they fail to recognize that there is usually sediment transport associated with storm waves. On barrier beaches, sediment overwash is one mechanism by which the entire barrier shifts landward. Structures constructed on pilings on these landforms may be undermined as sediment is removed by the overwash process.

Regulations for protecting wetlands and floodplains also apply to developed coastal floodplains in Massachusetts. These regulations provide design standards that consider not only the engineering integrity of the structure but also its effect on coastal processes. Design standards have been further clarified with recent judicial and administrative decisions. In a case before the Massachusetts Supreme Judicial Court, Lummis vs. Lilly, 365 Mass. 41 (1982), the court found that the owner of an existing stone groin was subject to the rule of "reasonable use" when the groin interrupted the littoral drifting of sediment along the shore. Although the structure had been licensed by the state and federal government before it was constructed, the groin in subsequent years caused the beach to widen in the updrift side of the groin and to narrow on the downdrift side. In adjudicating the rights of owners of oceanfront property, the court found that the reasonable use rule may be used to require the defendent to reduce or modify the size or shape of the groin.

A recent administrative decision concerned the construction of a 150-unit apartment building for the elderly on an extensively developed barrier beach. The decision required that the structure be constructed on piles, floodproofed, and designed so that there would be no increase in flood elevations on adjacent properties. An evacuation plan was also required. (An alternative non-floodplain site for this housing project has been subsequently secured.) These decisions and others relating to construction standards for piling depth, floodproofing, septic system design and coastal engineering structures now provide for improved storm protection.

Post-Storm Recovery

Following the 1978 northeaster, a policy for rebuilding storm-damaged buildings, roads, utilities and engineered structures was developed. The policy now requires that viable non-structural alternatives be identified. Funding of acquisition and relocation programs is given highest priority. The building code currently requires new and existing structures which are rebuilt to be elevated so that the first floor elevation is above the 100-year base flood including wave heights. Shoreline erosion rates can also be used to establish new setback requirements.

Future Management Issues

Although Massachusetts coastal floodplain management policy addresses many issues related to both undeveloped and developed floodplains much remains to be completed. Additional scientific studies are needed to determine erosion rates on large remaining segments of the coast. The dynamics of tidal inlets must be more closely examined, wave height studies need to be completed and sediment budget studies are required for certain areas of the coast. These scientific studies can provide the basis for implementing public policy changes with respect to coastal hazards. For example, erosion setback rules or real estate disclosure statements concerning natural hazards require a comprehensive inventory and analysis of historical shoreline changes. Other public policy issues that should be addressed include innovative land preservation programs, expanded post-storm reconstruction policies, modifications in tax policy and improved enforcement of regulations.

Finally, the federal government continues to play a dominant role in state coastal floodplain management policy. Federal support of scientific research relating to issues of national concern is essential. The elimination or reduction of federal subsidies for growth and development in coastal floodplain areas must be addressed. Amending federal tax policy can reduce incentives for some development in coastal hazard-prone areas. Enforcement of flood insurance program regulations and federal executive orders on wetlands and floodplains also needs to be vigorously pursued and further cooperation between state and federal agencies is required to minimize policy conflicts arising from coastal floodplain development activities.

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FLORIDA'S PROGRAM OF BEACH AND COAST PRESERVATION

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Introduction

In 1970, the Legislature of the State of Florida made the following observations:

> The attraction of Florida's beautiful beaches and shores accounts for a substantial portion of the state's annual tourist trade;
>
> Beach and shore erosion is a serious menace to the economy and general welfare of the people of this state;
>
> Unguided development of these beaches and shores coupled with uncontrolled erosive forces are destroying or substantially damaging many of our valuable beaches each year;
>
> Preservation of our beaches and shores is therefore a subject of great public interest and concern which requires appropriate action by the legislature to prevent further loss to one of our greatest natural resources;
>
> The greater public interest compels that certain reasonable restrictions be placed upon the location of coastal construction and excavation even though such construction or excavation be located on privately held land.

The legislature then passed into law the Beach and Shore Preservation Act (Chapter 161, Florida Statutes), charging the Florida Department of Natural Resources (through the Division of Beaches and Shores) with its administration. Although the law has been somewhat modified over the years to more closely address specific needs and conditions, the basic intent has remained (early history is discussed by Purpura, 1972, and Purpura and Sensabaugh, 1974). At present, the regulatory essence of the law is found in section 161.053 of the Florida Statutes, which reads:

> The legislature finds and declares that the beaches of the state, by their nature, are subject to frequent and severe fluctuations and represent one of Florida's most valuable natural resources and that it is in the public interest to preserve and protect them from imprudent construction which can jeopardize the stability of the beach-dune system, accelerate erosion, provide inadequate protection to upland structures, and endanger adjacent property and the beach-dune system. In furtherance of these findings, it is the intent of the legislature to provide that the department, acting through the division, shall establish coastal construction control lines on a county basis along the sand beaches of the state fronting on the Atlantic Ocean and the Gulf of Mexico. Such lines shall be established so as to define that portion of the beach-dune system which is subject to severe fluctuations based on a 100-year storm surge or other predictable weather conditions, and so as to define the area within which special structural design consideration is required to insure protection of the beach-dune system, any proposed structure, and adjacent properties, rather than to define a seaward limit for upland structures.

These statutory provisions charge the Division of Beaches and Shores with two basic regulatory responsibilities. The first is the establishment of coastal construction control lines (CCCLs), administered through the Bureau of Coastal Data Acquisition, which also has the responsibility of collecting and analyzing all field data necessary for CCCL establishment. Actual work resulting in recommendations for the location of CCCLs is not performed by the Department, but rather it is contracted to outside coastal scientific and engineering expertise at the legislatively established Beaches and Shores Resource Center located at the Florida State University. The second is the regulation of activities occurring seaward of or straddling the CCCLs. This task is accomplished by the coastal engineering staff of the Bureau of Coastal Engineering and Regulation in the permit review process.

In order to further enhance the provisions of Chapter 161, and to assure that constraints of professional coastal engineering practice are met, detailed rules for the regulation of activities conducted relative to CCCLs have been promulgated in Chapter 16B-33 of the Florida Administrative Code (F.A.C.).

The Division of Beaches and Shores also administers a trust fund from which significant amounts of funding support are disbursed annually to cost share in civil works projects (e.g., beach nourishment, sand bypassing, dune reconstruction, and revegetation projects.). In addition to regulation, then, the Division actively supports and promotes projects in the interest of beach and coast preservation.

The Control Line Program

Establishment of coastal construction control lines on a county-by-county basis requires field data collection, and storm surge and dune erosion modelling.

Field Data Collection

The basis of the field data collection effort conducted by the Bureau of Coastal Data Acquisition is the maintenance of Department of Natural Resources reference monuments installed at 1,000-foot intervals upland of Florida's oceanfront beaches. The monuments are tied into the state plane coordinate survey system, and to a system of massive monuments located further landward (the latter to serve as a backup system for reference monument recovery and to enhance surveying control).

Prior to a control line study, profiles are measured at each reference monument. Beach profiles extend from behind the dunes into the surf; special features such as the vegetation line and existing structures such as seawalls are noted and recorded using ground photography. Offshore profiles are surveyed at every third reference monument, extending from the surf to about 3,000 feet offshore to water depths of from 25 to 35 feet. Details of field measurement equipment and methods used are discussed by Sensabaugh, Balsillie and Bean (1977).

In addition to control line surveys, periodic condition surveys are conducted as are post-storm surveys. To date, over 3,400 beach profiles and about 1,200 offshore profiles have been measured. Controlled stereoscopic aerial photography is flown for each control line study. It is reproduced to provide detailed working photomaps at a scale of 1 inch = 100 feet. DNR reference monuments (targetted prior to photo flights) are plotted on the photomaps, as are photogrammetrically generated contours (2-foot contour interval) delineating beach and dune details.

Data obtained from this effort are stored in the beaches and shores data bank on the Natural Resources Management Systems and Services (NRMSS) IBM 4341 Model Group II computer system. Data so managed remain immediately available for a wide variety of coastal engineering purposes.

Storm Surge and Dune Erosion Modelling

In 1978 the legislature modified Chapter 161 to place greater emphasis on the storm surge accompanying the design hurricane event to determine the location of CCCLs. The task was contracted to outside experts, who selected Dean's newly developed storm surge model. The model is used to determine combined total tides including storm tide, astronomical tide, and dynamic set-up occurring inside the breaking wave zone, to provide valid estimates of storm surges for events with return periods ranging from 10 to 500 years (Dean and Chiu, 1981a, 1981b, 1982a, 1982b).

Realization of final results from the storm surge model requires considerable data (e.g., historical storm/hurricane, bathymetric and on-shore topographic information) and work (e.g., calibration of the model using historical data). The numerical model operates through the NRMSS data center, whose processor has been substantially upgraded to accommodate massive data storage requirements.

In addition to water levels and wave heights, it is desirable to know of dune/bluff erosion expected from design storm impact. The staff of the Beaches and Shores Resource Center have adopted a time series model devised by Kriebel (1982), which has been computerized, available on the NRMSS system, and operates with the storm surge model.

Control Line Adoption Restudy

Following consideration of the collected field data, storm surge results, historical and predicted dune/bluff erosion trends, and existing upland development, the contractor recommends to the Department location(s) of the CCCL for a given county under study. Upon review by the Department, Florida law (section 161.053 (2)) requires:

> No such line shall be set until a public hearing has been held for each area involved. After giving consideration to the results of said public hearing, it shall, . . . set and establish a coastal construction control line and cause same to be duly recorded in the public records of any county and municipality affected and shall furnish the clerk of the circuit court in each county affected a survey of such line with references made to permanently installed monuments at such intervals and locations as may be considered necessary.

The impression is often given that the CCCL for a given county is a straight line or a relatively small number of lines when, in fact, a CCCL has many linear segments commonly changing direction at each DNR reference monument, and may even change direction between monuments. For this reason, the Bureau of Coastal Data Acquisition is involved with maintaining precise surveying control of the CCCLs with reference monuments, massive monuments and the state plane coordinate system.

Restudy of the CCCLs is placed in the discretion of the Department or may be initiated at the request of officials of affected counties or municipalities. The Department may authorize such a review after consideration of hydrographic and topographic data which indicate shoreline changes that render established lines ineffective. Based upon the time required and computer resources available, the Division schedules review of five counties per year. This schedule is flexible, however, since storm or hurricane impact or other erosion trends can cause a change in priorities.

Currently, all 24 coastal counties having sandy beaches fronting on the Atlantic Ocean and Gulf of Mexico have established CCCLs, and the Department is in the restudy phase.

The Regulatory Program

Concerning the regulation of Florida beach and coast activities, Chapter 161 stipulates:

> Upon the establishment, approval, and recordation of such coastal construction control line or lines, no person, firm, corporation, or governmental agency shall construct any structure whatsoever seaward thereof; make any excavation, remove any beach material, or otherwise alter existing ground elevations; drive any vehicle on, over, or across any sand dune or the vegetation growing thereon seaward thereof except as ..... provided by the act.

Regulatory aspects of the provisions of Chapter 161 are implemented by Chapter 16B-33 of the Florida Administrative Code. This rule sets forth the requirements and procedures relating to coastal construction, excavation and alteration seaward of CCCLs to include procedures for surveying, procedures for processing applications for permits to conduct activities seaward of CCCLs, and conditions to be placed upon permits. Because of its highly detailed nature, it is not possible to present an in-depth discussion of this rule. However, with regard to the permit application review process, it is possible to highlight some of the more important review issues.

When applying for a permit the applicant is required to provide technical data including a recent topographic survey (within six months from the date of application) certified by a land surveyor registered in Florida, providing topographic information including the location of the water's edge, vegetation line, the coastal construction control line referenced to the closest two DNR reference monuments, and any existing structure(s) on the subject and adjacent properties; detailed site, grading, drainage and structural plans and specifications for all proposed activities including subgrade construction or excavation with pertinent engineering calculations and elevations referenced to datum; and other site-specific information deemed necessary by the Division for evaluation of the application.

Design force element categories considered by the coastal engineering staff include the wind, storm surge water levels, and waves which propagate upon the storm surge. The design wind velocity, for structural loading computations, is based on a minimum of 140 mph (Balsillie, 1978) using boundary layer formulation cited in the rule, including appropriate shape factors in accordance with standard building code practice.

All major structures are required to be elevated on, and securely anchored to, an adequate piling foundation such that the underside of the lowest supporting structural member excluding the piling foundation, shall be above the 100-year return storm surge plus an additional vertical distance to allow for appropriate site-specific wave heights. The staff is also required to consider federal base flood elevations recommended by FEMA's Federal Insurance Administration. (A complete file of all available FIA FIRMs and FIRMs plus wave height analysis is maintained by the Division.) The pilings must be designed to withstand all reasonably anticipated loads resulting from a 100-year return hurricane including at least wind and wave forces acting simultaneously with typical structural loads. No substantial walls or partitions are allowed below the first finished floor and seaward of the CCCL. The elevation of the "soil surface" used in the calculation of piling reactions and bearing capacities is that which is reasonably expected from anticipated beach and dune erosion (including dune/bluff recession and local scour) due to the 100-year event.

Coastal or shore protection structures extending totally or in part seaward of the CCCL are required to be designed to resist the predicted natural forces consistent with the proposed usage and design life of the structure. Design considerations for such structures include structural siting, crest and toe elevations, structural slope(s), components as impacted by waves superimposed upon the design storm surge, expected scour, and impact on the beach-dune system and adjacent properties.

The applicant is also required to furnish the Department with certification by a professional engineer or architect, registered in Florida, that the design plans and specifications submitted as a part of the application are in compliance with provisions of the rule.

In addition to technical issues, beach-dune preservation and project siting are considered. While the program acknowledges the existing line of construction as well as reasonable use of property, efficient usage of property upland of the CCCL is prerequisite to a favorable staff recommendation for a permit.

In addition to use of latest editions of the Standard Building Code (Southern Standard Building Code Congress International, Inc.), South Florida Building Code, Shore Protections Manual (U.S. Army Corps of Engineers, 1977) and other pertinent design force documents (e.g., CERC and ASCE technical publications, FEMA's Design and Construction Manual for Residential Buildings in Coastal High Hazard Areas), the Division is authorized to compile Beaches and Shores Technical and Design Memoranda (e.g., Clark, 1980).

A distinction is made between major structures such as houses, condominiums, motels, restaurants, seawalls, and swimming pools and minor structures such as pile-supported dune walkovers and viewing platforms, beach access ramps, and cantilevered decks or porches. Minor structures are not required to meet specific structural requirements for wind and waves, but are required to be designed to produce minimum adverse impact on the beach-dune system and adjacent property and to reduce the potential for generating aerodynamically or hydrodynamically propelled missiles.

Following completion of the permit application review process, the coastal engineering staff of the Bureau of Coastal Engineering and Regulation make a recommendation with supporting evidence of either approval or denial. This recommendation undergoes review by the Division executive staff, followed by the executive staff of the Department and then to the Cabinet Aides at the Florida Capitol. These reviews are conducted to insure consistency with goals, policies and jurisprudence considerations of the State of Florida. Final decision-making authority rests with the Governor and six-member Cabinet, who convene twice monthly to deliberate such matters.

Violations of Chapter 161 or any supporting rules are prosecuted, accompanied by a fine of each offense in an amount up to $10,000 to be fixed, imposed and collected by the Department. Each day during any portion of which such violation occurs constitutes a separate offense. Discovery and monitoring of violations and the progress of permitted activities are made by a staff of field inspectors, and periodic site visits by the coastal engineering staff. Physical mitigation including removal or modifications are additional enforcement options. The permitting workload of the Division of Beaches and Shores is illustrated in Figure 1.

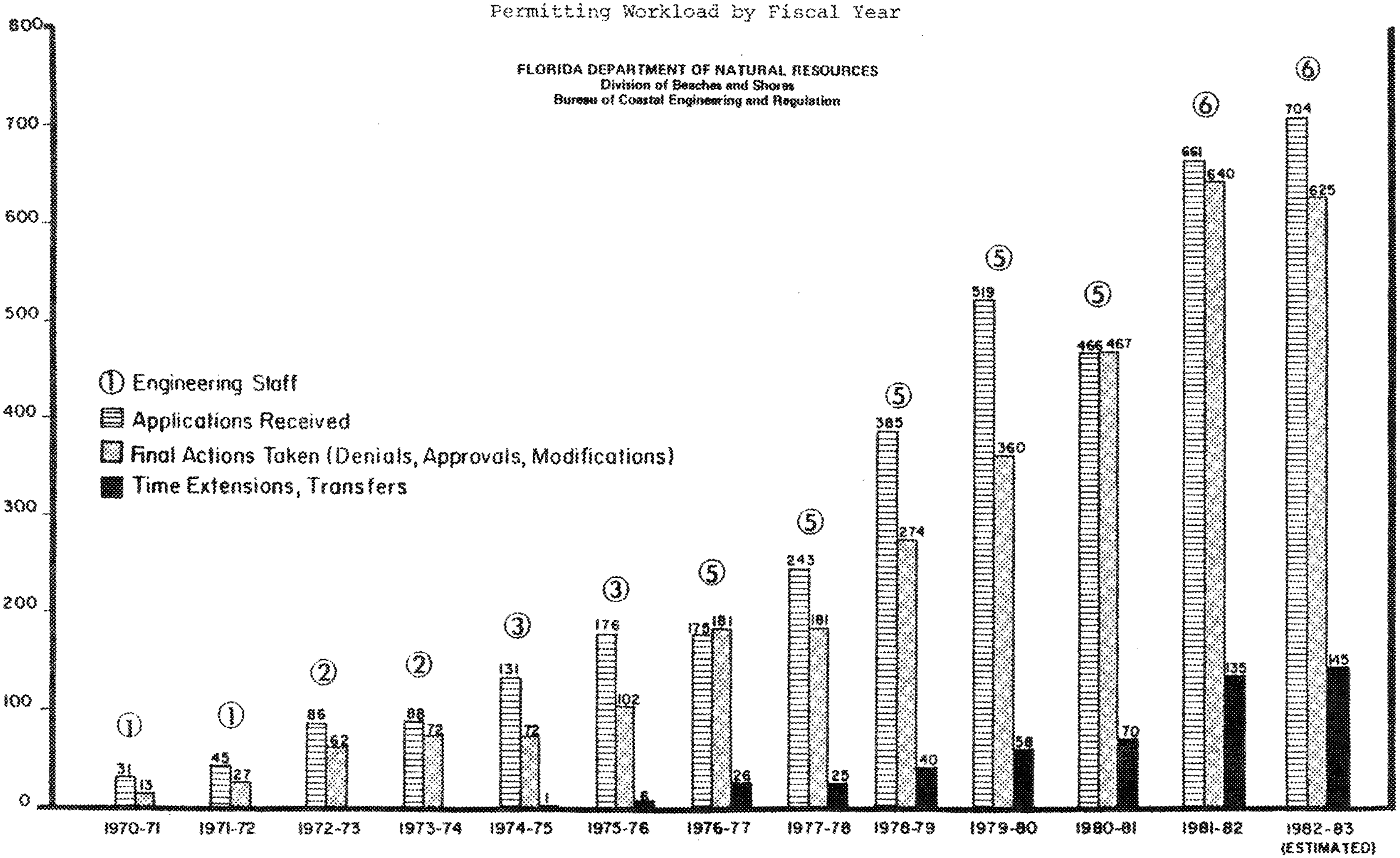
Discussion: Velocity Zones and Wave Heights

Although the preceding is an overview, it does demonstrate the scope and depth of the coast and beach preservation responsibilities of the Florida Department of Natural Resources. In this program, tolerances of plus or minus one foot in horizontal siting of certain coastal activities, or in terms of tenths-of-a-foot for structural component elevations, are not uncommon. It is also recognized that the Federal Insurance Administration, which requires the consideration of velocity zones and wave heights, has uncommonly extensive responsibilities, including not only littoral environs but inland areas as well. However, Flood Insurance Rate Maps (FIRMs) do not provide detail sufficient to satisfy conditions of Florida's Shore and Beach Preservation Act and supporting Florida Administrative Code. This is not to imply that FIRMS are not considered by Florida's program (see earlier text), but that they are employed as "rule-of-thumb" measures for comparison with more detailed, site-specific coastal engineering reviews.

Wind-generated waves are considered to produce the most critical forces to which the beach, coast and structures can be subjected. In addition, however, wave conditions at a particular site also depend critically on the water level. A rise in the water level can significantly increase the destructive potential of waves propagating on the water surface. Initially, then, it is necessary to determine the expected increase

FIGURE 1

Permitting Workload by Fiscal Year



in water level elevations accompanying a design storm.

The adopted storm surge models of FIA and the Florida Department of Natural Resources have been developed from separate sources, and there are differences in the results. An example is illustrated in Figure 2 for some data from Dade and Broward Counties using data from the Federal Emergency Management Agency (1981b, 1982a, 1982b, 1983) and Dean and Chiu (1981a, 1981b), and shows FEMA surges to be, at a minimum, three to four feet lower than those endorsed by the Florida DNR. It is considered that the differences occur because FEMA surges do not include the dynamic setup resulting from nearshore wave activity.

The manner in which waves are treated by the FEMA and the Florida DNR also differs. While the inclusion of waves in FIRMS (National Academy of Sciences, 1977; Federal Emergency Management Agency, 1980) is applauded, the application of wave dynamics during DNR's permit review process must be considered based on specific site conditions. This approach, in turn, requires additional considerations.

Wave characteristics are significantly transformed as the waves shoal (Balsillie, no date). The characteristics of breaking and broken waves are of particular interest, because of sediment transport and impact loading potential. Since wave mechanics also depend critically on the water depth, any erosion or scour occurring during design storm impact must also be considered. The Florida DNR has received funds from the federal Coastal Zone Management Program (through the Florida Department of Environmental Regulation, Office of Coastal Management) to develop computer programs addressing these processes. Some results are available. A method for treating offshore profile data for use in coastal engineering applications is applied to Florida data (Balsillie, 1982a, 1982b), and a model for predicting dune/bluff erosion (Balsillie, 1982c) has been completed. Other endeavors related to nearshore wave transformation, breaking wave mechanics, and vertical and horizontal wave impact loads are in the development stage.

The effort of the Florida Department of Natural Resources to develop computer tools that replicate natural processes and forces to enhance capabilities of coastal engineering review responsibilities is continuing. While significant progress has been made, much work still remains.

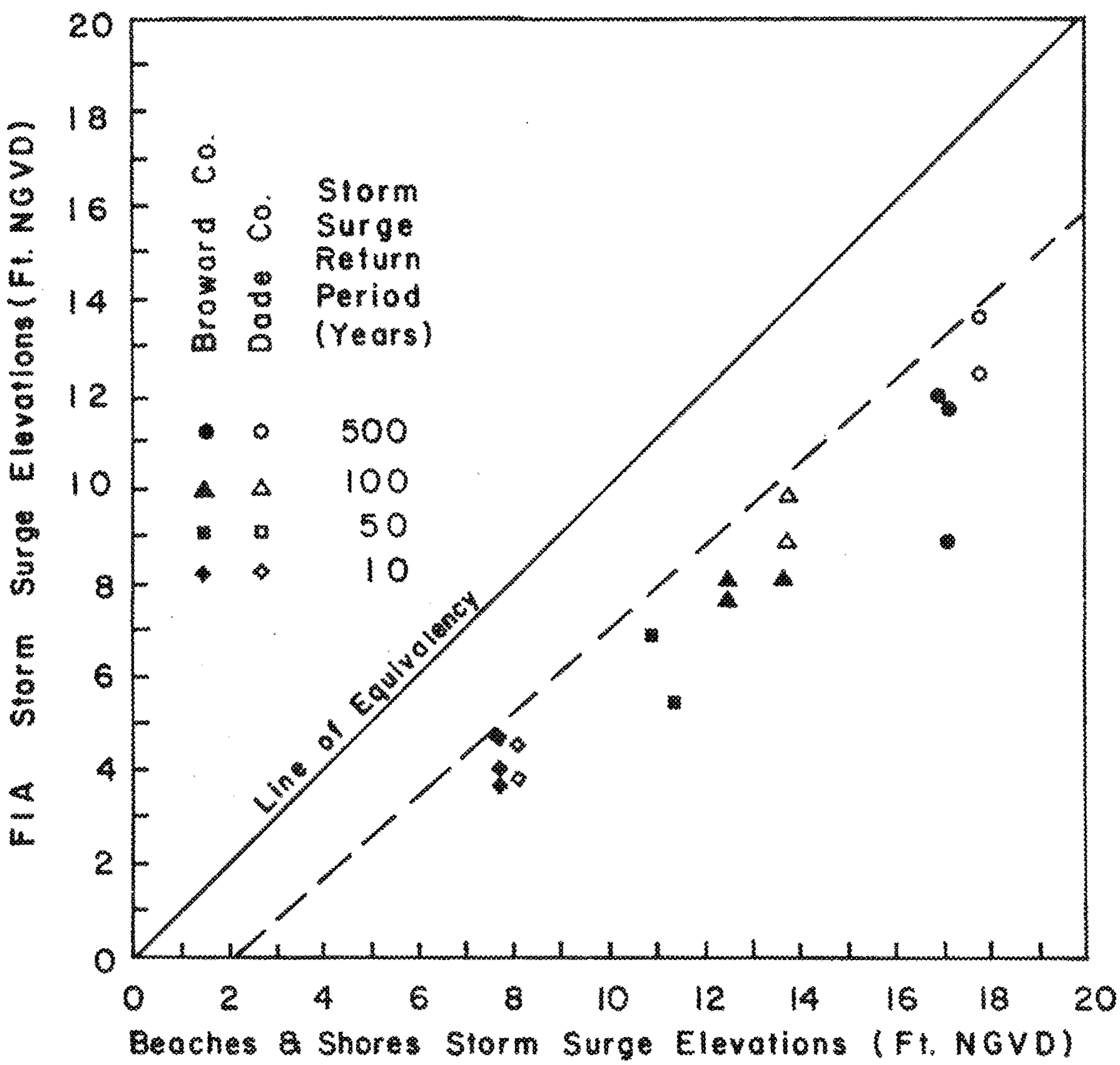


FIGURE 2

Difference Between FEMA/FIA and Florida DNR (Beaches and Shores) Storm Surge Elevations

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COASTAL FLOOD VULNERABILITY ASSESSMENT

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In 1981, the State of Connecticut began a program to identify coastal flood vulnerability. This was necessary for two reasons. First, Connecticut had not experienced a major coastal storm since 1955, but the shoreline towns have rapidly developed in those 25 years. Coastal flood damage potential had never been quantified or documented. Second, in 1981 the state published a flood hazard mitigation handbook for municipalities outlining a recommended local program. At that time a number of towns indicated that neither the personnel nor the funding were available at the local level to carry out such a program.

When Connecticut provided both the personnel and the funding at the state level, it eliminated two of the better excuses for inaction. Assistance was offered to all 25 coastal towns in Connecticut. One-third of the state's population, or one million people, live in the coastal towns and were potentially affected by the study.

The Assessment

The first step of the program was to look at the development within the flood zones of the coastal towns. It was found that the most efficien way to do this was to transfer flood zones from the flood insurance rate maps to transparent overlays of the 1980 aerial photographs, and literall count every structure located within the floodplain. Thirty-five thousand structures within Connecticut's shoreline towns were identified as flood-prone. That includes homes, businesses, industries, utility substations, fuel tanks, sewage treatment plants, greenhouses, high schools and convalescent homes. Four thousand of these structures are located in coastal high hazard zones. When field-checked, these figures have been found to be conservative.

Having identified the potential flood hazard on the shoreline, an attempt was made to document each town's capability for handling that hazard. First, a municipal profile was developed which assessed the overall level of flood preparedness within the community. Second, local zoning regulations governing the use of floodplains were analyzed. Next, existing emergency operation plans were reviewed and evaluated, looking specifically for flood preparedness and flood mitigation measures. Final it was noted whether or not the community participated in the National Flood Insurance Program.

This part of the program was designed to assist the local government in upgrading their level of flood preparedness. To address the needs of th owners and occupants of those 35,000 flood-prone structures, a public awareness and preparedness campaign was designed, directed specifically to those people living in the coastal flood zones. The aim was to assess the present level of flood awareness, and at the same time prompt people to consider various precautionary measures and floodproofing techniques. This was done by distributing a coastal property homeowner's questionnaire

Results

The development of a municipal profile was found to be particularly useful to the local officials of coastal towns. In many cases, it represented the first effort ever made to compile all local flood-related information in one place. That profile entailed such fundamental tasks as listing the names and phone numbers of the local officials involved in flood planning and response and recovery efforts, identifying the population living in flood hazard areas, and looking at the state of repair of flood control structures. Additionally, the profile prompted the towns to consider the consequences of flood-related business interruptions--the temporary or permanent loss of jobs, the lost tax revenue, and the dollars needed in public relief money to re-establish the integrity of the affected businesses. Attention was brought to bear as well on the effects of flooding on publicly owned structures.

The profile listed the number and location of dams within each town. State and local bridge locations were listed, as were marinas, electric and gas utilities, and water supply sources. In addition to looking at existing development, the profile stressed the importance of maintaining wetland areas to provide a buffer against flood waters.

A review of local zoning regulation revealed a wide diversity in the implementation of the minimum requirements of the National Flood Insurance Program. All of Connecticut's coastal towns are enrolled in the regular program of the NFIP. However, in practice enforcement of the regulations ranged from one town that had granted every variance for construction in a flood zone for which application was made to a city that not only enforces the regulations but now requires developers to submit emergency operations plans with any permit application for an office building or multi-family housing unit in a flood zone.

The coastal property homeowner's questionnaire was successful in getting information out to people, and it brought back some interesting comments. One person even filled out his questionnaire as water was rising around his house during last June's flood.

The results of the questionnaire show that overall flood hazard awareness was high, even though few people had experienced a flood in their present location. Most homeowners do carry flood insurance but very few are insured to full replacement value. Most shoreline residents are prepared to take basic common-sense precautionary measures such as shutting off utilities and moving their possessions. Very few had imlemented any residential floodproofing measures, but many requests for floodproofing information were received. In fact, interest was so high that the state is now considering offering "flood audits" to homeowners. Coastal homeowners would be visited on an individual basis and be provided with figures on flood elevations and recommendations of various floodproofing techniques with cost estimates.

Connecticut's coastal program will probably have its greatest influence on emergency operations planning. Surprisingly, only one of the 25 coastal towns had identified and addressed flooding as a potential hazard in its emergency operations plan. The towns generally have no established procedure for receiving flood warning information, no methods for disseminating flood warnings to the general public, no evacuation procedures, no damage assessment provisions and no community education programs. Plan improvement and practice procedures are grossly inadequat

It is for these reasons that measures taken immediately before and during a flood are reactive in nature and that little is done to prevent flood damages from occurring before a flood strikes. The Natural Resource

Center, in cooperation with our state office of civil preparedness, is therefore encouraging town officials to adopt mitigative measures that would reduce property damage, reduce the need for public relief assistance and increase public safety. It is recommended that each town adopt a flood annex to its emergency operations plan. This section would address flooding specifically: it would specify a flood warning system, a flood evacuation plan, and measures to reduce flood damages; establish methods to assess flood damages; outline procedures to mobilize flood assistance from outside sources; and educate the public in flood preparedness.

Cost Effectiveness

The coastal flood vulnerability assessment has cost $29,000 over two years. The results are not immediately quantifiable, but the program has the potential of being extremely cost-effective. If it is responsible for saving one structure during the next flood, or the contents of two homes, or six cars or 12 motorcycles, then the program will have paid for itself: and the program has the potential of affecting any number of owners of the 35,000 flood-prone structures on Connecticut's shoreline.

SOME OBSERVATIONS ON BEACH EROSION CONTROL IN THE STATE OF DELAWARE

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The State of Delaware incorporates approximately 25 miles of ocean coastline and about 35 to 40 miles of sandy barriers along the western shore of Delaware Bay. All of these areas are subject to significant shoreline erosion problems.

Delaware's entry into the field of beach erosion control was prompted by a severe storm in December of 1914 which "practically destroyed the entire oceanfront of Rehoboth Beach." In February of 1915 the state's General Assembly authorized the Commissioners of Rehoboth to issue bonds and borrow $20,000 to repair and permanently improve the streets and oceanfront of the community. Two years later the state kicked in $10,000 of its own money because the $20,000 had been expended and the repairs were still uncomplete. The General Assembly reasoned that the funds were warranted since Rehoboth was the only seaside resort within the state at that time and it therefore was of special interest and importance to all the citizens.

Now, almost 8 million cubic yards of sand, 72 groins, hundreds of feet of bulkheading, and several million dollars later, sea level is still rising, coastal storms are still occurring, and people still want to live close to the water's edge. In administering a program that attempts to regulate home construction along the beach, one sometimes gets the feeling that there is a better chance of reversing the first two trends than the last. One thing has become apparent in the last decade, and that is one never really controls beach erosion, but instead one mitigates it--sometimes. Contrary to what the 1915 Delaware General Assembly may have intended, no shoreline protection work is permanent and very rarely is it effective if it is inexpensive.

Only two general methods of beach erosion control have been used extensively in Delaware over the last 60 years: groin construction and beach nourishment. From the 1920's to the 1950's groin building was very common in the state. Beach nourishment began being used as a control measure in the 1950's and, as groin construction declined, has become the principal method of coping with erosion. The construction of bulkheads along the ocean and bayfront has been done almost exclusively on a privat and municipal basis.

Some general observations can be made about the performance of these three methods. Some groin fields have performed well, as in Rehoboth, and some not quite as well, as in Bethany Beach. The success of groins is to a large degree dependent upon the availability of sand to the beach system. Bethany Beach is in a nodal area and sand is transported away from the area both to the north and to the south by longshore currents. Rehoboth, on the other hand, has undoubtedly benefited from the over thre million cubic yards of sand which, since 1957, have been placed on the feeder beach north of Indian River Inlet and distributed northward by littoral currents. An important point to remember is that groins, or any other structures for that matter, do not put new sand into the system, they merely direct the distribution of the sand already there.

Beach nourishment, on the other hand, does contribute additional san from outside the active beach system. In doing so it provides flexible protection and recreational benefits with few adverse side effects. Nourishment can be very expensive, however, and sometimes the projects are short-lived. It is important to avoid nourishment of a short stretch of beach unless the ends can be stabilized with some type of structures. The grain size of the fill should also be compatible with the beach being filled, i.e. as coarse or coarser.

As beach erosion control structures, bulkheads have generally been a disaster in Delaware. Those that have worked have done so at the expen of the beach in front of them and as the shoreline has migrated landward in response to natural processes their owners have been forced to extend their return walls to keep from being flanked. Eventually the property begins to look more and more like an island and the bulkhead begins to function as a groin. Most bulkheads installed on the ocean coast have failed, many times catastrophically, due to inadequate design or poor construction techniques such as insufficient sheeting or pile depth resulting in undermining or overturning; short return walls resulting in loss of the supporting fill behind the structure; or undersize materials and connecting hardware which succumb to the forces generated by direct wave impact.

Delaware does not prohibit bulkheads in its regulatory program, but it has made it more difficult to get a permit because the applicant is required to submit signed releases from the adjacent property owners indicating their awareness of the potential problems to which their property is subject as a result of such a project. This has reduced substantially the number of permits issued for bulkheads in the last few years. Property owners have been encouraged to seek alternatives to bulkheading such as stone riprap revetments, which will dissipate wave energy rather than reflect it. It is also now required that all plans for erosion control structures submitted for permits be approved by a registered professional engineer. This has helped eliminate many of the sure-fire failures of the past.

III. BARRIER ISLANDS

BARRIER ISLANDS: PUBLIC VALUES AND PUBLIC COMMITMENT

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U.S. Army Corps of Engineers

Human beings have lived near the sea for thousands of years because of its value as a primary transportation mode. In early years, however, settlements were located away from areas susceptible to direct attack from the sea. In this century, increases in leisure time combined with automobile-generated urban and surburban sprawl have resulted in vast numbers of primary and secondary homesites in the coastal zone. Humans have encroached on that landform called the beach.

Beaches are recreation areas but, very importantly, they are also the first line of defense for inland areas against storm waves that attack the mainland. On the east coast of the United States, especially south of Long Island, many beaches are located on barrier islands. Archeologists have confirmed that centuries ago, native Americans recreated on barrier islands. In the summer they set up their tent cities, but as the storm season approached, they journeyed back to the mainland and higher ground. If a severe storm or hurricane threatened during the summer, they would temporarily abandon the barrier islands, to return only after the storm surge had subsided. In this instance, these early Americans were pioneer practitioners of a recognizable form of wise land use.

Unlike our Indian predecessors, we build permanent structures--fixed homes, condominiums, hotels--and then enable and encourage vast numbers of people to get to them by building fixed bridges, causeways, and super-highways. Under ordinary conditions this intense development might be acceptable; but in no sense do barrier islands represent "ordinary conditions."

Barrier island is the generic name for a class of geologic features that includes islands, spits, bay barriers, tombolos, and other similiar accumulations of unconsolidated sediments positioned between the ocean and some landward aquatic habitat. Barrier islands are subject to many stresses--wind, wave, and tidal forces--and they protect the landward bays, sounds, estuaries, and marshes from direct wave attack.

Barrier islands also move with relation to roads, buildings and bridges. In some areas of the country, barrier islands are becoming narrower by the action of the sea. In other areas, the islands are migrating shoreward. In still other areas the islands are translating seaward. The complex interaction of the waves, currents, and wind forces on the sediments is a fascinating study, but it is not amenable to precise prediction because of the great variability of the forces.

To protect barrier islands from human beings, and to protect human beings from themselves, it has been proposed that all human activity be restricted from those islands. Environmental interests wanted to protect the rich aquatic habitats and the marine life associated with inlets, estuaries, and wetlands. Those responsible for the preparation of national budgets and natural disaster planners were concerned about the personal dangers associated with locating in storm-prone sites, and about the fact that mainland taxpayers have had to subsidize barrier island dwellers: taxpayers and relief agencies had to pick up the tab--and the pieces--after a storm. In the event of a hurricane, the evacuation problem greatly magnifies that burden--even where it is possible to timely evacuate.

Last year legislation established the Coastal Barrier Resources System (P.L. 97-348). This law established the exact locations of undeveloped barrier islands that are to be protected. In this context, protect means to preclude any federal expenditure on these undeveloped barrier islands that would tend to encourage development. The Army Corps of Engineers considers it to be a fine piece of legislation. It simultaneously accommodates the twin concerns of maintaining economic efficiency and preserving environmental integrity, clearly a happy wedding. A companion piece of legislation passed the previous year, the Omnibus Budget Reconcilation Act of 1981 (P.L. 97-35), prohibits flood insurance coverage for new structures on undeveloped barrier islands after October 1, 1983.

By these laws, the federal government has established a policy of protecting undeveloped barrier islands by stopping all federal expenditure on such islands, with some pertinent exceptions where appropriate such as national defense, energy development, and navigation safety.

States have been encouraged to protect their resources by the Coastal

Zone Management Act (P.L. 92-583, as amended), the first and only natio wide land use planning measure to make it through Congress. It affects 30 coastal states, including the Great Lakes states. In this law federal policies of supporting the states in their regulation of coastal zones are enumerated. With federal grants, each state develops a plan necessar to effectively manage its coastline, including barrier islands. When that plan is approved by the Secretary of Commerce, the federal governme is obligated to be consistent with that plan to the maximum extent practicable.

In summary, barrier islands are subject to biophysical stresses of an order that mainland areas rarely experience. Human cultural, social, institutional, and political factors are indivisible from the natural forces at work on these islands. As Emerson has reminded us, nature "...never gives anything away. Everything is sold at a price. It is only in the ideals of abstraction that choice comes without consequence." In the final analysis, the choice we make about the use and protection of barrier islands is more than a matter of law--it is a matter of public conscience, public values, and public commitment.

HAZARD MITIGATION ON ATLANTIC
AND GULF COAST BARRIER BEACHES

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Introduction

Mounting technical knowledge and public awareness of ecological sensitivity, dynamic coastal processes, increased development pressures and potentially high economic losses illustrate the need for improved flood hazard management on one particular type of coastal landform--barrier beaches. The term "barrier beach" (which includes islands, spits and baymouth barriers) has become so familiar over the past few years that a definition is hardly necessary. Flood hazard management, on the other hand, requires more attention, particularly as one considers the extent of development on barriers. A distinction is now made between undeveloped and developed barriers (U.S. Department of Interior, no date).

The concept of coastal flood hazard mitigation specifically, is critically important for developed barriers along the U.S. Atlantic and Gulf coasts since most have not experienced a major northeast storm or hurricane over the past 20 years. At present, several structural and non-structural hazard mitigation techniques are used to address erosion and flood control problems. The techniques are usually compared and selected separately on the basis of benefit-cost ratios and public opinion. Although interdisciplinary studies of the natural and built environments, hazard vulnerability, land use regulations and economic investments are conducted, a combination of structural and non-structural techniques, innovative strategies and long-term management approaches is rarely used. Ultimately as pressures of urban development intensify, flood mitigation--in the broadest sense of the term-- must become an integral facet of comprehensive community planning (National Science Foundation, 1980).

The major purpose of this paper is to provide information on current state management approaches for developed and undeveloped barrier beaches Background information on the progress of scientific research is provided to explain why barrier beaches in particular are receiving so much attent

Results from a questionnaire are used to identify particular hazard mitig tion techniques and their effectiveness along the U.S. Atlantic and Gulf coasts. Government programs that encourage and discourage mitigation efforts and the way in which the federal government could further encoura state efforts are discussed. Concluding remarks address the implications of the Coastal Barrier Resources Act (CoBRA) to state programs and whethe the coverage of the Act should be extended to other areas.

Background

Coastal barriers have been the subject of intense research over the past 15 years and, to date, three origin theories are prevelant (Hayes and Kana, 1976). Classification schemes, including subclasses by shape, have been presented (Leatherman, 1980). Regional variations as a functic of tidal range have been described (Hayes, 1979). Ecologic and geomorphi descriptions of individual barrier components, beach erosion and barrier inventories, as well as geological atlases, have been compiled in the las 10 years to serve as useful baseline information (Humphries and Benoit, 1980). Currently, research on sea-level rise is being conducted in severa barrier environments (Titus et al., 1983). The overwhelming majority of this data demonstrates that significant levels of flood hazard vulnerabil rates of landward movement or migration and degrees of sensitivity to human-induced modifications through construction exist on most undevelope and developed barrier beaches.

Efforts to improve public awareness and education concerning the hazards and costs of living on barriers require translation of that scientific research. The National Flood Insurance Program and the Coastal Zone Management Act are two primary mechanisms for bringing about and improving the understanding of scientific research for the layperson. Among the many conferences and workshops that have presented information on barriers, the Barrier Islands Workshop in Annapolis, Maryland (1976) and the Barrier Island Forum and Workshop in Provincetown, Massachusetts (1980) were specifically devoted to expanding public awareness and chang management policies within the federal government. These educational efforts preceded the passage of the Omnibus Budget Reconciliation Act of 1981 and CoBRA in 1982 curtailing federal expenditures that, in the past have promoted unwise growth and development on previously undeveloped barriers.

A summary of the testimony and facts presented to support passage of CoBRA includes the following:

- The estimated federal cost to develop only 50% of the remaining undeveloped barrier islands and portions of islands ranges from $4 billion to $11 billion over the next 20 years.
- The federal share of funding for sewers, wastewater treatment, roads, bridges, shoreline stabilization, flood insurance, and disaster relief on barrier islands ranges from 75% to 100%. The cost of these facilities and services on barrier islands is two to three times greater than what is spent for the same facilities and services on the mainland.
- Seventy-eight percent of the national flood insurance claims for 1978 and 1979 were paid to coastal states at a rate four times the amount collected in premiums.
- The federal government committed at least $500 million to development of barrier islands in fiscal years 1975-77.
- Since the eye of Hurricane Frederic passed over Dauphin Island in 1979, federal expenditures to put it back together have mounted to at least $50,000 for each of the residences.
- Federal Highway Administration figures show that during fiscal years 1976-1978, over $37 million in 70% federal and 30% state or local matching grant monies were provided to state and local agencies for development of roads and highways on barrier islands.
- Carrying out the Army Corps of Engineers' planned beach restoration projects nationwide---similar to the wasted $20 million effort of five years ago at Cape Hatteras, North Carolina---would cost an estimated $2 billion, with annual maintenance costs of $73 million.
- The rate of urban growth on barrier islands between 1960 and 1976 was four times the national average. Each year 6,000 acres of barrier islands become developed.

As in the case of undeveloped barriers, scientific and planning research for developed barriers must precede changes in governing policies and regulations. Baseline data need to be collected to better understand the specific flood hazard vulnerability, erosion trends and migration rate of a particular developed barrier and should recognize the following four factors: onshore sediment movement, storm activity, equilibrium readjustment of sea level rise, and construction activities along shore (Fisher, 1977).

Developed and highly urbanized barriers no longer have the natural environmental characteristics they once had in the undeveloped state. Instead, a large financial investment and population center has been substituted. However, the hazard vulnerability of the barrier still remains and actually may increase with expanded growth and development. Based on the scientific understanding of a particular barrier, planning studies can be used to formulate a set of site-specific recommendations for reducing or mitigating future storm damages. It is then up to government officials to select and implement the appropriate mitigation activities from those recommended.

To understand more about the specific attention states are giving to developed and undeveloped barrier beaches, a questionnaire (Table 1) was sent to a coastal zone manager and floodplain manager in 18 Atlantic and Gulf Coast states in April 1983. Responses from 11 coastal zone managers and 12 floodplain managers in 15 states were received. Both managers replied from eight states which provided for regional representation: in the northeast, New Hampshire, Massachusetts and Rhode Island were represented; in the southeast, Virginia and South Carolina were represented; and, in the Gulf, Mississippi and Texas were represented.

Admittedly, the responses to the questionnaire are subjective and any position taken is not to be considered a formal one on behalf of the state. They, nonetheless, come from knowledgeable individuals in the field of coastal floodplain management. Some of the responses, not all, are summarized and discussed qualitatively for this paper. A statistical analysis did not lend itself to this type of questionnaire.

Hazard Mitigation Approaches

Identification of the hazard mitigation approaches currently being applied to developed and undeveloped barriers by a number of states was made by summarizing questions 5 and 6 of the questionnaire. The specific purpose was to have the managers identify the specific type of nonstructural or structural approaches being applied and to define their effectiveness. The terms nonstructural and structural are used to distinguish those measures which are intended to keep people away from the water versus those which are intended to keep the water away from people, respectively. In question 5, approaches (a) through (f) are considered nonstructural

BACKGROUND DATA

1. Name of coastal state ____________

2. Which of the following serves as the basis for existing state programs?

   (a) Wetlands - legislation ___ ___ (yes no) regulations ___ ___ (yes no) exec. orders ___ ___ (yes no)

   (b) Floodplains ___ ___ (yes no) ___ ___ (yes no) ___ ___ (yes no)

3. Which of the following, if any, defined and contained in the language of the state enabling programs?

   (a) Barrier islands ___
   (b) Barrier beaches ___
   (c) Undeveloped barrier beaches islands ___
   (d) Developed barrier beaches islands ___
   (e) None ___

4. Has the state completed or have plans to complete the following for barrier beach/island resources?

	Completed	Planned	Not planned
(a) Inventory			
(b) Photo inventory			
(c) Maps			
(d) Erosion rates			

MANAGEMENT APPROACHES

5. Which of the following hazard mitigation approaches have been applied to developed and undeveloped barrier beaches/islands (enter "d", "u", both "b" or neither "n")

   (a) National Flood Insurance ___
   (b) Land Acquisition ___
   (c) Building Acquisition ___
   (d) Building Relocation ___
   (e) Elevated Buildings ___
   (f) Evacuation - vertical ___
   horizontal ___
   (g) Beach Restoration ___
   (h) Dune Restoration ___
   (i) Offshore Breakwaters ___
   (j) Riprap or seawalls ___
   (k) Emergency sandbags ___
   (l) Other ___________

6. (a) Which of these approaches have been the most successful or effective? (list in decending order by letter a - k)

   1. ___ 2. ___ 3. ___ 4. ___ 5. ___ 6. ___ 7. ___

   (b) Which approaches have not been effective?

   1. ___ 2. ___ 3. ___ 4. ___ 5. ___ 6. ___ 7. ___

   (c) On what basis was effectiveness determined? (check)

   Cost ______ Public acceptance ______ Storm tested ______

   Other (explain) ____________

7. Which of the following federal programs, laws or policies have encouraged (+) or discouraged (-) those applied mitigation approaches?

   (a) Sewer and water facilities grants ___
   (b) Disaster assistance ___
   (c) Highway, bridge and tunnel assistance ___
   (d) Income tax write-offs ___
   (e) Subsidized flood insurance rates ___
   (f) FEMA wave heights ___
   (g) Coastal Barrier Resources Act ___
   (h) Executive Orders on floodplains and wetlands ___
   (i) Environmental Impact Statements ___
   (j) Section 1362, Disaster Relief Act ___

8. What are the implications of the Coastal Barrier Resources Act to state programs? (check)

   Major ______ (e.g., it has contributed to new or forthcoming changes in legislation, regulations, executive orders or building codes that will limit state expenditures encouraging growth and development).

   Moderate ______ (e.g., it has contributed to changes in policy guidelines in existing legislation, regulations ...encouraging growth and development).

   Minor ______ (e.g., it has encouraged more technical assistance requests to communities that are affected).

   None ______ (e.g., the type and extent of areas affected are not significant enough to influence a change in state programs).

   Note: If there are other reasons that define the implications or if there are negative implications, please briefly explain.

   ____

   ____

9. Should the coverage of the Coastal Barriers Resources Act be extended to other areas?

	Yes	No
(a) V-zones on developed barriers		
(b) All V-zones		
(c) Developed barriers		
(d) Poor Act - ineffective		

10. In what areas could the federal government further encourage state hazard mitigation efforts on barrier beaches/islands?

	Increase	Decrease
(a) Legislation/regulations		
(b) Financial assistance		
(c) Technical assistance (e.g., hazard maps)		

TABLE 1

Hazard Mitigation Questionnaire
Sent to 18 Atlantic and Gulf Coast States, April 1983

and approaches (g) through (k) are structural. Other approaches not listed but which were added by individual states included zoning, building setbacks and groins. In addition, the term hazard mitigation collectively refers to erosion and flood reduction.

The hazard mitigation approach most applied on developed and undeveloped barriers is flood insurance. Dune restoration ranks second but is closely followed by elevated buildings, riprap or seawalls and beach restoration which received an equal level of response. The hazard mitigation approaches least applied on barriers are building acquisition and relocation, emergency sandbags and offshore breakwaters. Most approaches apply to developed or both developed and undeveloped barriers with very few approaches applying to just undeveloped barriers.

The mitigation approaches identified as the most effective include elevated buildings (preferred by floodplain managers), flood insurance (preferred by coastal zone managers) and dune restoration and land acquisition (preferred equally by coastal zone and floodplain managers). The least effective approaches are considered to be riprap or seawalls, offshore breakwaters and building relocation. Coastal zone managers find offshore breakwaters to be more ineffective than do floodplain managers. There was an equitable response to the ineffectiveness of seawalls and building relocation. The lowest response concerning both the effectiveness and ineffectiveness of specific mitigation approaches includes emergency sandbags, building acquisition and evacuation. Overall, there were twice as many responses to mitigation effectiveness as there were to ineffectiveness.

In summary, several structural and nonstructural mitigation approaches are used throughout the coastal zone. These general approaches are considered effective as well as ineffective. It does not appear that one approach is preferred over the other. In fact, a combination of structural and nonstructural approaches is indicated if one considers those that are most applied and most effective. Dune restoration, flood insurance and elevated buildings are specifically identified and highly rated by most coastal zone and floodplain managers.

Riprap or seawalls, one of the most-applied approaches, is considered one of the least effective. This structural approach has a high cost associated with construction and maintenance, usually accelerated beach erosion and provides a false sense of security. In contrast, building and land acquisition are applied the least yet are considered to be the most effective. These nonstructural approaches are creative and cost-effective over the long-term, allow natural changes of the barrier to occur and eliminate a concern about flood hazard vulnerability.

Government Involvement

Many government programs, policies and laws encourage as well as discourage hazard mitigation efforts on undeveloped and developed barrier beaches. There are several areas in which the federal government can further encourage state efforts. Responses to questions 7 and 10 of the questionnaire clearly define these positions and indicate the need for the involvement of all government levels in managing barrier resources.

Sewer and water facilities grants; disaster assistance; highway, bridge and tunnel assistance; income tax write-offs; and subsidized flood insurance rates discourage the application of mitigation approaches as indicated by a large majority of coastal zone and floodplain managers along the Atlantic and Gulf coast. Many of these construction and relief programs were initially recognized and documented for their negative impact and the extent to which growth and development was encouraged near four national seashores (Sheaffer and Roland, Inc., 1981). Although the federal government is heavily involved with these programs, state and local governments at least share a responsibility in modifying the application of these programs on barrier beaches.

Government efforts that encourage the application of hazard mitigation approaches include FEMA wave heights (and the more accurate delineation of V Zones), CoBRA, environmental executive orders and impact statements and Section 1362 of the Disaster Relief Act (which enables building and land acquisition). These efforts primarily involve the federal government with state and local coordination during implementation. However, executive orders protecting wetlands and floodplains are also adopted by state government. The Massachusetts Executive Order No. 181-- Barrier Beaches specifically identifies seven means of discouraging growth and development of both undeveloped and developed barriers.

An overwhelming majority of state coastal zone and floodplain managers consider that an increase, not a decrease, in federal assistance is needed to further encourage state hazard mitigation efforts on barrier beaches. In order of descending preference, state managers feel technical assistance, financial assistance and new or revised legislation and regulations will be beneficial.

Implications and Expectations for CoBRA

State coastal zone and floodplain managers have only had six months to evaluate the effect of the Coastal Barrier Resources Act of 1982. However, response to questions 8 and 9 of the questionnaire was substantial enough to summarize the implications that CoBRA has had to state programs and individual opinions on extending the coverage of the Act to other areas. The provision for eliminating flood insurance coverage is not effective until October 1, 1983, so positions are based on the elimination of other forms of federal assistance.

An overwhelming majority of state managers feel CoBRA has not been significant enough to influence a change in state programs. Coastal zone managers from Florida and Massachusetts feel that the legislation has contributed to changes in policy guidelines to limit state expenditures encouraging growth and development. A coastal zone manager in Connecticut and floodplain managers in Rhode Island and Massachusetts feel more requests for technical assistance have come from communities. Specific comments from the state managers about limitations of CoBRA include:

- a high level of protection already exists for undeveloped barriers;
- areas included probably would not be developed anyway;
- it does little to deal directly with the real problem areas--developed barriers;
- definitional criteria were unevenly applied by Congress and the Department of Interior; and
- it is too new to make any determination about the implication of CoBRA to state programs.

A desire for extending coverage of CoBRA to V Zones on developed barriers was strongly and equally expressed by coastal zone and floodplain managers. Collectively, twice as many managers favor the extension of coverage to all V Zones and all developed barriers as disfavor it. This indicates that even before enough time has passed to properly evaluate the impact of CoBRA, states want to see the legislation expanded to other hazard-prone areas. The position taken that CoBRA has not had an influence on changing states' laws, regulations or policies might be considered in a broader context to say that the federal government did not go far enough.

Clearly, CoBRA is an important initial step in better managing land use on undeveloped barrier beaches. The risk of future losses in areas mapped as environmentally sensitive and vulnerable to erosion, migration and flooding will be borne by the private individuals and local and state governments that proceed with development. Elimination of government programs on many developed barriers would be considered abandonment and practically a violation of the Constitution. However, areas not overly developed and not mapped as undeveloped barriers are critical because damages can be mitigated by managing new growth and development. These "intermediate areas" may be best determined and better managed by the state and local governments. At a minimum, CoBRA serves as a model for managing authorities who are closer to the site-specific problems.

Conclusions and Recommendations

Based on the accumulated scientific information about their hazard vulnerability, and the increased growth and development during a relatively storm-free period over the last 20 years, barrier beaches along the Atlantic and Gulf coasts require immediate attention and perhaps drastic solutions for mitigating storm damages. More scientific data and planning studies for specific developed barrier beaches are necessary to provide hazard mitigation alternatives for state and local coastal zone and flood-plain managers. A number of structural and nonstructural approaches need to be considered and a combination of approaches may be the most creative and cost-effective. Perhaps structural approaches (i.e., beach and dune restoration) should be used to mitigate erosion and nonstructural approaches (i.e., elevated structures and flood insurance) should be used to mitigate flooding.

Involvement of all government levels in some proportion is necessary for managing barrier resources. The Coastal Barrier Resources Act may, at a minimum, best serve its purpose as a model for states to reduce their financial responsibility associated with many programs that have been shown to encourage growth and development and are considered to discourage the application of hazard mitigation approaches. Similar provisions in CoBRA should be considered in additional legislation that would apply to hazard-prone areas in more developed coastal environments. But state and local governments are probably in the best position to take initiatives in implementing hazard mitigation approaches on individual developed barrier beaches.

Interaction and coordination between state coastal zone and flood-plain managers will be an essential key to the prompt attention of hazard mitigation needs and implementation of cost effective solutions on developed barrier beaches. Financial and technical assistance from the federal government is declining and can no longer be relied upon for the most effective means of preventing coastal flood damages.

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SHIFTING SANDS OF COASTAL BARRIER DEVELOPMENT SUBSIDIES

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Federal subsidies for access, infrastructure, and disaster assistance have played a significant role in coastal development since the end of the Korean War, and have been the principal source of direct federal monies on coastal barriers. In the last quarter-century the country has undertaken and nearly completed the largest public works program in its history, the interstate highway program, made substantial inroads into the second largest, the federal water pollution control program, and satisfied much of the demand for other major infrastructure. Juxtaposed against those and other subsidies for community infrastructure has been the mounting public investment in disaster assistance and hazard mitigation costs. Our policies have effectively encouraged development but, once having done so, are uncertain how to mitigate losses to it.

Recent shifts in government policies at all levels may significantly reduce the federal role in subsidizing future coastal barrier development. These shifts were triggered by several factors including major reductions in federal aid to state and local governments; state tax and expenditure limitations resulting from the taxpayers' revolt begun in 1978; shifts in state and local capital expenditures, accompanied by needs for innovative financing arrangements; and growing demands that the costs of infrastructure be borne by those who benefit directly. The shifts in federal policies have forced a review of state priorities, and in so doing, provide an opportunity to consider the long-term effects of governmental subsidization of development in dynamic, often hazardous coastal areas.

Federal Aid for Infrastructure

Although the federal role in subsidizing infrastructure can be traced to our efforts to recover from the Great Depression, not until the end of the Korean War did concerted efforts to establish a nationwide foundation of infrastructure begin in earnest. By the mid-1970s the interstate highway system was near completion and much of the demand for schools, universities, wastewater treatment facilities, mass transit systems, and other new infrastructure had been satisfied. By the late 1970s the most pervasive problem affecting the nation's infrastructure was physical deterioration and there was increased need for repair, rehabilitation and replacement. Widespread decline in the condition and performance of streets, bridges, sewer and water systems was accompanied by a sharp decrease in direct federal subsidization of capital facilities.

From 1954 to 1978, federal outlays to states and local governments had increased steadily. Since 1978 there has been a steady decline. The decline was attributable initially to the end of countercyclical aid programs and to the growing federal budget squeeze, according to the Advisory Commission on Intergovernmental Relations (ACIR) (1983). Increased defense appropriations and major tax cuts in 1981 intensified the cutbacks (see Figures 1 and 2).

Trends in State and Local Debt

As federal priorities shifted, fundamental changes were taking place at state and local levels, triggered by major shifts in state and local debt, and by shifts in the purposes for capital expenditures.

Shifts in purposes for which capital expenditures were made reflected the myriad forces at work. New debt issued for "traditional" purposes--education, highways, and water and sewage facilities--declined from 51% of the 1966-1970 market to slightly more than 20% in 1977-1978 (Forbes, 1981). This decline is directly traceable to a slowing of population growth, gradual completion of the interstate highway system, and satisfaction of much of the demand for other public investment in infrastructure.

So long as the federal government funded major commitments to roads, mass transit, pollution control, and related infrastructure, real levels of capital spending by state and local governments fell almost 30%. Between 1960 and 1977, the portion of capital spending in total state and local budgets fell almost 50% (Forbes, 1981). When the federal commitment to those areas was strong, state and local governments found other, new areas for growth, especially social welfare projects such as housing, hospitals and recreation facilities. New issues of tax-exempt bonds doubled approximately every five years in the past decade and a half, with an average compound growth rate of 13%. By 1978, bond sales were

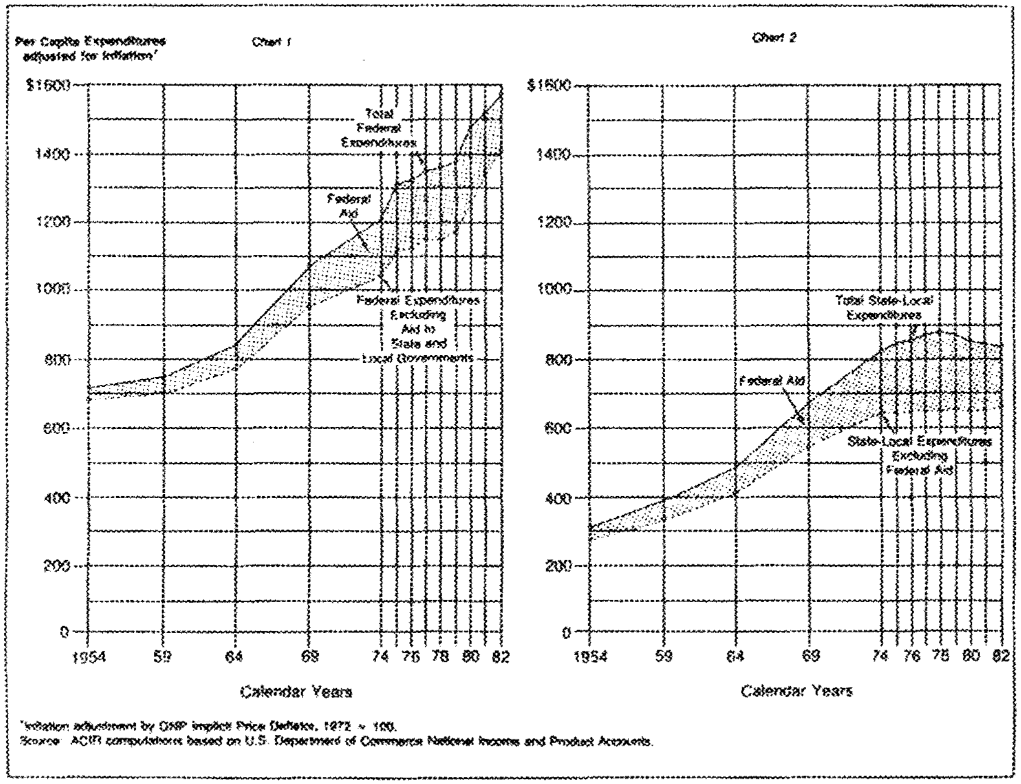


FIGURE 1

After the Tax Revolt:
Federal and State-Local Spenders Go Their Separate Ways

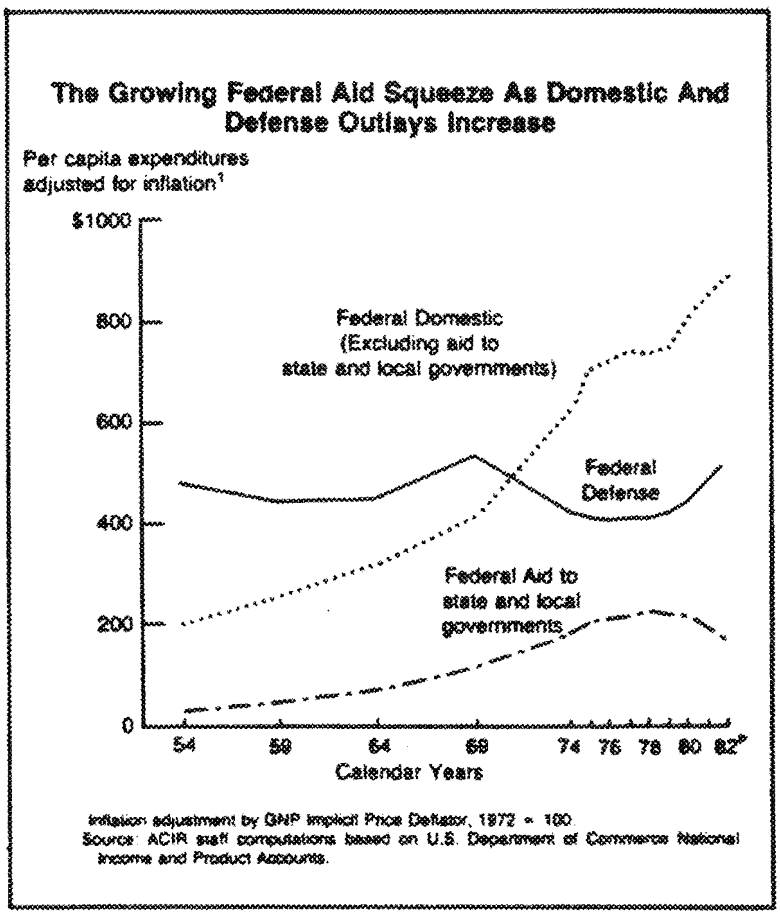


FIGURE 2

The Growing Federal Aid Squeeze:
Domestic and Defense Outlays Increase

more than four times the 1969 volume (Forbes, 1981).

Parallel to the growth in volume and size of new issues were shifts from general obligation financing to revenue bonds. In the 1960s, over 60% of all new issues were secured for repayment by the general tax revenues of the community. By 1977-78, many general purpose and special governmental units had turned to revenue bonds, securing repayments to specific user charges, special taxes, and other nongeneral tax revenues. Revenue bonds accounted for more than 60% of all new issues by the late 1970s (Forbes, 1981).

The Taxpayers' Revolt: Tax and Expenditure Limitation Systems

The year 1978 marked the beginning of the taxpayer's revolt, and the braking effect that that movement had on state and local expenditures. As documented by the ACIR (1983) between 1957 and 1978 the average annual increase in per capita expenditures by state and local governments was 4.4%. Between 1978 and 1982, the average annual increase was only 0.5%. Public employment declined from an average annual increase of 2.7% in the 1957-1978 period to -1.1% in 1978-1982. Over half of the states formally adopted tax and expenditure limitation systems, and all but Alaska and Wyoming significantly curbed state and local spending as well as state and local employment (Table 1).

At least 27 states have adopted tax or expenditure limitation legislation in response to taxpayer revolts and other pressures to cap or reduce taxes and government expenditures. Tax limitation systems are characterized by rollbacks of assessed property valuations, limits on percentage increases in property tax rates, requirements for voter approval before levy of new local or "special" taxes, or combinations thereof. Expenditure limitation systems limit government appropriations to some prior year's level, limit spending increases so that they are not greater than the increase in gross state product, prohibit government spending in excess of a specified percent of state personal income, tie spending limits to the consumer price index, or combinations thereof.

Impacts of Infrastructure Subsidization Shifts on Coastal Barrier Development

It is apparent that the trend toward reduced federal capital expen-

TABLE 1

The Tax Revolt's Effect on State-Local Expenditures and Employment
(State-Local Expenditure & Personnel Growth Before & After Proposition 13)

Average Annual Percent Increase or Decrease (-)

	Per Capita Expenditures (Adjusted for Inflation)		Public Employment (Per 1,000 Population)	
State and Region	1957-1978	1978-1981	1957-1978	1978-1981
United States Total	4.40%	0.54%	2.7%	-1.1%
New England				
Connecticut	2.85	0.52	2.2	1.2
Maine	4.66	-1.12	2.6	-0.1
Massachusetts	4.03	-0.10	2.0	-0.5
New Hampshire	3.43	1.12	2.4	-0.9
Rhode Island	5.17	2.08	2.9	-0.6
Vermont	4.69	-1.39	2.9	-0.7
Mideast				
Delaware	4.63	2.30	3.4	-0.7
District of Columbia	7.12	-1.31	5.0	-0.8
Maryland	4.86	-1.39	3.6	-2.2
New Jersey	4.68	1.15	3.0	0.0
New York	4.89	0.24	1.9	1.6
Pennsylvania	4.93	-0.82	2.8	-0.6
Great Lakes				
Illinois	4.49	0.97	2.7	-0.6
Indiana	3.56	2.88	2.6	-0.2
Michigan	4.30	0.40	2.7	-3.2
Ohio	4.16	0.71	2.3	-0.2
Wisconsin	4.44	1.90	3.0	-0.1
Plains				
Iowa	4.22	0.85	2.6	-0.7
Kansas	3.55	1.97	2.5	0.3
Minnesota	4.51	1.53	2.6	-0.2
Missouri	3.85	3.05	2.9	-0.4
Nebraska	6.68	0.60	3.1	-0.7
North Dakota	3.85	2.64	2.7	0.4
South Dakota	3.75	1.18	2.7	-0.8
Southeast				
Alabama	4.65	0.48	3.2	-1.1
Arkansas	4.89	1.48	2.9	0.2
Florida	3.90	-1.10	2.4	-3.9
Georgia	4.68	1.46	3.4	-1.4
Kentucky	5.34	1.56	3.1	-1.9
Louisiana	3.37	3.22	2.4	-1.0
Mississippi	5.40	1.41	3.2	-0.4
North Carolina	5.03	0.50	3.5	-0.3
South Carolina	5.11	1.72	3.8	-1.6
Tennessee	5.23	-0.41	3.0	-1.1
Virginia	5.07	1.67	3.6	-2.7
West Virginia	5.72	0.55	3.8	-0.6
Southwest				
Arizona	3.88	-0.01	3.3	-4.1
New Mexico	3.64	3.59	3.0	1.1
Oklahoma	3.12	3.99	2.5	1.4
Texas	4.09	1.22	3.1	-1.5
Rocky Mountain				
Colorado	3.71	-0.42	2.9	-3.5
Idaho	3.96	-1.93	2.5	-2.3
Montana	4.05	-1.34	3.0	-2.1
Utah	4.18	0.36	2.7	-3.9
Wyoming	6.08	6.41	2.4	2.2
Far West				
California	4.31	-0.73	1.8	-2.2
Nevada	3.16	-0.99	2.7	-6.2
Oregon	4.48	0.23	2.5	-2.2
Washington	3.91	1.84	2.2	-3.1
Alaska	10.14	14.54	6.2	3.5
Hawaii	4.99	-3.76	2.3	-1.6

Sources: ACIR computations. Fiscal year expenditure data from: _Historical Statistics on Governmental Finances and Employment_, 1977 Census of Governments; _Governmental Finances 1977-78_; _Governmental Finances 1980-81_. (U.S. Bureau of the Census Publications) Implicit GNP price deflator from October 1982 _Survey of Current Business_, U.S. Department of Commerce.

Significant Features of Fiscal Federalism 1981 - 82 Edition, Advisory Commission on Intergovernmental Relations, USGPO, Washington, D.C., April 1983 ditures will continue, perhaps throughout the 1980s. Federal deficits estimated at $200 billion per year for the foreseeable future should be the principal factor driving such a policy. The move toward shifting certain federal burdens to the state, local, and private sectors gained forceful momentum with the taxpayers' revolt in 1978. Accentuated by Reagan Administration policies, the trend transcends particular political parties and seems likely to continue for the rest of the decade.

The federal government will nevertheless continue to have an important role in financing infrastructure. However, a narrowing of federal priorities should be expected (e.g., focus on the interstate highway and primary road systems, and phasing out of federal aid for rural, secondary, and urban systems); along with a possible reduction in certain federal standards such as those for bridge width geometry and water pollution control. Greater attention will be afforded maintenance, repair, and rehabilitation of existing infrastructure, and there will be reduced federal matches on capital grants and aid (see, for example, current proposals to reduce federal matches for wastewater treatment facilities from 75% to 55%; federal disaster relief has already been reduced to 75% of qualified costs) (Congressional Budget Office, 1983; Peterson and Miller, 1982).

As states and local governments feel the pressure of reduced federal aid, the message of the taxpayers' revolt becomes clear: be certain that increases in public spending do not exceed growth in the private economy. Thus, how states adjust to the increased burdens they must assume will depend in large measure on the recovery and growth of state, regional, and national economies. In order to deal with increased costs of infrastructure, states and local governments are tending to reshape their capital budgets to emphasize preservation and rehabilitation of their basic, existing infrastructure; to reduce support for new infrastructure; to shift the costs of new infrastructure to the private sector through such devices as dedications and exactions; and to provide the facilities and services and charging users for them through user charges, special assessments, development fees, and similar arrangements (Peterson and Miller, 1982).

Federal Subsidies and Coastal Development

Since the mid-1950s the policy in the majority of coastal states and communities has been to foster development and economic growth, while protecting public health and providing services to city residents. Those priorities still prevail (U. S. Conference of Mayors, 1983).

Federal programs have been very supportive of those development policies. Federal subsidization on the coastal barriers has been most evident in roads, bridges, and causeway access; water storage, water treatment and wastewater treatment facilities; shore protection; flood insurance subsidies; and disaster assistance. In almost all instances, federal funding came after initial development of the community was financed by private capital, by local or state revenue bonds, or by other nonfederal sources.

> . . . Initial development costs of access and infrastructure were borne by private interests or by local or state governments. Federal bridge permits were granted almost as a matter of right so long as bridges or causeways did not impede navigation on the Intracoastal Waterway or otherwise interfere with interstate or foreign commerce. Federal subsidization of coastal barrier development typically began not with initial development but when it was necessary to expand, improve, repair, rehabilitate, or replace existing access or community infrastructure to meet the needs of community growth (Miller, 1981, p. 37).

In a 1980-81 study of coastal barrier development near four National Seashores, the author and colleagues found that the federal expenditures and obligations amounted to an average direct subsidy of $25,570 per developed acre. Importantly, a very high percentage of that total was for the expansion, upgrading, replacement, and reconstruction of access and other community infrastructure, not for initial development. The cycle of development from which federal involvement stemmed was described in the report:

> Under current federal programs, federal involvement in community development tends to increase with population and with each program that expands the capacity of individual systems to accommodate growth. Enlargement of a road system to accommodate inbound traffic encourages housing development, which in turn must be accommodated with increased water supply and improved wastewater management facilities. Ensuing development tends to exceed whatever is the current capacity of the community's infrastructure--leading to successive rounds of expansion, upgrading, replacement, and reconstruction. And each round of growth leaves the community increasingly vulnerable to major coastal storms--to damage or destruction of access roads and bridges, infrastructure, and houses and businesses (Miller, 1981).

Flood Insurance. The jury is still out on the impact of flood insurance on coastal development. The myth in many coastal circles, fostered in part by the author's 1975 studies in Rhode Island (Miller, 1975) is that flood insurance is a prime factor stimulating coastal development. Case studies in at least two dozen coastal communities since 1975 have tested for evidence of a direct cause-effect relationship between the availability of flood insurance and stimulation of new coastal development With one exception the studies have found no reliable, measurable evidence of flood insurance as a prime stimulant of new coastal development (Miller, 1977).

The only instance in which flood insurance clearly made the difference between development or nondevelopment was in Galveston, Texas. There the two savings and loan associations effectively controlled financing of real estate on the island. Before flood insurance was available, the associations would not take first mortgages in the West Island area west of the 17-foot high, 10-mile long Galveston seawall. After flood insurance became available they began to finance development in the previously proscribed area, as long as it was secured by flood insurance and built to the standards required by the National Flood Insurance Program.

The situation in Rhode Island, where banks voluntarily withdrew from the first mortgage market in certain delineated high hazard zones before flood insurance was available, differed markedly from that in Galveston. Despite the banks' withdrawal, financing was readily available from other sources. According to real estate brokers, properties were rarely on the market more than two weeks before they were sold. Moreover, on one particularly hazardous beach, withdrawal of a state septic system moratorium was the key action permitting development, not the availability of flood insurance (Miller, 1975).

Elsewhere on the coasts of the United States, studies revealed that mortgage money was generally available before flood insurance was, and no reliable, measurable changes in the pattern of new development occurred after flood insurance became available.

Despite such evidence, the myth survives--sufficiently so that two members of the Senate recently asked the General Accounting Office to examine and report on whether the flood insurance program stimulated flood plain development. GAO's study of six coastal communities, interviews with 115 people, and other analyses, concluded that

> The flood insurance program does not discourage new construction and development from occurring in the flood plain of coastal and barrier island communities, nor is the flood insurance program the principal reason for that development. While we did not statistically determine the degree of influence that flood insurance has had on development, our other analyses, reviews, interviews, and observations lead us to believe that flood insurance offers a marginal added incentive to development in the coastal and barrier island communities because it offers financial security against the risk of loss, and requires better construction (U.S. GAO, 1982).

The author's estimates of barrier island development under then-current policies indicated that federal subsidies of flood insurance would be about 6% of the total direct federal subsidies expended if programs were funded and policies remained unchanged (Miller, 1981). Subsidies for bridge access, roads, water supplies, water treatment, and waste water treatment were generally higher than estimated flood insurance subsidies, and would have had a more profound and immediate impact on development than flood insurance would. This observation may change with regard to development in the units designated under the Coastal Barrier Resources Act.

Coastal Barrier Resources Act (CoBRA). The Coastal Barrier Resources Act of 1982 (P.L. 97-348, 96 Stat. 1653) is an important initial step in recognizing the role that the federal government has played in subsidizing and stimulating development in hazard areas on the one hand, and being increasingly burdened with disaster assistance costs on the other. The Act bars new federal expenditures or financing on certain designated coastal barriers that are undeveloped but also unprotected from development. It prohibits federal funding and assistance for such items as construction or purchase of any structures, facility or related infrastructure; construction or purchase of any road, airport, boat landing, or other facility; any project to prevent or stabilize erosion of any inlet or shoreline; and sale of flood insurance for new or substantially improved structures. Administered by the Department of the Interior, 186 coastal barrier units with a beach length of about 725 miles, are presently designated in the Coastal Barrier Resources System (U.S. Department of the Interior, 1982).

The effectiveness of that Act has not been tested--its flood insurance prohibitions, for instance, do not go into effect until October 1983. However, there is reason to believe that the Act will only be marginally effective in slowing or curtailing coastal barrier development, because of the exceptions to its provisions and the expected availability of financing for coastal development without flood insurance.

Exceptions to CoBRA--A first concern relates to the exceptions in CoBRA. The Act excepts from its prohibitions (and thus will permit) federal expenditures or assistance for "the maintenance, replacement, reconstruction, or repair, but not the expansion, of publicly owned or publicly operated roads, structures, or facilities that are essential links in a larger network or system" (§5(c)).

As noted above, federal participation in the cost of roads, bridges, wastwater treatment facilities, shore protection devices, and other types of infrastructure tends to come after private, local, and state commitments to the initial coastal barrier development. More than half the federal funds expended in coastal barrier study communities were spent for maintenance, replacement, reconstruction, or repair of infrastructure, the very areas excepted from CoBRA's prohibitions, and may continue to be spent (Sheaffer and Roland, Inc., 1981).

Prohibition of flood insurance--A second area of concern relates to the impact that prohibition of flood insurance in the Coastal Barrier Resources System after October 1, 1983 will have on future development. Again as noted above, past studies have indicated that in most coastal communities development will be financed without flood insurance, even in instances such as that in Rhode Island, where financing institutions had voluntarily withdrawn from the first mortgage market (Miller, 1975 and 1977).

Will banks and other lending institutions withdraw from construction and permanent financing in Coastal Barrier Resources System units if flood insurance is not available? Undoubtedly there will be some that will refuse to finance structures in those areas, perhaps based on recent storm damage experience, perhaps based on heightened flood hazard awareness resulting from the National Flood Insurance Program. If past experience is any indicator, however, construction and permanent financing will be generally available if there is a demand for them, and particularly if there is competition with other institutions.

Disaster assistance and flood insurance losses. While federal subsidies of infrastructure were tending to decline, federal disaster assistance has been increasing (Figure 3). Between 1972 and 1979 the Small Business Adminstration (SBA) and the Federal Disaster Assistance Administration (now a part of the Federal Emergency Management Agency (FEMA)) spent an average of $1.14 billion annually on disaster relief. Much of the SBA's physical disaster assistance loan program fell within the realm insurable by flood insurance, while FDAA's President's Fund was expended largely for damages to community infrastructure. The SBA experience was of particular concern inasmuch as it had been anticipated that flood insurance would lead to a decrease in flood disaster expenditures. As of the late 1970s that had not occurred.

In keeping with other attempts to reduce federal costs, the federal matching share of disaster assistance costs was reduced to 75%. As a minimum, it can be expected that the federal matching share will remain at that level, or decrease even further, shifting still more costs to the state, local and private sectors.

Given the level of infrastructure subsidies by all levels of government and the development those subsidies have fostered, it comes as no surprise that disaster assistance costs are rising. Both the quality and the quantity of construction on coastal and riverine flood plains have increased. Damages are inevitable with such increased use, the more so if no flood protection or loss mitigation measures are taken.

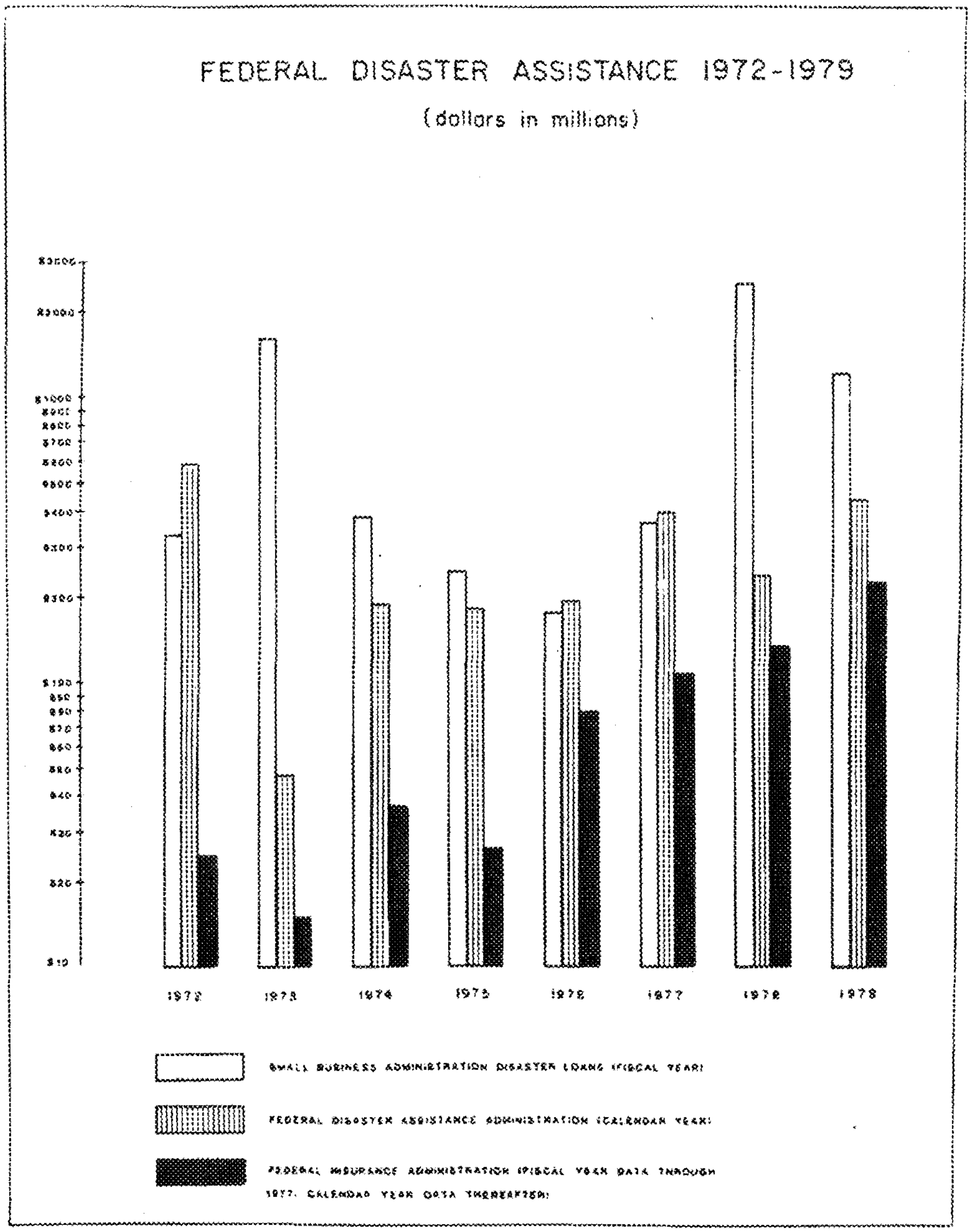
Conclusion

Shifting federal priorities and reduced federal domestic aid to states and local governments can be expected to continue so long as federal deficits and defense spending remain high and the national economy remains weak. As infrastructure costs are shifted from federal to state and local governments, greater percentages of state and local operating and capital budgets will be devoted to "traditional" purposes of education, highways, and water and sewage facilities, perhaps reverting to percentage levels last seen in the early 1960s.

At this juncture the tax and expenditure limitation systems adopted by many states represent a basic change in state and local policy toward spending, tying increases in public spending to growth in the private

FIGURE 3

Federal Disaster Assistance 1972-1979



Source: R.H. Platt, Federal Disaster Assistance 1972-1979.
(scale is logarithmic: low values appear exaggerated high; high values appear exaggerated low)

economy. They may become long-term fixtures. Whether such limitation systems are formally adopted by the state, evidence is strong that the tax and expenditure limitation movement is influencing governments in almost all states. One result is that all levels of government are reshaping their priorities to favor capital investment maintenance, repair, and rehabilitiation of existing infrastructure. Trends are distinctly toward less emphasis on new development and more emphasis on preservation and rehabilitation of existing facilities. Economic demand is becoming the standard for new development, sometimes shifting the costs of needed infrastructure to the private sector, sometimes charging users for facilities and services.

With regard to new coastal development, the author believes that reduced federal spending may not significantly reduce new development: it may slow it, but not prevent it. Historically, federal monies have not been expended on initial coastal development as a matter of policy and of law. Rather, new development has started with the private sector and ofte with state or local tax-exempt financing. The important question for new coastal development will be the role that state and local governments play in light of tax and expenditure limitations or policies.

State and local governments have a new opportunity to review their priorities regarding development in hazardous areas. If they, following the lead of the Coastal Barrier Resources Act, were to withdraw state and local subsidies from new development, they might have a substantial impact on the economic viability of many marginal new developments, slowing, if not preventing, certain development. If they elect to subsidize new development by direct grants, tax exempt revenue bond issues, or otherwise, one can reasonably predict a recurring pattern of development, disaster, and redevelopment, particularly for infrastructure and buildings located in areas prone to erosion, storm scour, and wave action.

Existing development may be affected more by the reduction of federal subsidies than new development. The principal effect of reducing federal subsidies will probably be a reduction in federal costs for expansion, replacement, and reconstruction of access and other community infrastructure. But because development can be expected to continue despite withdrawal of federal funds, increased disaster relief and insurance costs can be anticipated.

As federal shares are reduced or phased out, states and local governments will have to reassess their priorities. Should they support new development or the maintenance, repair, and rehabilitation of the existing basic infrastructure? Should they devote higher percentages of their operating and capital budgets to infrastructure at the expense of social programs? Given increased demands on state and local appropriations and limitations on taxes and expenditures, one could expect to find a slowing of major rehabilitation projects as well as new development.

There is very little evidence of any basic change in prevailing state and local attitudes toward coastal development. Most governments still encourage it. The changed federal, state, and local policies may slow future coastal development, but they certainly will not prevent it or the recurring pattern of damages and destruction that accompanies development in hazardous areas.

We know how to encourage development in hazardous areas. We have not come to grips with preventing inappropriate development before it occurs. Nor do we act boldly to mitigate losses once we have encouraged development. Reduction of federal expenditures and tax and expenditure limitation systems and policies of the various states offer an opportunity to reassess our priorities for development in hazardous areas. It is important and appropriate that we do so.

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COASTAL HAZARDS MAPPING ON BARRIER ISLANDS

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Introduction

Barrier islands are dynamic landforms, subject to storm surge flooding and sand transport processes. These coastal features are particularly vulnerable areas for human habitation since they extend seaward of the mainland and are composed entirely of loose sediment.

The outlying position of barrier islands along the U.S. East and Gulf Coasts renders them subject to flooding by seaside overtopping as well as bayside storm surges. Hurricanes create the greatest flooding hazard due to their large storm surges (sometimes approaching 20-25 feet as occurred during Hurricane Camille in 1968), but intense winter north-easters have also been known to generate considerable surges (e.g., Ash Wednesday Storm of March 5-9, 1962).

As a storm approaches the coast, strong onshore winds push the ocean water onto the shore. Large breaking waves superimposed on the storm surge can quickly erode beaches, breach dune lines, and destroy buildings and human infrastructure on the barrier island. Occasionally, a major washover will result in the creation of a new inlet, where the overtopping surges are confined and the island is low and narrow. However, most inlet are actually outlets according to their genesis.

When the low pressure cell (coastal storm) moves onshore or alongshor the winds reverse direction, blowing strongly offshore. At this point the large quantities of trapped bay water (derived from local precipitatio overwash, and flood flow through existing inlets) are pushed against the barrier bayside. These walls of water can quickly envelope the unsuspecti victims who were lulled into complacency by the belief that storm passage equated abatement of the hazard. In fact, many of the early losses of lif on the Outer Banks of North Carolina were due to this bay ebb storm surge (Leatherman, 1983a).

The ebb storm surge is particularly effective in creating new inlets due to the hydraulic conditions. The superelevated water stockpiled in the shallow bays and lagoons behind the island can be quickly pushed by the hurricane-force wind onto the barrier bayside. At the same time these offshore winds are driving the ocean waters onto the shelf, creating a large head difference between the ocean and bay waters. The hydraulic gradient is increased where the island is narrow since the gradient is equal to the head (water level difference) divided by the distance between the ocean and bay.

The built environment can have significant effects on storm surge egress by concentrating the flow. These constrictions due to buildings result in a venturi effect, wherein the water velocity and hence the scouring potential are greatly increased. Other human modifications of the barrier, especially the construction of finger canals, greatly increase the likehood of inlet formation at these localities (Figure 1).

The second factor that makes barrier islands such vulnerable places to live involves their geomorphic structure. In essence, barrier islands are accretionary landforms that have formed in the last 5-10,000 years during rising sea levels (since the last glacial retreat). Unfortunately for human occupation, these barriers have continued to evolve through time resulting in landward migration in response to sea level rise (Figure 2). This transgression of the sea is manifested as beach erosion when measured against property boundaries and building locations.

Since barrier islands are composed entirely of loose sediment--sands gravels, and clays, this coastal landform is subject to erosion down through its entire core. This fact is hard for most people to envision since the populace at large often equates terra firma to "hard" ground. While bedrock may be close to the surface on mainland areas, consolidated sediments of this nature often lie thousands of feet below the present barrier, far too deep to be of any importance in barrier stability.

Barrier islands viewed three-dimensionally are essentially sand wedges, pinching off seaward on the shoreface and interfingering with marsh and lagoonal deposits on their bayward flank. The sandy barrier cores are often only tens of feet deep and rest on lagoonal clays or pre-existing Pleistocene topography. These now-buried surfaces often contain large fluvial channels as determined from core and auger data (Kraft et al., 1983). For instance the three-dimensional stratigraphy of Ocean City

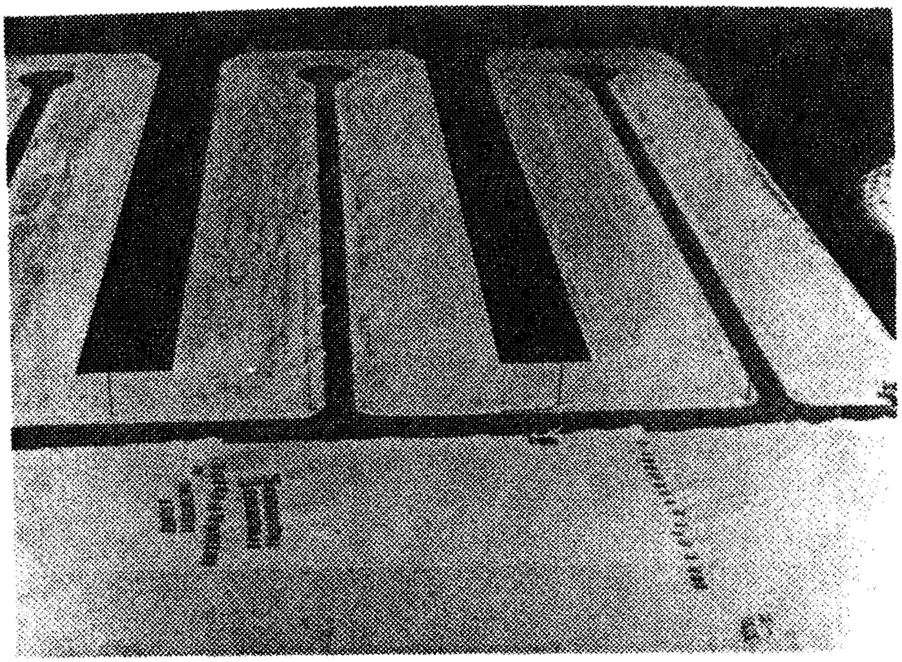

FIGURE 1

Finger canals oriented from the bay toward the ocean serve as corridors for ebbing storm flood water and greatly increase the likelihood of inlet breaching during these conditions.

Maryland, shows an undulating subsurface along the length of this barrier. The depth to this compact clay under the sandy barrier core varies from ten to more than forty feet; those areas that are underlain by considerable thicknesses of just loose sand are the most susceptible to inlet formation when compared to adjacent sites with nearer surface contact of the more erosion-resistant clays.

Shoreline and Offshore Analysis

In addition to consideration of the geomorphic framework, coastal hazards mapping must involve an assessment of historical changes. Such maps, charts, and records should first be assembled in order to obtain a general picture of barrier evolution. Whereas these early coastal maps allow for a qualitative evaluation of barrier changes, particularly historical inlet occurrence and migration, the first charts from which quantitative measurements can be obtained were produced by the U.S. Coast and Geodetic Survey (now the National Ocean Survey) in the mid-1800s. Ocean and bay shorelines are well-depicted on these charts, whereas dunes. marshes and washovers are in many cases more roughly sketched or entirely

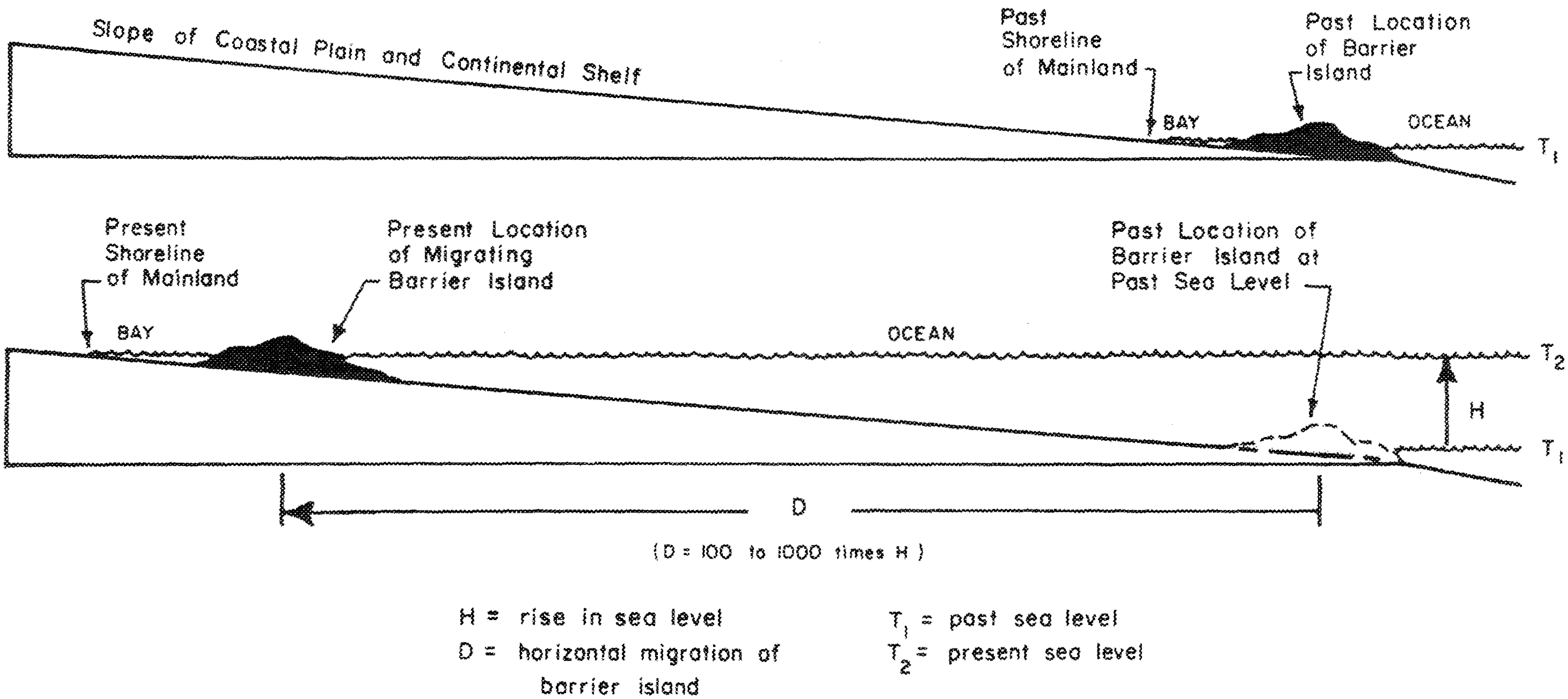

FIGURE 2

Barrier islands must retreat upon the gradually sloping coastal plain with sea level rise over geologic time. Without landward migration, the barrier can be drowned (Leatherman, 1983d).

omitted.

Historical shoreline changes based on comparisons of the NOS "T" sheets can be updated or complemented with vertical aerial photographs (acquired since 1938 for most coastal areas). However, air photos are not maps, even though they are often regarded as such by the untrained photogrammetrist. Shoreline movement maps based on uncorrected imagery can result in potential errors exceeding the actual amount of change (Leatherman, 1983b). Unfortunately, some coastal geomorphologists ignore these severe limitations to air photo-derived shoreline change data. Corrections by sophisticated equipment (stereoplotters) or mathematical corrections (metric mapping) should be applied in all cases.

Planners and administrators tend to believe a well-drawn map--the feeling being that the lines depicting historical shorelines on the map are exact without question. These data users are often totally unaware of the fact that the error bar for any one measurement may exceed the mapped shoreline movement (Figure 3). In short, it should be remembered that "all maps are not created equal", and the best policy is to rely upon only accurate mapping techniques where quantitative shoreline changes are required.

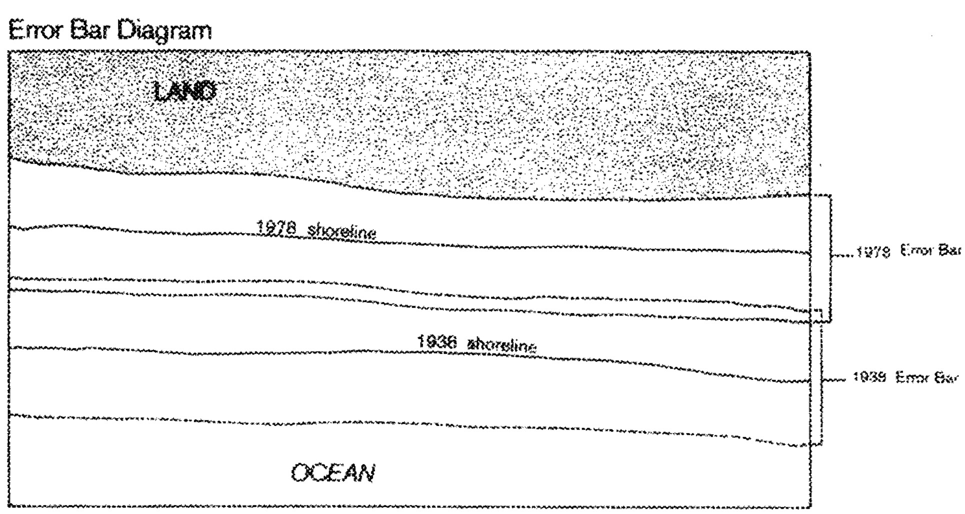

FIGURE 3

The error bar diagram illustrates the mapped position of the shoreline (solid lines) based on uncorrected vertical aerial photographs. The potential range of error is indicated for each photographic set. In this case, it is possible that the shoreline was actually stable (overlap area of two error bar limits), but the air photo derived map erroneously showed net recession.

While maps of historical shore position are recognized by coastal professionals as prerequisite for planning and coastal hazards analysis, offshore changes have received scant attention. Shore position is a reflection of adjustments along the entire active, sand-sharing profile so that subaerial changes may amount to only 10-20% of the total adjustments. The shoreline may remain in relatively the same position for an extended period of time (decades), particularly where "stabilized" by coastal engineering structures, such as groins and jetties.

Moody (1964) showed through historical offshore bathymetric comparisons of the Delaware coast that the shoreface steepened during a 33-year time interval. This hinge point of the "stable" shoreline was displaced landward in a quantum fashion during a major storm. Concurrently, the offshore gradient was suddenly reduced. The offshore zone of Ocean City, Maryland is apparently steepening at present (Trident Engineering, 1979), and future storms can be expected to trigger the rapid and permanent loss of beach sand.

Wave and Surge Analysis

Variations in shoreline change along the coast are also related to differential wave energy. Offshore shoals and large dredge holes, where present, can cause the waves to refract, concentrating wave energy in particular zones along the shore (Goldsmith et al, 1975). It is necessary to undertake a wave refraction analysis for all wave and tide conditions important to the study area in order to evaluate the differential wave energy and hence vulnerability along the shoreline.

Similarly, a storm surge analysis should be performed in order to define flood levels. The entirety of most barrier islands falls within the 100-year storm surge level, but clearly some areas are more vulnerable than others, depending largely upon site elevation and water flow (velocit characteristics. For major urbanized coastal areas, the U.S. Army Corps of Engineers has compiled the peak heights of historical storm events. These data are used to construct a flood frequency curve; this relationshi can be utilized to define recurrence intervals for particular size storms (e.g. 10, 50, or 100-year events). The still water level at any particula location on the barrier can be determined by subtracting the land elevatio from the storm surge.

The FEMA flood insurance rate maps (FIRM) indicate the risk to flood damage by various vulnerability zones (e.g., V, A, B). Buildings in the V Zone are in the most hazardous locations since these areas are subject to wave attack and high water velocities in addition to still-water flooding. Unfortunately, the FEMA maps do not take into account bay storm surges, which result when the winds turn offshore and the ebb surge flows across the barrier from the bayside. As previously discussed, much damage can result, and this is the time when most inlets are cut.

More recently, the National Weather Service has developed a numerical model of storm surge prediction, applicable for use along barrier islands and adjacent bays (Jelesnianski and Chen, 1983). The SLOSH (sea, lake, and overland surges from hurricanes) computer program has already been used to model Galveston Bay, Texas and a number of other coastal embayments along the Gulf Coast. Eventually all major coastal areas will be modeled with this sophisticated technique. The advantages of the SLOSH data are that they represent the most accurate predictions of storm surge values, are plotted on a grid basis for accurate determinations of local variations, and are computed for various size storms (hurricane categories I through V). This type of information is crucial in designing coastal evacuation routes (Ruch, 1981) and should eventually be used to refine insurance acturial rates and building control lines.

Previous efforts at mapping coastal hazards were predicated on a stable water level. A preponderance of climatological data and results from global climatic models (Hoffman et al, 1983) stongly suggest that this will not be the case in the future. Indeed, tide gauge data along the U.S. East and Gulf Coasts indicate that sea level has been rising during at least the past century. With the doubling of carbon dioxide in the atmosphere during the next century, the earth's surface will warm by several degrees due to the greenhouse effect. Consequently, sea level will rise between two and ten feet by 2100 based on projections by the U.S. Environmental Protection Agency (Figure 4). Such large increases in the water level portend major geomorphic alterations to barrier landforms.

A pilot study of the Galveston Island and Bay in Texas was recently completed by Leatherman (1983c). This analysis showed that shoreline recession would proceed at rates exceeding seven times the current amount

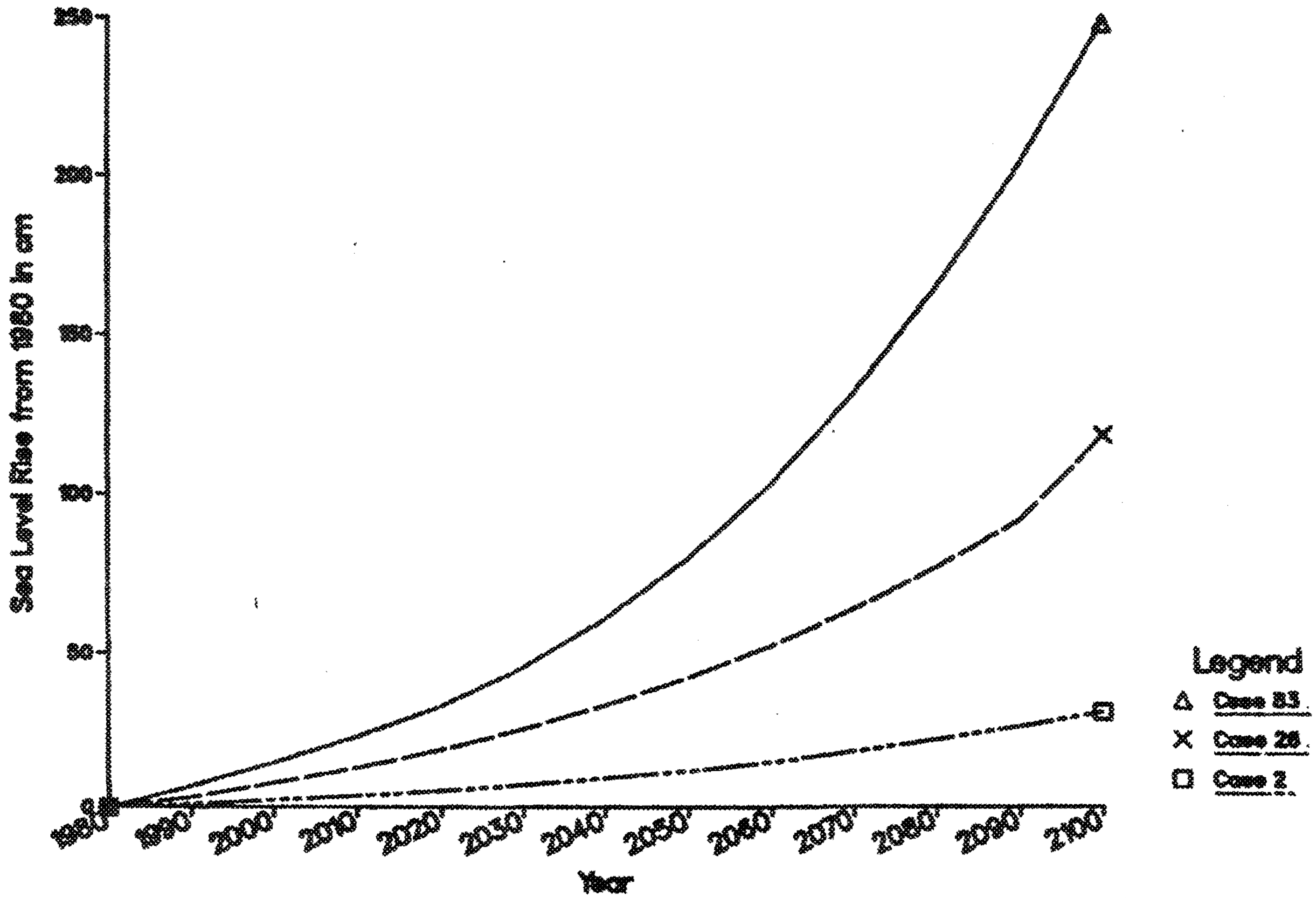

FIGURE 4

Scenarios for projected sea level rise based on EPA estimates (from Hoffman et al., 1983).

for the high scenario condition. This translated to shoreline recession of several thousand feet by the year 2075 for some low-lying coastal areas unprotected by coastal engineering structures. Even where such devices are installed, accelerated erosion is still projected to occur, albeit at a somewhat reduced rate. In some cases, protective structures would undoubtedly be undermined and experience catastrophic failure during storm conditions without future large-scale engineering projects and major expenditures of funds (Figure 5).

A rise in the water level would also subject more inland areas to flooding than had been the case in the past. Also, areas that are currently flooded by low frequency events (100-year flood) may be subject to such catastrophic damage during even the 10-year flood with rapid sea level rise. Therefore, the hazards to storm surge flooding can be anticipated to increase dramatically in the future, with barrier landforms taking the brunt of the punishment.

Conclusions and Recommendations

This paper has attempted to define the type of geologic and geomorphic data prerequisite for coastal hazards mapping on developed or planned-to-develop barrier islands. A complete complement of data for such an assessment is rarely available for any coastal area. The problem stems from the paucity of certain types of information (especially bathymetric surveys) to the actual loss of valuable data sets. For instance, the U.S. Army Corps of Engineers has a policy of discarding old information (apparently including historical shoreline maps and surveys) after a period of time. These hard data, which are often one-of-a-kind, can never be replaced by hindcasted or simulated values.

Each coastal community should undertake an archival service for all pertinent scientific data. Also, the availability of a descriptive listing of these data would facilitate information usage by all interested parties and insure the inclusion of such data in coastal hazards mapping. This task should be as important to coastal communities as their tax and zoning maps. After all, the long-term human habitation of barrier islands and associated costs depends upon the geomorphic alterations of these dynamic landforms. It certainly makes sense to have all the pertinent

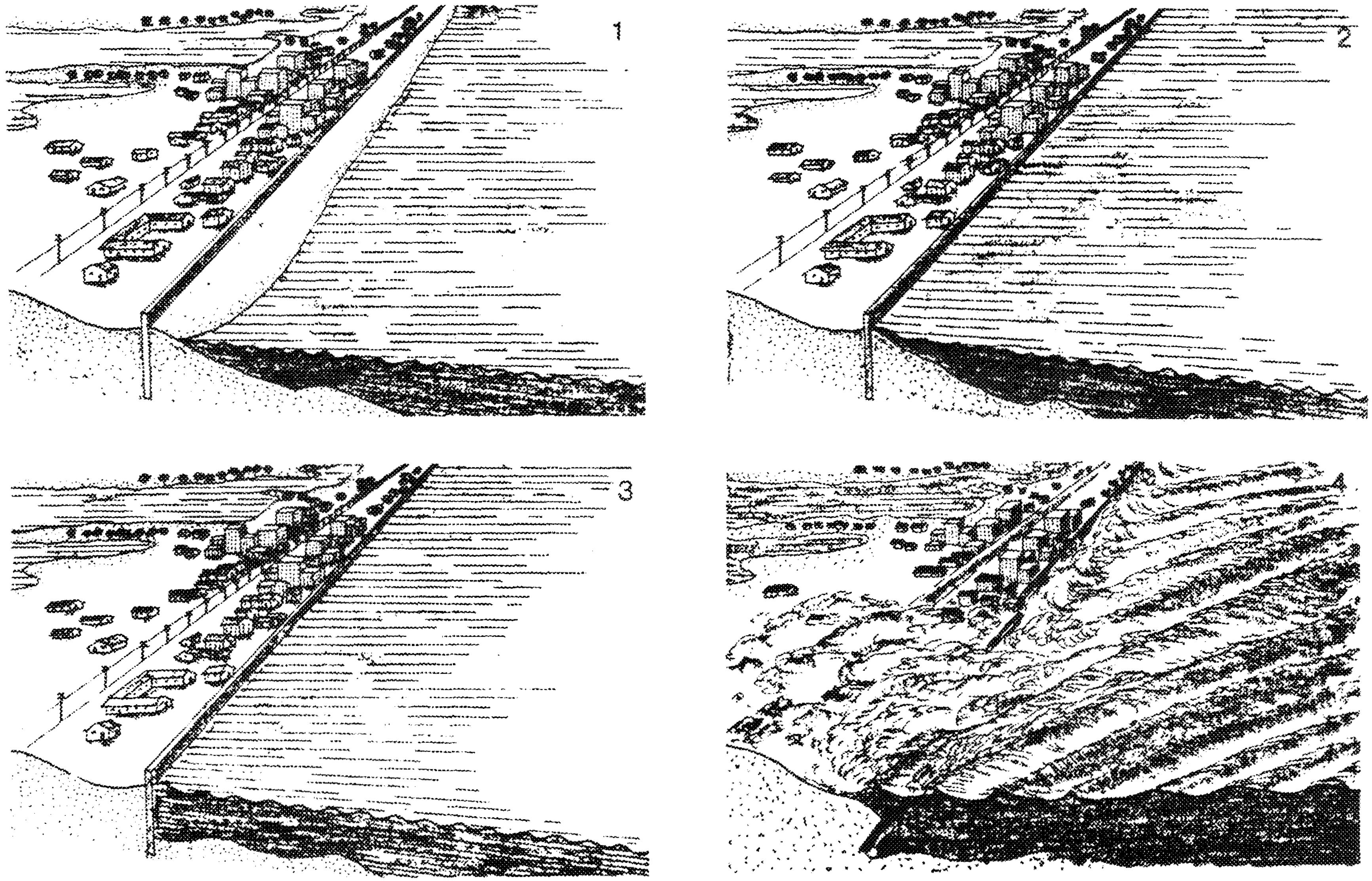

FIGURE 5

This sequence demonstrates the inevitable problems associated with emplacement of a seawall along information and an accurate analysis of those data in order to more aptly plan for future changes.

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BARRIER ISLAND LEGISLATION IN RHODE ISLAND:
THE COASTAL RESOURCES MANAGEMENT PROGRAM

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Rhode Island is particularly susceptible to coastal flooding and damage from hurricanes. Unlike many Atlantic coastal states, its ocean shoreline runs east-west and lies exposed to the full force of a tropical storm approaching from the south. It is directly in the path of most major hurricanes that reach New England before the storm tracks veer east over the North Atlantic, and it is unprotected by large islands such as Long Island, Fisher's Island or Martha's Vineyard that lie off other stretches of mainland to the north and south.

The shore's glacial sediments are highly susceptible to erosion, and the New England hurricane season coincides with the abnormally high tides of the autumnal equinox. Because of this, major storm surges can lift the zone of wave attack 10 to 15 feet and subject bluffs, headlands and dune fields to the direct attack of storm waves (Boothroyd et al., 1981). In the hurricane of 1938 the southern shore of Rhode Island experienced winds and waves of the greatest speed and height recorded anywhere in New England (Brown, 1976). The high cliff at Watch Hill receded some 35 feet, and the large dunes at Weekapaug receded 50 feet, all within a few hours (Brown, 1976; Providence Journal, 1938 and 1954). Rhode Island's dunes have not recovered from the erosion of the major hurricanes in 1938 and 1954, and its barrier beaches have an exceptionally narrow and low profile, making them less effective in protecting the coastal shoreline from severe wave damage and erosion (Boothroyd et al., 1981).

Throughout Rhode Island's recorded history, hurricane-driven storm surges and tidal flooding have caused enormous destruction, killed hundreds of people and cost millions of dollars in property damage along the coastline. According to accounts compiled by the Army Corps of Engineers, 71 hurricanes have struck Rhode Island's shore since 1635 with an average frequency of one every seven years (1960). There is, however, no regularity to their occurrence: no major hurricanes have swept across the state in the last 30 years, whereas four occurred between 1944 and 1954.

It is difficult to plan for an event that occurs so sporadically yet with unbelievable force and devastation. After the 1938 hurricane, many of the coastal areas were rebuilt, but another major hurricane in 1954 again swept the barriers clean, took the lives of 19 people, eroded the headlands, and caused $90 million of property damage (Providence Journal, 1954). Today several of the barriers and much of the low-lying coastal areas are again developed. There has been a post-war burst of suburban and commercial development which has spread out from the Providence metropolitan center at the head of Narragansett Bay. Although they are aware of the occurrence of hurricanes and the destruction they have caused in the past, many residents are new to the coast and have never experienced the force of a major hurricane (Gordon, 1980). They consider themselves safely removed from the destructive power of an ocean that is a mile away across a placid salt pond and barrier beach.

In response to the devastation of the 1954 hurricanes, several of Rhode Island's coastal communities were among the first to join the National Flood Insurance Program (Miller, 1975). One town included a high flood danger zone in its zoning ordinance to prohibit further development on the barriers. It is now before the Rhode Island Supreme Court after having been judged unconstitutional by the State Superior Court. At present all the coastal towns participate in the National Flood Insurance Program and have adopted building codes and local ordinances to minimize future damage. As in many states, the National Flood Insurance Program has tended to encourage development in hazardous areas of the coastal zone. Land values in high hazard areas along Rhode Island' barriers have not declined, but continue to appreciate. Houses on 50 x 100-foot lots on the barrier which were undermined by storm waves in the blizzard of 1978 depreciated immediately after the storm but then sold for as much as $135,000 five years later. The federal program has made it easier to build houses in hazardous areas where the local banks were refusing to grant mortgages after the hurricanes of 1938 and 1954 (Miller, 1975). The "flood proof" regulations improved the construction standards and increased the investment in structures build more recently in the flood zone throughout the state.

In order to develop a state program to protect the barriers, the Rhode Island Coastal Resources Management Council commissioned the Coasta Resources Center to do a study of the problem and recommend policies for state regulations where none previously existed (Olsen and Grant, 1973). In 1975 Rhode Island's Coastal Resources Management Council adopted the findings and regulations from the study, enabling the state to deal realistically with as many of the coastal hazard issues as a regulatory program can address. In spite of an unsupportive legal climate the regulations were successfully designed to prevent further destruction and erosion due to uncontrolled use and building on the barrier beaches. Several important restraints were articulated including a prohibition of further building on dunes, a requirement that new structures be elevated an additional six feet in velocity zones to allow for waves on top of flood waters, and prohibition of additional structural shoreline protecti on the barriers even though there were many proposals to use riprap and groins to combat erosion.

The program identified those beaches that were undeveloped and placed them in a special protective category with strict regulations prohibiting further development of any kind. Future construction could only occur on barrier beaches designated as developed and then only in accordance with the construction regulations. As a consequence of these measures, only 35% of Rhode Island's 27.3 miles of ocean-front barrier beaches are developable. With an eye toward the future, the state progra prohibits reconstruction on dunes of any structures damaged 50% or more by storm-induced flooding or wave or wind damage, regardless of the insurance coverage carried (State of Rhode Island, 1977).

During the past year, the state program has been revised to reflect ten years of experience in regulating activities in Rhode Island's tidal waters and along the shore. The program has been reorganized and condensed to streamline the permitting process and to make the management policies of the Coastal Resources Management Council more effective. In these new regulations, specific erosion rates, measured every several hundred feet along the barrier beaches, have been included and areas with accelerated erosion rates have been mapped (Regan, 1976). A minimum construction setback of 50 feet from the shoreline has been established. In designated critical erosion areas setbacks are equivalen to 30 times the calculated average annual erosion rate and may be as much as 180 feet, giving new construction a 30-year life span. Regulations for building in high flood hazard areas go beyond the state building code in requiring such future construction practices as pilings that penetrate 10 feet below mean sea level, floors, roofs and walls fastened to floor beams with metal straps or "hurricane clips', a roof pitch greater than 40 degrees to reduce its tendency to lift during high winds, and glass windows that can withstand 100 mph wind loads. In stillwater flood zones, buildings must be elevated above the 100 year flood line and must meet the storm-proof construction codes (Coastal Resources Management Council, 1983).

Rhode Island's Coastal Resources Management Program has taken a comprehensive view of the management of the coastal environment and has specific regulations that address the protection of erosion-prone and flood-prone coastal areas from unwise development or uncontrolled use. The program has effectively prevented development of 65% of the ocean barrier shoreline by designating certain beaches as undeveloped. However, most of the shoreline of the state surrounds Narragansett Bay and other small estuaries and salt ponds. In these already developed areas coastal regulations are aimed primarily at reducing future losses by requiring setbacks and sensible storm-proof construction. An attempt has been made to face the "taking" issue, the public health and safety issues and the mandate for protecting the natural environment. So far, the court record has been excellent, with decisions upholding the soundness and practicability of the program.

Nevertheless, only the first few steps have been taken. The soundest regulations are useless if they go unheeded or unenforced. The state is facing monetary crisis, and with severe reductions in the budget there are not enough people to enforce fully the regulations or to inform the public of their value. The only sure way to prevent redevelopment after the next major hurricane is to purchase flood hazard areas that have been developed, but the necessary funds are not available. Neither is there sufficient money for proper maintenance of boardwalks, dune grass revegetation, snow fences, educational programs, or dredging and beach nourishment projects. All these things--education, enforcement and purchase of hazard-prone coastal areas--are needed to make the regulatory program successful. Federally subsidized land acquisition programs specifically targeted to reducing flood hazards would be welcomed wholeheartedly. Such federal efforts that assist the state and local governments in identifying and purchasing damaged property would be very effective in Rhode Island. The recent Department of Interior designation of barriers which will no longer be eligible for federal subsidies is a step in the right direction.

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USE OF THE COASTAL BARRIER RESOURCES ACT TO PREVENT COASTAL FLOOD DISASTERS

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Conservationists were excited and relieved when the Coastal Barrier Resources Act (CBRA) was passed by Congress last fall. We were relieved because barrier islands legislation had been under consideration for four years, or two Congresses, and was not expected to pass in a Congress that was very conservative and not particularly sympathetic to environmental legislation. We were excited because the CBRA established the first federal land protection system since the Wild and Scenic Rivers Act in 1968. Part of our excitement stemmed from the new approach to environmental problems taken by the CBRA. Rather than resorting to the expensive option of buying land with important natural resource values, Congress simply cut off the flow of federal dollars to the Coastal Barrier Resource System--the storm-prone barrier islands and beaches of the Atlantic and Gulf Coast.

While the CBRA is an innovative public policy resulting from a recognition of the hazards of barrier island development, it is not the answer to preventing barrier island flood disasters. It is a beginning.

For the first time, the federal government has focused attention on specific areas of the coast that play a unique role in hazard mitigation. The Act identified barrier islands and beaches as natural storm buffers whose shifting sands deplete the energy of ocean waves but make a poor foundation for construction projects. The Act went on to state that a program of coordinated action by federal, state, and local governments was critical to the more appropriate use and conservation of barrier islands and beaches. Thus, it has been left up to others to really solve the problem of hazardous development on coastal barriers. For their part, conservationists concerned about barrier island development are being urged to turn their attention to local zoning boards, planning departments, city councils, banks, chambers of commerce, and state coastal zone management agencies.

This conference has addressed the initiative and solutions undertaken by the various states in preventing coastal flood disasters. Using the impetus of the CBRA, municipalities are also taking steps to recognize the unique qualities of coastal barriers and to change their policies.

Milford Point, Connecticut, is a part of the CBR System. Although it is renowned for its bird populations, it has been under development pressure since 1979. This month, the Connecticut Fund for the Environment argued against a zoning variance request before the Zoning Board of Appeal, saying that the development would contravene the purposes of the CBRA and the variance application would violate the state's Coastal Zone Management Act. They are hopeful of a favorable decision next month.

On Shelter Island, New York, the zoning board has adopted restrictions on development of "undeveloped coastal barrier districts." The restrictions prohibit changes in use of structures without approval of the Board of Appeals. In approving any changes, the Board must consider whether the structure should be covered by flood insurance, whether the structure is appropriate and suitable to an area designated as an undeveloped coastal barrier, and whether it meets state and federal guidelines and standards for designated lands. Conservationists are working to see that similar zoning restrictions are adopted by other municipalities containing units of the CBR System.

All of these legislative, planning, and citizen efforts are even more critical when the likely course of future coastal flooding is considered. EPA has undertaken a major study of sea level rise. Significantly, the study is not about whether sea level will rise but rather how much and how fast. EPA's scenarios project a rise from 18 inches to 12 feet by the year 2100. The government has undertaken this effort in order to help communities and individuals respond to the effects of sea level rise. The draft report suggests that "communities can construct barriers and issue zoning regulations; companies and individuals can build on higher ground; and environmental agencies can take measures to reserve dry lands for eventual use as biologically productive wetlands." It is an ominous but fair warning that more and better efforts will have to be made to direct development away from low-lying, coastal areas.

IV. STATE ASSISTANCE TO LOCAL PROGRAMS

THE JUNE 1982 FLOOD IN CONNECTICUT
POST DISASTER RESPONSE

Marianne Latimer
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Prolonged, excessive, and, in some cases, record rainfall from Friday night, June 4, 1982 to Sunday morning, June 6, resulted in flooding which exceeded the devastation caused by the 1955 hurricanes in southern Connecticut. The major damage occurred mainly along small streams where 48-hour rainfall exceeded 15 inches at a few locations. During the week prior to the flood up to six inches of rain fell over the area, resulting in saturated soil. The heaviest rainfall occurred in southern Connecticut In south central Connecticut, many of the smaller streams had floods of record exceeding the 1955 hurricane floods.

On Friday, June 4, the National Weather Service issued a Flood Potential Statement and, by Saturday afternoon, the State Emergency Operations Center was staffed to provide assistance to local officials, coordinate evacuations, and provide technical assistance regarding dam safety. Department of Environmental Protection field personnel were dispatched to monitor flood control structures and state-owned dams.

By Sunday, Federal Emergency Management Agency personnel were in the state and, following a tour of the hardest hit areas with FEMA personnel, Governor O'Neill declared a statewide emergency.

On June 10, the governor requested a statewide Presidential disaster declaration, and on June 14, the President issued a major disaster declara tion. The entire state was declared eligible for individual assistance programs and the four southern counties were also declared eligible for public assistance.

The Hazard Mitigation Team (HMT) met on June 17 to discuss initiation of mitigation activities and begin preparation of the 15-day report. The team was briefed by the state and the National Weather Service on known areas of flood damage. Following field visits to 30 communities and detailed discussions of potential mitigation measures, eight comm-munities were targeted for specific measures. Several general measures were also developed. The general mitigation recommendations address dam safety, flood forecast and warning systems, replacement of bridges and culverts, and strict enforcement of the flood management standards of the National Flood Insurance Program.

Prior to the June flood, all but one Connecticut community had been participating in the NFIP. The June flood quickly changed its opinions about potential flood hazards and federal involvement, especially when the Small Business Administration refused to give loans to the non-participating community. Connecticut now has 100% participation in the NFIP. Out of a total of 182 communities, 141 are in the regular phase and 41 in the emergency phase. FEMA and state personnel under the State Assistance Program are continuing to provide general and technical assistance to community permit officials, as well as conducting Community Assistance and Program Evaluation (CAPE) meetings in those areas hardest hit by flood damage.

The replacement of local bridges and culverts presented many problems for state and local officials. For those destroyed stream crossings located on the state highway system, the replacement was funded by the Federal Highway Administration with a 100-year hydraulic design standard. The controversy arose over the replacement of local stream crossings. State, and many local officials felt that where the opportunity to upgrade a previously hydraulically inadequate structure arose, it should be done. However, FEMA's public assistance program mandates in-kind replacement unless local standards mandate otherwise. It was soon discovered that, although Connecticut has strict standards for state bridges and culverts, locals did not have specific regulations or standards which mandated upgrading. Several appeals are still underway.

The Hazard Mitigation Team supported the development of a statewide automated early flood warning system, which was under consideration by the State Department of Environmental Protection following the flood. An automated flood warning system will be initated by the DEP as a pilot program in five communities. In addition, as a matter of policy, the Commissioner of DEP now requires an automated warning system to be installed as an integral component of any flood control project.

Dams and dam safety received tremendous criticism as the breaching and/or partial failure of 30 dams significantly contributed to the flood damage in many areas. During the special session of the legislature, whic was called following the flood, the DEP was instructed to undertake a comprehensive study of its policy, procedures, resources and planning for the safety of public and private dams. The report reviewed the adequacy of existing authorities, procedures, staffing and funding. Recommendations were made for improving dam safety regulations and alternative mechanisms for funding the repair or removal of public and private dams. Based on this report, the DEP has submitted a legislative package which should greatly improve Connecticut's ability to adequately oversee the safety of the 3,200 dams in the state.

The damages in the areas targeted for specific mitigation actions were similar in that the structures affected were in place prior to the initiation of the NFIP and flood plain management standards at the local level. Except within the town of Essex, few structures were totally or even substantially damaged.

In the intensely developed coastal town of Milford, the two rivers which flow through the community had not caused any problems in the recen past. During the June event, these rivers inundated commercial, industri and residential areas, as well as the town hall. Valuable tax records were stored in the town hall basement, which was completely flooded. The records were salvaged and relocated to other town buildings with the basement now vacated. Additionally, both the Army Corps of Engineers and Soil Conservation Service are investigating solutions to reduce the futur flood damage potential from both rivers.

A trailer park located in the flood plain and floodway of the Quinni River in Wallingford has been a problem area for state officials for over 25 years due to repetitive flood damage. Now, with local support, the Corps is investigating a nonstructural relocation project for the park. A past study indicated that a structural solution was not feasible.

The occupants of the Yantic River flood plain in Franklin and Norwic have also been subject to repetitive flood damage due to past unwise floo plain management. In 1974, the SCS and state DEP developed a work plan for watershed protection, flood protection, and recreational development. The plan called for the installation of land treatment measures, the construction of two floodwater retarding structures, one multi-purpose structure for flood prevention and recreation, and 7,000 feet of channel improvement. In 1977, the upper watershed communities withdrew their support for the construction of flood-retarding structures in their communities. Following the June event, SCS has developed a preliminary structural/nonstructural solution for the City of Norwich which is presently under review by both state and local interests.

The town of Essex was not only located in the area which received the greatest rainfall but also on a small tributary to the Falls River, where an earthen dam failed, causing or at least contributing to the failure of five additional dams downstream. The excessive rainfall, coup with the dam failures, resulted in severe destruction to the development adjacent to the Falls River. Several homes were destroyed, others displaced from their foundations, many businesses suffered substantial damag and several road crossings were washed out. It was fortunate that no lives were lost in this area, as the potential certainly existed. The owner of the dam had a person monitoring the structure during the night who notified the fire department when the dam appeared to be unstable. The quick response by the fire department in evacuating the downstream area saved many lives. The SCS, under their Emergency Watershed Protecti Program, removed the debris from the clogged river and stabilized the river and banks. Also, FEMA has initiated a new flood insurance study. The rebuilding, where it is taking place, is being done in strict conformance with all flood management standards. The SCS, Corps and the state are continuing to work with local officials and residents to implement mitigation measures.

In closing, the state is pleased with the postflood progress. Essentially every recommendation set forth by the hazard mitigation team is being acted upon, as well as many other areas not identified by the team. The Corps and SCS have provided a tremendous amount of assistance in addressing our flood hazard. Immediately following the event, the governor requested the Corps to inspect and report upon the condition of 70 dams which had previously been identified by the National Dam Inspecti Program as having major deficiencies. The Corps has also initiatied 12 investigations of flood-prone areas under their section 205 program. The SCS, immediately following the event, initiated 13 emergency stream restor ation projects and followed up with 25 non-emergency projects. The SCS is investigating 12 watersheds under an ongoing river basin study and is anticipating the initiation of several more before the end of the fiscal year. Meetings are held regularly to ensure coordination and cooperation The state has initiated repairs to 25 state-owned dams and, in cooperatio with local governments, is undertaking or investigating 20 state/local flood control projects. Connecticut's state and local governments are making significant commitments to reduce future flood hasard potential.

POST FLOOD RESPONSE: A CHANCE FOR LONG-TERM IMPROVEMENTS IN FLOOD PROGRAMS

Allan Williams
Connecticut Department of Environmental Protection

The emergency operations were superb, if not heroic during the June flood. Unfortunately, many still see flood management only as a response to flood. Our programs are failures if we yield to the practice of being "rowboat managers." The most difficult task is preventing disasters from happening, or at least reducing losses. Ironically, it is the flood event itself that provides the opportunity to correct many long-term floodplain management problems.

After the June flood, we were given the opportunity to conduct a complete review of our flood programs. That opportunity was the Section 406 requirement of P.L. 93-288. Section 406 requires us to describe methods to reduce flood hazards. We set about delineating flood damage potential and examining flood hazard mitigation programs. We determined that there were many local roads constructed to inadequate standards; there were about 40,000 buildings in flood zones; there were 74 communiti with over one million dollars of flood insurance policies; there were policies statewide close to $700 million; there were 50 state-owned dams needing repairs, and hundreds of private dams were in similar condition.

To address these problems, we developed over 100 specific areas of improvement; a few of those recommendations are listed below.

. Draft legislation to require a standard for municipal road, culvert and bridge construction and reconstruction.

Will you experience a major flood event and discover that there is no incentive for municipalities to reconstruct road, culvert, and bridge openings to the 1% standard? FEMA will not provide funds for upgrading structures without a policy (or procedure) requiring such upgrading prior to a flood.

. Prepare a statute that declares state policy on flood management and sets standards for development by state agencies.

Perhaps you will find as we did that state agencies were not obeying executive policies and procedures, and that more specific state standards were needed; there was a need for the state to finally adopt the standard: which it promotes for municipalities; a stormwater management standard was needed; and most of all, a stated policy on flood management was needed.

. Improve the dam safety program.

With the failure of 30 dams, it became evident that the weakest link in our flood management program was our lack of attention to the dam safety program. Not only were we slow in inspecting and enforcing dam safety orders, we had neglected maintenance on many state-owned dams. Sweeping changes are needed; including regular inspections of all 3200+ dams; $30 million to repair state-owned facilities; $64 million for privat dams; and a major reorganization of personnel and an increase in staff. Up until now, the entire dam inspection, licensing, and repair program consisted of only 2 full-time persons. The state legislature has in fact authorized $100,000 for new personnel and $1,000,000 for repairs.

. Draft legislation for a state/local cost-sharing formula for disaster assistance to municipalities.

The state picked up the entire local share of the diaster assistance in the June flood. Some feel this is a bad precedent because it continue: the theory that big government will bail out the municipalitites no matte: how poor their floodplain protection programs are. Few other states have done what we did. In a postflood situation, make sure the governor knows the score immediately, before he or she promises more than should be delivered.

. Revise emergency operations plans for all state agencies involved in responding to floods.

We found that nearly every state agency involved last June needed changes to allow more effective disaster response.

. Conduct a workshop for commercial and industrial property owners on flood preparedness.

There are significant numbers of businesses that would profit from better flood preparedness and floodproofing. Bouyed by Maryland's earlie: efforts, we will be conducting such a workshop with the assistance of the Corps of Engineers.

. Work with local officials to help towns educate their citizens on the importance of flood insurance.

Preliminary studies indicate that less than half of those eligible for flood insurance have purchased it.

- Conduct a workshop or workshops on updating municipal emergency operations plans to include a flood element.

In a review of emergency operations plans for coastal communities, we found that all municipalities needed to develop or improve their warning, preparedness, and flood response directives and capabilities.

- Expedite feasiblity studies for about 24 municipalities with significant flood problems.

The state has requested the Corps of Engineers and the Soil Conservation Service to study or restudy many flood problems to determine feasibility for flood projects. If the state had been more diligent duri the past two decades, these projects might not have been necessary.

- Streamline FEMA procedures for distribution of disaster funds in order to expedite disaster payments.

There were many complaints about the timeliness of payments. Perhap not a lot can be done about this problem, but we owe it to our citizens to attempt to alleviate it.

- Consider purchasing flood plains as a priority for purchase of recreational land.
- Consider purchase of flood plain farmland in purchase of development rights.

There are several programs now purchasing land or land rights. It is our hope that, where possible, these programs will obtain flood plain properties as part of their efforts.

- Implement a pilot program for a state-wide automated flood warning system.
- Investigate development of an automated flood warning system for all state-owned dams posing a significant threat to public safety.

If we were able to save 10% of total annual residential and commerci damages, we would save $4 million per year. The cost of building an entire statewide system would be around $1 million, and would be repaid during the first three to four hours of the first major flood.

- Inventory progress on these actions one year from the date of the final report, and report to the governor's office.
- Incorporate long term issues from the 406 report into the long-range water resources planning program.

This provision will help implementation by letting agencies know that the governor's office is aware and concerned about the issues. It is helpful to refocus attention on long-range problems.

We had a major flood, but its impact was minor compared to the costs of a full-blown coastal storm. We responded to it well, but we also realize that flood fighting is not the important issue: it is flood damage reduction and prevention of loss of lives. To that end, we have reviewed our flood management programs and have determined that many corrective actions are needed. We also recognize the difficulty of improving flood programs as distance from a flood event increases. If your state experiences a major flood, I urge you to use the 406 process to further the goals of your flood program. It may be a requirement, but it also can work for your state. In fact, the kind of work required by Section 406 should be done before the flood occurs. We are all much better off preventing flood damage before it happens.

MARYLAND'S COASTAL FLOOD HAZARD MITIGATION ACTIVITIES

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The State of Maryland, the Town of Ocean City and Worcester County have taken several steps to reduce flood hazards along Maryland's Atlanti coastline. Two-thirds of Maryland's approximately thirty-mile Atlantic coast is permanently protected in an undeveloped state, lying either in Assateague State Park or Assateague National Seashore. The town of Ocean City, on Fenwick Island, comprises the remainder of Maryland's Atlantic Ocean shoreline. In 1974, the state established a static building limit line seaward of which no construction was allowed, thus preventing encroachment upon Ocean City's beaches. The town of Ocean City was the first community in the regular phase of the National Flood Insurance Program.

However, additional steps need to be taken. Ocean City has undergone major new development since the last major storm hit the area in March, 1962. While desk-top exercises of Ocean City's evacuation plan have been undertaken periodically, no field testing of the plan has been attempted since its adoption several years ago. The town has only one building inspector to cover the extensive development that occurs each year. Finger canals have been built along the bay side of the island, making it more vulnerable to being breached. The static building limit line does not fully recognize the effects of coastal natural processes such as erosion. The town's existing building ordinance, adopted several years ago, does not incorporate all the knowledge gained in recent years regarding hazard-mitigating construction measures in coastal areas. Like most coastal communities, the town of Ocean City does not have a plan to guide long-term reconstruction and relocation actions following a major storm.

To respond to these concerns, Maryland has initiated a contractual study to identify measures other than emergency management measures to be undertaken immediately prior to, during, and immediately after a major storm. These are actions that can be taken by the state, the town of Ocean City and Worcester County to reduce danger to life and property from a major hurricane or northeaster. A major emphasis of study is to identify steps that can be taken both now, before a storm occurs, and also after the town has suffered significant damage. The combination of these measures should enable the town to guide recovery actions so that future flood hazards can be reduced. In some areas it may be appropriate to prohibit reconstruction while in other areas repair and reconstruction activities can be safely undertaken if certain procedures are followed. In addition, the study will examine the effectiveness of several beach protection plans recently proposed for Ocean City and how those plans relate to other flood loss reduction measures.

Specific objectives of the study and the general approach to identifying additional hazard mitigation measures are described by the following five tasks.

1. Identify areas of greatest risk, areas likely to suffer heavy damage, areas of potential breaching and portions of the island that may be isolated due to major storm flooding and erosion processes;

2. Analyze four storm and beach protection alternatives for their effectiveness as beach protection and hazard mitigation measures, their costs and benefits and the implications of their implementation on other proposed hazard mitigation measures;

3. Identify approaches and criteria for flood hazard mitigation that have been used or considered in other areas that may also be applicable to the Ocean City area;

4. Determine what modifications may be appropriate to existing codes, ordinances, legislation, plans, programs and other land use controls; and

5. Develop performance criteria that can be used by the state, county, and city in guiding relocation/redevelopment decisions and actions after a major storm has occurred.

This study is an example of cooperation between Maryland's coastal zone management and flood hazard management programs since it is funded by FEMA's State Assistance Program and administered by the state agency responsible for the state's Coastal Zone Management Program (the Coastal Resources Division, Tidewater Administration, Maryland Department of Natural Resources) with the assistance of the state's floodplain management agency (the Water Resources Administration, Maryland Department of Natural Resources) and the state's emergency management agency (Maryland Emergency Management and Civil Defense Agency). Since it can not cover all outstanding flood hazard mitigation issues, particularly those relating to emergency preparedness activities and those requiring extensi new technical studies, it will likely be followed by a study funded by the state's flood hazard management program, which will cover such issues in depth, building upon the results of the contractual study now underway With the results of both studies, Ocean City, with assistance from the state, will be able to implement a truly comprehensive flood hazard mitigation plan.

Based upon experience gained to date in addressing Maryland's coasta hazards issue, the following observations can be made regarding federal support of state and local efforts.

- Completion and refinement, where necessary, of detailed flood insurance studies is needed.
- Continued federal funding of coastal zone management and state assistance program efforts is essential if coastal states and communities are to address adequately coastal hazard issues.
- Federal regulations should support state and local efforts to regulate construction in coastal hazard areas in a comprehensive manner. While it is recognized that national standards must be maintained, flexibility should be allowed in such regulation to support state and local community efforts to address coastal hazards issues, shore erosion hazards, and flood hazards, in one comprehensive management program.
- Continued technical assistance is needed from FEMA for specific measures states and coastal communities can adopt to address coastal hazard issues. The standard language in NFIP regulations is performance-oriented and in several instances not specific enough for state and local agencies to implement and enforce. Also, such situations as the potential for damage from overwash from the bayside of barrier islands during the last phases of a tropical storm needs further study if the danger to life and property from such processes is to be reduced.

DISASTER PREPAREDNESS IN OCEAN CITY, MARYLAND

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Throughout history, people have built their own problems, and Ocean City is no exception. The ocean and the bay are the city's greatest economic assets and, at the same time, the city's greatest potential natural hazard. People have invested millions of dollars to have an ocean view, overlooking the fact that the ocean has a good view of them.

Unlike many other coastal communities, Ocean City has been fortunate. Over the last twenty years, there have been few serious threats of major storm damage. This good luck has a negative side, however; many of the people who have built or bought property in the area have little or no experience with a life-threatening storm.

In the past concerns about emergency preparedness were stifled through fear of possible adverse economic impact. Recently, however, the business community and local government have become increasingly aware that a strong emergency preparedness program is a necessity. There is a need to enhance public and private emergency planning. Some work has already been accomplished. An emergency plan for Ocean City was developed several years ago, and table-top exercises have been held with local officials. A storm evacuation map has been prepared by the National Ocean Survey, working with both the state and local officials. Much more work should be done because even cursory observation shows that present evacuation routes are vulnerable lifelines.

Basic information is lacking on evacuation time estimates for the Ocean City area, especially those that consider different times of the year, day, and night, and weather conditions. It is not known how many people would leave when advised to do so. One of the significant aspects of this question is that Ocean City is becoming increasingly popular as a retirement area. In many emergency situations around the country, elderly people have been reluctant to evacuate. No one knows how much time property owners would require to secure their boats, homes and businesses, or even whether property owners have prepared to secure their property to minimize storm damage.

Several actions should be taken.

. Basic evacuation information should be developed as quickly as possible to help local officials determine appropriate time windows for action. This information should be reviewed and revised periodically.

. Every resident and property owner in the Ocean City area should be made aware of the preparedness measures that they can take to be ready to respond quickly.

. A concerted effort should be made to secure the cooperation of the public to evacuate when instructed to do so.

. There should be annual exercises to test warning and evacuation plans.

. Warning and evacuation considerations should be incorporated into future development of the area. If evacuation time estimates are too great, one option that should be considered for the Ocean City area would be to impose temporary restrictions on new residential development and transient accommodations until increased capacity could be provided to get people out in a reasonable time.

Many people have a lot at stake in Ocean City, including their lives. It is in everyone's interest to be prepared for a hazard that will occur sooner or later. A combined public and private effort is needed to get ready and stay ready.

ENCOURAGING HAZARD MITIGATION AT THE LOCAL LEVEL

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Flood hazard mitigation is the act of doing something today that will reduce the impact of tomorrow's flood. It can involve an entire community through massive relocation or a levee, or it may involve an individual property owner through floodproofing or relocation. Historically, mitigation efforts were largely the responsibility of the individu if floods occurred, individuals rebuilt their own property and the community might assist in that effort along with rebuilding roads and sewers. In the 1930s the federal government began to build large structu projects, especially dams, to protect communities from flood losses. The federal government has spent over $11 billion on structural flood control works between 1936 and the mid 1960s (NSF, 1980).

For these federal projects, alternative solutions were explored by the federal agency and those selected were usually ones that involved the least cost to the federal government. While a flood problem was usually raised by the locals through a letter to their congressmen, the projects were largely visualized and solved by a federal agency. Public meetings were held to involve local government and the public but oftentimes interest was mild because costs were borne almost entirely by the federal government. Such solutions offered locals a means of getting the problem solved while upsetting few people's lives or pocketbooks. There was a widespread belief that we could control nature if we could just build a dam big enough, channel a stream deep enough, or build a levee high enough. Through the 50s and 60s we came to realize that we could not completely control nature nor would anything built by humans last forever. Dams failed, levees overtopped and those that did not fail took on an ever-increasing amount of funds to operate and maintain.

In the 70s, we started to look more to nonstructural mitigation solutions. Some shining examples exist, including Rapid City, South Dakota; Big Thompson Canyon, Colorado; Soldiers Grove, Wisconsin; Littlet Colorado; and Prairie du Chien, Wisconsin. The focus for mitigating flood losses has now returned to local governments and the private citize

Federal and state programs must concentrate on encouraging those efforts.

What Roles Have States Been Playing?

There has been a wide variation in the efforts states have directed towards flood hazard mitigation. Some states have active coastal zone programs, however, most of those programs are directed to improve and enhance coastal values and are more apt to address standards for new development rather than mitigation of losses to existing development. Other states have floodplain management programs that started before the National Flood Insurance Program and are now working to integrate with that program. Still other states had no program until the National Flood Insurance Program funded some initial efforts. State programs may or may not address mitigation efforts. Most of them tend to focus on regulations rather than mitigation.

Coastal states are performing the flood hazard mitigation activities shown in Table 1.

TABLE 1

State Mitigation Activities

Land Acquisition and Public Investment

	Number of States
Acquisition of flood hazard areas for natural areas, open-space, parks and other uses.	4
Acquisition of existing structures in the floodways (Not known if this includes coastal V zone)	1
State construction of flood control works	8
Postdisaster Assistance	
Predisaster planning for reconstruction	10
Reconstruction technical assistance	11
Reconstruction of public facilities assistance	14
Reconstruction of private facilities assistance	7
Contingency funds for postdisaster assistance	17

In this study, 32 coastal states were interviewed. It can be seen that nearly half are active in postdisaster assistance to locals, especially for planning, technical assistance and contingency funding. Direct acquisition or public investment funding is less prevalent. (from Burby et al.,

What Measures Have Been Particularly Innovative and Cost-effective?

A number of these programs have been particularly effective. Wiscons mitigation activities occur through the floodplain management program (mostly technical, monetary and planning assistance to locals) and a coast program (again, technical assistance to locals for regulation and plannin

In Wisconsin, two well-known examples of flood hazard mitigation hav occurred at the local level. Prairie du Chien is one of the few Corps of Engineers nonstructural acquisition relocation projects in the nation. The Corps worked with the local community to relocate over 150 homes from a floodway island in the Mississippi River. The project cost about $4 million with HUD Community Development Block Grants (CDBG) providing most of the local share. This project relocated primarily residential structures. Implementation has been well received locally, perhaps because the Corps contracted with the city to deal with landowners on acquisition and relocation. The floodway will be cleared and a reuse plan has been developed by the city, focusing on open-space use.

The Village of Soldiers Grove relocated its entire business district out of the floodway and floodproofed residential structures in the flood fringe. The village decided against a Corps of Engineers levee and developed its own relocation plan. It was searching unsuccessfully for cost-sharing for the plan when it was hit by a major flood in 1978. Since many structures were substantially damaged and could not be rebuilt under the floodplain zoning ordinance, alternative actions for relocation were necessary. The village packaged various sources of funding to pay for about 50% of the project cost. The other 50% was paid by property owners or the community through such techniques as tax incremental financ The floodway will be completely cleared for recreational use.

In the City of Richland Center, the Soil Conservation Service has worked closely with the state and the city to develop local multi-purpose alternatives to reduce flood losses to existing structures. This involve over 150 structures, mostly residential, with some commercial and industr along the Pine River. That project has gone through the planning phases and the Soil Conservation Service is now attempting to work out policy implications to determine if a preapproved PL-566 structural project can be simply converted to a nonstructural project and the funds used to implement thecity's plan. A key to the success of this project so far has been the emphasis on local planning and input through neighborhood committees with the city clearly in charge of developing alternatives which meet various local goals.

In an effort to encourage more local communitites to plan and implement flood hazard mitigation, the state is holding a series of two-day workshops for key local officials and members of the public to acquaint them with the ideas of hazard mitigation, share other community successes with them and help them determine ways to get their community to realize that action must be initiated at the local level. Upon the request of the community the state will then assist them in planning, technical analysis and liaison with federal agencies on techniques and funding for implementation.

To What Extent Has Federal Government Encouraged Such Efforts?

The strong point of federal involvement has been the funding of the many innovative local projects which have relied on that cost sharing for implementation. The funding dollars have usually been most effective if used for technical analysis or implementation. The major disincentives t nonstructural flood hazard mitigation have been the policy and planning aspects of federal programs. Benefit/cost ratios are particularly discouraging. No one can agree on a method that treats structural and nonstructural alternatives equitably and there is little agreement within the administration or Congress about how to straighten out this matter.

The planning process usually results in some structural project being recommended because it has the highest benefit/cost ratio. Furthermore, the community perceives the structural solution as less disturbing and requiring less local disruption or funding. As a result, the community becomes disinterested in pursuing other options because those are more apt to be directed at changing people rather than changing water. At the same time, almost no structural projects have been funded by Congress since the early 70s. As a result, communities sit for years hoping the federal government will solve their problem. The federal government gets no dollars and locals do not explore alternatives to meet their needs if they require a larger local share of funding.

How Could Federal Programs Help States Implement Local Mitigation?

- Development of improved mapping techniques. Improved map criteria and cost-effective techniques for generating map data and preparing maps need to be developed. These techniques need to take into account unique hazard areas such as dunes, and coastal erosion. They need to have sufficient information so that communities can also use these maps for flood hazard mitigation planning. Mapping must be completed for all communities so they participate in the regular phase of the NFIP.

- Building state capability. The federal government, Congress and agencies must agree on continued funding efforts that will provide sufficient personnel within states to build strong state programs and to assist local communities in implementing their programs for floodplain regulation and flood hazard mitigation. The states must take an active lead in providing technical assistance to local communities, monitoring and enforcement of local communities' programs, training and education, permit processing, and administration of acquisition activities.

- The training and education programs of federal agencies should emphasize mitigation tools and techniques. The system must be oriented to train key local officials through state agencies.

- Development and implementation of a data base. The federal agencies, under the umbrella of the Unified National Floodplain Management Program, should agree on a method to develop an adequate data base that includes technical and mapping information, flood damage information, insurance data and other data that are made available to states and local communities to help determine the effectiveness of programs and shape future policy.

- The federal agencies, Congress and the administration must revise cost-sharing policies so that they will provide proper incentives for nonstructural hazard mitigation at the state and local level. Without adequate and equitable policies for such programs as flood warning, acquisition, and relocation, communities will not act as they should.

- Congress, the administration and the agencies must agree to develop a packaged approach to funding flood hazard mitigation for projects that accomplish multi-purpose goals at the local level--reducing flood damages, developing the economic base of the community, preserving energy, enchancing and preserving soil conservation, etc. There must be an identifiable nonstructural program for communities and states just as there now is a structural program for dams and levees.

- It is important that incentives that will encourage more active state and local involvement in flood hazard mitigation be established. Incentives should also be aimed at individual property owners. Incentives can be developed through the insurance rate structure, cost sharing, disaster relief and other techniques. The more a private citizen or local community does to help themselves to reduce damages to existing structures the more federal money it saves and the more the federal government should thus be able to provide cost sharing or reduced insurance rates or additional disaster help to that community.

- It is important that a national goal be established which will help in evaluation of local flood hazard mitigation projects. That goal should relate to limiting the number of structures at risk in the 1% flood or to holding the average annual damages in the nation to a given amount. Such a goal would provide a yardstick by which to measure flood hazard mitigation projects and would provide long-term direction for all levels of government.
- Predisaster planning is essential for all communities in the nation. Program priorities and incentives must address the need for such planning not only for flood damage reduction measures but to achieve the goals of their emergency management systems. The emergency management aspects of the FEMA program and local community programs should require an element of predisaster planning for both short and long-term.
- Coordination of multi-hazard mitigation efforts. Mitigation actions at the local level are usually the same whether dealing with floods, dams or earthquakes. Yet federal and state programs are delivered to locals as separate programs. Federal programs must be packaged and delivered to states so they integrate common elements. In turn, states can further integrate other state programs when they assist locals.

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STATE/LOCAL COOPERATION IN MARYLAND

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Maryland Department of Natural Resources

In the past, a major concern of the states was that they were not being adequately involved in the development of national flood hazard management policies. Now, of course, there is greater interaction between the states and federal agencies about flood hazard management issues and we enjoy a cooperative relationship.

Now local governments are expressing similar concerns about state flood hazard management programs. State and federal governments call upon local officials to manage their flood problems; however, local communities are not provided the proper planning tools for integrating flood hazard management into existing local planning and zoning programs and local land use permitting processes.

The Maryland program provides an example of how flood hazard management may be achieved at the local level and implemented in a comprehensive state-wide manner. The Maryland Flood Hazard Management Act of 1976 set forth a strategy to reduce flood hazards by addressing the flood problem on a natural watershed basis and mandating local involvement and implementation. Inspired and encouraged by an aggressive local program, the goal of the Maryland initiative is to incorporate flood hazard management into existing local plans, programs, and procedures and provide the technical and financial assistance necessary to achieve this goal. Flood hazard management is not usually a major local concern. Local officials must contend with more pressing social and economic issues. The state believes that, with proper assistance from the state, local governments can and will assume their rightful responsibility in managing flood hazards along with their other local management duties.

Basically, the Maryland Flood Hazard Management Act requires flood hazard management on a watershed basis and the state Water Resources Administration (WRA) to conduct comprehensive watershed studies. In turn, local jurisdictions are required to prepare flood hazard management plans for the watershed, which must be approved by WRA and other state agencies. A priority study list has been established by the local governments and WRA;

state funds have been appropriated through a bond issue to conduct the watershed studies and provide 50% of the cost for flood mitigation projects, preferably acquisition of floodprone homes; and technical and coordinating assistance is available to local governments to develop and implement the flood management plan. Where the watershed involves more than one jurisdiction the local governments are required to produce compatible plans. A major benefit of this is that it provides an incentive for local communities to cooperate with each other.

The watershed study will be the technical basis from which the flood management plan can be developed and will evaluate such information as the flood history and previously conducted floodplain studies; master plans and subdivision plans; existing and proposed utilities; capital improvement projects; park acquisition and road construction; property damage, unrecoverable losses of wages and business, traffic delays; cost of emergency operations and cleanup; and areas of significant historical, environmental and archeological value. The watershed study produces a map of the watershed at a scale useful to the local governments, and which describes existing and planned development, 100-year floodplains, flood damage sites, location of flood mitigation measures, and other natural and geologic features of the watershed. Where necessary, the watershed study will provide hydrologic and hydraulic information to complement existing flood data or studies. Perhaps the most benefical product of the watershed study is a determination and evaluation of alternatives for flood hazard mitigation, including both structural and nonstructural measures. All alternative methods shall, by law, enhance or, at a minimum, maintain, environmental quality, and clearly define any negative impact. All evaluations must show the total cost of the mitigation measure and the number of residential, commercial and industrial properties protected for both existing and planned development. Of course, nonstructural flood mitigation alternatives will be favored, such as floodproofing and acquisition. However, low-maintenance structural measures may be considered and necessary. In addition, the watershed study evaluates state and federal programs and activities and suggest ways of expanding or initiating these programs to reduce flood hazards and achieve multipurpose objectives.

Throughout the study process members of the local government, environmental groups, the commercial and industrial community, and the concerned public will be involved to insure proper consideration of all relevant issues. A task force is established to assist with the study as well as the development and implementation of the flood management plan.

The state believes that this approach to flood hazard management will be successful because local governments will be provided with the necessary planning tools and will be totally involved in the watershed study process. Furthermore, the flood management plans developed by the local governments will incorporate flood hazard management into existing local plans and programs and will reflect the social, environmental, economic, and political concerns of the area.

Maryland is presently undertaking a study of the Ocean-Back Bay watershed. The existence of Ocean City as a major recreational resource has increased development pressure on the back-bay side of the watershed. The Ocean-Back Bay watershed study will enable the city and the county to work together in developing a flood management plan for the entire watershed and to consider such problems as evacuation from the city into the county, barrier island breach from the bay side, and inland non-tidal flooding contributing to the flooding of the back bays and possibly destroying valuable marshlands.

When the cost of flood disasters, which in the past decade has been $300 million, is compared with flood hazard management, the Maryland program is cost-effective, but it is not cheap. Maryland probably spends more per capita on flood hazard management then any other state in the country. The state has appropriated $12.5 million for watershed studies and 50% capital project cost sharing alone. That figure does not include the operating budget for issuing floodplain encroachment permits, sediment and erosion control, stormwater management, and wetland protection. However, because Maryland has invested heavily in flood hazard management, the state is less of a liability to the federal government. That should be incentive for the federal government to continue to encourage state programs which reduce flood hazards and prevent future flood hazards through proper local planning.

Continued flood studies and restudies are essential to the state program. If the state had to pick up the cost of studies there would be much less to spend on acquisition of flood-prone homes and conducting watershed studies. Developers, realtors, and insurance agents could contribute greatly to our flood hazard management effort by providing accurate information to the public. FEMA can help in this regard by providing more training and education and certification of insurance agents. During the last session the Maryland legislature considered a bill which would require more professional responsibility and accuracy of insurance agents writing flood insurance policies.

Through comprehensive flood hazard management at the local level Maryland is building a federal-state-local team that capitalizes on the programs and benefits offered by each governmental entity. Participation in the National Flood Insurance Program is a requirement for receiving state funds for flood management. Communities must also be in good standing with other resource protection requirements. The availability of flood insurance, federal disaster relief, and state capital improvement funds has been a major incentive for Maryland communities to practice flood hazard management.

The federal government could improve the involvement of local communities by greater training and education efforts geared toward local situations. Regional workshops and increased use of the Community Assistance and Program Evaluation effort would be a tremendous help to local and state programs. The FEMA State Assistance Program is a valuable asset to state programs and could eventually be expanded into a Local Assistance Progam to encourage local initiatives and sound flood hazard management.

COMMUNITY FLOOD HAZARD MANAGEMENT FOR THE COASTAL BARRIERS OF APALACHICOLA BAY, FLORIDA

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In 1980 and 1981, the authors assisted Franklin County, Florida (population 7,000) in the analytical and land-use regulatory aspects of a community flood hazard management program. The Franklin County effort was one in a series of coastal resource management demonstration projects begun in the late 1960s by the Conservation Foundation. The work was supported by Franklin County, federal and private foundation sources.

The result was an integrated, federal-state-local program spearheaded by the county to conserve coastal resources and prevent life and property damage from coastal storms and hurricanes. The center of ecological concern was the fishery resource of Apalachicola Bay. The center of coastal flood hazard concern was Franklin County's chain of coastal barriers, particularly St. George Island, a 23-mile long barrier island of the Florida Panhandle (Figure 1). The flood hazard elements were accomplished mainly by a local ordinance based on the land-use stipulations of the Federal Insurance Administration (FIA) of the Federal Emergency Management Agency (FEMA). Specifically, Franklin County imposed the following controls on development in high hazard zones (V zones),

- no alteration of any kind to active (unvegetated) sand dunes,
- no fill to be used for structural support,
- all houses to be supported on pilings of columns and anchored so as to withstand the full loading from storm waves (verified by structural engineering certification),
- lower floors of houses to be elevated above maximum 100-year storm height, plus wave run-up (11 - 14 feet above mean sea level).

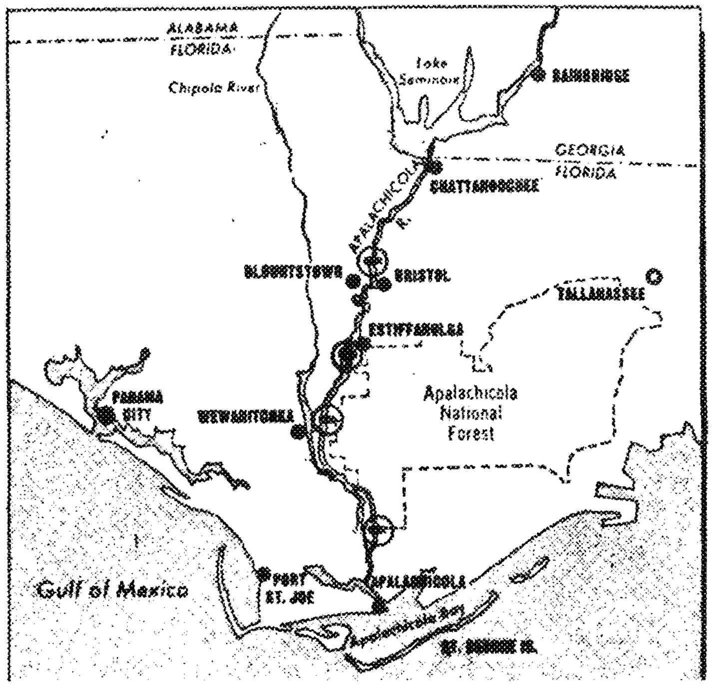

FIGURE 1

The Apalachicola Area of the Florida Panhandle

Franklin County had already qualified for the "emergency phase" of the program to obtain assistance after Hurricane Agnes struck in 1972. Emergency program features included a mandatory four-foot elevation for coastal structures, and a modest level of hurricane protection. The new hazard zone program was adopted while Franklin County was still in the emergency program, because the community wanted to act fast, but in a way that would address federal requirements for entrance into the "regular program." The action was also coordinated with Florida's mandatory "coastal construction setback," a statewide regulation administered by the Department of Environmental Regulation which imposes a seaward limit on structures built on the shore. It also reinforced several state and federal level programs aimed at resource conservation.

<u>Barrier Island Dynamics and Flood Hazards in Franklin County</u>

Franklin County's coastal barriers (islands and spits) have experienced extensive changes in morphology as a result of storm-driven waves and currents. These reflect the force of ten major hurricanes which have struck in recent history (Conservation Foundation, 1980), including five direct hits on Franklin County (Figure 2).

Our review of historic maps (U.S. Coast Survey and U.S. Coast and Geodetic Survey) dating back 130 years shows that geological instability is the most consistent characteristic of Franklin County's barrier island system. This is especially evident in changes in number and location of inlets through the island chain. The hurricane of October 9, 1852 opened two new inlets on St. George and Dog Islands. By 1860, the inlet on Dog Island had closed; St. George Island was still breached in two places. Approximately fifty years later, the northernmost inlet on St. George Island had closed. During the next thirty years, the remaining inlet on St. George Island closed, reuniting the island. This island remained whole until the early 1960's when an artifical channel, Sikes Cut, was dredged.

Mapping of areas subject to storm surge and wave run-up (V Zones) as part of the National Flood Insurance Program confirms that coastal hazards must be one of the most important considerations in guiding shoreline development. The pattern of development in Franklin County is almost exclusively concentrated along the shoreline of the mainland and St. George Island. Although current levels of expansion are light to moderate, some 76 shoreline subdivisions have been plotted and sold. The Flood Insurance Rate Maps prepared for Franklin County show that approximately 75 linear miles of shoreline fall within the designated coastal high hazard zones, and would experience the combined effects of storm surge and wave run-up. Flood heights caused by storm surge alone in a 100-year event can range from 9 to 14 feet. Among Franklin County's 76 shoreline subdivisions, 47 are at least partly in the high hazard zone, and 11 are entirely within the high hazard zone (Conservation Foundation, 1980).

One of the most dramatic effects of hurricane-force storms is the overwash barrier islands. These areas are subject to washout of sand dunes, flooding and wave action, and during severe storms, complete breaching of the island. In the context of the NFIP, overwash areas can be identified by existence of V Zones extending across the width of an island or beach. Three distinct overwash areas were identified in Franklin County: Alligator Point to Peninsular Point on the mainland, Unit 1 of St. George Island, and the vicinity of Sunset Beach on St. George Island

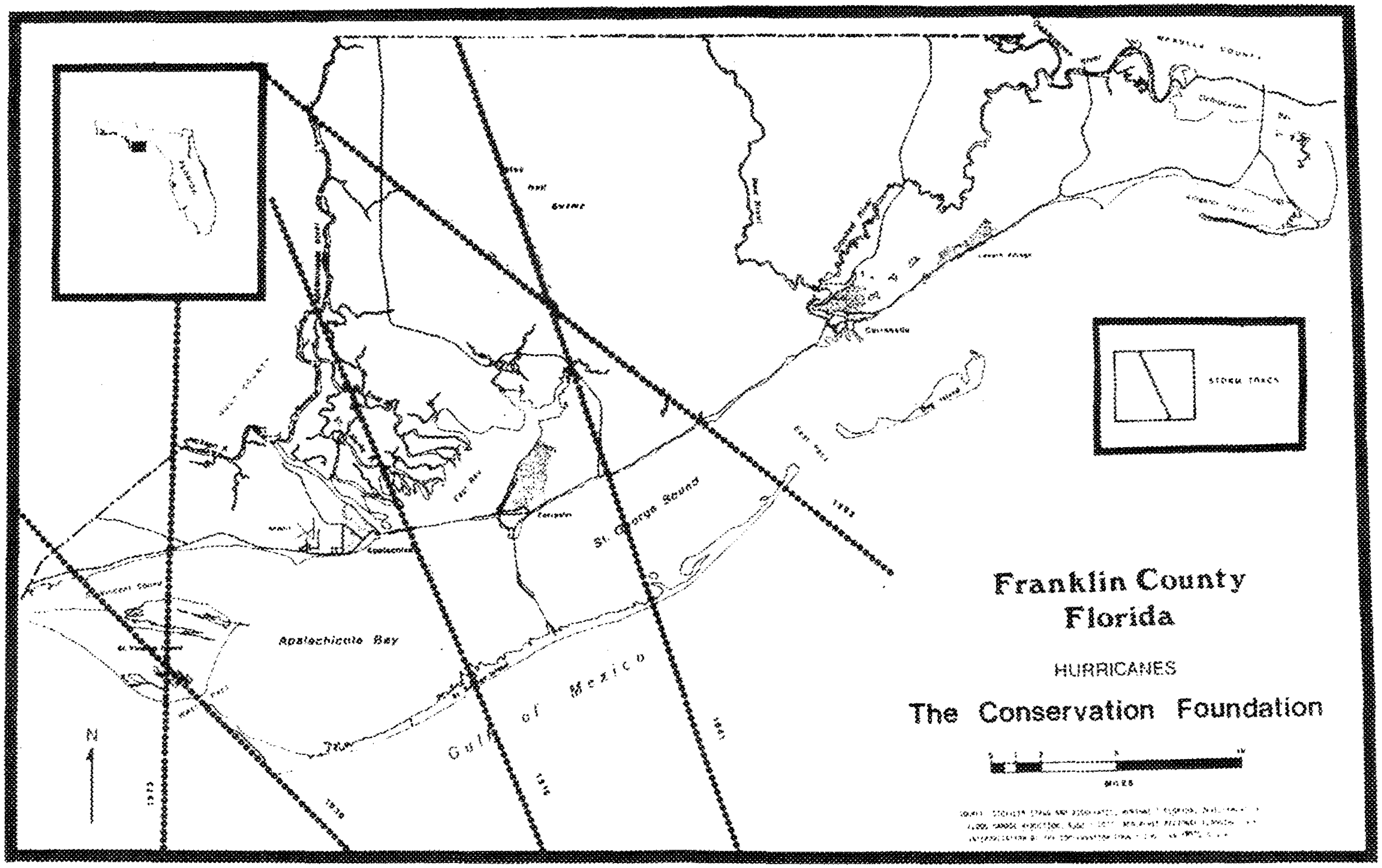

FIGURE 2

Tracks of Major Hurricanes with Landfalls in the Apalachicola Area

(Conservation Foundation, 1980). Figure 3 illustrates primary and secondary overwash areas in the vicinity of the bridge linking St. George Island to Eastpoint. In this area, nearly one hundred lots of record are subject to overwash. The primary overwash zone is the minimum probable overwash area, interpreted from the flood insurance maps. The secondary overwash area includes a portion of the V Zone along the shoreline that is likely to be subject to storm surge and waves moving across the width of the island.

Major Elements of the Shoreline Strategy

The Conservation Foundation's Shoreline Strategy emphasized four related factors in flood hazard management (Clark, et al, 1980):

- guidance of site planning and structural integrity for development in the high hazard zones (V Zones),
- restoration of sand dunes degraded through a combination of insensitive site preparation, random access to the beach, and damage inflicted by Hurricane Agnes in 1972,
- guidance for the total amount and rate of new development, linked to hurricane evacuation needs, and
- guidance of site planning and structural integrity for development of special flood hazard zones (A Zones, storm water rise without velocity).

In addition, the Conservation Foundation proposed several land use policies directed at protecting the ecological integrity of Apalachicola Bay. This included the designation of a "critical shoreline zone" around the bay on both the mainland and the barrier islands, where installation of new septic tanks and removal of shoreline vegetation was severely limited. The result was that the whole shoreline of Franklin County was controlled for various purposes (Clark, et al, 1980).

High Hazard Zone Ordinance

The initial and major success of the hazard management program was the adoption of an ordinance in June 1980 after extensive workshops, hearings, discussions with planning commissioners and county commissioners (Ordinance No. 80-5, 1980). The preamble of the ordinance presents the rationale for the new regulation:

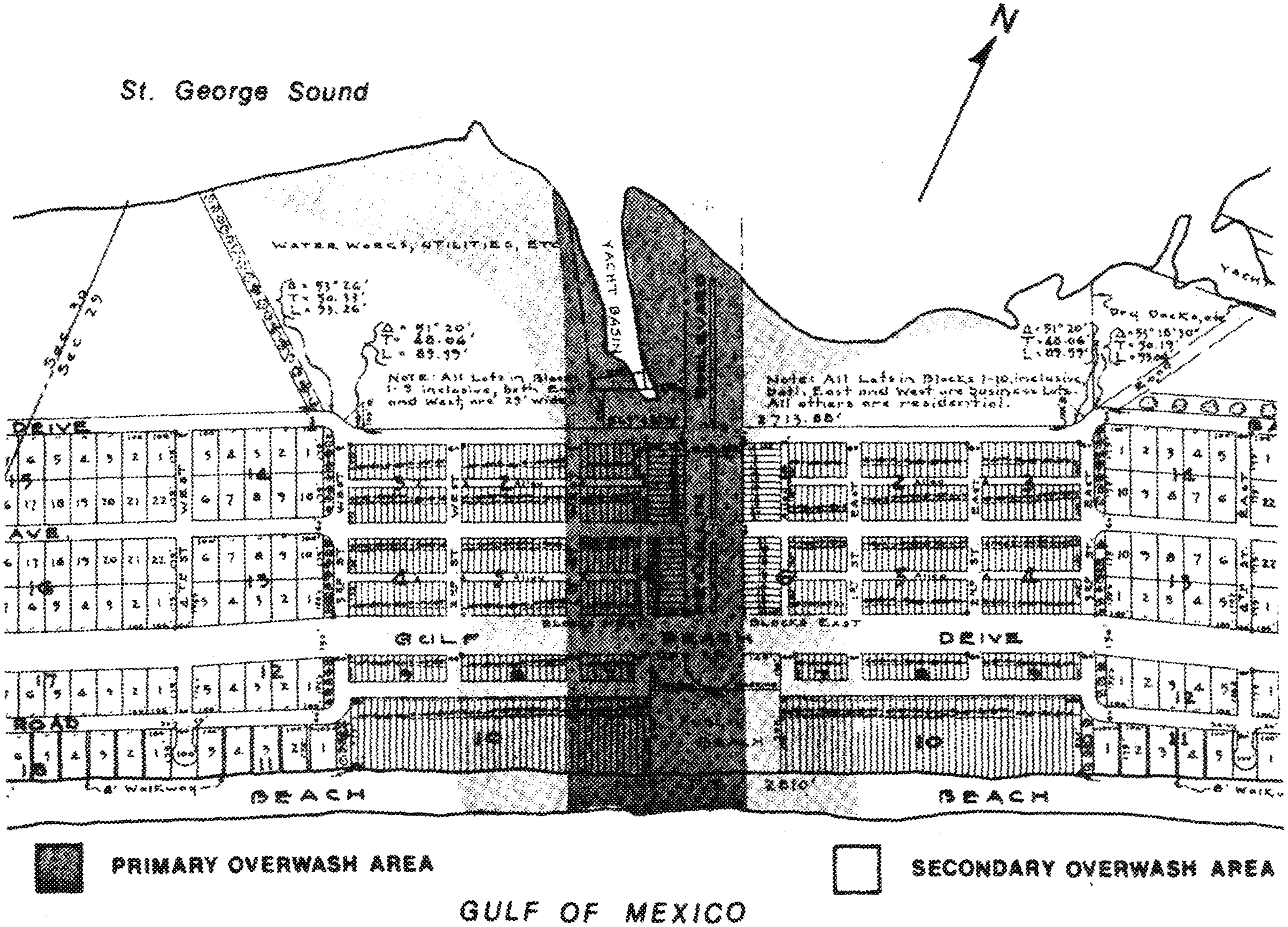

FIGURE 3

Areas Subject to Hurricane Overwash on St. Georges Island

- "Franklin County's sand dunes function as natural barriers and sand-sharing systems that mitigate the effects of coastal flooding, hurricanes, and high waves caused by severe storms.
- "There is an immediate need to protect human life and property from the dangers of severe flooding, particularly in flood and overwash areas.
- "Protection of flood hazard areas will help to avert the dangers to human life and property caused by periodic inundations, which dangers include health and safety hazards, disruption of commerce and governmental services, disruption of seafood industry, and loss of human life and property.
- "In order to fully participate in the National Flood Insurance Program, the flood-related dangers of the use of fill, and man-made alteration of sand dunes and high hazard areas must be adequately provided for in ordinances of the County.
- "Studies conducted by the National Weather Service (NWS-Hydro-20) have determined that during the 100-year flood, open-coastal flooding in Franklin County can be expected to reach 13 feet above mean sea level.
- "The present regulations and ordinances of Franklin County do not adequately address the flood-related dangers of the use of fill, and the man-made alterations of sand dunes and high hazards zones."

The ordinance defines two areas as demanding special attention in site preparation and construction: "high hazard zones" and "active dunes". High hazard zones refer to areas that may be inundated by water from tidal floods, hurricanes, or severe storms of substantial velocity. Active sand dunes are defined as dunes not stablized by trees or other woody vegetation. For both areas, the requirements for high hazard zones must be met.

Elevation requirements were keyed to the water elevations from the combined effects of storm surge and wave run-up, as determined by the Flood Insurance Rate Maps (FIRMs). Where the combined storm surge and wave heights exceed 10 feet, the lowest floor of any dwelling must be at least 11 feet above sea level. Where the combined height exceeds 12 feet, the lowest floor must be at least 13 feet above mean sea level.

All structures in the high hazard zone must be securely anchored on pilings or columns that are capable of withstanding the combined loading from the velocity of tidal flooding, hurricanes and severe storms, according to existing engineering standards.

The ordinance prohibits the alteration of any active sand dune by excavation, leveling, filling, surfacing, or other construction that would impair the ability of the sand dune to provide storm protection. Two administrative requirements are imposed by the ordinance: 1) applications for development in the high hazard area must be reviewed by the Planning Board or a subcommittee, and the Board is to recommend whether or not a building permit shall be issued; and 2) no site preparation can be undertaken without a building permit.

To implement the ordinance, the Planning Board appointed a three-member subcommittee to review proposals for development in the high hazard zone, and Conservation Foundation planners prepared a simple permit application. The procedure asked landowners to spell out the location of sand dunes relative to the location of proposed buildings, list site planning and structural features to be incorporated in building design, and provide a photograph of the site. Formal engineering certification was required to confirm that the structures could withstand the stresses of a 100-year storm. Applications were considered at monthly meetings of the "high hazard subcommittee", and the group's recommendations were presented to the full Planning Board. Before a building permit could be issued for any site alteration, the Planning Board had to render a favorable decision.

Restoration of Dune Systems

The Conservation Foundation, in preparing its final recommendations for implementing ordinances, felt that additional impetus was needed to provide maximum protection afforded by dunes. Many individual dunes and dunefields in the county had been altered by past construction and other activities, reducing natural storm and erosion protection functions and leaving the shoreline with inadequate natural defenses.

Rate of New Development Linked to Hurricane Evacuation

Given its flat topography and concentration of development in shoreline areas, Franklin County is exceedingly vulnerable to the consequences of a hurricane or major storm. Conservation Foundation planners believe that a coherent program of hazard management must link the expansion allowed under prevailing zoning with hurricane evacuation considerations. An analysis was completed which divided Franklin County into six hurricane evacuation zones, and evacuation time was computed for both current levels of buildout under prevailing zoning. A key benchmark in this computation is that the National Hurricane Evacuation Center cannot issue an evacuation order more than 12 hours before the storm reaches landfall. The total evacuation time is equal to the sum of the following: time for preparation to escape, the time needed to drive to safety, and the time in advance of hurricane landfall that the escape route floods. The causeway connecting St. George Island to the mainland is only four feet above sea level in places and advance sea level rise can flood it hours ahead of landfall. The analysis showed that under full development, eastern portions of the county could be safely evacuated in about 10 hours, but for St. George Island, 20 hours of advance notice would be needed (Clark, et al, 1980). Recognizing that some additional growth had to be accommodated, planners recommended a ceiling on growth that would make possible a maximum 16-hour evacuation time. This ceiling, which would have allowed about 1,100 new units on St. George Island, was tied to the recommendation that new growth be phased at the rate of 120 units per year. (The county was still considering the feasibility of this approach at last report.)

Apalachicola Bay is highly productive of natural resources (Livingston and Loucks, 1979). It is noteworthy that structural safeguards and protection of dune systems were enacted along with a conservation program designed to protect aquatic resources of Apalachicola Bay. The latter was accomplished by restricting shoreline development adjacent to critical estuarine resources such as oyster bars, scallop beds, and marine grass beds. The conservation program was reinforced by the designation of the bay as an estuarine sanctuary (Figure 4). It is doubtful that the high hazard controls would have been enacted without the conservation measures. They reinforced each other as parts of a total coastal management program.

Transferring the Franklin County Experience

The success of the Franklin County program is unusual in the context

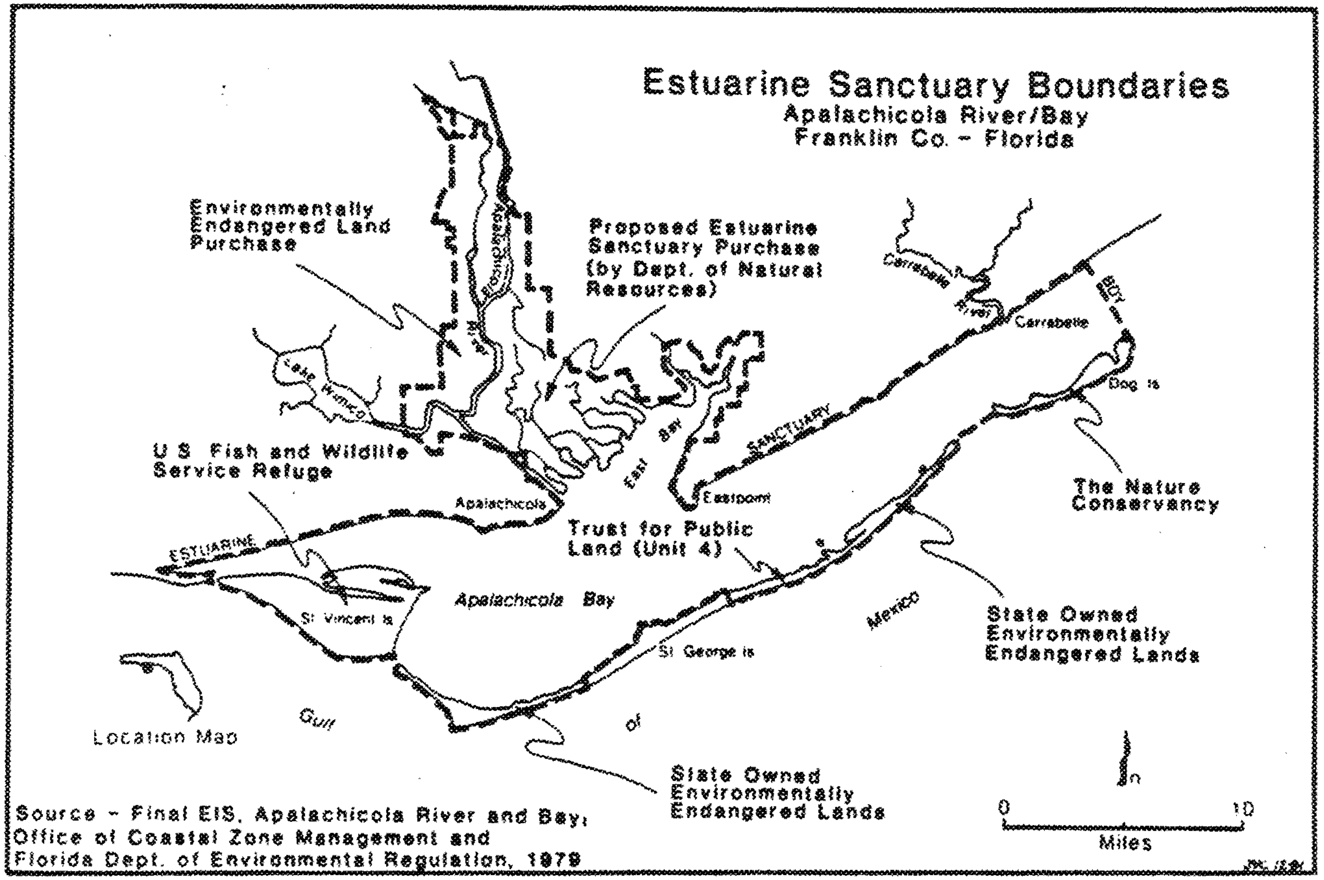

FIGURE 4

The Apalachicola National Estuarine Sanctuary, Franklin County, Florida of land-use regulation in north Florida. This is an area where regulations imposed by the state have generally been viewed as overbearing and burdensome, and where local governments are largely permissive in land use.

There are several reasons why Franklin County took an affirmative stance. First, the economy of the region is bound to the well-being of Apalachicola Bay aquatic resources, so there is a heightened awareness of the risks to fisheries posed by uncontrolled development.

Second, the area has been the willing subject of several special area designations: Aquatic Preserve in 1970, a state "critical area" in 1974, the site of extensive purchases of "environmentally endangered lands" in the late 1970s, the site of a "development of regional impact" in 1975, and the designation of the Apalachicola National Estuarine Sanctuary in 1980. These brought Franklin County to the "top of the list" of a variety of state and state-federal programs.

Third, the importance of the Apalachicola Region provokes an unusual degree of cooperation and participation by local, state, and federal governments. FEMA regional officials, along with state planners from the Community Planning and Development Agency worked closely with the Conservation Foundation in making Franklin County eligible for the Regular Program of the NFIP. For example, FEMA staff were instrumental in making interim FIRM maps available from the consulting engineers (Gee and Jensen, Inc.) in order that ordinances could be adopted immediately. The technical foundation of the flood maps was carefully explained by beach process specialists, and state and federal hazard managers to all interested parties in a workshop. Air photos of recent hurricane devastation on Dauphin Island were presented and connected with the local political implications.

Fourth, the leaders of Franklin County were in a mood to act to correct the risks of poor flood planning. Commissioners and planning board members had been struggling for ways to manage development on the barrier islands. The high hazard ordinance provided the ideal vehicle: it simultaneously offered the carrot of higher insurance coverage, and the stick of restrictions on dune alteration and filling of low areas of the barrier island.

Fifth, the proposed language was developed by beginning with federal guidelines, then adopting the language to address the concerns expressed by the County Commissioners, Planning Board and the county's attorney.

Sixth, the Conservation Foundation provided the county with a simple procedure for ordinance implementation, matched to the capabilities of the Planning Board, county staff, and permit applicants. This was especially critical because the county had neither a permit process of any kind nor a planner before the shoreline planning program got underway. A county planner position was eventually filled, first by the state of Florida, and later by the County Commissioners themselves. Applicants were able to deal with staff and Planning Board members on a one-to-one basis, so site plan details could be worked out reasonably. This strategy was in keeping with the style and philosophy of decision-making in Franklin County.

Three years after the shoreline planning program began, it appears to be working well in Franklin County. Communities wishing to build on the Apalachicola experience would benefit from the following strategies:

- Emphasize the ecological benefits of sound hazard management through sand dune protection.
- Emphasize the clear economic benefits to communities eligible for the regular flood insurance program.
- Foster strong communication between technical experts and local elected officials responsible for ordinance adoption.
- Involve state and federal officials as technical advisors and advocates of good hazard management.
- Foster strong communication between local decisionmakers, technical experts, and agency personnel.
- Design methods for implementation matched to local capabilities and styles of decisionmaking.
- Cite the problems encountered by similar communities without adequate hazard management.

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V. MAPPING

COASTAL HIGH HAZARD AREA STUDIES

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New Jersey Division of Water Resources

New Jersey has not to date undertaken independent studies to identify coastal high hazard areas, but instead is working with the Federal Emergency Management Agency (FEMA) and its engineering consultants to produce hazard zones that realistically identify high risk areas. This task is complicated by the fact that the adopted simplified method proposed by the National Academy of Sciences (NAS) for computing wave heights fails to properly consider wave runup, over-topping and transmission particularly over artificial barriers, or beach erosion that occurs at an accelerated rate during coastal storms and as a result yields the minimum wave heights possible.

These facts became apparent to the Division of Water Resources (DWR) staff while conducting the first two wave height analyses undertaken in New Jersey under contract to FEMA. Experience gained by undertaking these studies, did, however, indicate that the exercise of proper judgement could produce meaningful results and compensate for the method's deficiencies. The DWR has since done everything in its power to assist FEMA and to improve the quality of subsequent wave height analyses. This effort has entailed recovering vertical reference marks, conducting field instrument surveys, collecting existing topographic mapping and plans of wave protection structures, and carefully reviewing completed studies.

Wave height studies that initially failed to assume significant erosion produced meaningless results and have had to be revised. Zone boundaries frequently have had to be modified and the number of zones reduced in order to produce maps that can be properly interpreted by local construction officials and insurance agents. Field checking of preliminary maps often has led to the discovery of additional wave protection structures not considered by the analyses and subsequent revisions.

The major unresolved question concerning wave height analyses prepared for FEMA by its engineering consultants is whether or not the maps produced were developed with adequate vertical and horizontal control and whether or not the maps produced accurately reflect the ever-changing topography of the ocean beaches. The structural integrity of various artificial wave barriers is unquestioned under the adopted method and requires further investigation together with research to study the damage associated with the overtopping of such structures by storm waves (see Chart 1 and Figure 1).

There is unfortunately an insufficient basis for comparing the recently completed wave height analyses of New Jersey municipalities with historic storm surge and wave damage. Future storm damage will be the only way of verifying the accuracy of these studies.

WAVE HEIGHT ANALYSIS COMPUTATION SHEET

COMMUNITY NAME Brigantine City
TRANSECT NO. Typical
STILLWATER ELEVATION (S_1) 9.5 NGVD
ZONE V/ZONE A BOUNDARY At Tim. Blkhd

REFERENCE SOURCES:
MAPS:
PHOTOS:
OTHER:

COMPUTED BY: C.D. Gilman
DATE: 5-4-83
CHECKED BY:
DATE:

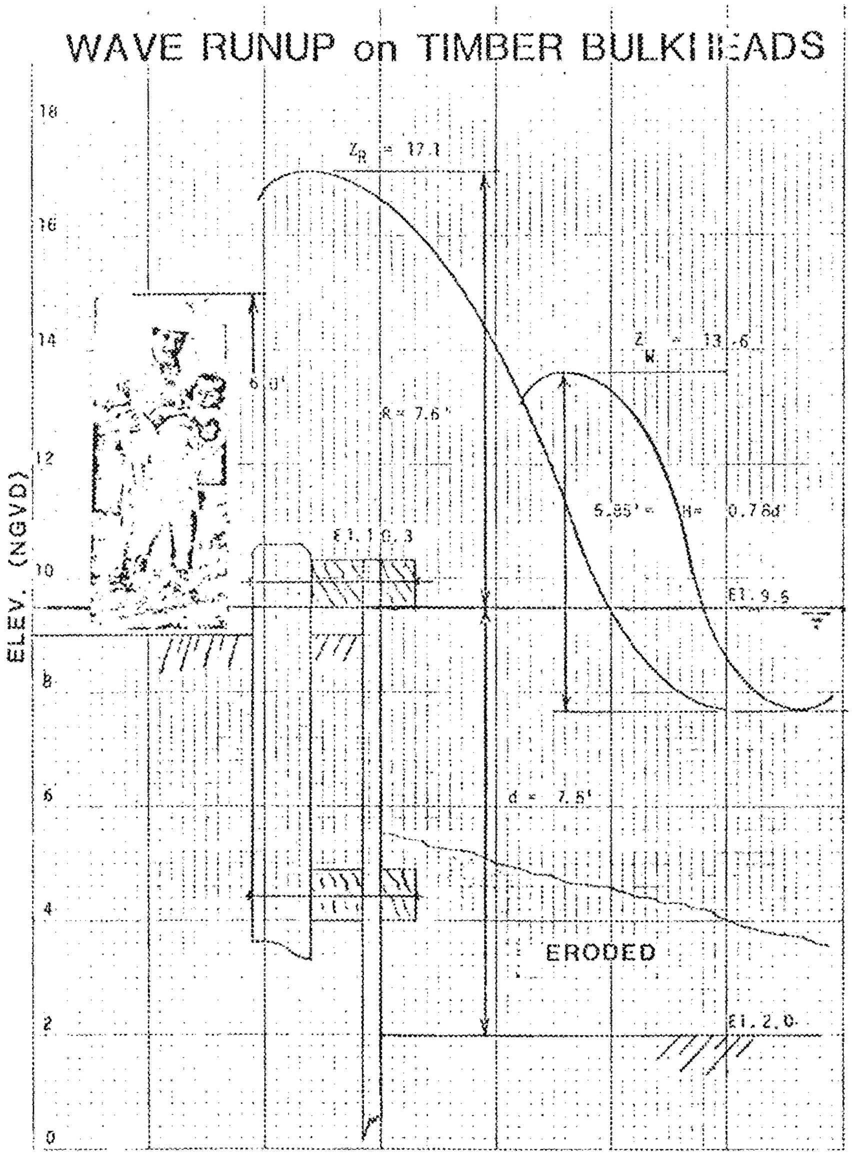
STATION (FEET)	DESCRIPTION	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	H_i	[illegible]	[illegible]	D	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	H_b, H_i, H_f	Z_w
	Existing Condition (No Erosion)																		
0	Shoreline						0	9.5										7.41	14.7
75	Beach						5.5	4.0	7.41								.042	3.12	11.7
80	Timber Bulkhead (Typical)						103	0	3.12								.024	0.76	10.0
									Min. Wave Ht. - No Additional BFE										
	Assume Erosion to Elev. 2.0																		
0	Shoreline						0	9.5										7.41	14.7
75	Beach						2.0	7.5	7.41								.079	5.85	13.6
80	Timber Bulkhead (Typical)						10.3	0	5.85								.036	2.12	11.0
									Max. Wave Ht. - BFE Increased 1 Foot										
	Compute Runup (Assume Erosion to Elev. 2.0)																		
	$R = HC_1\left(0.123\frac{L}{H}\right)^{\left(0.228\sqrt{H/d}+0.0578\right)}$								– CETA 8-7										
	Assume: T = 10 seconds, L = 155'																		
	$R = 5.85 \times 0.958\left(0.123\frac{155}{5.85}\right)^{\left(0.228\sqrt{\frac{5.85}{7.5}}+0.0578\right)}$																		
	R = 7.61'																		
	$Z_g = 9.5 + 7.6 = 17.1$ (NGVD)								Wave Runup Max. Water El.									7.61	17.1
									5.85								0.437	2.55	11.3

CHART 1

Wave Height Analysis Computation Sheet

FIGURE 1

Wave Runup on Timber Bulkheads



MAPPING MASSACHUSETTS BARRIER BEACHES

Gary R. Clayton
Massachusetts Executive Office of Environmental Affairs
Coastal Zone Management Program

Introduction

Mapping of coastal hazard areas is essential for state and federal coastal resource management agencies. Comprehensive coastal hazard inventories can play an important role in implementing public policies and regulations that deal with the impacts of development on barrier beaches, sea cliffs and tidal inlets. Unfortunately, the need for these tools seems to be increasing at the same time that financial and other resources needed to acquire them are decreasing. The coastal states are often in the best position to assess mapping priorities but may not have all the resources to accomplish them. The federal government must continue to play a significant role in mapping programs by providing technical, financial and policy support to the states. After all, the federal government through some of its programs and policies has encouraged the very growth and development in coastal hazard areas that is causing the problems that many states face today (Sheaffer and Roland, 1981). This paper will describe Massachusetts' recent experience with coastal hazards mapping and compare the Massachusetts Barrier Beach Inventory Project with certain aspects of the recent federal mapping of undeveloped coastal barriers.

In Massachusetts, public funds have been used historically to encourage the development of barrier beaches and their redevelopment after damage from major storms. The blizzard of 1978 was the most recent example of the danger posed to life and property by severe storms. As a result of that one storm, the Governor of Massachusetts signed Executive Order No. 181 in 1980 (Governor of Massachusetts, 1980). The Executive

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Order is designed to eliminate the use of state and federal funds that encourage growth and development of barrier beaches. The Order excludes those funds used for new projects such as sewer and water lines and coastal engineering structures; clarifies state wetland policy for managi[ng] the natural characteristics of these areas; gives priority status for relocation assistance to storm-damaged barrier beaches; and encourages public acquisition of barrier beaches for recreational purposes.

When the Executive Order was signed, only a limited inventory of barrier beaches existed (Kaufman, 1979); a comprehensive description of the numerous small barrier beaches in Massachusetts was unavailable. With financial assistance ($21,000) from the federal Office of Coastal Zone Management, the inventory project was completed for all of Massachusetts' barrier beaches. The process involved developing definitions, criteria, and method for this comprehensive inventory.

Massachusetts Barrier Beach Inventory Project

Definitions and Criteria

The criteria used for identifying and delineating the barriers are based on the definition of a barrier beach as contained in the preamble to Executive Order No. 181. This definition of a barrier beach is also identical to the one in the Coastal Regulations of the Wetlands Protection Act (Mass. Gen. Laws, c. 131, s. 40):

> A barrier beach is a narrow low-lying strip of land generally consisting of coastal beaches and coastal dunes extending roughly parallel to the trend of the coast. It is separated from the mainland by a narrow body of fresh, brackish or saline water or marsh system. It is a fragile barrier that protects landward areas from coastal storm damage and flooding.

The coastal beaches and coastal dunes that make up a barrier beach are further defined in the coastal wetlands regulatory definitions as follows:

> "Coastal beach" means unconsolidated sediment subject to wave, tidal and coastal storm action which forms the gently sloping shore of a body of salt water and includes tidal flats. Coastal beaches and tidal flats extend from the mean low water line landward to the duneline, coastal bank line or the seaward edge of existing man-made structures, when these structures replace one of the above lines, whichever is closest to the ocean.

"Coastal dune" means any natural hill, mound or ridge of sediment landward of a coastal beach deposited by wind action or storm overwash. Coastal dune also means sediment deposited by artificial means and serving the purpose of storm damage prevention or flood control.

From these definitions, general criteria were developed as follows:

1) Narrow low-lying strip of land--barrier beach landforms are generally low-lying and narrow in width due to their geologic origin and evolutions. The width and height of a barrier beach varies due to numero factors including sediment supply, sediment transport patterns and rates, exposure to waves and human alterations. In Massachusetts, barrier dimen sions range in width from over hundreds of feet to only tens of feet.

2) Consist of coastal beaches and coastal dunes--coastal beaches and coastal dunes are formed by coastal processes such as wave, tidal and coastal storm action. Their existence helps distinguish barrier beach landforms from other coastal landforms that make up the Massachusetts coast. Unaltered dunes may range in height from a few feet above sea level to over 50 feet. As a result of filling, construction or structura stabilization, many barrier beaches have heavily altered beach and dune areas. These areas are still important buffers that help protect land-ward areas from storm damage and flooding. Regardless of the type of alterations that have occurred, the beach or dune deposits, if not their forms, continue to exist. Consequently, developed barriers are protected by the Massachusetts Wetlands Protection Act and have been mapped as beach areas in the project.

3) Parallel to the trend of the coast--the mainland Massachusetts coast is quite irregular due to a non-uniform distribution of primary coastal deposits (glacial landforms and bedrock). Barrier beaches fill irregularities in the primary deposits, and they are generally oriented perpendicular to the direction of maximum wave fetch. Thus, barrier beaches are parallel to the trend of the coast, but, since the coast is so irregular, barrier beach orientation is likewise variable.

4) Separated from the mainland by a wetland or waterbody--by defini tion, a barrier beach is separated from the mainland by a narrow body of fresh, brackish or saline water or marsh system.

5) A barrier beach may be joined to the mainland at one or both ends--at the lateral boundaries the barrier beach "ends" where there is no longer a wetland or waterbody behind the landform and when a glacial, bedrock or fill upland is encountered. The barrier may also terminate at a water body, marsh or inlet.

6) Developed barrier beaches--neither the Executive Order nor the definition of a barrier beach imply that altered barrier beaches should be identified or designated with any special status. Neither does the Order indicate that a landform must exceed any specific size threshold to be considered a barrier beach. Whether small or large, developed or undeveloped, these coastal barriers remain subject to significant storm damage. Therefore, if a landform meets the geomorphic requirements, it is identified as a barrier beach regardless of size and degree of alterati (i.e., development).

7) Artificially created landforms--entirely artificially created landforms with some characteristics similar to a natural barrier beach exist along the Massachusetts coastline. These features, however, do not reflect the geologic evolution necessary for the landform to be classifiec as a barrier beach nor do these artificial landforms necessarily respond to storm processes in the same manner that a naturally formed barrier does.

8) Perched barrier beaches--in certain coastal areas, beach and dune deposits overlie an irregular glacial surface. If the glacial landform extends above mid-tide, the overlying beach and dune resource areas are not mapped as barrier beach. When the underlying glacial surface only extends to a mid-tide, the overlying beach and dune resource areas are not mapped as barrier beach. This criterion was selected because it could be applied to most coastal areas through the use of aerial photos and direct field observation. Also these identified "perched barriers" provide storm damage protection and flood control. Overwash fans are present on several of these perched barriers indicating that these landforms are dynamic and are potential storm hazard areas.

9) Influenced by regular tidal action--all the barrier beaches influenced by tidal action are mapped, even small barriers in coastal embayments. Depositional features in areas episodically subject to tidal action (such as in ponds occasionally opened to the sea) are not iden-

tified as barrier beaches.

10) Barrier margins--the margins of a barrier beach include the seaward (exposed) side, the landward (protected) side and lateral boundaries. The lateral margins of barrier beaches encountered in Massachuse include upland margins and water-body or wetland margins. While the wate body or wetland margin is not complicated, the upland/barrier beach margi delineation can be quite difficult to determine. There are three basic types of barrier/upland margin: coastal banks, dune-upland, and bedrock.

In Massachusetts coastal banks often consist of glacial sediments which were formed by the last major ice advance over New England. These deposits are variable in composition and texture. They may consist of glacial till, glacial outwash or glacial lake or marine deposits. The dune-upland margin occurs when coastal dunes are present on top of or seaward of an upland. The upland may consist of glacial material, bedroc or artificial fill. The dune-upland margin can form when a barrier beach builds laterally in front of an upland or when a barrier migrates landward and attaches itself to an upland. This margin also occurs when the landward marsh or water body behind a barrier has changed to upland as a result of artificial filling of a portion of the marsh/wetland area.

The lateral margin of a barrier beach can also terminate at bedrock, massive rock material formed by metamorphic, igneous or sedimentary processes.

Method

Using U.S. Geological Survey topographic quadrangle maps and Nationa Ocean Survey nautical charts as well as the barrier beach characteristics described previously, a preliminary list of barrier beaches was developed. These maps were refined using all available historical accounts, scientifi investigations and surficial geology publications, including quadrangle maps published by the U.S. Geological Survey.

The Massachusetts Department of Environmental Management's Wetland Restriction Program (Mass. Gen. Laws c., 130, s. 105) orthophoto maps wer available for all of Cape Cod, eastern Buzzards Bay, the South Shore (Cohasset to Plymouth), Martha's Vineyard, and portions of the Parker River Estuary and Plum Island Sound on the North Shore. Barrier beach areas were delineated on some of these maps by the Wetland Restriction Program. The purpose of the criteria used in these delineations, however, was the placing of deed restrictions on property; this required, in most cases, a more limited area identified as barrier beach.

Aerial overflights were made of most coastal regions to further delineate the barrier beaches identified through the map analysis. For some coastal areas, especially more rural areas of Martha's Vineyard and Nantucket, no access was available on the ground. Therefore, the aerial flights represented the primary data source. Low altitude, oblique-angle photographs were taken and analyzed to help determine barrier beach boundaries. All accessible coastal areas were visited and studied on the site to identify and delineate the barrier beaches. Photographs, black and white prints and color 35mm slides were taken to show boundaries, alterations and resource characteristics. Sediment properties (grain size, fabric and sedimentary structures) were analyzed on beaches and dune and bank faces to aid in distinguishing coastal banks (glacial deposits), artificial fill and beach and dune areas. The U.S. Geological Survey topographic quadrangle maps of the state were used to present the barrier beach delineations. A data sheet was compiled for each barrier beach management unit. On this data sheet, each barrier beach was identified by a management unit code. Geographic names, derived from names on USGS topographic maps, were also assigned to each unit. In some cases no geographic name sufficiently identified a particular barrier, so nearby street names were used for identification. Boundary determination and delineation notes were included to define the lateral margins of the barrier beach. Information of alterations including houses, buildings, roads and utilities was also included on the data sheets.

Results

The inventory of the 628 barrier beach management units for Massachusetts was completed in 1981. Some barrier beach landforms may be composed of more than one barrier beach managment unit if the landform falls within the jurisdiction of more than one municipality. (Since most land use decisions are made at the local level in Massachusetts, barrier beach management units were selected for mapping purposes to be coincident with municipal jurisdictions.)

Barrier beaches in Massachusetts form much of the coast that is exposed to the open ocean. These barriers tend to be large bay barriers or barrier spits; relatively few barrier islands are found along the coast

Most of the barriers in Massachusetts, however, are small bay barriers with coastal bank lateral margins. Many of these landforms are found in large tidal bays in the southeastern part of the state as the followin distribution of all coastal barriers indicates: North Shore, 32; Boston Harbor, 29; South Shore, 30; Cape Cod, 213; Martha's Vineyard and Nantuck 233; Buzzards Bay and Mt. Hope Bay, 120. This inventory continues to be supplemented with additional geomorphic and socioeconomic data and it provides the basis for further scientific research.

Comparison of State and Federal Mapping of Massachusetts Barrier Beaches

Recently, Congress has taken steps to modify federal policy concerni barrier beaches. These actions complement similar efforts in Massachuset but differ in certain important ways including the detail and scope of th mapping programs.

In 1981, Congress passed the Omnibus Budget Reconciliation Act of 1981 (OBRA) which included an amendment that banned the availability of federal flood insurance on undeveloped coastal barriers beginning October 1, 1983. This law required the U.S. Secretary of the Interior to designat undeveloped coastal barriers (U.S. Department of the Interior, 1982). In October 1982, legislation was enacted establishing the Coastal Barrier Resources Act (CBRA) (P. L. 97-348). This law immediately prohibited most new federal financial assistance. The Coastal Barrier Resources Act also amended and conformed the provision of the OBRA pertaining to undeveloped coastal barriers. The statutory ban on federal flood insurance goes into effect on October 1, 1983. CBRA established the Barrie Resources System by including certain undeveloped coastal barriers locate on the Atlantic and Gulf Coasts. Many of the undeveloped coastal barrier identified by the Department of the Interior for OBRA were adopted withou change by Congress.

In Massachusetts, 39 undeveloped coastal barrier complexes were adopted by Congress pursuant to CBRA. The barriers included in the syster generally conform with those identified in the Massachusetts Barrier Beach Inventory. There are, however, important differences. For example, coastal barriers within CBRA include not only the beach and dune landform but all or a portion of the water resource (marshland, estuary or bay) behind it. In Massachusetts the barrier beach landward margin is limited to the mean low tide line. Also, coastal barriers within CBRA also include a large contiguous glacial (Pleistocene) landform as part of the undeveloped coastal barrier complex while the Massachusetts criteria for barrier beaches include landforms of Holocene origin only. The use of similar but varying standards as well as different map bases and scales has resulted in two distinct mapping products which reflect the different purposes of the federal and state initiatives. The state inventory includes all barrier beaches regardless of the extent of development or alteration but utilizes a more restrictive geomorphic definition. The state's executive order applies to all state funds and federal grants which would provide new or enlarged facilities and services that contribu to increased growth and development of barrier beaches. The order does not affect federal flood insurance.

The differences between the state and federal mapping program of Massachusetts barrier beaches do not necessarily suggest that a single, comprehensive system is not possible or advisable. For example, similar inventory programs already exist for coastal floodplain and wetland areas. Rather, it indicates the need for a complete national inventory of coastal resource areas in which there is an important national interest in avoiding or reducing coastal storm damage.

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IDENTIFICATION OF COASTAL HIGH HAZARD AREAS

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Introduction

The concept of a "velocity zone" was introduced in flood insurance studies to account for damage potential from high velocity water associate with wave action. Nature, in multifarious ways, subjects coastal areas to velocity hazard: tropical storms, hurricanes, winter-time low pressure systems (northeasters), squall lines, all are capable of producing the 3-foot or greater wave height that distinguishes the V Zone from a zone of more moderate hazard. It has been determined (U.S. Army Corps of Engineers, 1975) that waves below three feet generally do not cause failure of typical wood-frame or brick veneer structures. In the context of the flood insurance program it is waves accompanying the 100-year storm surge level that are of interest.

In the execution of a wave height study the contractor undertakes two principal activities: an investigation to obtain as much pertinent data as possible (e.g., topography, cultural features, vegetative cover, shore protection measures, historical flood information) and the applicati of an acceptable method for computing the inland penetration of wave effects (e.g., FEMA-approved wave height or wave runup computer programs). Admittedly, there are aspects of this procedure where engineering judgemer must be exercised and the limitations of the method understood. This is important for it is the study contractor who communicates the results of the efforts to the community in a study report and through a final meetinc

This paper examines some of the procedural and technical issues that should be of concern to the study contractor. It also provides some background for interpreting the V-Zone phenomenon.

Wave Height Study - Preliminary Investigation

Usually, the study contractor who is responsible for originating the

100-year surge (stillwater) elevation for a coastal area is also responsible for assessing wave action effects. Part of the normal procedure is to contact officials and individuals in the community and to undertake a field investigation. Suggested contacts include the political representatives (mayor, manager, board of selectment), tax assessor (has property been added to or deleted from the tax rolls due to accretion or recession of the shoreline?), town or city engineer and/or director of public works (what engineering projects have been undertaken for shoreline defense and have they met with success?), director of parks and recreation housing inspector (what has been the history of buildings in the coastal zone?), historical society, community librarian, newspaper editor and other individuals who can give an historical perspective to local flooding problems. This type of contact is beneficial for two reasons: it supplements information from other sources (e.g., Corps of Engineers, state agencies) and it familiarizes the community with the nature and method of the study (thereby dispelling misconceptions), allows the local people to provide input, and, in general, promotes confidence that the study is being conducted properly. A field investigation is also mandatory. Topographic maps, aerial photographs, flood reports, and community master plans cannot always convey the level of detail required for an engineering study, especially in a relatively narrow coastal zone. A ground-level investigation can uncover:

- vegetative characteristics not discernible form aerial photography,
- the structural integrity of shoreline protective devices (seawalls, breakwaters, groins, bulkheads, levees, revetments),
- the crest and toe elevations of structures such as seawalls; these elevations limit the maximum wave height that can pass over the structure,
- dune characteristics that would affect the dunes' ability to withstand storm surge and waves, e.g., longshore continuity and uniformity of height, width of the dune system normal to the shore, sediment type and consolidation, vegetation cover, or location with respect to mean high tide, and
- encroachment of buildings on the beach.

In some cases a wave height study will be undertaken years after the orginal 100-year stillwater flood level has been established. Sometimes the study contractor who performs the wave height work is not the contractor who generated the 100-year stillwater levels. In these and like circumstances it is equally important that the steps outlined above be part of the study procedures. Inattention to this level of detail could render the study less accurate, less defensible and more prone to appeal by the community.

Other considerations in the conduct of a study are:

- In a dynamic coastal area where the shape of the shoreline is changing rapidly, the study contractor must "freeze" the shoreline profile and perform the analysis with that profile (note: this comment does not apply to the normal seasonal fluctuations in the beach profile but to the more irreversible trends and alterations in the landform of the coastline that can occur; ideally, for example, one would use the "winter" beach cross section to model a northeaster storm and a "summer" beach profile to model a hurricane). The flood insurance program allows for periodic restudy of an area if there is a significant change in its physical features. However, the ability to monitor the effect of shoreline changes is often limited by the quality and precision of the topographic data available and by the frequency with which surveys are done. An additional element that will affect the shoreline equilibrium over the long term is the rise in sea level evident during this century (as much as one foot per century with the possiblity of an accelerated rate of rise due to the "greenhouse" effect).
- The study contractor should not restrict himself to the main study area in the initial data-gathering effort. Historical accounts of storm damage, and dune erosion at other locations can be relevant to the area under consideration. The laws of physics that dictate the interaction between storms and coastlines are invariant; it is only site-specific conditions that are variable. For instance, a hurricane, at any one time, can influence a segment of the coastline that is several hundred miles long; however, the peak destructive force is concentrated within a relatively narrow band 15-40 miles from the eye of the storm. Therefore, although one community may not have experienced, within memory, conditions characteristic of the 100-year storm, another coastal community 50 miles away may not have been so fortunate.
- It is incumbent upon the study contractor to ensure that the study is coordinated with prior or concurrent studies in contiguous areas. Thus, the study contractor must be aware of the basis for the study results in adjacent areas so that any potential discrepancies can be resolved.

With this type of foundation for the study the final presentation of results to the community should proceed smoothly. However, given the potential impacts on flood insurance rates and new construction in the coastal zone, it is possible that some segments of the community might not be receptive to the study. There are several points that the study contractor can emphasize:

- The FEMA study is not a typical engineering study where a safety factor is built into the design. Each component of the study is approached from the standpoint of "what is reasonable, expected or representative on the average;" a "worst-case" scenario is not adopted.
- The study portrays the minimum hazard associated with the 100-year event; other phenomena, not explicitly accounted for, may increase the risk. The community has the option of adopting even more stringent flood management regulations and is encouraged to do so.
- There is a 1% chance in any given year of having the 100-year flood level equalled or exceeded; in a 30-year period (average length of a mortgage), there is a 26% chance of such an event. In any year a storm greater than the 100-year storm could occur (Hurricane Carla in Texas, 1961; Hurricane Camille in Mississippi, 1969; Hurricane Frederic in Alabama, 1979; Hurricane Hazel in South and North Carolina, 1954).
- The fact that a severe hurricane has recently occurred in an area does not preclude an immediate recurrence. Evidence suggests that there is a somewhat cyclical shift of "high exposure" areas. That is, one location may be subject to a grouping of severe storms and then enjoy a quiescent period. For the same reason an area which has not recently experienced an extreme storm event is not guaranteed immunity; it may have had several "near-misses" with the brunt of the storms being felt a relatively short distance away.
- The community always has the opportunity to appeal the results on the basis of scientific inaccuracy. The elevations can be challenged based on better data or more appropriate method.

Wave Height Study - Technical Procedures

The methods by which wave heights are added to the stillwater elevation are described in various FEMA publications (FEMA, 1981a, 1981b, 1981c). The study contractor must ascertain which method is applicable in the particular study area. On a relatively steep, non-erodible shoreline exposed to long-period storm waves, wave runup can be significant; on an erodible shoreline runup can also be important initially, but as the beach deforms and flattens to defend itself, runup is minimized. On a mildly sloping shoreline wave runup is minimal and wave height is limited by the local water depth (as the stillwater depth approaches zero so does the wave height). For both cases when the shore is erodible, some consideration must be given to dune erosion and shoreline recession. A certain amount of subjectivity enters at this point, although recently some more quantitative approaches (Tayfun et al., 1979) to the problem have been introduced.

As alluded to above, calculation of wave crest elevations for waves passing over a stable ground profile may not, of itself, accurately protray the local hazard. Unstable ground is one additional factor in the delineation of the V Zone. Examples of hazards created by the mobility of beach material are scour at the base of a seawall, which allows a higher wave to attack the seawall; the deposition of sand underneath an elevated house, which prevents waves from passing harmlessly below the structure, thereby focusing wave energy on the house; atop an escarpment or dune field, erosion at the toe of these promontories undermines the foundation of the house; and the excavation of material from the front side of a dune can collapse the dune and flatten the beach profile with subsequent greater inland incursion by storm waves.

The tools available to the study contractor to account for these effects include:

. An examination of historical records of beach response to severe storm conditions, generalizing the resultant empirical relationship between beach change and storm intensity so that it can be applied to the coastal location of interest.

. Reliance on local accounts of dune and beach erosion on both short and long-term time scales. Long-term trends (such as described in the Corps of Engineers' National Shoreline Study (1973)) would identify areas that are becoming more (less) resistant to the erosive force of storms. Short-term changes would indicate extreme response to severe individual storms. For example, if the dunes were eliminated during one storm and subsequently reconstructed, it can be presumed that they are equally vulnerable to a similar event in the future.

. Implementation of a specific, quantitative procedure such as employed in North Carolina (Tayfun et al., 1979), to predict the reduction of the dunes.

Allied somewhat with the erosion issue are the effects of the mean currents associated with the storm surge itself. These velocity waters are not explicitly addressed in the V-Zone formulation. Although the magnitude of these currents would not generally equal that in a breaking wave, it is not inconsequential. The surge wave that propagates toward shore and inland through the estuarine system is similar to the astronomical tide wave. It can be expected that where the normal tidal currents are intensified the surge currents will, likewise, be strong. Formerly dry areas now inundated by surge waters will be subject to a re-working of whatever erodible material is present. Over the duration of a storm such currents could cause serious scour problems.

A second phenomenon associated with the surge currents is the trapping of water behind the first line of coastal barriers, the subsequent release of which generates strong currents. A longshore string of barrier islands backed by a narrow bay or lagoon and characterized by narrow and/ or shallow inlets is a case in point. Storm water is pumped into the backside lagoon through the inlets and driven by the wind across the lagoon to be "set up" on the mainland side. A reversal, or simply a cessation, of the onshore winds allows for a relaxation of the hydraulic head that exists across the lagoon. Constricted flow back through the inlets favors the generation of high velocity water directed toward the leeside of the barrier islands. It is possible that low-lying sections of the island could be breached.

In implementing the wave height method the study contractor must make engineering judgements.

- Wave height is computed along transects oriented roughly perpendicular to the coastline. Buildings and vegetation will dampen the incoming wave whereas open, unobstructed areas will promote regeneration of the wave by the wind. In each case the rate at which the wave decays or grows depends on the length of the transect used in the computation. That is, the more the transect is subdivided the more accurate the resultant wave crest profile.
- It must be judged whether buildings subject to direct wave action will survive or be destroyed and their debris become battering rams against other structures.
- The stability of the dune system must be evaluated.

The additive nature of the wave crest calculations (the wave height is a direct function of the local water depth and the wave crest elevation is the sum of the stillwater surge elevation and that portion of the wave above the stillwater level) is premised upon the stillwater elevation and the waves associated with it having a common origin--the same wind conditions. On the open coast it can be assumed that the winds which produce the local 100-year surge level are the same winds which would create maximum local waves. Interior water bodies that experience the storm surge may be wholly or partially protected from wave action. The fundamental question to be answered on a case-by-case basis is: do the winds responsible for the local 100-year surge level favor the concurrent development of local maximum waves? The complexity of the timing and dynamic interaction among wind, surge and waves precludes a definitive answer. However, there are ways to arrive at a reasonable solution. Among the factors suggested by FEMA for consideration are:

- Historical data and accounts of past storms (note: availability of detailed wind and/or wave data is suspect).
- Data developed from the storm surge computer simulations performed to determine the 100-year stillwater level. Data on the wind-field, the residence time of the surge peak, and the capacity of inlets to convey flow could help to identify areas prone to peak surge and waves. (Note that the availability of wind data is uncertain and detailed surge data are not always available).

In the absence of, or complementary to, this type of data a more general approach for practical application has been suggested and used by the author. The approach recognizes the following mechanisms:

- There is a range (sector) of wind directions which has the potential to produce the local 100-year surge.
- Corresponding to each wind direction there is a sector (an angular spread about the direction of the wind) within which significant wave generation will occur.
- Refraction will alter the wave height as the wave approaches the shoreline.

Reasonable, fixed limits are assigned to each of these variables. The person performing the wave height calculation only needs to know the local orientation of the shoreline in order to determine if an area is subject to coincident peak surge and wave activity. The methods cited above are suggestive but certainly not exclusive.

A related issue also confronts the study contractor: what is the probable inland extent of the V Zone for areas that are affected by coastal surge but lie some distance inland from the ocean or bay shoreline where the surge waters originate? For example, in broad estuarine regions appreciable surge levels can exist more than 25 miles inland from the open coast, providing sufficient water depth for wave propagation and generation. Will the maximum local wave occur approximately at the same time as the peak of the 100-year surge? Some insight can be gained from historical accounts and storm surge computer simulations. Additional considerations would include the reduction of winds inland from the coast, the openness of the flood plain, and the timing of the surge wave as it propagates through the estuary.

With respect to the first factor, both historical records and independent computations demonstrate that high winds can prevail many miles inland from the coastline. In regard to the second, in low-lying estuarine areas the storm surge can create a rather broad flood plain with little impediment to incoming waves. It is only farther upstream, where the flood plain begins to narrow, vegetation encroaches and/or the river resumes its meandering pattern, that wave action will be restricted. The timing of the surge refers to the speed with which the surge peak propagates inland (upstream) in relation to the movement of the storm. For a storm with an onshore component of wind velocity, the peak surge on the open coast will probably occur some short time prior to the landfall of the storm. It appears that the likely overlap in the speed of the surge wave and the forward speed of the storm system would favor the generation of wind waves concurrent with the arrival of the surge peak at inland locations. Therefore, in many circumstances there is physical justification for displaying V Zones at points several miles inland from the open coast.

Over the past several years FEMA has recognized the velocity hazard in flood-prone areas and has supplied its contractors with some of the tools needed to delineate the hazard. The goal has been to apply a wave height method uniformly to all affected coastal areas in the United States; however, the program is flexible in that unique regional problems can also be accommodated, either through technical submittals by third parties or through the formal appeal process. As with any branch of science or engineering there is a continous evolution in the understanding of the physical phenomena and how to represent them. In this regard FEMA's responsibilities should be to apprise study contractors of any ambiguities or pitfalls in the current method to clarify, where possible, the application of the method, so as to lighten the burden of "engineering judgment", and to acknowledge advances in the science and incorporate these at appropriate times.

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THE IMPLICATION OF A RISING SEA TO POSTDISASTER PLANNING

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Introduction

The development of coastal areas has always involved the risk of erosion and storm damage. Nevertheless, millions of people have decided that the benefits from this development exceed the costs associated with these risks, and there has been no reason to expect these risks to become worse in the future. Therefore, when a storm has devastated an area, development after the disaster has rarely departed dramatically from its previous pattern except where the land is actually lost. At most, the rebuilt structures have been modernized to conform with changing construction practices or other conventions.

Recently, however, independent sources have suggested that erosion and storm damage may increase in the future. In many areas, erosion is already removing the natural protection from storms that beaches once provided. Some coastal geologists have suggested that the one-foot rise in sea level in the last century along most U.S. beaches could be responsible.* Furthermore, the Environmental Protection Agency and others have estimated that an expected global warming, resulting from emissions of carbon dioxide and other gases, could cause the sea to rise as much as two feet by 2025, and eight feet by 2075.**

The views expressed herein are solely those of the authors and do not constitute the official policy of the U.S. Environmental Protection Agency.

*Pilkey et al., 1982. Estimates of a worldwide sea-level rise for the last century range from 4 to 6 inches. However, tidal gauge measurements along most of the U.S. coastal areas show rises of approximately one foot.

**Environmental Protection Agency and ICF, Inc., 1983. These scenarios were generated using high and low estimates for each of the major factors that determine sea-level rise in the next century: energy consumption, the fraction of CO_2 emissions remaining in the atmosphere, the sensitivity of the climate to CO_2 concentrations, heat transport into the oceans, and the behavior of glaciers. However, all scenarios assumed zero population growth by 2075.

An acceleration of sea-level rise could have important implications for all coastal communities. Higher wave heights and water levels during floods could greatly increase storm damage. Thousands of square miles of land and their accompanying structures could be lost. Efforts to protect property from erosion and storms could result in the disappearance of natural beaches along much of the coast. Fortunately, many of these adverse effects could be prevented if timely action is taken in anticipation of them.

At a recent conference on sea-level rise, it was estimated that undeveloped areas around Charleston, South Carolina and Galveston, Texas could avoid hundreds of millions of dollars in damages over the next century by taking account of sea-level rise as they develop (Gibbs, 1983). New structures can be located outside areas that will be subsequently inundated by a rising sea, and can be elevated above future flood levels. For older communities it is too late to exercise many of the options available to new communities. However, after a major storm has destroyed existing structures, coastal communities can reassess the proper location for development.

This paper illustrates some benefits of anticipating sea-level rise in the aftermath of a hypothetical storm in 1990 for two coastal communities, Sullivan's Island, South Carolina, and San Leon, Texas. It is estimated that up to one-fourth of the houses of Sullivan's Island might not be rebuilt after a storm if postdisaster planning incorporated sea-level rise. However, sea-level rise would not be important to San Leon's postdisaster planning.

On the basis of analyses presented here and elsewhere, it is recommended that postdisaster plans incorporate a mechanism for informing the public about the possible impacts of sea-level rise.

Decisions that Could Be Influenced by Sea-Level Rise

The prospect of sea-level rise could influence the outcome of two types of postdisaster decisions: how to build, and where to build. Increased risk from erosion and storms could encourage people to build cheaper structures at higher elevations, and possibly avoid siting houses in the areas of greatest hazard.

Even where structures would not be lost to a rising sea soon enough to make their construction uneconomic, erosion could consume nearby beaches. Communities that desired the continued availability of a beach could resort to either beach nourishment (sand pumping), or purchasing acreage inland of the existing beach. Although the former option can be taken at any time, the most opportune time to purchase land would be after a major storm had destroyed the buildings resting on top of that land.

The analysis here focuses primarily on a property owner's decision whether to rebuild or sell out. The implications of sea-level rise to building elevation requirements were not as important for these case study sites because the most vulnerable houses would be lost to erosion. Finally, data limitations precluded assessing the communities' interests in maintaining a beach, and the options of building smaller houses or seawalls.

Methods

Figure 1 is a schematic of the case studies. Using damage functions developed by the University of Colorado (Friedman, 1975), and storm surge estimates by Leatherman et al. (1983) and Research Planning Institute (1983), calculations were done of the damage that would result if a 100-year storm occurred in 1990. The level of damage is assumed to never exceed the value of the structure itself. Therefore, because the "rental" value of services from using the property justified building the original structure, it was assumed that it would always justify rebuilding it.

If sea-level rise were expected to increase the risk from storms and erosion, however, then the rental value of the property might no longer justify both reconstruction and the risk from erosion and storm damage. Therefore, anticipation of sea-level rise might cause some property owners to decide not to rebuild. Using EPA's low and high sea-level rise scenarios (Environmental Protection Agency and ICF, Inc., 1983) (Figure 2), estimates of erosion and storm surge from Leatherman and RPI, and damage estimates from Gibbs (1983), this decision rule was applied to determine which structures would not be rebuilt if sea-level rise were anticipated. The analysis assumed that property owners purchase non-subsidized insurance and are not insured against erosion.

Because of data limitations, it was assumed that structures would

FIGURE 1

Postdisaster Decision Whether to Rebuild

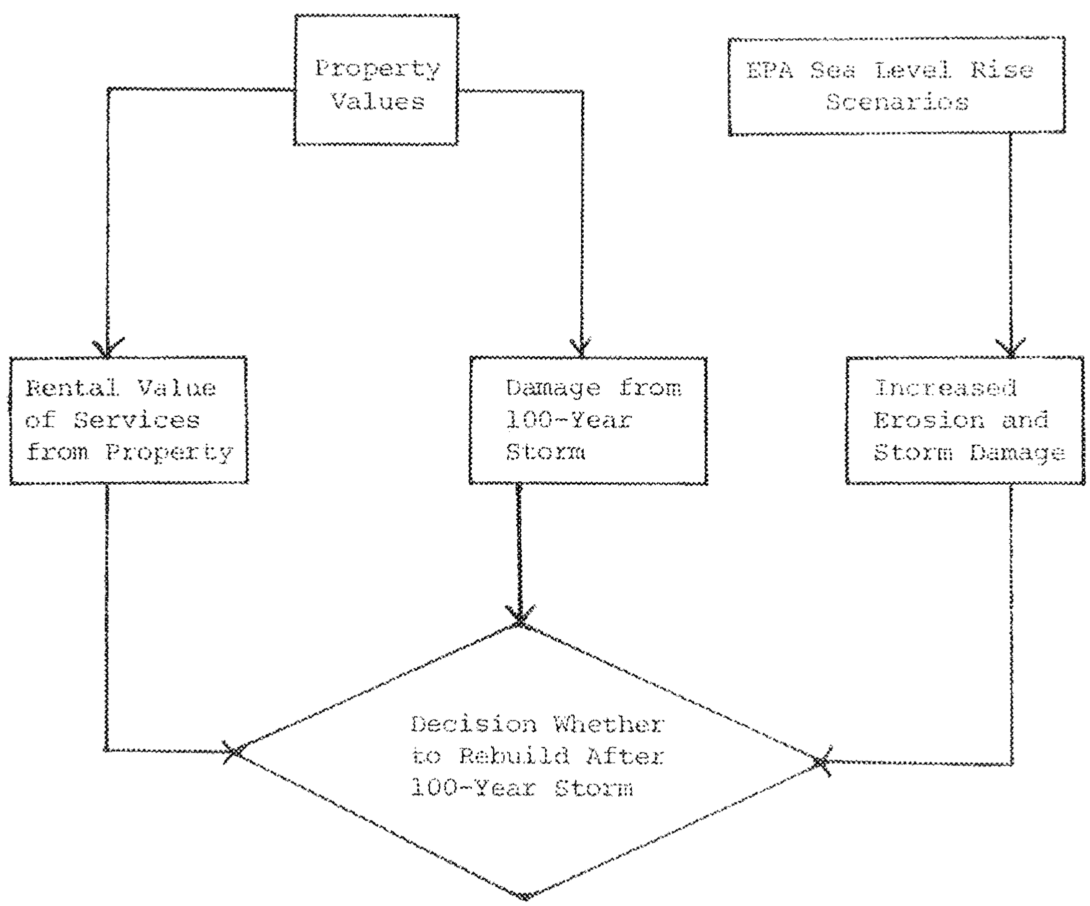
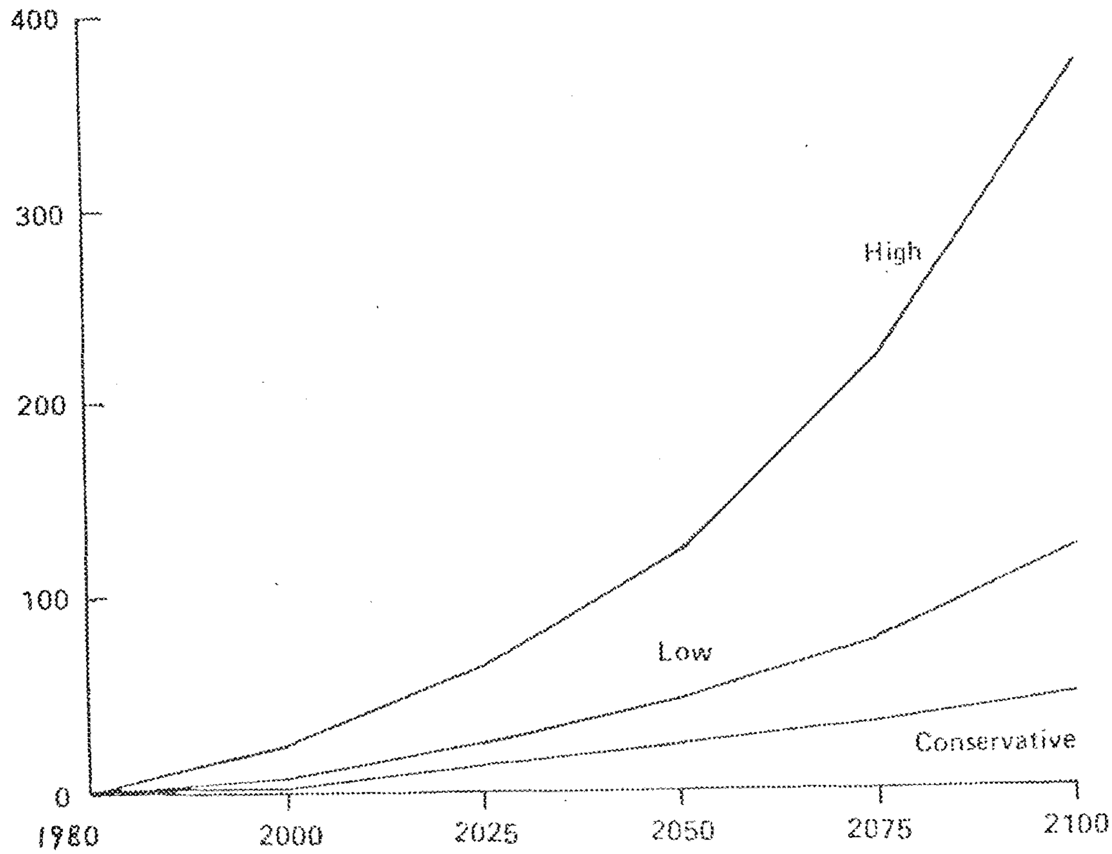


FIGURE 2

Conservative, Low and High Sea-Level Rise Scenarios

centimeters



either be rebuilt in their original form or not at all. This assumption may understate the impact of anticipating sea-level rise by ignoring superior options that might be implemented. For example, if erosion were expected to destroy a house fifteen years later, then building a temporary structure might be preferable to both rebuilding the original structure and not rebuilding at all.

Sullivan's Island Results

Sullivan's Island is a residential resort community on a barrier island north of Charleston, South Carolina. In 1980, the island contained 570 single-family homes valued at $48 million. A 100-year storm in 1990 would cause $27 million in damages. Particularly vulnerable would be the 275 houses worth $19 million that lie less than four feet above mean spring high water. A 100-year storm would destroy over two-thirds of the value of these structures.

If the sea level rises, the most vulnerable houses would be the same houses that would be vulnerable to a 100-year storm. Under the high sea-level rise scenario 80 houses would be lost to erosion by 2020, and several hundred by 2075. Applying the decision rule discussed above, we found that 166 should choose to abandon the property rather than rebuild. Furthermore, many of the properties that we calculated as economical to repair were not completely destroyed by our simulated 100-year storm. If a storm completely destroyed these houses, then as many as 110 additional should not be rebuilt. Failure to anticipate sea-level rise could lead to these houses being rebuilt, only to subsequently succumb to erosion.

San Leon Results

San Leon is a residential community south of Houston, Texas. In 1980, the community contained 1300 single-family homes valued at $42 million. A 100-year storm in 1990 would cause $11 million in damages. For the low and high sea-level rise scenarios, 28 to 50 houses would be lost to erosion by 2025.

However, anticipating sea-level rise would not be important to post-disaster planning in San Leon. The major reason is that the houses that would be destroyed by a 100-year storm are not the houses that would be lost to erosion from sea-level rise.

Conclusion

This analysis suggests that anticipation of sea-level rise could induce property owners to choose abandonment over reconstruction in the wake of a storm if these choices were the only ones available. Certainly there are almost always other alternatives. However, the existence of other possibilities, such as sale of one's land, and altering the design of the house, further emphasizes the potential importance of sea-level rise

The analysis assumed that flood insurance does not insulate property owners from the consequences of their decisions. Because erosion was a major risk, and the houses were worth several times the ceiling for subsidized flood insurance, this was a reasonable assumption. However, in other areas, subsidized flood insurance would insulate property owners from the major risks of a rising sea. In these instances, a locality that attempted to plan for sea-level rise could face intense opposition from people whose subsidies would be threatened. Fortunately, market mechanisms such as lump-sum payments and transferable subsidy rights could remove the incentive to resist responsible development, without threatening existing financial commitments.

The political climate is rarely receptive to policies that impose costs now to protect against unknown risks in the future. But that climate will never be more favorable than when people are in the midst of recovering from a disaster that could have been avoided. The current imprecision of sea-level rise projections also makes adoption of anticipatory policies difficult. However, projections will be improved over the next decade. Therefore, for many communities accurate sea-level rise projections may be available by the time the next disaster takes place. To ensure that these communities take advantage of this information, the creation of a mechanism for informing the public of the potential impacts of sea-level rise is essential.

Development of these mechanisms should not await the resolution of all elements of scientific uncertainty. There is virtually no reason to doubt that the sea will rise at least two feet by 2100. Furthermore, the time necessary for institutions to develop a capability of addressing sea-level rise is probably as long as the time necessary to refine sea-level rise projections. Finally, by starting to assess possible responses to sea-level rise, localities can help ensure that the scientific community recognizes the need for better projections.

Therefore, to ensure that communities are prepared to respond to better sea-level rise projections, and to hasten the day when accurate projections are available, it is recommended that postdisaster plans incorporate a mechanism for informing the public about the possible impacts of sea-level rise.

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VI. SPECIAL PERSPECTIVES

ARCHITECTS' ROLE IN REDUCING FLOOD DAMAGE

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Flood Damage Mitigation

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Introduction

Rivers and seacoasts have always been focal points for development. Access to water has provided drinking supplies and sanitation, an important source of energy and a valuable part of the transportation system. Recreational opportunities and aesthetic enjoyment further stimulate waterside development.

This development pattern, however, leads to a conflict between the natural and built environments. The need for direct access to water place human settlements in low-lying areas subject to periodic inundation by rivers and the sea. In the United States, more than six million dwellings and a large number of nonresidential buildings are currently located in the nation's 160 million acres of floodplains. Flooding of these floodplains is responsible for more damage to the built environment than any other type of natural disaster. The following figures indicate the seriousness of the problem:

- In the six-year period between 1973 and 1979, 193 major natural disasters and 77 Presidentially declared emergencies occurred; approximately 80% involved flooding.
- The total flood damage in 1978 has been estimated at \$3.8 billion.
- The estimated average property loss in the 1970s was over \$1.7 billion a year.
- In 1978, 17 states suffered flood damage serious enough to be declared as disaster areas.
- In 1979, Hurricane Frederic alone caused \$1.8 billion in damages, much of it from flooding.

Floods are part of the natural hydrologic process. Riverine flooding is associated with a river's watershed, the natural drainage basin that conveys water runoff from rain and melting snow. Water that is not absorbed by soil or vegetation seeks surface drainage lines, following local topography and creating rivers and other streams. Flooding results when flow of runoff is greater than the carrying capacity of watershed streams.

Flooding usually involves a slow build-up of water and a gradual inundation of surrounding land. However, flash flooding, a quick and intens overflow with high water velocities, can result from a combination of stee slopes, a short drainage basin and a high proportion of surfaces impervio to water and unable to absorb runoff.

Coastal flooding is generally due to severe ocean-based storm systems Hurricanes and tropical storms are the principal causes, with flooding occurring when storm tides are higher than the normal high tide. This is known as a storm surge. The maximum intensity of a storm surge accompanies high tide, so storms that persist through several tides are the most severe.

Coastal flooding is most frequent on the Atlantic and Gulf Coasts, which are made up of a succession of barrier islands, beaches, dunesand bluffs. These physiographic elements are maintained in dynamic balance as sand is moved by wind, waves and ocean currents. This self-replenishing beach dune system takes the brunt of the force of storm tides and surges and helps buffer inland areas.

In coastal areas the removal of beach sand and the leveling of dunes, along with the construction of seawalls, jetties and piers, are common practices. Yet these help destroy the shoreline's natural protection system, exacerbating the impact of storm surges and high winds.

In addition to the direct threat to buildings, development in riverin floodplains alters natural topography, modifying drainage patterns and usually increasing storm water runoff. Development also displaces much of the natural vegetation that formerly absorbed water and decreases the permeability of the soil by covering it with buildings or with nonporous surfaces for roads, sidewalks and parking. The effect of these changes is to increase the severity of flooding throughout the riverine environmen

Architects' Role

There have long been attempts to moderate the impact of flooding, with major federal efforts in the United States since 1936. Until recently, these efforts have been concentrated on flood control measures devised to reduce or eliminate flooding itself--chiefly, dams, levees and similar structural works. Despite a number of positive results, these measures have not succeeded in reducing flood damage.

Since the mid-1960s, therefore, flood damage reduction policies have reflected a recognition that structural works need to be complemented by nonstructural measures. Rather than trying solely to prevent floods, current programs address the need to reduce the losses incurred when inevitable flooding does happen.

Ideally, flood damage would be reduced to a minimum if new buildings were prohibited throughout floodplains and existing buildings there were moved or razed. This is clearly impractical. A more realistic approach is the policy adopted by the American Institute of Architects:

> WHEREAS, floodplains adjoining inland rivers and coastal waters have been preferred locations for human settlements throughout history;
>
> WHEREAS, current land use practices and increased urbanization have significantly increased human intervention within floodplain boundaries;
>
> WHEREAS, construction in floodplains carries the risk of severe damage to such construction and its occupants and affects water quality, drainage patterns and balances between human and material systems;
>
> WHEREAS, architects could be held liable for damages if they ignore floodplain information that is readily available, therefore, be it
>
> RESOLVED, that architects should become involved in their local communities in order to develop wise floodplain management, regulations, and practices.
>
> FURTHERMORE, The American Institute of Architects calls upon its members to exert leadership by alerting their clients to federal flood hazard boundary maps and data as to the human and material hazards and the potential environmental impacts of building in floodplains, and by assisting clients in seeking alternative locations for building projects. However, when construction in floodplains is undertaken architects shall incorporate mitigating measures into both site development and building designs.

The AIA policy statement points to three major areas in which the architect can have a major impact on flood damage potential: policies and programs, community planning and development, and building design.

Policies and programs include building codes and regulations, zoning ordinances, and state and federal programs established to regulate and encourage effective floodplain management. Of the federal programs, the most important is the National Flood Insurance Program (NFIP), which is administered by the Federal Emergency Management Agency (FEMA). The NFIP is the federal government's principal administrative mechanism for reducing flood damage, providing an incentive to local governments to implement sound floodplain management controls. Using the limited availability of flood insurance as leverage, the NFIP has established requirements and guidelines for development in flood-prone areas. The rate structure of NFIP insurance premiums reinforces the intent of these regulations by charging higher insurance rates for buildings subject to greater risk. Insurance rates are set on the basis of designated hazard zones and the elevation of the building or structure in relation to the base flood elevation (BFE) in that particular zone. The effect of this differential rate structure is to provide an incentive to increase the safety of buildings beyond the minimum standards by giving significant financial benefits to owners of buildings at higher elevations and in less hazardous zones. Insurance rates are an important element in the analysis of life-cycle costs and can be the designer's best argument for proper siting and design of a proposed project. The dual benefits of reduced insurance costs and reduced damage potential will generally balance any increase in design and construction costs necessary when building in flood hazard areas.

Note that the NFIP standards are minimums, and that many state and local governments have adopted regulations that are considerably stronger. It is thus vital that architects familiarize themselves with all relevant local, state, and federal requirements before approaching any design. This information is generally available from local building officials, insurance agents and FEMA regional offices.

Community planning and development is a second aspect of the architect's role in reducing flood damage. Designers should play an active part in encouraging their communities to conform fully to NFIP guidelines and otherwise reduce flood damage potential by developing early flood warning systems, acquiring vulnerable land and dedicating it to open-space uses, and relocating vulnerable buildings and functions to safer sites. Architects can in this way both contribute to the welfare of their communities as a whole and reduce the likelihood of flood damage on their clients' flood-prone sites.

Building design, which is usually the role in which architects can have the greatest impact on flood damage reduction, is discussed in the following section. The architect with a firm grasp of flood-related policies, programs, and design techniques is better prepared to generate appropriate design responses for each specific project and site. Increased knowledge allows the architect to accept the creative challenge of designing to meet programmatic and aesthetic standards while simultaneously reducing flood losses throughout the natural and built environment. The architect is thus able to meet professional responsibilities while benefiting both the client and the community.

Design for Flood Damage Reduction

In many communities development has been prohibited or minimized in the most hazardous areas and carefully monitored to avoid undesirable effects in others. Architects, in carrying out their role in the development process, should parallel these efforts, consciously including damage-reduction strategies in the design process. Such action requires that the architect be aware of both site-specific flooding characteristics and appropriate techniques for mitigating flood damage through project design (see Figure 1).

Site Design

As with any aspect of a design problem, the starting point in analyzing the potential flood impact on a project is the collection and analysis of pertinent data. Data on a proposed site encompass a number of elements, the most basic being flood hazard boundaries, depths and velocities. The architect must be concerned with the effects of the water pressure associated with flooding, which can cause lateral displacement, overturning, uplift or flotation of buildings, as well as increasing erosion and sedimentation on the site. Other pertinent factors are duration and frequency of flooding and local climate and weather patterns. These influence the saturation of soils and building materials, the amount of seepage and the length of time that facilities might be inaccessible or inoperable, which can have a major economic impact.

A number of specific physiographic site characteristics also affect flooding and the choice of strategies for flood damage reduction. The location of stream channels, drainage courses, wetlands and slopes, for example, should be identified to indicate which areas of the site should

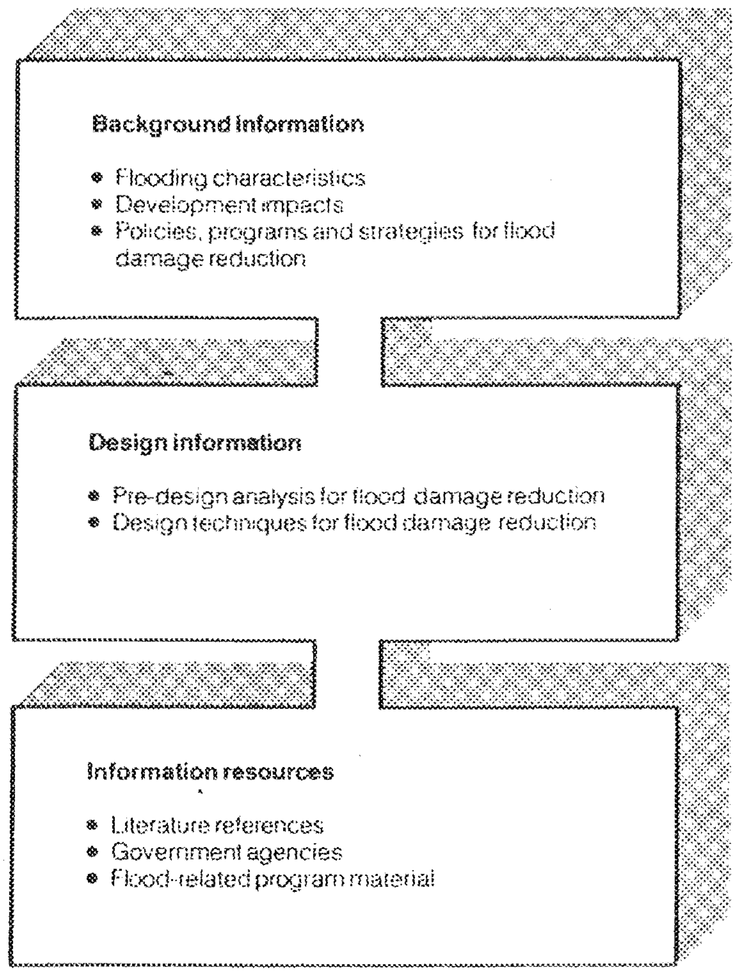


FIGURE 1

Data for Flood Design

be avoided or protected during development. Such features will help identify advantages and constraints to be considered in site development. Soil permeability and vegetation determine the degree of water absorption, which, in turn, influences the rate of storm water runoff, erosion and ground water storage---all of which relate to flood severity. Surface water storage, such as ponds or surface depressions, aids in control of water runoff by holding excess runoff until it can be released gradually into the watershed, thereby avoiding the rapid accumulation that causes flooding.

Siting Individual Buildings. The primary objective in siting individual buildings to locate structures so that they will be safe (or can be made safe) from flooding. In practice this means locating on the part of the site that analysis of basic flood data has indicated is above the base flood elevation. However there are other factors to be considered. Nonresidential structures can use a combination of elevation and waterproofing to achieve the required degree of safety, as long as they are not located in the floodway or coastal high hazard area. For all structures, the designer should consider the potential for going beyond regulatory minimums, thus providing greater protection wherever possible. Some sites, for instance, allow buildings to be located completely outside the flood fringe, and this should be done wherever possible. Buildings should also be oriented so that foundations and floodproofed walls minimize obstruction of flood flows. Natural drainage lines and other natural features that help control storm water runoff should be preserved. These measures avoid raising the level of flood waters and minimize negative impacts on downstream property.

Coastal areas require additional safeguards in locating buildings. There must be no construction on beaches or dunes; buildings should be sited behind the secondary dune or elevated in the troughs between dunes, since these areas are generally more tolerant to alteration. It is also important that the stabilizing composition and vegetation of dune systems not be disrupted. Access to beaches should be carefully controlled, using elevated walkways to avoid damaging the dunes. Buildings should not be located, nor should any fill material be used, in wetlands.

Siting Multiple Buildings. Where multiple buildings are to be placed on the site, the objective when locating structures is the same as with an individual building. One approach is to disperse buildings throughout the site, applying the criteria discussed above to each building. An alternative to such dispersal, when local zoning ordinances allow (e.g., a planned unit development ordinance), is grouping buildings in clusters on the safest parts of the site, leaving the more vulnerable areas open. This approach not only reduces flood damage but also allows greater flexibility in protecting the natural features on the site and controlling water runoff (see Figure 2).

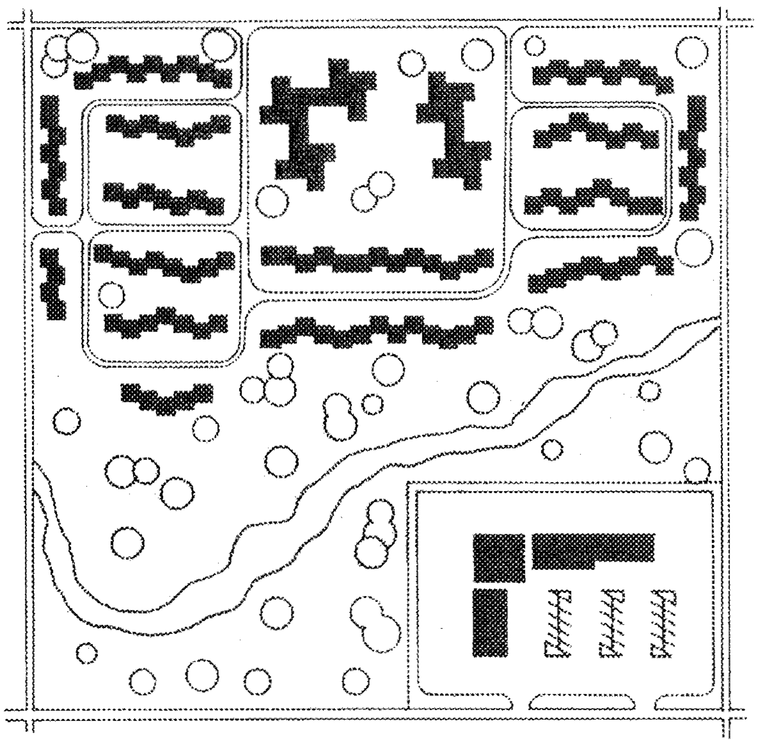


FIGURE 2

Cluster Development

Large open areas can be used in a number of ways, depending on the nature of the project. They can be retained as agricultural or conservation preserves or developed as low-intensity recreation areas. Smaller parcels also have conservation and recreation potential, and can be effective buffers between conflicting land uses. With any of these uses, open space can serve as an amenity that enhances the value of developed property. Another alternative is to develop open areas as parking or temporary storage for transportable goods.

Roads and Paving. Every site must connect with a road system for access to the surrounding infrastructure, and large development projects require circulation within the site. The objective in site design is to meet the program needs for circulation and access while maintaining safe egress during flooding and avoiding damage to natural features that aid in the control of runoff and flooding.

Roads should be minimized to reduce the amount of surface paving. Site layout should locate roads to approach buildings from the directions away from the floodplain so that access routes will be less likely to be blocked by the flow of flood waters and debris. This approach will protect natural features in the floodplain and will minimize obstruction of the floodway. To reduce potential erosion, siltation, and runoff problems, roads should not disrupt drainage patterns, and road crossings should be perpendicular to streams, with adequate bridge openings and culverts to permit the unimpeded flow of water. If roads are to be raised, the slope of embankments should be minimized and open faces stabilized with ground cover or terracing.

Streets and curbs are frequently added during development, and the layout and gradient should be designed to complement runoff and contribute to localized flash flooding. Site design should maximize the preservation of open space and vegetation and avoid large continuous expanses of impervious surfaces. Large parking lots should be punctuated with planted areas. Streets, walkways, and parking areas should be constructed of porous paving materials wherever possible. Gravel, for instance, is highly porous, and bricks and flagstones can allow infiltration between joints. When soil conditions vary on the site, buildings should be located on the less porous soils, leaving areas with better filtration as open space.

Vegetation. Landscaping of the site can provide useful protection against erosion, debris impact, and vandalism as well as enhance the design of the structure (Figure 3). Trees, plantings, fencing, earth berms, etc., can all provide this dual function of utility and aesthetics. Trees can be particularly useful as a natural barrier for deflecting floating debris, thereby minimizing the impact on building foundations. Size spacing, and placement of trees in relation to floodflow will determine their effectiveness.

Vegetation also aids in slowing the rate of stormwater runoff by holding water, both internally and externally, thus allowing it to filter into the ground or evaporate gradually. In addition, vegetation makes an important contribution by helping to prevent erosion and sedimentation that exacerbate flooding. Attention should focus on retaining natural vegetation wherever practicable, and on introducing plants in locations that will be most affected by runoff. The selection of plants should emphasise compatibility with natural conditions and the ability to hold the maximum amount of water. Leaf type, branching characteristics, and the texture of bark all affect water-holding capacity. A fibrous root structure can help control erosion. In coastal areas, vegetation can be used in conjunction with fencing to maintain dunes and encourage their growth.

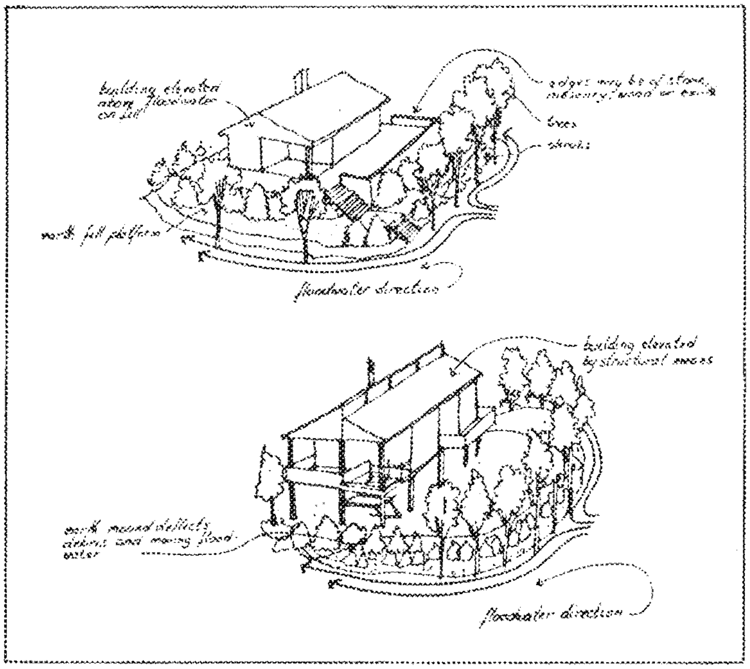


FIGURE 3

Vegetation and Earth Berms Used to Protect Structures

Soils. Soil porosity is an important component in controlling water runoff. Soil composition needs to be firm enough to adequately support buildings but at the same time permeable enough to allow percolation of water to recharge the water table and to allow water to drain away from buildings. Balanced soil composition slows water runoff, increases infiltration, and helps prevent the build-up of extreme water pressure on foundation walls, footings, and floors.

The type of soil on the site dictates the appropriate response for site development. Soils that remain saturated with water tend to corrode foundations. Heavy clay soils require the addition of sand to improve

Open channels can serve as both small-scale storage devices and a means of directing runoff away from vulnerable areas. Their primary purposes are to divert water away from areas likely to erode, such as large, gently sloping areas and shorter steep slopes, and to collect and transport water runoff to larger drainage courses. Channels with grass cover are appropriate where the channel gradient is low; they can serve as percolation trenches by allowing gradual infiltration while water is being transported. Linings are necessary in channels where vegetation cannot be established because flow is of long duration, runoff velocities are high, erodable soils exist, or slopes are steep. Concrete and asphalt paving or riprap are the most commonly used channel linings. However, such linings can increase the velocity of runoff, and thus should be designed with velocity checks to control the rate of water flow.

Installation of a storm sewer system is often part of site development in large projects, usually parallel to the street and curb system. Storm sewers should interconnect with other drainage devices to decrease the velocity of storm water runoff and to release water at controlled points and rates of flow. Lines and access points need to be sized and distributed to accommodate the runoff likely to be associated with the site and not cause backup of water and the resulting overspill of flash flooding. The capacity of the storm sewer system can be impaired by sediment deposits within the system. To avert this problem, drain inlets should be designed with sediment traps and filters.

Building Design

A building in a floodplain must exhibit

. lateral stability with regard to water and soil pressure,

. uplift resistance to resist buoyancy in the soil,

. resistance to overturning,

. resistance to erosion at the foundation, and

. resistance to impact from floating debris.

Flood forces on a building are hydrostatic (usually associated with riverine flooding) or hydrodynamic (associated with flash flooding or coastal storms). In addition, coastal areas are subject to extreme wind forces that increase requirements to provide lateral stability and, especially, uplift resistance.

their drainage, the provision of good surface drainage, or a bed of gravel between soil and foundation to prevent foundation corrosion. Sand and silt, though porous, are unsuitable for stable foundations. They necessitate pilings to anchor the structure to deeper bearing soils.

Restructuring Topography. On some sites it may be possible to use fill material--from either on-site or off-site--to create locations for buildings that are above the base flood elevation and meet other development criteria. Site restructuring can also be used to improve drainage and control runoff.

Special considerations should be given to soil conditions and slope stability, as well as flood water velocities and duration, to ensure that erosion does not add to flooding problems and endanger the structural integrity of the building. When restructuring topography, exposed cut and fill slopes as well as borrow and stockpile areas, should be protected. Runoff should be diverted from the face of slopes, and slopes should be stabilized with ground cover or retaining walls.

Stormwater Control. Water storage can be either temporary or permanent, depending on local ground water supplies, geology, and climate. Temporary storage can take a variety of forms, including the preservation of natural surface depressions in the landscape. Such "dry pond" storage helps to detain water after a storm, with gradual drainage, percolation, and evaporation to reduce the volume and velocity of runoff. This technique also helps replenish ground water supplies and can boost property values by increasing the site amenity and providing recreation space.

Temporary water storage can also be designed into parking areas by creating depressions in paved surfaces that, in combination with drainage channels, allow gradual runoff. In some situations large expanses of flat roof can be used to detain water, but this requires special attention to the roof's structural ability to support the weight of collected water and reliable waterproofing measures. Both of these methods can be helpful in offsetting the effects of existing impervious surfaces in urban areas where there is little open space to absorb runoff. Permanent water storage in the form of ponds or lakes can be used in circumstances where a consistent supply of water and sufficient space exist. Ponds and lakes can add to site amenity and offer added potential for recreation and conservation habitats, though they do require regular maintenance.

A number of building design strategies can be used to reduce the threat of damage from these forces. Entrance of water through building openings should be minimized, building finishes and contents should be protected, seepage through walls, floors and foundations should be eliminated. Attention should be directed to counteracting the forces of water pressure on foundations, walls and floor slabs, and to preventing the back-up of water through sewer systems.

To deal with these problems adequately, the architect can incorporate any of a variety of damage reduction techniques, termed floodproofing, into the design of buildings. These techniques interact with site design features and, as with site design, will vary with respect to individual circumstances. Such strategies are particularly appropriate where only moderate flooding (i.e., low flood stage, low velocities and short duration) is likely, or where flooding can be anticipated but buildings' uses require riverine or coastal locations. The principal approach to achieving this objective is to keep buildings dry during flooding. This usually involves either raising buildings above the base flood level or waterproofing portions of the building that are below it.

It should be noted that, in buildings without waterproofing, water entering the building serves to equalize water pressure that builds up on its exterior. If this equalization is eliminated by waterproofing, then the building is likely to collapse. If a strategy is adopted that keeps water out, then the building must also be made structurally capable of withstanding these exterior water pressures.

Elevating Structures. Elevating buildings above the base flood level is a common technique for reducing flood damage. Flood insurance requirements mandate that residential buildings in flood-prone areas be elevated and that other types of buildings be elevated and/or floodproofed. It is a particularly useful technique where site elevations are consistently below the base flood level and offers the greatest assurance of keeping a building dry during flooding.

One method of raising buildings is to use fill material to achieve the desired elevations. This technique interacts with the various site design issues and requires consideration of the type of fill, compaction and settlement of fill, protection against erosion and the effect of altered land forms on the flooding levels elsewhere in the watershed system.

Another approach to elevating buildings is to raise them on some form of stilts, such as piers, posts, or piles (Figures 4-6). This method puts the building above the base flood level and leaves the ground level predominantly open for recreational uses and parking. It offers the added advantage of not impeding a significant volume of water, thus minimizing increases in downstream flood levels.

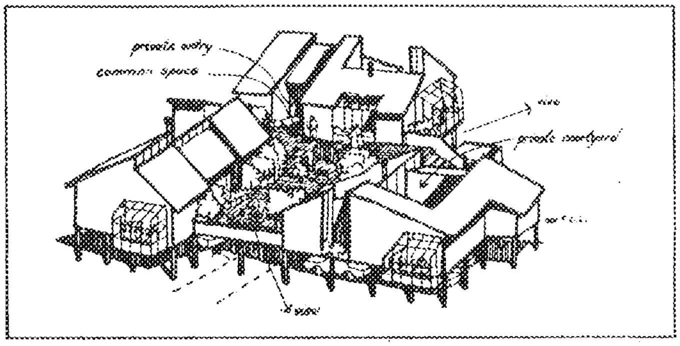


FIGURE 4

Multi-family Structure Elevated on Stilts

In using stilts, the designer must consider the size and spacing of stilts to ensure adequate support with minimum obstruction. Stilts should penetrate to bearing soil and be firmly anchored to ensure that they will be able to resist water pressure and debris impacts.

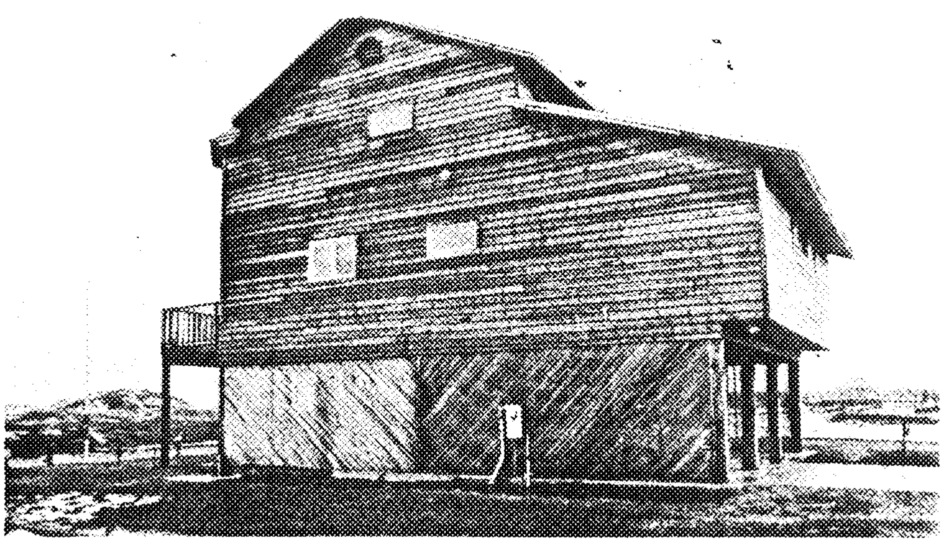


FIGURE 5

Single-family Structure Elevated on Stilts

Extended foundation walls can also be used to elevate buildings above flood levels. However, as with the use of fill material, the vertical surfaces of walls can obstruct the flow of water and are subject to greater lateral water pressure. Such walls should be located parallel to the flow of flood water to minimize these dangers and should be anchored to prevent displacement or flotation.

With any technique for elevating structures, the designer must consider access to and from the building during flooding, as well as the protection of utility inlets. In some cases it can be advantageous to use a combination of methods. For example, a building raised on fill at one end and on stilts at the other would provide ground floor access at the end of the building away from the floodplain while minimizing obstruction of water at the end nearer the stream channel.

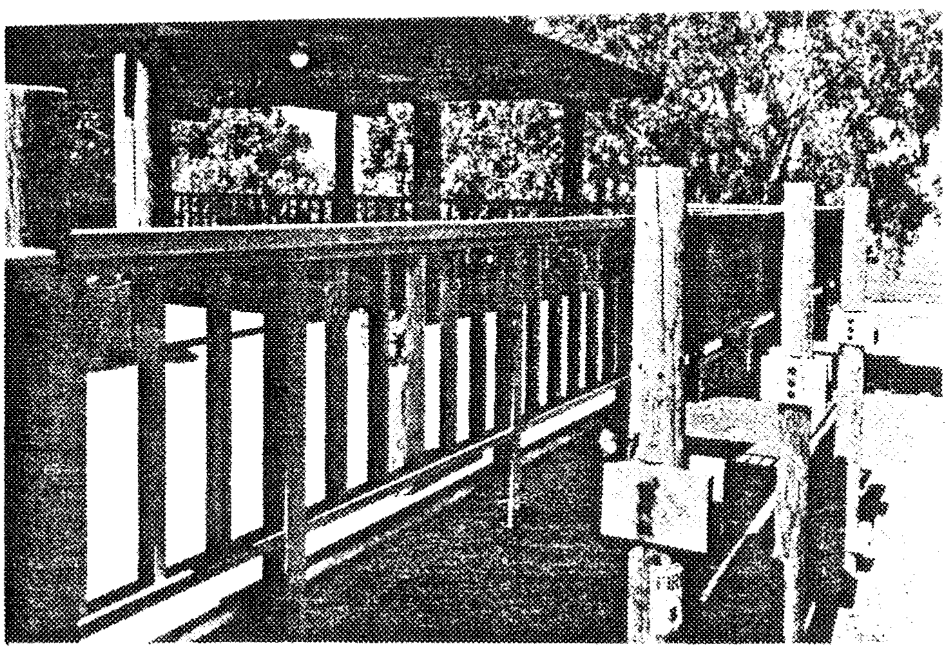


FIGURE 6

Pole Foundation

Elimination or Protection of Openings. The most vulnerable components of the basic building fabric are the points where walls below flood levels are penetrated. These points include doors and windows, utility inlets and, in some cases, underground tunnels to adjacent buildings. Such points should be either located above flood levels or thoroughly waterproofed.

Ideally, all doors and windows should be above the base flood elevation, with access provided via ramps, stairs, or fill. Rubber gaskets can sometimes be used to seal openings below the base flood elevation, and waterproof conduits can be used to protect utility lines. Openings for doors and windows unavoidably located below flood levels can be protected by flood shields that would be put in place upon receipt of flood warnings. These shields can cover openings ranging from small areas to large display windows. They can sometimes be incorporated in the building's structure, out of the way when not needed and, using hinges and rollers, put in place when necessary. They can also be separate from the structure and stored when not in use. Adequate warning time is a prerequisite to the effectiveness of shields.

Openings below the base flood elevation in existing buildings can often be eliminated, with alternative entry points provided at higher levels (see Figure 7). Windows below flood level can sometimes be replaced by glass bricks, which allow light but can withstand moderate amounts of water pressure during flooding.

Structural Walls. All structural walls should be designed to accommodate hydrostatic, hydrodynamic, and debris loads. The walls should be able to withstand the lateral forces from the predicted depth and velocity of flood waters, as well as the vertical forces from flood waters and rising ground water levels, which require secure anchoring to footings and foundations. Potential seepage requires the use of sealants, external wall coatings, and the secure joining of walls, floors, and foundations.

Floors. Floors should be designed to withstand the vertical pressures associated with flooding. This requires consideration of soil composition and ground water levels, as well as the likely flood levels in relation to building elevations. Floor design should provide adequate thickness and reinforcing to resist water pressure, and can include the provision of extra weight (e.g., concrete pads) to prevent flotation. Floors should be securely anchored to foundations, and joints between walls and floors should be securely tied and sealed to prevent displacement or seepage.

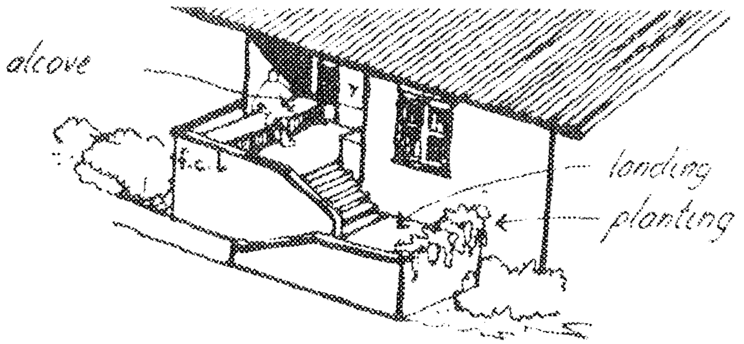
Footings and Foundations. Footings and foundations require special consideration in flood-prone areas. They should be at a sufficient depth and on bearing soil in order to provide the necessary lateral resistance to water pressure, and should also be able to resist vertical pressures. In some cases this may require additional anchorage with pilings or extra weighting with concrete pads. Also necessary is the protection of footings and foundations from erosion, which is especially important where they will be subjected to extreme velocities, such as with coastal tides and storm surges.

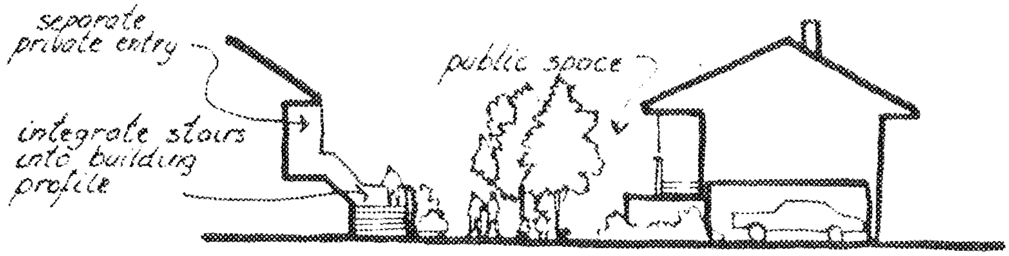
Utilities. All utility lines should either enter the building above the base flood elevation or be waterproofed and secured to prevent displacement due to water pressure. When a utility line enters the building below the base flood level, it should be routed so that the interior outlet point is above the flood level. Internal and external fittings below flood levels should be thoroughly waterprofed, and control panels should be above the base flood elevation to allow access during flooding (see Figures 8 and 9). Controls for lower floors and basements can often be isolated to allow them to be disconnected independently during flooding.

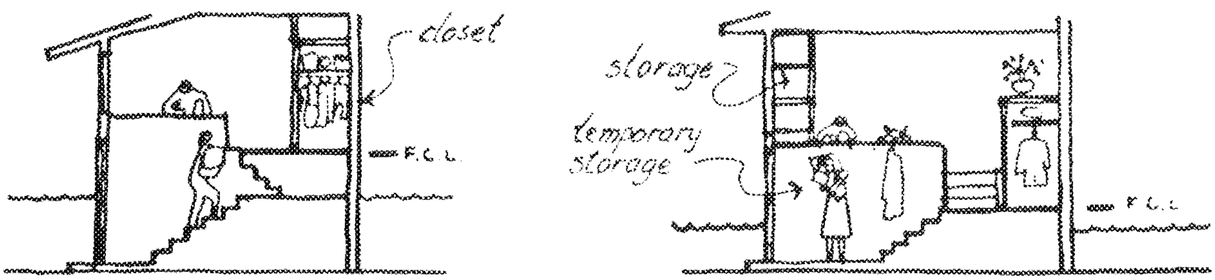
Interior Spatial Organization. The internal spaces of buildings located in or partially in a floodplain should be organized to minimize damage in the event of inundation. The most vulnerable elements of the building should be located above flooding levels. This would typically include placing all mechanical equipment on the upper floors or roof of the building. Depending on the respective elevations, machinery and similar equipment should be raised off the floor or anchored to prevent flotation. Particularly valuable and vulnerable contents, such as computer equipment, should be located in areas above flood levels or otherwise securely protected from inundation (raised on stilts or surrounded by a waterproof enclosure). Spatial configuration should also allow for access to, from, and within the building during flooding.

Building Materials. Regardless of the methods of floodproofing used, building materials may nevertheless be exposed to floodwater. Resistant materials should be used, including exterior grade plywood indoors, floor coverings, adhesives, and paints, as well as masonry construction and finishes, waterproof mechanical and electrical fittings, tempered hardboard, waterproof plaster on lath (instead of gypsum board, which is water absorbent), metal door and window frames, and hot-dip galvanized metal connections.

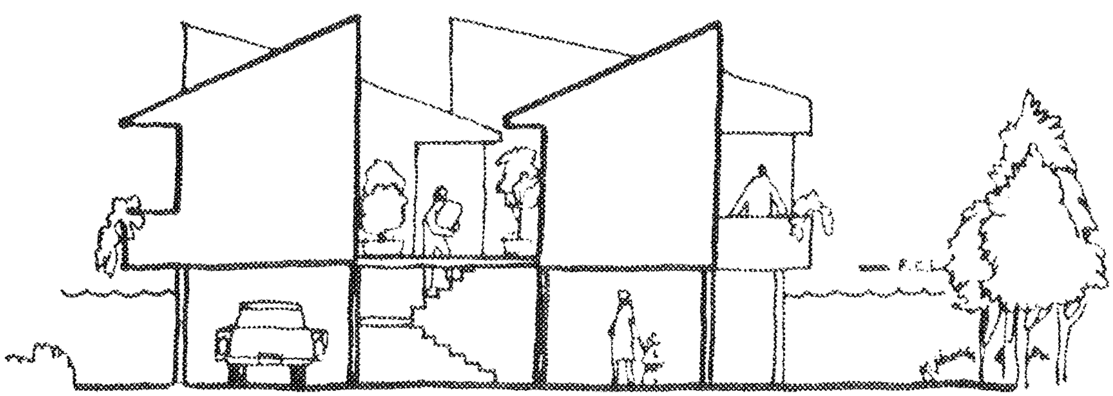
Mechanical Systems. All mechanical equipment and controls should be located above the base flood elevation to prevent damage and to allow







ENTRIES AT PERIMETER OF DWELLING



ENTRIES BENEATH DWELLING

FIGURE 7

Entryway Placement

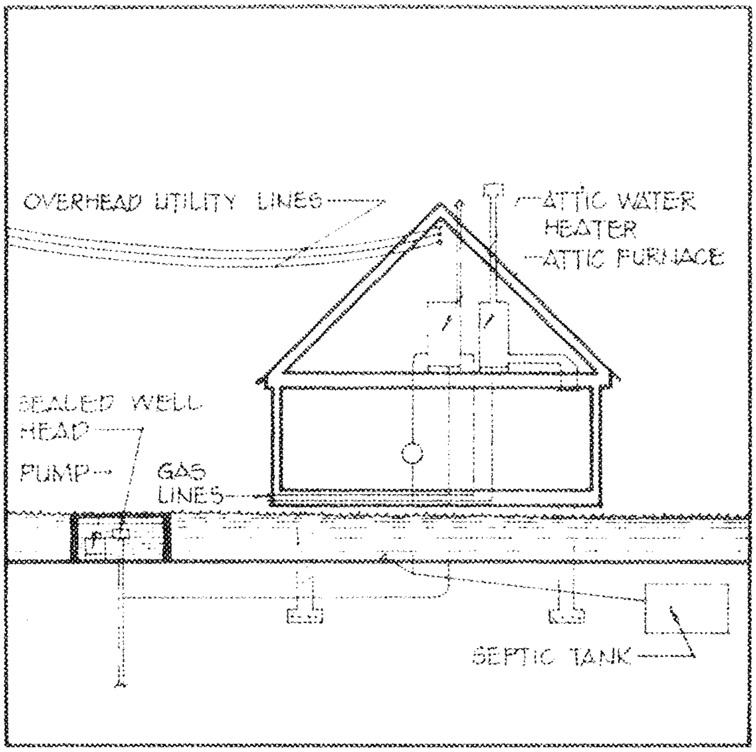


FIGURE 8

Locating Utilities

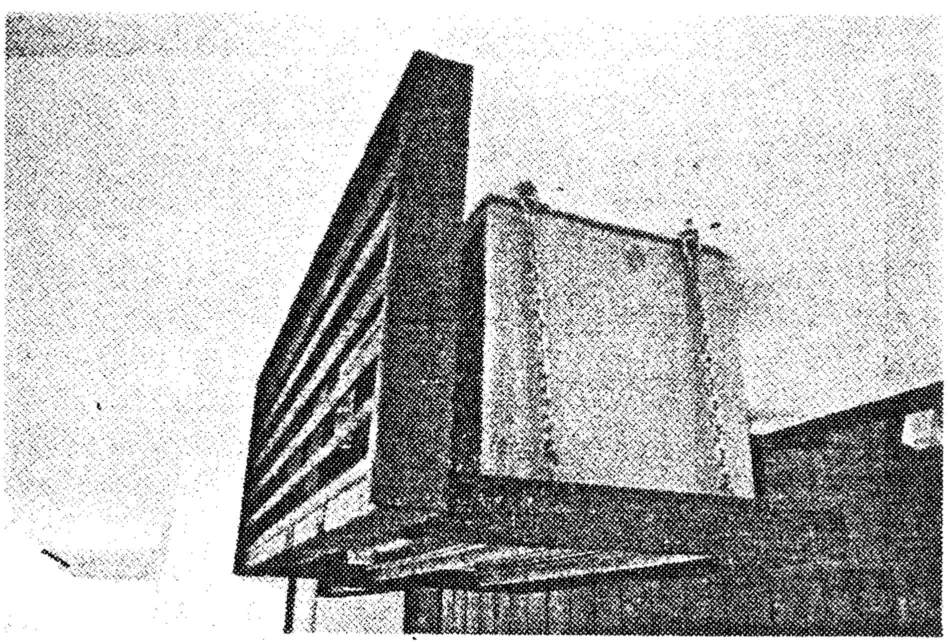


FIGURE 9

Mechanical Equipment Elevated Above Flood Levels access to the equipment during flooding. The duct work associated with the mechanical system should be elevated or otherwise protected from water damage.

Plumbing. Floor drains and other plumbing will often unavoidably be located below the base flood level. They should be fitted with valves to prevent the backflow of water that would damage the interior of the building. Sump pumps should be installed to remove small quantities of water, with the drain outlet of the pump located above the base flood level and an emergency power source available.

Insulation. Like exposed walls of conventional structures, the exposed floor of elevated structures must be insulated against heat losses and heat gains. Depending on the climate, two factors should be considered. First, elevating a building will expose plumbing; such plumbing must be insulated against freezing. In extremely cold climates, heating cables may be necessary with the insulation. Second, insulated floor decks may be subject to floodwaters and should therefore have either impermeable, closed-pore insulation able to withstand water submersion or insulation that can be replaced economically (see Figure 10).

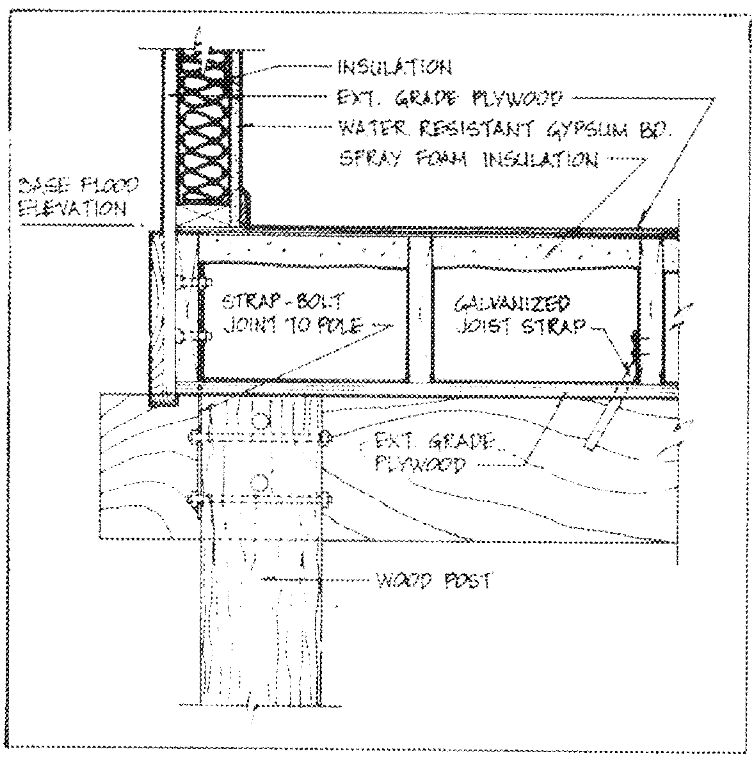


FIGURE 10

Insulated Floor Section

Wet Floodproofing. Wet Floodproofing is a special technique that can be used for nonresidential buildings under certain circumstances to reduce flood damage. The distinguishing characteristic of wet floodproofing is that rather than trying to keep water out, water is purposely introduced into a building at times of flooding. This is done so that the water level inside will counteract the pressure of rising flood water on the outside, thus reducing the possibility of major structural damage. This technique is potentially useful where damage from exposure to water will be minimal and post-flood clean-up relatively easy. Note, however, that FEMA's flood insurance rate criteria do not give credit for wet flood-proofing.

Wet floodproofing requires that all part of the building below the base flood level be constructed and fitted with water-resistant materials and finishes. Surfaces should be nonporous in order to minimize absorption and facilitate cleaning (e.g., concrete, metal, plastic, or glass). Pumping clean water in as flood waters rise, rather than allowing flood water to enter, will simplify clean-up. All interior spaces must be allow to fill with water, including any cavity walls, and must be able to drain and be cleaned after the water recedes.

It is essential in wet floodproofing that utility and mechanical systems be accessible and operable before, during and after flooding. Thus they must be either above the base flood elevation or waterproofed and anchored. Fuel and chemical storage tanks must be elevated or located on upper floors above flooding levels, or evacuated prior to flooding. Valves that maintain equalized water pressure and clean-up equipment must be included in a wet-floodproofed building.

The many special requirements of wet-floodproofing and its limited effectiveness in reducing damage to contents limit the number of situations to which it can be applied. However it could be useful in some industrial buildings and may be appropriate for limited-use basements that are below the base flood elevation.

Costs

The foregoing site and building design techniques for reducing flood damage are both feasible and effective. They are also worth the extra cost. Studies published by FEMA indicate that floodproofing buildings is cost effective in both riverine and coastal environments. One study looked at four different strategies as applied to a small commercial building. Analysis found that three of the four were economically justifiable. Another study found that, in the high hazard areas of the Atlanti and Gulf Coasts, new homes elevated above expected storm surge levels are also economical, both because of reduced flood losses and because of lower insurance premiums.

THE LAND DEVELOPER'S PERSPECTIVE ON FLOOD HAZARD MITIGATION

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Environmental Planner

National Association of Home Builders

Introduction

The developers' perspective on flood hazard mitigation is best characterized by the various criticisms they commonly direct at the Federal Emergency Management Agency (FEMA) and the National Flood Insurance Program (NFIP). The "typical" land developer questions the accuracy of flood elevations on the Flood Insurance Rate Maps (FIRMS) and finds the appeals process costly and burdensome. In support of the first criticism developers will point out that FIRM studies are often based upon outdated topographic maps which do not accurately reflect the community's land use pattern. The second criticism will be defended by referencing FEMA's regulations which give the community and private landowners thirty days to submit technical data when challenging base flood elevations that took FEMA a year or more to define.

In addition to these two complaints many developers will argue that base flood elevations change so often that they are never quite sure as to what the principle floodplain management standard is, or how long it will apply. Furthermore, they will state that the minimum construction standards of the NFIP are not clearly presented in FEMA's regulations or in the local building code. Finally, developers will criticize FEMA for its failure to inform them about relationship between the constructio standards and flood insurance policy premiums.

Whether or not these criticisms are valid is relatively unimportant. It seems reasonable to assume that FEMA has based some FIRM studies on poor data when better were available. On the other hand, some local governments and land developers have not taken full advantage of the opportunity to present FEMA with the best available data early in the mapping process. With respect to the criticisms of FEMA's failure to educate the private sector about construction standards, we suggest that local government, the private sector and FEMA are all to blame for failure to communicate with one another.

What does distinguish these comments is that they reflect the problem inherent in land planning programs being administered by the federal government. Moreover, the criticisms are indicative of the private sector's aversion to federal intervention in fundamental, local land use decisions--local government's history of poor floodplain management notwithstanding.

In a moment we will suggest how flood hazard mitigation can be undertaken in a manner that will overcome these criticisms. First, however, we must briefly examine FEMA's base flood elevation mapping process. It is not only the principle source of controversy, but one of the reasons why flood hazards are inadequately mitigated.

Base Flood Elevations: A Source of Controversy

An accurate delineation of base flood elevations is clearly the most important tool of the floodplain manager. Without this information, efforts to mitigate flood hazards and to establish actuarial flood insurance rates are impossible. Now that FEMA has provided most communities with base flood elevations to which structures must be elevated, why do flood disasters still occur with alarming frequency? Moreover, with approximately 85% of the flood insurance policies in force based on actuarial rates*, how is it that the Federal Insurance Administration (FIA) continues to lose money and forecasts even greater losses in the future? Finally, given the need to accurately assess flood hazards and FIA's mandate to become financially solvent, why do flood elevations generate such controversy?

These are difficult questions which cannot be completely resolved in this paper. There are, however, two partial answers which seem quite clear. First, the impact of waves on base flood elevations in coastal areas are just now being added to FIRMs. Presumably, the revised FIRMs will necessitate better flood hazard mitigation which, in turn, should result in less flood damage. The controversy results from the fact that wave heights are used as a basis for flood insurance policies before official wave height elevations are promulgated.

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* Conversation with Donald Beaton, Federal Insurance Administration.

The second answer is found in FEMA's method of mapping base flood elevations. Since flood elevations are based upon a community's existing development conditions, the risk of flooding reflected in the actuarial rates is always understated. As a result, the FIA will continually be faced with the prospect of paying out more in claims than it collects in premiums, and the FEMA will be confronted with the never-ending task of re-mapping base flood elevations to reflect the impact of on-going land development.

In many communities, the scenario will read something like this: FEMA publishes FIRMs, the community appeals, and builders elevate structures to base flood elevations. Development continues, and, provided the community has not implemented a stormwater management program, the flood hazard increases. When base flood elevations are higher than those mapped on FIRMs, structures are inadequately protected. The 100-year flood occurs, causing more damage than anticipated. The FIA must then pay more in claims than it collected in premiums. FEMA then finds it necessary to re-study the community's base flood elevations, which the community will likely appeal. The cycle is endless and probably institutionalized.

Recommendations

There are several solutions to the problems identified above. We suggest that the recommendations which follow will not only encourage better flood hazard mitigation, they will address the criticisms developers typically direct at FEMA.

. Delineate base flood elevations under conditions of maximum allowable development

Given that this approach will temporarily overstate base flood elevations, this suggestion might exacerbate the conflict between local government, land developers and FEMA. While this may well be the case, if one accepts the premise that any flood elevations FEMA promulgates will create controversy in many, if not most communities, the logical question arises: Is it advisable for FEMA to generate controversy once in every community, rather than several times as FIRMs require successive revisions. Moreover, if local officials and developers are educated as to the rationa for such an approach, some of the conflict should be resolved.

There is an alternative to the suggestion above which would encourage optimum flood hazard mitigation and would also be more politically acceptable.

. Reduce flood insurance premiums in communities that have preventative stormwater management programs

Many communities have adopted stormwater management programs that require developers to provide retention, detention and/or infiltration facilities to reduce peak flows of runoff. While such programs will not necessarily reduce existing flood hazards, they will prevent flood hazards from increasing. By doing so, they will also obviate the need for FEMA to re-study a community's flood elevations, thus saving FEMA considerable sums of money.

There is a potential problem with this suggestion. More often than not, a community's jurisdictional boundaries will not correspond to watershed boundaries. Therefore, all communities within a watershed would have to implement stormwater management programs if flood hazards are to be dealt with effectively.

. The state share of disaster assistance could be reduced in exchange for enactment of stormwater management legislation.

Several states have already enacted such legislation and it seems that more are moving in this direction. FEMA could substantially eliminate the jurisdictional/watershed problem if this recommendation were followed.

The recommendations offered would result in better identification of flood hazards and would result in better flood hazard mitigation. Structures would be elevated to flood elevations reflecting completely developed conditions. They would also reduce the need for flood elevation restudies and would address the issue of FIA financial solvency. The suggestions do not, however, address the most basic question in floodplain management: How can builders be discouraged from building in flood-prone areas?

There are a number of ways to meet this objective, though largely at a local level. Furthermore, its accomplishment will require substantial revisions to a "typical" community's development ordinances.

Several zoning and development techniques have been advanced to direct growth to areas most suited to development. Often used in support of an agricultural preservation plan, any of the following incentives could be applied to the preservation of flood-prone lands.

. Clustering, which allows developers to construct homes without conforming to the standard setback requirements, is a very cost-effective development technique. When clustering is allowed developers can build to the maximum density permitted by the zoning ordinance without locating structures in flood hazard areas. This enables the developer to realize the full development potential of the site while mitigating potential flood disasters at the same time.

. Density bonuses allow a developer to exceed the maximum density permitted by the zoning ordinance, usually in exchange for providing a public good such as open space. Offering density bonuses in exchange for not developing flood hazard areas would strongly encourage flood hazard mitigation.

. Transferable Development Rights (TDR), as the name implies, allow for the more dense development of one property by transferring the development rights from a noncontigous parcel of land that is to be preserved. Although there is still some question as to how successful TDR programs will be, it is a planning technique that should be examined for its applicability to flood hazard mitigation.

A discussion of the advantages and disadvantages of these planning techniques and other flood hazard mitigation incentives, such as tax credits for not developing flood-prone areas, is beyond the scope of this paper. The important point however, is that these techniques can be used to encourage development where it is most appropriate. Frequently, though these techniques are not permitted by a community's development ordinances

An other important question is: What can be done to encourage the best possible flood hazard mitigation for structures that are, for whateve reason, constructed in flood hazard areas? We must acknowledge that there is development pressure in flood hazard areas, particularly in the coastal zone. Accordingly, builders and home buyers must be given incentives to exceed minimum construction standards so that flood disasters are reduced to the greatest possible degree. Two recommendations are offered to meet this goal.

. Increase builder awareness of the insurance benefits of building beyond minimum standards.

Many builders are unaware of the reduced insurance premiums that result from exceeding minimum elevation requirements and from other construction practices. In fact, a review of the relevant literature indicates that the only publication that specifically relates insurance premiums to construction standards is the Flood Insurance Manual. The information in this manual must be clearly presented to builders and could be easily incorporated into the Design and Construction Manual of Residential Buildings in Coastal High Hazard Areas.

. Structure flood insurance premiums so that insurance savings outweigh the financing impacts of increased construction costs.

As a general rule, an increase of $1,000 in the cost of a home translates into an $11 increase in monthly mortgage payments. Therefore, a financially astute buyer would not pay for the increased construction costs unless his or her insurance premiums were reduced commensurately.

Conclusion

In presenting the developer's perspective on flood hazard mitigation we have argued that the promulgation of base flood elevations is the most controversial aspect of the NFIP. More importantly, we have suggested that the limitations inherent in FEMA's approach to mapping flood elevati will continue to create controversy without appreciably improving the quality of floodplain management. Finally, we recommended a number of ways that developers can be encouraged to exceed the minimum floodplain management and construction standards, but noted that local development ordinances often preclude their use.

The criticisms and recommendations offered in this paper address the fundamental problem with flood hazard mitigation efforts to date. That is, flood hazard management objectives have not been fully incorporated into the community's comprehensive land use plan. More specifically, floodplain management has focused on regulating development in flood hazard areas, rather than offering developers economic incentives to leave flood-prone areas undeveloped.

The proposals outlined in this paper could substantially improve the private sector's effort to mitigate flood disasters. More importantly, since these techniques would be implemented through the community comprehensive plan, flood hazard mitigation objectives would be considered with the context of the community's overall development goals. The proposals would not only improve the effectiveness of floodplain management, they would address the criticisms developers currently direct at FEMA.

ADEQUACY OF CONSTRUCTION STANDARDS
IN COASTAL HIGH HAZARD AREAS

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George Washington University
Associate, Dames & Moore

Introduction

The principal problem of construction in coastal high hazard flood areas is to design for the environmental forces present during extreme events such as hurricanes or other storms with high storm surge and wind-driven waves. This recognition of and design against environmental conditions may occur less frequently in the construction of single-family residences. Larger structures such as high-rise hotels and apartment buildings are usually designed by architects and engineers who can assign greater resources, personnel and finances, to the project.

A common denominator that contributes to flood-resistant construction of both small and large structures is the inclusion in model and/or community building codes of technically sound (and economically practical) minimum requirements. Over the past few years progress by some communitie and building code groups has been made largely in response to catastrophic losses from flooding in their jurisdiction. Additional code changes are coming about in an effort to assist communities in their involvement with the National Flood Insurance Program. Some examples of good construction requirements and how building codes are improving are included here. Many of the best examples involve the simpler single-family residences that are so frequently damaged by coastal storms.

Environmental Forces

The environmental forces to which coastal residential structures are subjected can be extreme. The 100-year flood is the design criterion promulgated by the Federal Emergency Management Agency (FEMA) for the National Flood Insurance Program. The 100-year coastal flood is frequent generated by hurricanes with wind velocities greater than 100 miles per hour and associated storm surge, plus waves that can require house elevations from 10 to 15 feet above mean sea level (msl). The base flood elevation (BFE) is that height of stillwater storm surge plus wave height above which one must elevate for safety (and to be eligible for flood insurance) from the 100-year flood event.

The basic environmental forces that are applied to an elevated residence include the lateral and uplift forces from wind and the lateral forces against the foundation from flowing water and wave action. If solid walls are present below the BFE, extreme lateral forces may be transferred to the elevating foundation piles, which normally are unable to resist the forces. In this case, failure may occur causing destructio of the house. Even so-called "break-away walls" below the BFE can overload the foundation and cause it to fail. Another important adverse acti of storm waves is erosion of soil, particularly sand, at the beach front. Scour of soil around foundation piles has been the cause of destruction of many residences. During a severe storm the lateral and uplift forces of the wind must be considered in the design of the foundation. Furthermore, the suction forces of the wind may result in roof and wall failures if the connections of the various structural elements are not well-designe

Flood-Resistant Design

The key ingredient to good flood-resistant design, after recognizing the magnitude of environmental forces, is providing good connections throughout the structural system. The critical connections include pile embedment into the soil, floor beam to pile, floor joists to floor beams, walls to floor system and roof rafters to wall system. Basically, there should be a continuous tension among the connections from the foundation soil up through the structure to the roof. If any one connection is a "weak link", major damage to the structure may occur. It is important that the floor system act to distribute loads among the elevating piles. Along with the wall and roof systems, the floor is particularly capable of this when the structural "box" is intact with good connections designe to resist wind and water forces.

Some of the details of good flood-resistant design have been presented in FEMA's Coastal Construction Manual (CCM). One of the design and construction concepts from the CCM suggests that wood piles should consist of at least 8 X 8 timbers, and preferably 10 X 10's for beach front houses with tip elevation at least as deep as 5 feet below mean sea level(msl). Another suggestion is that the floor beams be bolted to the piles with care taken that not too much material is removed when notching the pile for floor beams. The floor joist connection to floor beams should not be simple toe-nailing, which is weak. At least alternate floor joists should have metal or wood joist anchors permitting nails at right angles to the forces to be resisted. Finally, the CCM suggests that metal straps be used to connect wall studs to the floor system and to roof rafters. All of the design details in the CCM come from actual construction by builders across the nation with verification by standard engineering calculations in accordance with current practice and governing building codes. It has been shown that good construction of elevated houses only adds about 7 to 15 percent to the cost of construction of a similar non-elevated house without comparable connections. Obviously, elevated construction based upon the CCM can be cost-effective.

Building Codes

Some building codes have been changed recently to meet flood insuranc requirements. This is a necessary improvement in construction standards. Many of the code changes use the actual words of the FEMA regulations. Most of the codes present performance specifications. For example, Article 7 of the State of Massachusetts Building Code states that the following requirements shall be met: the structure is securely anchored in order to withstand velocity waters and hurricane wave wash and fill is not used for structural support. The model building code promulgated by Building Officials and Code Administrators (BOCA) has recently been amende to enlarge the section on floodproofing. Again, wording very similar to the FEMA regulations has been used, i.e., all buildings and structures located within a flood-prone area shall have the lowest structural member, except piles or columns, at or above the base flood level.

It is the preference of many building officials to have more specific requirements in building codes rather than performance specifications. For example, a 1980 amendment to the North Carolina State Building Code states for the size of wood piles, "round timber piles shal not be less than 8 inches in diameter at building level or at the building level. Squared piles shall not be less than 8 inches in square, nominal." Similarly, the proposed changes to the building code of the City of Sanibel, Florida, include many specific requirements. For examp under the section on pile foundations in V Zones the proposed code states "All foundation systems design shall assume that wave scour and soil movement can occur to a depth of five foot below the existing ground elevations. . .minimum pile tip penetration shall be to a depth of not less than eight (8) feet below msl or to a minimum driven depth of not less than twelve (12) feet, whichever is greater."

Conclusion

It is economically feasible to construct flood-resistant residential structures in the coastal high hazard flood areas. The knowledge of environmental conditions and the engineering design procedures is available. More local and model building codes should reflect the above information. Progress is occuring and should be encouraged so that all model building codes and more local codes include the information needed to aid in flood-resistant design.

GROINS, SEAWALLS, AND OTHER PROTECTIVE MEASURES

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U.S. Army Corps of Engineers

Human battles with the sea, usually fought at the land-water interface, have been continuing since human populations decided to live with fixed boundaries. As long as a constantly changing shoreline was accepted, and uses were adjusted to that change, conflicts were minimal. However, with the concept of "private property rights", areas were staked out for particular uses, and conflicts developed because "rightful" land was either submerged or emerged.

This need to maintain a fixed boundary at the sea edge led to the development of devices to "stabilize" the shoreline. One type would intercept the wave energy before it reaches the shore, another would armor the shore to retain the land in its present configuration, and a third would add an energy expender to the shore.

Breakwaters, seawalls, and groins are examples of these types of devices. A breakwater is usually located offshore, is massive and expensive, and creates an area of quiet water between the structure and the shore. A seawall or a bulkhead reflects wave energy seaward as well as holding fast the land behind it. Waves break on these devices, so they must be able to withstand this direct wave attack. Groins are only one of the third type. Also involved is a quantity of sand that is retained on the shore face by the groin (or more often, a field of groins) In those situations where there is a readily available supply of sand, and the movement of the sand is generally parallel to the shoreline, a groin field will help retain the sand blanket which acts as a wave absorber, dissipating the wave energy that would erode a shoreform. It is also to be expected that the sand will be lost to other locations over time, and that it will have to be replaced to maintain its function.

Such devices are constructed of a wide range of materials, sizes, and designs and they are used in various combinations. Not to be overlooked is vegetation. This device is usually used in combination with other devices, since, if a site were amenable to vegetation alone, nature would have provided it without the need for human intervention. When vegetation is not found, it usually means that wave action is too severe for the plants to have become established.

Because the Corps of Engineers has been historically mandated by Congress to investigate and then provide shore protection to federal lands subject to erosion problems, it was subsequently charged with the provisi of similar planning, design, and construction for other public lands, whe technically, economically, and environmentally feasible, and when appropri cost sharing was available.

About 70% of the shoreline of the continental United States is in private ownership and significant erosion is occurring on more than 40% o the shoreline. Thus, some 15,000 miles of U.S. shoreline is significantly eroding, and most of it is in private ownership where current feder law prohibits the Corps from providing shore protection projects. The Corps can, however, provide technical assistance and information that pri property owners can use in coping with their own problems.

Under the Shoreline Erosion Control Demonstration Program, Congress directed the Corps to develop and demonstrate low cost shore protection measures, and then to widely disseminate the results. This program, dubbed the Section 54 Program because is was authorized by Section 54 of the Water Resources Development Act of 1974 (P.L. 93-251), called for the Corps to conduct demonstration projects at 16 sites around the country. Many measures, including vegetation, were used at each site, and then each was intensively monitored on a daily, weekly, monthly, and quarterly basis. Finally, all the data (including photographs, profiles, samples, and written reports) were analyzed, judgements were made of the characteristics, structure and functional suitability of each device as installed at specific shoreforms, and the estimated life and maintenace requirements needed to assure a stable device. The investigation found a number of devices that could be recommended, a number that could not be recommended, and some others that could be transformed with minor changes into acceptable devices.

The underlying philosophy of the program was to think like a private property owner would, build devices at a low cost, and to treat them as a private property owner would. Keys to all this are the thought processes of the owner. What are the current uses for land and water? What are the future planned uses? What are the resources in time and funds? What are the physical and legal constraints? The property owner has only three choices: do nothing; sell the property and move; or take some positive steps. The information developed by the Corps of Engineers assists the property owners in logically arriving at the solution to fit their particular cases.

Dissemination of the results of the program has taken 3 forms: a final comprehensive report, workshops, and an audio-visual program. The report, which includes details and data for the devices monitored at 36 sites, was transmitted to the Congress in June 1982. Copies of the report were also made available to states, universities, and others interested in the program. To be more useful to private property owners, three guidebooks were produced, presenting the results in a general format--one for property owners who must make discussions on how to commit their funds, one for engineers and contractors who might be called upon to assist the private property owners, and one for local government officials who have a planning and permitting reponsibility for eroding shorelines. A 36-page brochure was also produced to give an overview of the program and its results. Organizations like Sea Grant and the Soil Conservation Service are helping to distribute these brochures.

Workshops were conducted at five locations around the country to help inform Corps personnel about the program results, and to introduce the program to the general public. A 50-minute audio-visual program was producedto inform the public about the program and its results. Each of these dissemination efforts has been well-received by the public, filling a need for coastal resource and engineering information not hitherto available to the public. There has been a continuous demand for the brochures and guidebooks.

Structures like groins and seawalls are certainly not the answer to all coastal problems. They do have a place, however, and if the economic, environmental, and legal constraints are satisfied, then a suitable device can be designed to do the job.

LOCAL GOVERNMENT LIABILITY
REGARDING COASTAL HAZARDS

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Introduction

Public response to coastal hazards falls into three categories:

- Structural measures, such as groins, jetties, and seawalls, which attempt to mitigate the damaging effects of storm surge and breaking waves upon shorelines;
- Land management measures such as land use zoning, minimum elevations, building code standards, subdivision and wetland regulations, and land acquisition through negotiated purchase or eminent domain; and
- Emergency management measures, including weather forecasting, warning systems, evacuation procedures, sheltering, sandbagging, rescue activities, and debris clearance.

Authority and responsibility to effectuate these responses are vested differentially among the various levels of government according to the type of measure considered. In most cases, some form of cooperative action among governmental levels is involved, although the primary initiative and funding responsibility may differ. Thus structural measures commonly are funded and designed federally but maintained under state or local auspices. Land management is chiefly a local responsibility with some degree of federal and state involvement under the National Flood Insurance Program and the Coastal Zone Management Act. Emergency management involves all levels of government.

Local Government: The Weakest Link?

The common participant in each form of response is the "local government." This term includes municipalities (cities, towns, villages) in the case of incorporated areas, county governments in the case of unincorporated areas, and certain special districts. Local government is pervasi in the American system of public administration as the protector of the public health, safety and welfare. This role embraces many functions: provision of public services such as police and fire protection, land use planning and regulation, operation of local public facilities such as pumping stations, and acquisition of open land for public recreation, natural habitat, or flood damage avoidance.

The involvement of local government in virtually any form of public response to coastal hazards implies major reliance of other levels of government, as well as by private citizens upon local capabilities and effectiveness. Local government, being closest to the scene, is expected to be cognizant of natural hazards pertaining to that geographic territory and to act responsibly, within the limits of its legal authority and fiscal resources, to mitigate potential harm to life and property. To be sure, natural hazards, especially those involving the ocean, transcend all political boundaries and local governments are powerless to "calm the restless waves." However, to the extent that threats to life and property arise from human use of shorelines, and such use is within the power of local governemtns to affect and/or protect, the local role is crucial indeed.

Local governments, however, possess some glaring deficiencies which impair their performance as responsible hazard managers. First, they are vast in number and often limited in territory. The 1982 Census of Governments lists 3,041 counties, 19,083 municipalities, 16,748 townships, and 28,330 non-school special districts. Furthermore, the Advisory Commission on Intergovernmental Relations has determined that the average metropolitan area in 1960 had an average of 93 incorporated municipalities with more than half of these averaging less than one square mile in areal extent. Second, local governments, especially cities and towns, are notoriously parochial in their eagerness to encourage taxable land development, in hazardous locations as well as anywhere else. Third, local governments frequently lack expertise in planning and land management. Available authority granted to them by state law may be unused or, worse yet, used in a careless or superficial manner to placate property owners and encourage development.

These deficiencies primarily affect local competence with respect to land management measures, but local performance regarding the maintenance and operation of structural measures and in the effectuation of emergency measures may be faulty as well. In other words, local government is the weakest link in the chain of federal-state-regional-local-private response to natural hazards.

The principal constraint upon dereliction of resposibility by local governments has been review by higher levels of government. Theoretically communities that permit violations of floodplain management standards established by the Federal Emergency Management Agency (FEMA) are subject to suspension from the National Flood Insurance Program and termination of eligibility for both flood insurance and disaster relief. Communities that fail to perform commitments regarding operation and maintenance of flood control structures may be subject to penalties based upon covenants made to the Army Corps of Engineers. These kinds of sanctions are rarely exercised, however, and the sheer numbers of local governments frustrate efforts by higher levels of government to monitor their performance. Coastal shorelines (including the Great Lakes) are shared by 2,058 municipalities and counties, according to FEMA. While considerably fewer than the total number of local governments listed above for the United States as a whole, this still is far too many to be effectively monitored by higher authority.

Are local governments therefore unaccountable for their conduct in the management of natural hazards? If so, we are faced with an insurmoun able barrier to mitigating future costs of natural disasters, both inland and coastal. We have vested both legal authority and the burden of initiative in an unruly mob of local governments over whom no one apparen ly has any significant control.

Liability for Mismanaging Floodwaters

As a possible escape from this impasse, let us consider an alternativ to review by "higher authority", namely review by "lower authority" in th form of lawsuits filed by private parties injured as a result of alleged negligence or other misconduct by the relevant local government (again, including municipalities, counties, and special districts). To the exten that a breach of a legal duty to the victim on the part of the local government can be proven, actions for monetary damages or, in appropriate cases, for equitable relief would seem to provide a needed impetus to improved local performance. Will such a breach be recognized in a court of law?

To the writer's knowledge, no case has yet addressed the questions of local government liability for alleged negligence to victims of coast hazards. However, analogies may be drawn from two directions, from suits among private parties regarding flooding and drainage problems, and from cases holding local governments liable for damage due to inland or riveri flooding.

For the sake of analysis, one may classify potential liability actio regarding floodwaters into four categories:

. private vs. private

. private vs. public

. public vs. private

. public vs. public

The last two categories are extremely rare in the context of natural hazards, although quite common in other circumstances (e.g.suits by governmental bodies against private parties based on breach of contract or against another public body regarding zoning policies which have extraterritorial implications---see Cresskill v. Dumont, 104 S. 2d 441, 1954). An important case pending at this writing illustrates both the third and fourth types, namely a suit by FEMA against a number of local governments and private parties in the New Orleans area for alleged negligence leading to increased flood costs incurred by the federal government (U.S. v Parish of St. Bernard, et al., Civil Action Nos. 81-1808 and 1810). Subsequent discussion will be limited to the first two kinds of actions.

Private vs. Private Suits

Suits between private parties regarding flooding chiefly arise under common law principles of drainage or under a theory of fraud in the sale of real property. Other possible theories based on trespass, nuisance, or statutory rights of action may be envisioned but will not be considere here.

The most straightforward case of liability for damage caused by water occurs where the water has been artificially impounded by one party and "escapes" to cause flooding of someone else's land. In the classic ruling in Rylands v. Fletcher, L.F. 3 L.H. (1868), an English court held the owner of a reservoir strictly liable (without proof of negligence) to the owner of an underlying coal mine that was flooded out. The doctri of this case has been widely accepted in American jurisdictions, namely that anyone who artificially confines water or other substance "likely to do mischief if it escapes" is strictly liable without proof of fault for harm caused by its escape. This doctrine has obvious application to issues of dam safety (see "Dam Failure: Applicability of the Rule of Strict Liability to Overflow or Escape of Water Caused by Dam Failure," 51 A.L.R. 3d 865 and Binder, 1979).

Where impoundment is not the problem, but rather some alteration of natural drainage patterns so as to change the amount, rate of flow, locat or other characteristic of drainage imposed on neighboring property owner common law drainage principles apply. Common law drainage decisions in the United States have followed three alternative doctrines: the "common enemy rule", under which property owners have an unlimited right to deal with excess surface flow in any manner which they choose, even to the detriment of surrounding owners; the "civil law rule", which requires property owners to accept normal quantities of runoff from upper riparian without artificial interference, and the "reasonable use rule", under whi courts may decide each case of interference with natural drainage proble on its own facts in light of benefits and costs. States differ as to whi of these doctrines are followed, but the trend seems to be in favor of the "reasonable use rule" (see "Modern Status of Rule Governing Interference of Drainage of Surface Waters," 59 A.L.R. 2d 42). Common law suits among private owners continue to arise under urban circumstances but the sheer complexity of metropolitan drainage patterns makes difficult the assignment of fault. Thus inter-private suits are of limited utility in reallocating the costs of major floods.

A different form of private vs. private liability for flood-related losses involves suits by buyers against sellers of real property. These may be based upon a contract theory of express or implied warranties of suitability for the buyer's purposes, or in terms of tort on the basis of fraud. In the former situation, the buyer will likely be faced with the defense of "caveat emptor"--that the purchaser is charged with a duty to investigate the condition of the property before buying. Thus in <u>Gill v. Marquoit</u>, 525 P.2d 1030 (Ore. 1974), the court held that flooding along the river in question was a "matter of common knowledge" and that the seller did not convey the land to the buyer for a specific use. Thus the buyer's failure to investigate precluded recovery from the seller. (see "Vendor's Concealment of Flooding Danger," 90 A.L.R. 3d 568).

But what if the seller is in a better position to investigate natura hazards than the buyer, and furthermore knows the purpose to which the buyer plans to put the land? Another Oregon case, pertaining to coastal property, Beri, Inc. v. Salishan Properties Inc., 580 P.2d (Ore. 1977) decided that where sellers ". . held themselves out as highly skilled and competent land and resort developers," they were subject to a duty to investigate and disclose potential erosion hazards. Drawing upon product liability cases in the building industry, the court concluded:

> "If builders can be held liable for their negligence in constructing a building without first making reasonable tests to determine the quality of the underlying soil, we see no reason why a land developer--one who chooses land and lays it out into lots which are sold for the specific and limited purpose of building a dwelling thereon--may not be held responsible for losses to purchasers caused by his failure to take reasonable precautions to determine whether the lots he offers are fit for that purpose. We have held as noted, that such a developer is not a guarantor that the land is free from all latent defects... We see no reason, however, why the commercial developer and seller of land should not be liable for the failure to exercise reasonable care in the project he has undertaken." (p. 174).

Over 10,000 communities now are enrolled in the regular program of the National Flood Insurance Program. This means that flood insurance rate maps are widely available in coastal areas as elsewhere. To the extent that such maps indicate the nature and scope of flooding hazards, buyers may be expected to consult them and failure to do so will likely be viewed as contributory negligence. In light of the limitations of flood insurance maps in depicting coastal hazards such as wave damage and erosion, however, sellers may still be vulnerable to lawsuits.

Private liability lawsuits are not often effective as a means of recouping the cost of flood losses. A major limitation is the problem of proof of negligence and proximate cause where the suit is based on tort principles. Natural drainage in metropolitan areas is altered in countless ways by myriad private and public actions. Pinpointing a singl private defendant as the primary cause of one's loss is difficult in most cases. Even if a principle source of the harm can be proven, the "reasonable use" doctrine may shield such party from liability if the benefit of the alteration outweigh the harm inflicted. The plaintiff, as mention above, may be subject to the defense of contributory negligence in failin to ascertain or take steps to protect himself from potential flood proble Finally, even if held liable, a private party may be insolvent or otherwise "judgement proof" so that the plaintiff cannot collect the fruits of his suit.

These and other obstacles to recovery from private defendants logica inspire interest in holding public entities liable where possible. Govern mental bodies certainly have "deeper pockets" than most private parties. Their role "in loco parentis" vis a vis individual property owners would suggest that they may be indirectly responsible for unwise actions of the latter. Most important, since public actions and policies affect many property owners, they are suseptible to class actions or at least multiple-plaintiff suits that spread out the cost of undertaking litigation.

Private vs. Public Suits

Suits against local public bodies regarding flooding and drainage problems are comparatively recent, and so far, have not clearly involved coastal hazards. The balance of this paper considers a series of potential obstacles to liability suits against local governments. All appear to be surmountable.

Sovereign Immunity. Historically, governments were considered immune to private suits based on negligence unless they consented to be sued. This was based on the theory that "the King can do no wrong." The doctrin was extended to municipal governments in the landmark English decision in Russell vs. Men of Devon (100 Eng. Rep. 359, 1798). The doctrine has received much lip service in the United States but has also been widely criticized and eroded. Most states have now abolished the defense of sovereign immunity by statute or by judicial decision, at least as to "proprietary" activities of local governments (Sands and Libonati, 1981).

Governmental-Proprietary. A major step in the curtailment of soverei immunity was the development of a distinction between "governmental" and "proprietary" functions of local government, first enunciated by a New York court in 1842 (Prosser, 1971). The doctrine distinguished between local activities which were mandated by state law ("governmental") and those undertaken voluntarily by the municipality in its corporate capacity ("proprietary"). Negligence by municipal employee was considered to be covered by sovereign immunity in the former case (e.g., police and fire protection) but capable of giving rise to local government liability in the latter case (e.g. water supply, recreation facilities).

Many activities, however, could not readily be assigned to governmental or proprietary status, thus requiring judicial interpretation. Such has been the case with municipal drainage and flood control activities. In Krantz v. City of Hutchinson, 196 P.2d 227 (Kan. 1948), it was held that construction on an emergency dike was proprietary in nature, thereby rendering the municipality liable for negligence:

> Having regard to the fundamental basis upon which the distinction between governmental and proprietary functions is based, we are unable to say that the acts of the city officials here complained of were in furtherance of a governmental function. They were not acts performed as an agency of the state, expressive of its sovereignty. They were not performed in promotion of the public welfare generally. They were performed for the special financial benefit of the city and its property, and of its property owners. That was the controlling consideration. The acts were essentially transactions by and for the city in its individual corporate capacity. (196 P.2d, at 232).

The need for such strained interpretations has led to a widespread repudiation of the governmental-proprietary distinction. According to Sands and Libonati:

> It has long been apparent that the governmental versus proprietary distinction serves as an incantation for stating results other than as a predictable and uniform guide to judicial decisions. (Sec. 2703) (1981).

Nonfeasance-Misfeasance. Assuming that the defendant local government is not immune to suit, the issue arises as to whether it owed a duty to the plaintiff to protect the latter from flood damage. This raises the distinction between "nonfeasance" and "misfeasance". It has long been held that local governments have no duty to protect their citizens from flooding. Even a flood control district is not required to install facilities everywhere within its jurisdiction. But where drainage and flood control facilities are constructed, they must be maintained and operated properly and without negligence. Hayashi vs. Alameda County Flood Control and Water Conservation District, 334 P.2d 1048 (1959). Thus a local government is not liable if it does nothing to protect plaintiffs, but if it attempts to control flooding in a particular area, it is liable if it bungles the effort. This apparently is the case wheth- or not the plaintiff would have been flooded if the local government had not intervened. In the Hayashi case, the district was held liable for failure to repair a levee to the detriment of the plaintiff whose land would certainly have been flooded without the levee.

Liability for misfeasance in flood control and drainage activities has been upheld against counties and cities as well as special districts in California. (See, e.g.: Carlotto Ltd. vs. County of Ventura, App., 121 Cal. Rptr. 688 (1975).) No doubt the coastal storms of 1982 and 1983 will yield a new rash of suits against California local governments. It should be emphasized however that local governments are not considered to be "insurers" of their citizens' safety and welfare. Even where a govern- ment embarks upon a flood control program, it is, at most, liable for its negligence, not for any damage which may occur (McQuillin, 1963). An exception to this is where new areas are flooded due to the project (see section on reasonable use, below).

Cloak of Federal Immunity. The Flood Control Act of 1928, Sec. 702c stated:

> No liability of any kind shall attach to or rest upon the United States for any damage from or by floods or flood waters at any place.

This provision has been held to constitute an exception to the Federal Tort Claims Act of 1946 to the effect that the federal government remains immune to suit regarding its flood control activities. Stover vs. U.S., 332 F.2d 204 (9th Circuit, 1968), cert denied, 85 S. Ct. 276 (1964). The question logically arises as to what extent this federal shield of immunity applies to nonfederal governmental bodies that cooperate with federal agencies in the design and construction of flood control facilities.

This question was specifically addressed in Florida East Coast Railway Co. vs. U.S. vs. Central and Southern Florida Flood Control District et al., 519 F.2d 1184 (5th Circuit, 1975). This case involved flood damage to plaintiff's railroad right of way on two occasions due to failure of a flood control levee designed and constructed by the Corps of Engineers and owned and operated by the defendant flood control dis- trict. The court held the federal government to be immune to liability under Sec. 702c but nevertheless held the District liable for its participation in the project:

> Although the Corps had primary responsibility for the design of the project, the trial judge found that the Flood Control District worked closely with the Corps in the planning stages. The Flood Control District,. . . "reviewed in detail, and commented on the General Design Memorandum. . . , the Detailed Design Memorandum . . . and the Project Plans and Specifications. It was responsible for alignment of the project. The Flood Control District also provided advice and assistance to the Corps with regard to the actual construction of the project." In addition the Flood Control District furnished 15 percent of the funds for completing the undertaking. (549 F.2d, at 1188).

It was further found that after an initial washout in 1979, ". . .neither the Flood Control District nor the Corps warned the railroad or took steps necessary to correct the defects." A second washout in 1970 caused $438,000 of damage to the plaintiff. The flood control district was accordingly found liable:

> . . .for permitting the construction of a nuisance on its land and for trespass by reason of the rapid runoff of water it had caused. It was also held liable for negligence as owner for failure to assure that the project was properly designed, constructed and operated, and vicariously as a joint venturer with the Corps. These grounds of liability were upheld on appeal. (549 F.2d, at 1189).

Act of God. An additional defense posed by the flood control distri(in the preceding case was that the washout was due to an "act of God," rather than the district's negligence. This was rejected by the trial court on the grounds that the rainfall involved was not "unprecedented" and was not the "sole proximate cause" of the damage.

A Colorado case, Barr v. Game Fish and Parks Commissioner of Colorado, 497 P.2d 340 (1972), rejected the defense that failure of a dam was due to an "act of God" in the form of extraordinary rainfall. The court held that the dam was improperly designed for the "maximum probable flood," which the defendant should have foreseen. Quoting Baum vs. County of Scotts Bluff, 109 N.W. 2d 295 (1864):

> In order for a flood to come within the term act of God, it must have been so unusual and extraordinary a manifestation of nature as could not under normal conditions have been reasonably anticipated or expected. . .An act of God does not necessarily mean an operation of natural forces so violent and unexpected that no human foresight or skill could possibley have prevented its effect. It is enough that

> the flooding should be such as human foresight could not be reasonably expected to anticipate and whether it comes within this description is ordinarily a question of fact. (Emphasis supplied by the Barr court.)

Reasonable Use. Even where negligence is not involved, a local government is liable to the owner of property that becomes flooded or is subject to increased levels of flooding as a result of the defendant's flood control efforts. The Ohio court in Masley vs. City of Loraine, 358 N.E. 2d 596 (1976), held the city liable to owners of property receiving flooding of increased frequency and intensity as a result of the defendant's storm drainage system:

> A municipal corporation may make reasonable use of a natural watercourse to drain surface water and will not be liable for incidental damages which may be considered "damnum absque injuria." It is also not liable for increased flow caused simply by improvement of lots and streets. . .
>
> But where a municipality constructs a public improvement, such as a storm sewer system, and thereby effectively takes private property for its own use by casting surface waters upon that property, it must pay compensation for the property taken. . . (358 N.E. 2d, at 600).

Permit-Granting Functions. A harder question which has seen little airing in the courts is whether a municipality or county may be liable fo flood damage arising as a result of the issuance of building, subdivision or other development approvals. Presumably the recipient of development permits would be estopped from holding the municipality liable on the ground that they were contributorily, and perhaps primarily, at fault by building in such a location. But what about the successor in title to one who has been allowed to build in a hazardous location in the recen past? What is the position of parties receiving increased flooding due to nearby development approved and perhaps encouraged by the municipality

All of the cases considered so far in this paper have involved some form of structural activity on the part of the local government defendant in which negligence or trespass was alleged. Another Ohio case, Myotte v Village of Mayfield, 375 N.E. 2d 816 (1977) also involves a structural activity but hints at wrong-doing in the city's permit-granting role as well. Noting the tax revenue accruing to the Village from a newly-built industrial park, the court holds Mayfield liable to a property owner who experiences augmented runoff from the paved surfaces of the development. The court upheld a ban on the issuance of further building permits by the defendant until drainage in the vicinity of the plaintiff is improved.

Until recently, municipalities were not usually held liable for flooding resulting from wrongful issuance of a building permit or from failure to enforce an ordinance or approving defective subdivision plans. (See Breiner v. C. and P. Home Builders, Inc., 536 F.2d 27 (3rd Circuit, 1976.) A recent Nevada case, however, may foretell stricter levels of scrutiny in the area of municipal permit-granting. In County of Clark v. Powers, 611 P.2d 1072 (Nev., 1980), a county and a flood control district were held liable for flood damages resulting from private development that caused greater surface runoff across defendant's land. Although no local flood control project was involved, the court found that:

> The County participated actively in the development of these lands, both by its own planning, design, engineering, and construction activities and by its adoption of the similar activities of various private developers as part of the County's master plan for the drainage and flood control of the area. (611 P.2d, at 1076)

The court went on to find that:

> ...the economic costs incident to the expulsion of surface waters in the transformation of rural and semi-rural areas into urban and suburban communities should not be borne solely by adjoining land owners. (Id., at 1076)

Summary and Conclusion

This paper has summarily reviewed several issues and doctrines affecting liability of local governments for actions that fail to restrain flood damage or make it worse. Analogy was drawn from suits between private parties involving flooding and drainage issues. Potential liability of private parties exists in many jurisdictions for alteration of natural surface flow to the detriment of upper or lower riparians. Inter-private suits, however, are ineffective as vehicles for large-scale loss-shifting due to the problem of multiple causation and other factors.

Suits against local governments (municipalities, counties, and special districts) have been successful in redressing flood-related losses in inland settings, particularly in California. While hydrologic circumstances of the coast differ from riverine flooding, it is likely that actions by coastal substate jurisdictions regarding structural measures, land management and emergency management may be subjected to judicial scrutiny in the near future.

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VII. FEDERAL/STATE POLICY

THE DEVELOPMENT OF A CONSISTENT FEDERAL POLICY ON COASTAL BARRIERS: A CASE STUDY

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Introduction

The enactment of the Coastal Barrier Resources Act of 1982 (CBRA) represents a milestone in the development of consistent federal policy for the protection of an important natural resource within the coastal zone. This legislation specifically identified a coastal barrier resources system comprised of 186 units, depicted on 177 maps, and totaling approximately 725 beachfront miles. Each unit has been determined by Congress to be a coastal barrier and to be undeveloped as provided by CBRA.

The legislation provides a valuable means of initiating protection for these undeveloped coastal barriers. Upon the date of enactment, October 18, 1982, no new federal financial assistance or expenditures may be incurred within the system except as otherwise provided by the Coastal Barrier Resources Act itself. This prohibition establishes a consistent federal budgetary policy with regard to the units of the system The financial prohibitions provided by CBRA, as well as the exceptions, represent the establishment of a coherent and consistent federal policy toward these important natural resource areas.

An important aspect of this act is its simplicity. It has only two key components: 1) the systematic identification of a specific type of natural resource, and 2) the implementation of a consistent federal policy toward those identified areas. This approach has profound implications for the future: these same components will work in other areas. Other significant natural resources--termed "areas of national importance"-- may be adaptable to the same approach.

Because of its simplicity, the coastal barriers concept could be used to protect wetlands, undeveloped river areas, high hazard chaparral and similar natural resource regions that merit federal attention. Units of the National Park System or the National Wildlife Refuge System--areas already identified by Congress--could also be provided protection in the same way. Success does not require federal management or acquisition; indeed, the goal is to protect these areas through less federal involvement rather than more. Private initiative is the key.

Equally significant, however, the coastal barrier concept is a product of the past. It represents a synthesis of many earlier efforts to protect coastal barriers and other natural resources by establishing consistency in federal policy. This approach has been successful because it resolves many of the internal conflicts inherent in the normal operations of the federal government. Previous attempts to establish federal consistency and to resolve these conflicts were the forerunners of the coastal barrier concept.

The first key component of the Coastal Barrier Resources Act was the identification of specific undeveloped coastal barriers to be placed in the system. The definition of an "undeveloped coastal barrier" is a product of both scientific and public concerns. It is not, and was not intended to be, a purely scientific concept: the Congress had to consider the best interests of the county as a whole. A similar approach would be necessary to implement a workable definition for the identification of other "areas of national importance."

The second component of the coastal barrier concept is the application of a consistent policy toward these areas. The federal executive should act in a consistent and systematic way with regard to specific and identifiable natural resources.

This article examines federal consistency in the past, working through the coastal barrier concept, and leading toward the protection of other "areas of national importance" in the future. To do this it is necessary to

- define the consistency concept;
- discuss the possible components of a consistent federal policy;
- review past efforts to establish consistency in federal programs;
- consider the coastal barrier concept from the perspective of the federal budget;
- consider federal tax policy from a consistency perspective; and

. apply the federal consistency concept to the protection of Congressionally established natural resource areas as well as future areas of national importance.

The Consistency Concept

The basic premise of consistency is simple: the federal government should act in a systematic manner toward areas that merit compatible treatment. This does not mean that a single-purpose policy is applicable, or plausible, for the vast majority of the United States. However, there clearly are some resource areas that are worthy of being considered from a common objective. The successful identification of undeveloped coastal barriers is evidence that identifying other areas of national importance is practicable.

Historically, key natural resource areas have been set aside as parks wildlife refuges, wilderness areas and the like. The CBRA now demonstrate that a second generation of natural resource protection can be initiated without expanding federal management and control. Already-established areas can also be protected in the same manner. Less government rather than more can be used to protect these key natural resources.

Two benefits accrue from consistency in federal policy. First, the government avoids expensive internal duplication. Projects funded or encouraged by one program need not be protected or acquired by another. Second, a consistent policy has a dramatic impact on private expectations and opportunities and, therefore, on the future development of the area in question.

The simplicity of this concept makes the lack of a consistent federal policy seem inconceivable. The federal government has spent millions of dollars trying to protect the natural resources of coastal areas; more millions of dollars for support facilities that create tremendous incentives toward development of the same areas; and even more millions of dollars in insurance claims and disaster relief when the people that have moved in are flooded out.

Components of Consistency

The impact of the federal government on the ultimate use of natural resources such as undeveloped coastal barriers is a product of federal expenditures, federal substantive legislation, and federal tax laws. These factors are distinct because of the way they are developed by the Congress and administered by the Executive Branch.

Within Congress appropriations, substantive laws and tax legislation are established independently. Under the committee system, legislation concerning each of these originates in a separate set of committees. This means that substantive legislation concerning, for example, federal flood insurance, will arise in one set of Congressional committees. Appropriation of funds for the insurance program will be the product of another set. Finally, tax policies for insured areas will be initiated by a third. The federal executive also separately addresses and implements substantive legislation, budget, and tax policy.

The existence of these three distinct legislative avenues complicates federal policy, both at the Congressional and executive levels. Obviously substantive laws and federal appropriations are closely related. Changing one will dramatically affect the other. A federal program created by substantive legislation will only work if it is funded by appropriations legislation. This is not true for those substantive laws that are not dependent upon the distribution of federal financial assistance such as federal license or permit programs. Although a cutback in appropriations may reduce staff and create delays, actual consistency in this area requires substantive legislative changes.

The third factor, tax policy, is independent of the other two. Tax committees are distinct from those that originate substantive laws. In addition, as with federal permit programs, the budget process does not directly change federal tax policy which is largely independent of appropriations. A reduced appropriation may limit the number of tax examiners, but people will still be required to pay their taxes consistent with existing requirements.

Past Efforts to Achieve Substantive Federal Consistency

A consistent federal policy for protection of certain natural resources means that all appropriate federal programs and projects will be designed and administered to achieve a common objective. Applied to coastal barriers, this would mean that all federal programs--not just new financial assistance and expenditures--would be geared toward protecting these natural resource areas. Federal permits for bridge construction or dredge and fill operations, for example, would also be affected.

Substantive consistency was not established by CBRA and this is typical of federal legislation. This is because substantive consistency with regard to coastal barriers, or any area of national importance, requires that federal actions have a common purpose and a single decisionmaker. Typically, the federal executive branch has neither.

Federal laws applicable to areas of national importance such as undeveloped coastal barriers often have inconsistent and conflicting goals. Federal legislation is typically directed at program areas such as highways, health, and education and most Congressional committees are responsible for these subjects, not for specific geographic areas. Each of these program areas has its own specific purpose, typically, to promote expand, improve, or maintain the subject of the legislation. This means that the federal government, through its diverse agencies and instrumentalities, may be encouraging and supporting highways, community development, power facilities and natural resource protection all at the same time. Subject matter laws with strict program-oriented purposes are the first major impediment to a unified federal policy for areas of national importance.

Further, there is no single federal decisionmaker available for areas of national importance. A substantive overall policy review of the interaction of federal programs applicable to a specific area is not feasible. As enacted, program area laws are administered by federal executive departments responsible for the subject. Most substantive federal laws are directed at the secretaries or other leaders of the various federal departments and agencies. Occasionally, the Congress will vest authority in a specific agency. Rarely, however, will a specific act directly authorize the executive branch as a whole to make substantive decisions. This problem, coupled with the divergent goals and purposes inherent in all these federal laws, makes it difficult to achieve substantive federal consistency.

Previous legislative and executive actions have not resolved this issue, but they have provided some models. Attempts to establish consistency of federal substantive policy have fallen into four categories 1) exercise of discretion within the federal executive; 2) Congressional statements of general policy; 3) specific project area legislation; and 4) specific legislation applicable to areas of generic concern.

Descretion with the Federal Executive

The exercise of discretion within existing authorities has been used in an attempt to establish a common purpose and unified decision-making. The authority of the Chief Executive has been used to supervise and lead the executive branch. Although Presidents may have only limited authority to act as, or in lieu of, a particular secretary, they have a significant responsibility to give direction and manage the federal executive as a whole. Directing and structuring the discretion available to program managers is one option that has been available to all Presidents. The dilemma, of course, is that the more specific the problem, the less effective the control and the more obvious any conflicts with the basic laws in question.

Chief Executive discretion and authority can be exercised in a number of ways. One of these is the Presidential Executive Order. The Regulatory Analysis Review Group established by Executive Order 12044 in 1978 by President Carter and President Reagan's Executive Order 12291 are examples of the exercise of the general management authorities of the Chief Executive. The Reagan initiative has been successful in establishing an Administration tone that has had a significant impact on decisionmaking within the federal government. Presidential Executive Orders have been used to address natural resources, wetlands, floodplains, and off-road vehicles.

Another way to use Presidential authority to establish substantive consistency is through the Office of Management and Budget, a part of the

Executive Office of the President. OMB has traditionally been utilized to set policy direction within legislatively established boundaries. One example is the OMB Circular A-95 review process (now being replaced by a new Presidential Executive Order 12372) which structures federal executive communications with state and local governments. As with Executive Orders, such circulars are effective in establishing tone and direction, but they have limits. They cannot change either the legislative basis for t decision or the decisionmaker. The formula established by Congress in the substantive legislation must be followed.

A third approach is the adoption of a more extensive sub-Cabinet or Cabinet Council, as has been done by the Reagan Administration. Here agai however, the inherent restrictions of narrow legislation and specific deci sionmakers will be a limitation. As with Executive Orders and OMB Circulars, such a structure can establish tone and direction but it cannot change the limitations created by Congress.

Congressional Statements of General Policy

Periodically Congress has passed a variety of laws designed to guide federal decisionmaking or to establish concern about protection of important natural or cultural resources, but not necessarily to amend existing substantive provisions or to change the decisionmakers. The National Environmental Policy Act, the Fish and Wildlife Coordination Act, section 106 of the National Historic Preservation Act, the Council on Environmental Quality, and the role of the now-defunct Bureau of Outdoor Recreation are illustrative of this approach. All have several aspects in common. First, they contain consultation and information provisions: they do not amend specific subject-area legislation. Second, they are not designed to veto projects but merely to introduce environmental, socio-economic and cultural considerations. Third, they leave the decisionmaking with the substantive agency or program and do not create an independent or single decisionmaker.

Assessing the overall impact of these Congressional statements of policy is difficult. These initiatives have played an important role in raising a greater general environmental, socio-economic and cultural awareness within the executive branch. Although these types of laws are of broad applicability, they tend to be effective only when truly significant resources are at stake. NEPA compliance, for example, is important when there are significant resources in jeopardy. At other times, it becomes routine and perhaps unnecessary and inefficient.

Specific Project Area Legislation

Specific project area legislation is legislation applicable to one type of resource and one or a variety of federal programs. Unlike the more general Congressional statements of policy, these provisions contain a substantive veto effect. That is, unless the conditions established by these separate laws are satisfied, an otherwise-authorized federal program or project cannot proceed. Section 4(f) of the Department of Transportation Act, §7 of the Endangered Species act, portions of the Clean Air Act and portions of the Surface Mining Control and Land Reclamation Act all reflect these qualities. Each is directed at a specifi type of resource and, with the exception of the Endangered Species provision, they are restricted to a narrow range of federal programs.

Specific Legislation Applicable to Designated Areas

Some legislation has attempted to establish a single federal purpose and single federal decisionmaker with regard to a fairly broad resource area. While there are no perfect examples, some laws at least have attempted to establish such broad-based federal substantive consistency. The Coastal Zone Management Act, the creation of the Federal Inspector for Construction of the Alaska Natural Gas Transportation System, and the Pinelands Natural Reserve Act are important examples. They are transitional, however, and each has significant limitations that frustrate establishment of a true federal consistency.

The Coastal Zone Management Act attempts to identify an area of concern and to establish a consistent federal substantive approach. There are several problems, however. First, the scope of the CZMA is overwhelmingly diverse and cannot possibly be subject to a consistent federal approach. While Miami Beach and desolate coastal stretches of North Carolina may both be within the coastal zone, they are not the same and cannot be treated the same. Second, and perhaps reflective of the diversity of the coastal zone, there is no single federal purpose in the Act. The objectives are vague and ill-defined when applied to the various areas within the coastal zone. Third, the executive has deferred to the coastal states in the articulation of the purposes provided by the Act and has therefore intensified this problem and the difficulties inherent in the consistency provision itself. CZMA does not meet either standard for substantive federal consistency: there is no single federal purpose nor is there a single federal decisionmaker.

The Federal Inspector for construction of the Alaska Natural Gas Transportation System was created pursuant to Chapter 9, Title 15 of the United States Code. The provision creates a single federal decisionmaker for the construction of the Alaska Natural Gas Transportation System. All federal actions applicable to this project have been identified. Implementation of each of these has then been transferred (reorganized) to the Federal Inspector. This is a dramatic and successful example of the creation of a single federal decisionmaker.

A third example of legislation attempting to establish a single federal purpose and a single federal decisionmaker is a series of laws enacted in 1978 incorporating Lowell, Pinelands, Jean Lafitte, and Santa Monica Mountains into national park and recreation areas. The Lowell Act (P.L. 95-290) has the better consistency provision. Section 102 provides as follows:

> Sec. 102 (A) Any Federal entity conducting or supporting activites directly affecting the park or preservation district shall--
>
> (1) consult with, cooperate with, and to the maximum extent practicable, coordinate its activities with the Secretary and with the Commission: and
>
> (2) conduct or support such activities in a manner which (A) to the maximum extent practicable is consistent with the standards and criteria established pursuant to section 302(e) of this Act, and (B) will not have an adverse effect on the resources of the park or preservation district.
>
> (B) No Federal entity may issue any license or permit to any person to conduct an activity within the park or preservation district unless such entity determines that the proposed activity will be conducted in a manner consistent with the standards and criteria established pursuant to section 302 (e) of this Act and will not have an adverse effect on the resources of the park or preservation district.

After 1978, Congress wrestled with a number of different areas in an attempt to refine and improve upon the legislative approach evolving with these new areas. Consensus broke down, however, as older concepts that would have depended upon nearly total federal management and control were advocated as improvements to this new approach and the momentum was lost.

Federal Budget Consistency: The Coastal Barriers Concept

It has only been within the last decade that the federal budget has been evaluated from an overall perspective--not to achieve federal consistency but to simply identify total federal expenditures. Obviously, internal budget consistency is a far more sophisticated demand and one that has just begun to evolve.

In addition, despite the lack of historical precedent, there are in fact few legal difficulties in establishing federal consistency through the federal budget process. Unlike the problems inherent on the substantive side--lack of a unified purpose and the proliferation of decisionmakers--the budget authority is clearly centralized. Under the Budget and Accounting Act of 1921, the responsibility to establish and transmit a budget to the Congress rests squarely with the President. In addition, lesser officials within the executive branch are specifically forbidden from providing an estimate or request for an approriation, or an increase thereof, to the Congress unless specifically requested by Congress, and only then through formal channels. The clear authority residing with the President to develop the federal budget and the fact that each budget is subject to review by specific appropriations committees, not the more diverse substantive committees, makes the budget process a powerful policymaking tool.

The traditional approach to protecting barrier islands would have been federal acquisition and management. Such an approach, considered in 1978 but not adopted, would have been extremely expensive, both initially and from a management perspective, and destructive of private or state and local government opportunities. Thereafter, a budget approach was initiated. Section 341 of the Omnibus Budget Reconcilation Act of 1981 (OBRA) (P.L. 97-35), spoke directly to the problem. Subsection (d) (1) provided that "(n)o new flood insurance coverage shall be provided. . . on or after October 1, 1982, for any new construction or substantial improvements of structures located on undeveloped coastal barriers which shall be designated by the Secretary of the Interior." In essence, Congress stopped future federal funding for flood insurance on the yet-to-be-designated coastal barriers.

The Coastal Barrier Resources Act of 1982 (P.L. 97-348), expanded the concept embodied in OBRA. Congress took the proposed designations, reviewed them carefully, and enacted new legislation creating a Coastal Barrier Resources System. There are several significant observations to be made about this law. First, although it restricts federal expenditures, it was not passed as a budget measure arising out of the appropriations committees. In this sense, CBRA is a substantive consistency provision rather than a budget provision. This switch from OBRA shows the close relationship between the two approaches. Second, the prohibitions on federal financial expenditures were significantly expanded from OBRA. Almost all new federal expenditures were prohibited. Third, CBRA specifically does not address strictly substantive federal actions such as permit and licenses that do not result in the specific expenditure of federal appropriations (other than administrative or overhead costs). This distinction illustrates an important difference between total substantive consistency and budget consistency alone.

The coastal barrier experience demonstrates the strength of a federal budgetary consistency program for an identified area of national importance. Through the Coastal Barrier Resources Act, the framework for resource protection has been achieved and powerful protection incentives set in motion with less federal involvement rather than more. Unwise federal expenditures have been averted, costly federal acquisition and management avoided, and state, local and private responsibilities and opportunities retained.

Federal Tax Consistency

Federal tax policy is the third major factor controlling the impact of the federal government. As with substantive legislation and budget policy, the Tax Code of the United States has a separate and dramatic

: on the future use of identified areas of national importance.
either the federal deficit perspective or with regard to impacts on
.dual decisionmaking, indirect tax expenditures (potential taxes
llected because of deductions and exceptions) are as significant
ect budget outlays. Here again, private sector expectations are
to the opportunities and difficulties provided by governmental
ms and policy decisions. As discussed previously, these actions
rectly influence future land use with regard to coastal barriers
er areas of national importance. Currently, tax consistency remains
e possibility and one that merits specialized treatment, both by
ecutive branch and the Congress.

ain the key is careful identification and delineation. Precise
ication of areas of national importance will permit and encourage
ent and supportive federal tax policy. Following the passage of
stal Barrier Resources Act, tax legislation was promptly introduced
uld have eliminated the deductibility of interest paid on a loan
construct a structure within the Coastal Barrier Resources System.
ould be no better example of an attempt to align federal tax policy
leral budget policy. A policy that restricts direct federal ex-
es on units of the Coastal Barrier Resources System should also
direct federal tax expenditures such as mortgage and casualty
uctions to achieve actual consistency of purpose.

The Federal Consistency Role

enactment of the Coastal Barrier Resources Act of 1982 represents
one in the development of consistent federal policy for the pro-
f natural resource areas. It has demonstrated two important
First, identification of natural resources is fundamental.
onsistency of federal purpose can assist to protect such areas
xpanding government control.

rkable definition and the actual designation of undeveloped
arriers made the Coastal Barrier Resources Act possible. There
to define and identify those remaining segments of the United
at are worthy of specialized federal attention. Congress has
stablished the groundwork for this identification process in

two ways. First, many key natural resource areas have already been identified through existing legislation. Second, with passage of the Tax Treatment Extension Act of 1980, Congress established a careful and workable definition of those additional areas of national importance that may merit additional federal concern. That legislation defines those special areas for which preservation or protection constitutes a "conservation purpose" under portions of the United States Tax Code.

Once key natural areas have been identified, two critical decisions must be made. Should the federal government participate in their protection and, if so, how should this be done? Both the existence of federally established natural resource areas and the Tax Treatment Extension Act definition suggest that there are areas of national importance that merit federal attention. This attention must be carefully structured, however. The coastal barrier concept has been successful because it is geared to the proposition that the federal role should be limited. Federal expenditures should be restricted to avoid expensive internal inconsistencies. State, local and private participants should be provided with an additional incentive to act, not to have the federal government act for them.

Federal consistency can accomplish these goals. Once areas of national importance have been identified, the federal impact on the area must be reevaluated, a single purpose must be established and the federal impacts aligned in a consistent manner. First, the three major federal factors affecting these areas, federal substantive legislation, federal tax policy and federal budget policy, must be reevaluated and adjusted, as appropriate, to be consistent with the federal objective. Second, to the degree further unity is appropriate, a single federal decisionmaker should be established for these areas. There may be a need for a consistent federal voice interpreting federal policy with regard to these identified areas.

In this manner, the federal government can create a significant incentive toward protection of areas of national importance and also avoid direct federal intervention and federal management outside of alread established areas. Important incentives for state, local and private protection efforts can be established without an expansion of the federal role. A Smaller federal government can be more effective.

It is from this perspective that the coastal barrier experience and the ideal of federal consistency it represents become most important. This approach has done away with traditional federal pigeonholes and has addressed a single type of resource, yet one that covers significant geographic areas, in a systematic and compatible way. Federal consistenc has been utilized to assist in the protection of a key natural resource, to save taxpayer dollars, and to avoid federal intervention and preemptio of state and local concerns. An effective and precise federal tool has been crafted. National priorities have been established, but not dictat and the stage has been set for additional non-federal protection.

SUMMARY OF RECENT GAO STUDIES RELATING TO THE NATIONAL FLOOD INSURANCE PROGRAM

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During the past year the General Accounting Office (GAO) has conducted a number of studies on the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP). GAO has examined the following issues:

- Is the flood insurance program stimulating flood plain development?
- Should flood insurance be available for development in high hazard areas?
- Are flood plain management regulations being adequately enforced?
- How does FEMA establish actuarial rates?
- Is it possible to eliminate the federal subsidy and make the NFIP self-sustaining?
- Is the federal flood insurance revolving fund an appropriate mechanism for handling the program's finances as compared with a direct annual appropriation?
- What is the impact of recent premium rate increases on individual and community participation in the NFIP?
- What is FEMA's progress in converting flood-prone communities from the emergency phase to the regular phase of the NFIP?

GAO's findings and recommendations relating to these issues are discussed below. A complete list of GAO reports on the NFIP is appended.

Flood Insurance Is Not a Significant Factor In Encouraging Coastal and Barrier Island Development (GAO, 1982)

Coastal and barrier island communities are developing rapidly because they offer many attractive features and opportunites for retirement and recreation. After studying six coastal communities, interviewing various federal, state, and local officials, and reviewing research literature, GAO concluded that the availability of federal flood insurance is not the principal reason for flood plain development in these communities, but that it does offer a marginal added incentive to development.

Flood insurance provides financial security to lenders to make loans and to individuals to buy homes or make investments and it requires that buildings constructed meet certain standards, thus providing communities with greater confidence to allow construction in such areas and individual with a more secure feeling of having a safer structure.

Other major factors promoting development of coastal and barrier island communities include bridge access to barrier islands; community infrastructure such as roads, water, sewers, and utilities; the availability of mortgage and investment capital; construction costs; the state of the economy; and regional and local economic conditions.

Many of the 115 people interviewed and the many research studies reviewed pointed out that these other factors were more important to development than flood insurance. For example, Maryland officials advised that a new bridge was responsible for increased development in Ocean City. The following table summarizes the views of the individuals interviewed.

TABLE 1

SUMMARY OF VIEWS REGARDING IMPACT OF FLOOD INSURANCE ON DEVELOPMENT

Group Interviewed	Reasons program aided development: Financial Security	Better Construction	No particular reason	No impact or No opinion	Program Discouraged	Total
Federal officials	3	6	1	2	0	12
State officials	6	12	7	0	0	25
Community officials	5	9	4	3	0	21
Business people	24	11	10	11	1	57
Total	38	38	22	16	1	115

No one cited flood insurance as the principal factor encouraging flood plain development, but 98 of 115 people interviewed thought that flood insurance aided development. The primary reasons given were financial security and better construction standards. Fifteen people said that flood insurance had no impact on development and one had no opinion. Federal, state, and local community officials thought that the primary reason the flood insurance program aided development was the better construction standards required under the program. Business people thought that the most important reason the program aided development was the financial security the program provides.

Should Flood Insurance Be Available For Development In High Hazard Areas? (GAO, 1982)

Development in coastal high hazard areas is permitted if certain flood plain management requirements have been met. Recent information, observations in the field, and discussions with community officials revealed that past development in some coastal high hazard areas may have been unwise because wave heights from storms and the stability of structures to withstand wave impacts had not been considered. FEMA has recently revised its insurance rating system to encourage elevation at least to the wave height level in the coastal high hazard areas as an interim measure until new maps are developed which reflect wave heights and are adopted as part of the local flood plain ordinances.

Even with this recent improvement, Congress should reconsider whether it is desirable public policy to continue providing flood insurance for new or substantially improved structures in high hazard areas adjacent to the coast--referred to as wave velocity areas or V zones--because of unavoidable potential for loss of life and destruction of property in these areas. At the same time, Congress should reconsider whether federal financial assistance for acquisition, construction, or reconstruction purposes should continue to be provided in the coastal high hazard areas. The policy question involved is whether the federal government, through its assistance programs and tax laws, should share in the risks or whether individuals who build in coastal high hazard areas in the future should assume the full risks of losses.

FEMA's Monitoring Program Inadequate for Enforcing Flood Plain Management Regulations (GAO, 1982)

FEMA conducts a limited monitoring program to determine how well communities participating in the flood insurance program are enforcing flood plain management regulations. The key element of this program is a visit by FEMA representatives to an individual community, referred to as a Community Assistance and Program Evaluation (CAPE) visit. A CAPE visit involves meeting with local officials and other community people, a review of construction permit procedures, and a field inspection of new construction occurring in the flood plain. The objectives of a CAPE visit are to explain and clarify the program (community assistance) and to check on a community's implementation of its flood plain management regulations (program evaluation).

The successful mitigation of flood hazards in the United States is dependent on the adoption and enforcement of sound flood plain management practices at the local government level. After 15 years, relatively little is known overall about how well communities in the flood insurance program are enforcing flood plain management regulations. GAO found that FEMA's monitoring program was limited, the method of selecting communities to visit was inadequate, and the results of community visits were not evaluated.

FEMA had established a goal of monitoring about 20% of the regular program communities in the flood insurance program each year. For the five years ending September 30, 1981, FEMA had visited only 77% of the number of communities that it intended to visit. FEMA Regions IV (Atlanta) and VI (Dallas) attained only about one-third of their goal, yet those two regions account for about 70% of policies in force and new construction in the flood plains and about 57% of total insurance claims paid to date.

GAO also found that strong perceptions exist that FEMA headquarters was lenient in requiring that program regulations be enforced by participating communities. FEMA management told us of their intent to pursue an aggressive monitoring program and suspend communities that did not comply with flood plain management regulations.

GAO recomended that FEMA:

. Establish a centralized control system to direct and guide the monitoring and enforcement program. This system should include the systematic selection and periodic updating of information on those communities in each region whose compliance with flood plain requirements is considered critical. These communities should receive priority for monitoring visits. The system should also include continuing evaluations of community visits to measure individual and overall community compliance and to evaluate the effectiveness of the monitoring program in each region.

. Reallocate staff resources to increase monitoring activities in regions IV (Atlanta) and VI (Dallas).

. Issue a policy statement to regional offices and program participants setting out the agency's position on suspending communities for failure to enforce required flood plain management regulations

FEMA's Ratesetting Process Needs to Be
Changed To Increase Premium Income (GAO, 1983a)

Between 1978 and 1981, a period of moderate flooding experience according to Federal Insurance Administration's (FIA's) Deputy Administrator, the vast majority of the program's risk premium rates did not produce adequate premium income to cover their associated costs. Despite three successive rate increases since January 1981, these rates are still inadequate.

Inadequate rates have created an unnecessary fiscal drain on the program and may have worked counter to Congressional intent. The act requires policyholders in newly constructed property to pay actuarial rates in order to create the proper incentives for taking flood loss mitigation measures. Rates for new construction in zones A1-A30 and V1-V30 have been inadequate and may have dampened incentives to mitigate flood losses. In any event, the federal government has had to provide a substantial subsidy in an area where none was originally intended.

FEMA's risk premium rates need to produce adequate premium income to cover their associated costs. By setting a fiscal year 1988 goal of a self-sustaining, actuarially sound program, FIA's administrator has focused the agency's attention on the adequacy of the risk premium rates. In our discussions with FIA officials, we identified various efforts that are underway to address the weaknesses we have identified. FEMA's effort to date, however, is in a very preliminary stage and all the actions and resources necessary to produce adequate risk premium rates have not been fully defined. FEMA will need to put forth a considerable effort if it is to produce a credible ratesetting method that will generate adequate risk premium rates by fiscal year 1988. FEMA's effort would be materially assisted if, as it has proposed, it develops a plan that provides a clear agenda for addressing the data and methodological weaknesses that have contributed to the current situation.

Besides correcting the identified weaknesses, other actions are needed to improve FEMA's ratesetting and make it more in line with accepted actuarial principles. First, FEMA needs to estimate and begin to accumulate a catastrophic reserve. Accepted actuarial principles clearly warrant such an action. FEMA's borrowing authority is not, in GAO's view, an adequate surrogate for a reserve since its use increases rather than offsets program costs.

Second, FEMA needs to explore ways to simplify its rate structure. The current structure is too complex and may actually contribute to the program's financial problems. Fewer classifications would not prevent FEMA from charging policyholders on the basis of the risk through broader risk categories--an important consideration in light of the program's problem with adverse selection.

Finally, in setting rates FEMA needs to continue to give more credence to its recent loss experience. We recognize that the nature of floods can result in highly variable data. Indeed, FEMA's adoption of the hydrologic model is an attempt to deal with this phenomenon. This model, however, has not proven to be a very accurate predictor. Further, rates in some of the program's major zones, particularly zones B and C, are not based on the model but on judgment.

To develop a risk premium rate structure that produces adequate premium income and is in line with accepted actuarial principles, we recommended that the Director of FEMA

- Develop and implement a plan to correct the identified data and methodological weaknesses in FEMA's current ratesetting approach.
- Estimate and establish a catastrophic reserve.
- Develop a rate structure which appropriately reflects variations in risk without unnecessary complexity.
- Increase reliance on recent loss experience in setting rates.

Alternatives Exist for Eliminating
the Federal Subsidy (GAO, 1983a)

To develop a self-sustaining, actuarially sound program by fiscal year 1988, FEMA will need to eliminate the federal subsidy. This will require an increase in the chargeable rates and/or a decrease in the value of the insurance provided. It is unrealistic to expect the policyholders paying risk premium rates, who constitute less than half of the program and whose rates are already inadequate and will have to be raised to bear the full burden of the existing federal subsidy through a cross-subsidy. Faced with substantially higher rates, these policyholders might leave the program.

FEMA will have difficulty deciding exactly what changes in chargeabl rates will be necessary. The current chargeable rates in the regular program were set on the basis of what FIA officials believed was affordab and not with reference to the risk premium rates which could be charged. As a result, the amount of the intended subsidy cannot be readily determined. While this approach was appropriate for the emergency program, it was not and is not appropriate for the regular program.

In order to decide what changes are necessary to eliminate the feder subsidy, FEMA needs to develop a chargeable rate structure which clearly identifies the amount of intended subsidy. The best way to accomplish this is the approach Congress suggested in the Act: establish risk premium rates that produce adequate premium income and derive a set of chargeable rates which could be determined by subtracting a percentage subsidy from the risk premium rates.

Raising the chargeable rates or decreasing the values of insurance provided, if done in a relatively short time frame, could be harmful to program objectives by reducing participation and increasing the use of disaster assistance and casualty loss tax writeoffs. Thus, FEMA must carefully monitor the impact of its chargeable rate increases on its policyholder base. FEMA also needs to develop a method to monitor the impact of any changes it might institute in the value of insurance coverage on the demand for disaster assistance or the level of casualty loss tax writeoffs. FEMA may find it necessary, as the Administrator recognized, to extend the time frame for eliminating the federal subsidy

The Act currently allows FEMA considerable freedom in establishing chargeable rates. Former FIA Administrators believed that eliminating the federal subsidy was to be accomplished over a considerable period of time through the turnover of the insured properties inventory and the positive impact of flood plain management regulations and not through changes in the chargeable rate. The current Administrator has taken a different approach. He wants to eliminate the federal subsidy in a much shorter time. To do so will require changes in the chargeable rate and/or in the amount of insurance provided. While the Administrator has indicated that he does not want to achieve his objective of a self-sustaining, actuarially sound program by reducing participation in the program, his approach does represent a fundamental change from how the program has previously been administered.

In view of this the Congress needs to consider telling FEMA whether it agrees with the shift in direction and giving FEMA specific guidance on how the federal subsidy should be eliminated. If Congress supports the current Administrator, it needs to recognize that chargeable rates are likely to increase, possibly by a substantial amount, and that wide participation may not be achieved. On the other hand, if Congress supports the more gradual approach employed by previous Administrators, it needs to recognize that a substantial federal subsidy could continue into the next century.

Congress Can Increase Its Control Over How Flood Insurance is Financed (GAO, 1983a)

Congress established a revolving fund to finance flood insurance. Such funds are typically set up to finance government programs where a buyer/seller relationship exists. When the congress established the flood insurance revolving fund, it expected the program to be run as a joint government-insurance industry operation and viewed the fund as necessary to provide flexibility and timeliness in paying claims. After a series of disagreements, in 1978 the government terminated the insurance industry's involvement and took over the program.

Because premium income has not covered costs, FEMA financed the insurance program's losses by borrowing funds from the U.S. Treasury.

Between 1970 and 1980 it borrowed about $854 million and by the start of fiscal year 1981 had almost exhausted its $1 billion borrowing authority. Appropriations in fiscal year 1981 and 1982 have restored FEMA's borrowing authority to just under $1 billion. Although it borrowed money each year, FEMA was not required by its enabling legislation to regularly request appropriations to repay its borrowings. GAO believes that the lack of a regular requirement to request appropriations to repay borrowin has reduced the ability of Congress to oversee the flood insurance progra and to identify why the program was operating at a deficit.

GAO has often expressed concern over Congress' weakening its control over program activities when it authorizes revolving funds. GAO believes the public interest is best served when the congress exercises direct control through the appropriations process. At the same time, GAO has recognized that there are legitimate reasons for establishing revolving funds and as a result has stated that revolving funds need to be examined periodically to determine whether they still meet the criteria that justified their creation. Because the basic conditions surrounding the flood insurance revolving fund have changed, GAO believes that Congress needs to review how flood insurance is financed.

GAO believes a congressional decision on program financing needs to be closely tied to action Congress takes on continuing the federal subsidy. If Congress chooses to support FEMA's effort to make the progra self-sustaining in a relatively short time frame, GAO believes the revolving fund can be retained, but GAO recommends that Congress amend the National Flood Insurance Act of 1968 to increase its oversight and control over how FEMA finances its losses.

If, on the other hand, Congress wishes to have the federal subsidy gradually eliminated over the next several decades, thereby making the need for continued federal funding an integral part of the program, GAO believes the flood insurance program should be financed through direct appropriations. To accomplish this change and retain FEMA's flexibility to pay flood claims, GAO recommended amendments to the National Flood Insurance Act of 1968.

Various Factors Have Contributed to the Decline in NFIP participation (GAO, 1983b)

Congress established the NFIP to reduce mounting federal expenditure for disaster relief. To help accomplish this objective, flood insurance was to be offered only in those flood-prone communities that adopted and enforced adequate flood plain management regulations. Having as many individuals and communities as possible in the program is a critical objective. If large numbers of individuals purchase flood insurance, the demand for other forms of postdisaster assistance, such as Small Business Administration disaster loans, can be reduced. In addition, wide individual participation can make the insurance more affordable by allowing the risk of flooding and the fixed costs of the program to be spread over a broader base. Maximum community participation is also important because it ensures that flood plain management regulations, designed to reduce future losses, will be in effect in as many flood-prone areas as possible.

The same month FEMA first raised rates--January 1981--individual participation in the program as measured by the number of policies in forc began to decline. Participation fell from a peak of about 2,014,500 polici in December 1980 to about 1,860,400 in November 1982. During this same time period, six small communities left the program. GAO identified several factors in addition to the rate increases which could have contributed to the decline in individual participation. These factors are the decline in the housing market during the last few years, the smaller number of floods and flood losses experienced in the last few years, and t general economic recession that began in July 1981.

GAO's analysis indicated that while the rate increases did have some influence on the decline in program participation, other factors, in particular the smaller number of floods in recent years and the general recession, also negatively affected program participation. The statistical techniques (regression analysis) used by GAO cannot determine with an degree of precision the relative effect on program participation of the rate increases as opposed to the other factors.

GAO contacted the cognizant local official in each of the six communities which voluntarily withdrew from the program. None of the communities left the program because of the rate increases. In any event, the communities were very small, with the total number of policies in the six communities accounting for only 0.01% of the total number of policies in the program.

The FIA Administrator has been concerned about the possible adverse impact of rate increases on program participation and the program's objectives. He has stated that if FEMA determines that rate increases are hurting program participation, FEMA will re-examine and revise its goal of achieving a self-sustaining program by fiscal year 1988.

Improvements FEMA Could Make to Expedite Transfer of Emergency Communities Into Regular Phase of NFIP (GAO, 1983c)

To enter the "regular" phase of the National Flood Insurance Program, a community needs a Flood Insurance Rate Map. This map shows areas of relative flood risk and helps determine the rate a policyholder pays for flood insurance. The National Flood Insurance Act of 1968 gave FEMA 15 years to produce rate maps for the over 17,000 flood-prone communities in the nation. As of May 1983, FEMA has produced rate maps for 8,600 communities and has another 1,400 communities under study. This has left 7,300 communities in the "emergency" phase of the program, where limited amounts of flood insurance are available.

FEMA has used three techniques to produce flood insurance rate maps--detailed studies, existing data studies, and special conversions. FEMA has generally obtained flood insurance rate maps though detailed studies. These studies take about four years to complete and have cost on the average about $50,000. The alternative mapping techniques, existing data studies and special conversion, can be used to produce flood insurance rate maps in less time and at less cost. For example, FEMA estimates that existing data studies cost about $8,000 and take two years to complete and special conversions cost as little as $1,000 and can be completed within a year. FEMA, however, has chosen to rely on the detailed study technique to develop flood insurance rate maps for about 73% of the communities in the regular phase of the flood insurance program.

FEMA's process for making mapping decisions can be improved. The process as currently implemented focuses only on whether or not to map a community in detail. It does not include a systematic analysis of other available, less costly alternatives for converting communities to the program's regular phase. In addition, because each FEMA region makes mapping decisions differently, the process places varying emphasis on the community's future development potential as a factor affecting the decision to map.

GAO believes that development potential is the key factor in making decisions about how to map a particular community. If a community is growing, it will need the detailed risk zone and flood water height information a detailed map provides in order to develop adequate flood plain management regulations. If a community has no potential for development, the extra information a detailed map provides that a flood hazard boundary map may not, in GAO's view, does not warrant the added cost.

Because FEMA's approach to date has focused on detailed mapping and has placed varying amount of emphasis on analyzing a community's growth potential, opportunities to convert communities to the regular phase without detailed mapping may have been missed. As recently as January 1983, FEMA proposed a long range plan which would provide for a significa[nt] number of special conversions among the 7,300 communities still needing rate maps; however, FEMA was still proposing to map about 2,800 communiti[es] in detail.

GAO believes that FEMA needs to take a closer look at how it will make future mapping decisions. FEMA has recognized the need to revise its approach and has taken the first step by proposing to rank the remaining 7,300 communities based on criteria which measure their development potential. FEMA should develop a systematic approach that incorporates other mapping approaches into the decision-making process, and weigh[s] the added flood plain management data provided by a detailed map against the map's cost and the development potential of the community in question[.]

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CONTEMPORARY WATER RESOURCES POLICY: FEDERAL ADJUSTMENT AND STATE ASCENDANCY

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That this meeting is timely is well attested to by the coastal hazard experiences of this past winter: the damage caused by Hurricane Iwa in Hawaii, two California coastal storms of high intensity, and a major storm that reached from Long Island up through the New England coast. Coastal hazard concerns, including the prevention of coastal flood disasters resulting from hurricanes, "northeasters", and other high-energy coastal storms, are among the most dynamic and complex water resources problems facing the nation, and represent a particular challenge to some 30 states that border on the sea coasts and the Great Lakes. Over the past two decades, about 90% of the national population growth has been in the 30 coastal states, which now contain over 75% of the nation's population and 12 of the 13 largest cities. Since the coastal zone is growing more rapidly in population than other parts of the nation the hazard potential intensifies each year.

Additionally, studies show that the national shoreline is generally in "bad shape". Of the 84,000 miles of U.S. shoreline some 21,000 miles are undergoing serious erosion causing widespread loss of land and property. It is expected that lives will be endangered within five years in most threatened portions. It should be noted that the extent of coastal erosion should be of considerable significance to the private sector, since about 70% of the eroding shoreline is in private ownership. There is fairly general agreement that coastal problems are more complex than riverine ones, of which we have considerably more knowledge and experience. In short, while much is known about the coast and the coastal zone, there is yet a great deal to be learned.

Underlying the many diverse presentations and discussions of coastal concerns, problems, and opportunities at this symposium has been a clear, fairly definite general awareness that as a nation we are caught up in changing times, uncertain times and, incontrovertibly, in a national budget crunch. In a disastrous year of floods, mudslides, and other aberrations of nature, even The American Red Cross has run out of disaster assistance money. There also is a keen awareness of new and emerging national policies pertinent to the management of water resources in general and coastal high hazard areas in particular; and, among many people there appears to be a view that the old ways of doing things no longer work, or a least do not work effectively. Finally, there is a quite general awareness that in the future the federal government will be doing less and the states will be doing more. Call all of this the "New Federalism", or whatever, but in seeking to place the greatest possible reponsibility on the states, it emphasizes

- State primacy and state (and local) ascendancy in assuming greater responsibility for the planning and management of state water resources;
- Significant increases in non-federal cost sharing toward bringing about more cost-effective projects, discouraging overinvestment in water facilities, improving the federal fiscal condition, and abetting the advance to full economic recovery;
- Regulatory reform and permit simplification in water resources management;
- Greater accountability to taxpayers in the expenditure of public funds; and
- In general, a focus on economic efficiency and the elimination of percieved wasteful expenditures, on "privatization", and on the related play of the market.

Under the umbrella of the interrelated policies encompassed by this New Federalism, the states are being challenged not only to "put their money where their mouths are" but also to revise their own regulations, procedures, and policies consistent with that commitment and in accord with their ascendancy in water resources management.

At the same time, however, the consideration of interstate regional water planning and management programs is not precluded. Interstate compacts have been used for at least 60 years in such programs as transportation, water pollution control, fisheries, and port development. Such compacts must have the consent of Congress, and Congress may become a party to them. In our area of interest, perhaps the best known example is the 1961 Delaware River Basin Compact among Delaware, New Jersey, New York, Pennsylvania, and the Congress of the United States. Its

Commission, which represents all five parties to the Compact, can adopt and promote uniform and coordinated policies for water conservation, use, control, and river management. In accord with such policies, it can encourage the planning, development, and financing of water resources.

Doubtless, compacts, agreements entered into by administrative officials without legislative action, and other innovative ideas for the attainment of more flexible and equitable institutional arrangements among local, state, and federal entities will be seriously explored in the years ahead. Thus, as many states move toward sharing responsibilitie with each other and with the federal government in water resources plannir development and management partnerships, a special challenge awaits those persons who are already involved, to contribute their skills and expertise to the articulation and conduct of both intra and interstate water resources programs.

It is notable that a concern for environmental quality or environmental sensitivity has undergirded almost every presentation and related discussion at this meeting. It is evident that most people concerned with coastal issues are environmentally aware. There are few people better equipped by training, experience, and practical observation to appreciate the considerable environmental values of coastal beaches and barriers, and their integral role in protecting and nurturing the biologically rich, diverse, and valuable plant and animal aquatic habitats and marine life generally associated with inlets, bays, sounds, estuaries, and salt marsh ecosystems. Coastal people "study nature, not books," as the great Louis Aggasiz directed over a century ago.

In this regard, it is well to remind ourselves that national polls continue to show a consensus in support of environmental programs, particularly clean air, clean water, and endangered species. While some of our environmental laws and programs pertinent thereto may yet be tempered and modified, a concern for the environment appears to be firmly establish in the national ethos. Environmental quality is not to be viewed merely as a "side problem" to be handled on an ad hoc basis. At the same time, however, the need to attain and sustain a high level of economic growth and to reduce budget deficits that hinder economic recovery is recognized as absolutely essential to national progress and well-being. What the public appears to be saying is that it does not want indiscriminate growth in any location at any cost, i.e., an attitude of "damn the negative externalities, full speed ahead." Congress has acknowledged this sentiment with passage of the Coastal Barrier Resources Act. Consistent with this, private planners and developers as well as local, state, and federal resource managers all share the need to make it economically attractive to do the environmentally desirable. This embraces a positive view of economics and the environment, rather than a polarizing view of economics versus the environment. We delude ourselves, however, if we think striking a balance between the two is easy. It is not. Nonetheless as conscientious professionals--and professionals of conscience--we are bound to seriously address this concern within the advances and limitation of the arts and sciences in which we are variously trained, the policies mandated us by constituted authority, and the legislative enactments of the Congress of the United States.

The Corps's civil works program is generally associated with highly visible public works projects aimed at a variety of purposes--navigable waterways and ports, hydropower, water supply and quality, and the planning and construction of engineering projects to mitigate coastal and riverine flood hazards. In its role as a provider of technical expertise, the Corps has conducted feasibility studies and designed, built and maintained coastal works for many decades. Starting with the protection of federal property, expanding to studies of public property, and thence to participation in the protection of public property, the Corps has done research to address a wide range of coastal hazard problems. Our research on coastal processes and coastal engineering is continuing.

The Corps also provides direct planning assistance, technical services and studies related to both riverine and coastal flood hazards, as well as technical reports related to shore protection. It should be emphasized that the Corps provides assistance and services, not money grants. Through the Planning Assistance to States (PAS) program, Corps planning expertise is made available, upon request, to assist states in the preparation of comprehensive plans for the development, utilization, and conservation of water and related land resources of drainage basins. Also, at the request of cities, counties, states, and federal agencies, through our Flood Plain Management Services (FPMS) program, the Corps furnishes to cities, counties and states flood plain information and a full range of technical services and planning guidance for determining prudent use of flood plain properties. In helping to achieve the social goal of the wise and prudent use of the nation's flood plains, the functioning of the Corps' FPMS program is firmly grounded in the concept of economic efficiency: its purpose is, via the carefully selective expenditure of relatively small amounts of federal funds now, to help reduce the need for large future capital investments in flood control, as well as related calls for emergency disaster assistance expenditures. Under this program, the Corps has been a pioneer in developing and evolving approaches to hurricane evacuation planning. The three initial studies have been undertaken in Florida. The first study for Lee County on the southwest coast, was completed in 1979; the second study was completed in 1980 for the Tampa Bay area; and the third study for the Lower Southeast Region will be completed later this summer.

In addition, the Corps performs Flood Insurance Studies for the Federal Emergency Management Agency (FEMA). These technical studies are used by FEMA for its National Flood Insurance Program, and contain detailed flood hazard data needed by communities to regulate the use of flood-prone lands, prevent unwise development, and minimize future flood problems. To date, the Corps has completed more than 2,150 such studies. The Corps also has produced three detailed technical reports as part of its Shoreline Erosion Control Demonstration Program, conducted under Section 54 of the Water Resources Development Act of 1974 (P.L. 93-251). Information in these reports enables responsible officials and property owners to make appropriate decisions concerning shoreline erosion problems.

Finally, the Corps has significant flood emergency operations responsibilities. The Corps response takes a variety of forms, including the following work whenever and wherever required: flood emergency preparation; flood fighting and rescue operations; emergency repair and restoration of flood-damaged or destroyed flood control works such as levees; emergency protection of federally authorized hurricane and shore protection works being threatened; and the repair or restoration of federal hurricane or shore protection structures damaged or destroyed by wind, wave, or water action of other than an ordinary nature. Further, in the event of Presidental declaration of a major disaster, or emergency declared by the Administrator of the Federal Emergency Management Agency, assistance to state and local governments is provided in essential recove operations when and as directed by the President through FEMA under the provisions of 93-288. Under the Interagency Agreement of December 16, 1980 relating to flood disaster planning and postdisaster recovery, the Corps is a participant in the hazard mitigation teams mobilized by the FEMA regional directors.

Consistent with the interest and commitment of the Association of State Floodplain Managers in working on all aspects of riverine and coastal flood plain management, the Corps of Engineers and its FPMS and related technical assistance programs can be counted on to

- Continue support of the Association, whose purposes are consisten and harmonious with the long-established objectives of the Corps' FPMS Program,
- Continue to work with, and in support of, the flood hazard programs of FEMA, NOAA, and other federal agencies,
- Continue to provide support and committment in advancing the work of the Floodplain Management Task Force newly established under the aegis of FEMA,
- Continue our support, both advisory and practical, in furthering the work of the Natural Hazards Research and Applications Information Center at the University of Colorado,
- Continue active participation in, and support of, the Interagency Coordinating Committee on Hurricanes which FEMA, NOAA and the Corps helped establish last year,
- Continue to improve our management, administration, and effectiveness in the delivery of Corps' FPMS Program services to variou users, both federal and non-federal,
- Continue to be an active voice within the Corps in further advancing the consideration of nonstructural measures in flood plain management planning, whether singly or in combination with structural measures, depending upon the situation and problems to be solved, and
- Continue efforts to advance our ability to provide more technical expertise upon request to assist states in their preparation of comprehensive water resources plans, including related flood plain management considerations.

Although the Corps has a positive outlook, that should not be taken to mean that there is a large program budget for technical assistance and services. There is not. Nonetheless, we have a well established, decentralized program, we know the territory, and we have had substantial experience. Thus, the Corps can be counted on to continue to deliver essential services to help those outside the agency to more effectively address riverine and coastal flood hazards.

NFIP - INDIVIDUAL RISK
RATING FOR COASTAL AREAS

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Background

The National Flood Insurance Program, established by an Act of Congress in 1968, provides 1) the means by which flood insurance, over a period of time, can be made available through the cooperative efforts of the federal government and the private insurance industry, and 2) the flexibility for such insurance to be based on workable methods of pooling risks, minimizing costs, and distributing burdens equitably among those protected by flood insurance and the general public (P.L. 90-448).

The responsibility for administering the NFIP insurance mechanism has been delegated to the Federal Insurance Administrator, a statutory position assigned to the Federal Emergency Management Agency (FEMA). Under Public Law 90-448, the system of insurance and pricing must further the purposes of the Act, which include, among other things, to "(1) encourage State and local governments to make appropriate land use adjustments to constrict the development of land which is exposed to flood damage caused by flood losses, and (2) guide the development of proposed future construction, where practical, away from locations which are threatened by flood hazards. . . ."

In order to give practical meaning to these objectives, the NFIP adopted the 100-year flood elevation standard. This flood elevation standard (base flood elevation) is now used by virtually all federal, state and local agencies, and participating communities in the administration of flood plain management programs. There are sound practical reason for adopting the 100-year flood elevation standard. The use of a lower standard, such as the 40-year flood elevation, which would approximate pre-1969 building practices, would expose structures to about a 50% chance of being flood damaged during a typical mortagage period. This degree of exposure to risk would require insurance rates many multiples higher than those reflecting the 100-year flood elevation standard. These high insurance rates would make the sale of flood insurance much more difficult. This would negate the obvious advantage of widespread insurance to help defray the cost of repairing flood-damaged buildings, rather than complete reliance on disaster relief funds and federal income tax deductions for uninsured property losses.

It was this consideration of high insurance rates that prompted Congress to "grandfather" in existing construction at subsidized rates. Conversely, owners of new buildings (and substantially improved existing buildings) located in the flood plain are required to pay full risk insurance rates based on the flood risk zones and base flood elevations shown on the Flood Insurance Rate Maps (FIRMs) published by the NFIP, if the start of construction was on or after the effective date of the FIRM. If the insurance premiums adequately reflect the risk they will provide an economic incentive to builders and property owners to consider the flood peril in the design and placement of new buildings in the flood hazard areas.

As the NFIP accumulated information on the matter of insuring buildins in coastal high hazard areas (V Zones), it became clear that the flood insurance rates and the 100-year flood elevations were too low. This resulted from the fact that two key risk factors had not been adequately taken into consideration, namely

1) wave heights in establishing the 100-year base flood elevation, and

2) the ability of the structure to withstand wave action and velocity flood waters.

To put the NFIP on a sound actuarial basis, it is required that the full impact of these factors be taken into consideration.

At this point a chronology of important NFIP milestones in addressing the insurance rating of new buildings or the substantial improvement of existing buildings will be helpful.

1968 NFIP established by an Act of Congress.

1969-72 NFIP resources were primarily directed toward identifying areas of special flood hazards, encouraging community participation, and establishing cost-effective means of determining flood risk zones and base flood elevations in communities with heavily populated flood plains.

1972 NFIP established coastal high hazard areas as flood risk zones V-1 to V-30 and began to identify technical problems involved in the risk evaluation.

1975 Techniques to compute the additional elevations produced by wind-generated waves associated with tides and storm surges were analyzed and submitted to the National Academy of Sciences for peer review.

1978 Until now, the engineering/hydrology state of the art employed by the technicians in establishing base flood elevations in coastal V Zones only accounted for a combination of astronomical tides and storm surges. In 1978, acceptance of a state-of-the-art method to determine base flood elevations including the effect of wave action was obtained and incorporated into the Flood Insurance Study processes (FEMA Document TD-31, April 1981).

The NFIP began a study of the design and construction practices for residential buildings in coastal high hazard areas.

1980 Coastal Design and Construction Manual was completed (FEMA Document FIA-7) and the study contractor, Dames and Moore, assisted in the development of an individual risk rating plan. The individual risk rating plan was designed with weighted point values assigned to the more critical aspects of constructi including building site, support size and imbedment depth, and adherence to the requirements of the Coastal Design and Construction Manual. FEMA published proposed rules for comment that would have required minimum construction standards and the submission of an individual risk rating plan evaluation to obtain a local building permit.

1981 Information gathered during the proposed rulemaking process indicated a strong preference by various stake-holders not to make the individual risk-rating plan mandatory. FEMA published final rules making the individual risk-rating plan an optional procedure to obtain lower insurance rates by a certification of building factors that should lower the risk. Insurance rates reflecting the elevation of the building's lowest floor and the flood risk zone would be applied to risks submitted without an individual risk-rating plan certification.

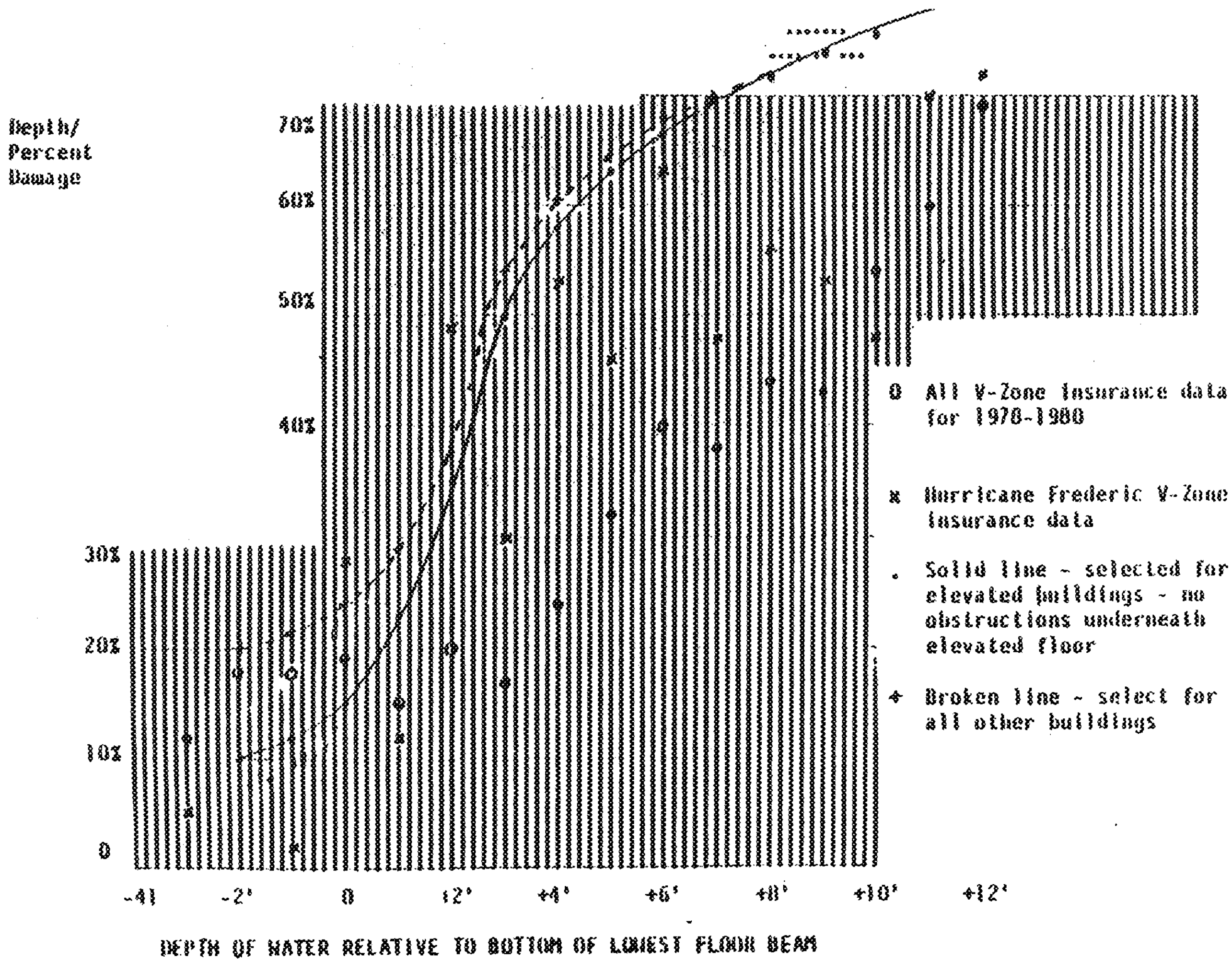
Development of V Zone Rating System

As work progressed in developing the manual for the design and construction of residential buildings in V Zones, the Dames and Moore engineer working the project participated in several meetings with the FEMA engineering/actuarial committee to develop concepts and approaches for the insurance rating of V-Zone buildings. The concept of an "average' building for "expected" damage purposes, although difficult to envision, became an important element for a class rating system based on the elevation of the building's lowest floor and the flood risk zone. The "expected" damage portion of the insurance premium reflecting only the elevation criteria was determined by using the "hydrologic method of estimating flooding damage", namely, accumulating the effect of applying depth-percent damage values by building type to the probability of a particular water surface elevation relative to the 100-year base flood elevation.

The 1981 rate revision depth-percent damage values were determined by an actuarial/engineering review of the 1978-1980 insurance claims data for V Zones. The data and curves derived therefrom are exhibited on Chart 1. Two sets of values were calculated based on all V-Zone insurance claims for the period 1978-1980 and on flood insurance claims filed only as a result of Hurricane Frederic in 1979. These values were compared with historical values previously selected. The old values were estimates reflecting informed judgments, not flood insurance data. Table 1 shows this comparison of the old values and those selected for the 1981 V Zone rate revision. This table exhibits various V Zone depth-percent damage values used by the engineers to estimate the flood damage to buildings. The Gulf Coast and North Carolina Wrightsville Beach Flood Insurance Studies were determined by detailed inspections of a sample of structures and contents located in the study area. The 1974 50% surcharge depth-percent damage values were calculated by applying a 50% increase to the depth-percent damage values determined by an actuarial/engineering review of data for all risk zones combined.

The most significant change in the 1981 depth-percent damage values was the introduction of values below the "0" benchmark, the bottom of the lowest floor beam. A review of the calculations of expected damage made prior to 1981 showed that the first increment of damage to a building with no basement was assumed to occur when water reached the lowest floor. However, when the building is located in a V Zone, insurance claim files document that considerable flood damage begins to occur when flood waters and wave action first reach the building site, prior to any water actually entering the building. In order to quantify the potential damage at this lower end of the depth-percent damage curve, the FIA asked the Dames and Moore engineers to consider this problem and estimate depth-percent damage values. In addition, the FEMA staff reviewed flood insurance claim files from Hurricane Frederic, and computer runs of

CHART 1


Depth/
Percent
Damage
70%
60%
50%
40%
30%
20%
10%
0
-4'
-2'
0
+2'
+4'
+6'
+8'
+10'
+12'
DEPTH OF WATER RELATIVE TO BOTTOM OF LOWEST FLOOR BEAM
0 All V-Zone insurance data for 1978-1980
x Hurricane Frederic V-Zone insurance data
. Solid line - selected for elevated buildings - no obstructions underneath elevated floor
+ Broken line - select for all other buildings

actual depth-percent damage values.

The review of claim files and computer runs revealed that elevated buildings suffer significant damage even if the flood waters do not enter the first elevated floor of the building. Additionally, the loss of sand around the base of the pilings and the erosion at the shore make the building's location more hazardous than it was prior to the storm. Although there was some uncertainty as to how best to deal with these factors, it was certain that some reflection of this risk in the rates was necessary.

As a result of discussions and analysis provided by Dames and Moore, it was agreed that the depth-percent damage values below -2 feet were to be determined separately for several different flood stage frequencies. The criteria for determining the values are as follows:

- Elevated building free of obstruction underneath the horizontal beam supporting the building's lowest floor: 1% damage accumulation for each one foot of flooding above the 20-year storm (the corollary being that no damage is expected from the water source, e.g., the Atlantic Ocean, the Gulf of Mexico, bays along East and Gulf Coasts, 95 years out of 100).
- All other buildings: 5% damage for each one foot of flooding above the 20-year storm.

In arriving at the selected curves shown on Chart 1, the actuarial/engineering committee determined the values between water depths of -2 and +2, measured from the underside of the horizontal beam supporting the building's lowest elevated floor. The insurance data was a mixture of buildings with obstructions and those without obstructions. In the range of -2 to +2, the selected values generally stay within the actual data points plotted for insurance claims resulting from Hurricane Frederic and all V-Zone insurance claims filed during 1978-80. The recognition of the two types of construction, with and without obstructions below the lowest elevated floor, introduced a departure from the past when the number of floors was used as the insurance classification. Although it might be argued that there is a similarity in these criteria, it was the judgment of the actuarial/engineering committee that the new classifications were superior. The new classification definitions could address more precisely the questionable use of breakaway walls as an acceptable construction practice in the V-Zone environment, an issue raised by some community officials and structural engineers.

TABLE 1

Flood Insurance: Depth/Percent Damage--V Zones

Depth of Water (From Lowest Floor Beam)	1970 Gulf Coast		1970 - North Carolina Beach		1974 - 50% Surcharge		1980 - 75% Surcharge		1981 - Rate Revision	
	One Floor	Two Floors	One Floor	Two Floors	One Floor	Two Floors	One Floor	Two Floors	A	B
-2									10.0%	20.0%
-1									12.0	21.5
0	9%	5%	11.0%	6.0%	10.5%	7.5%	12.3%	8.8%	15.0	24.0
+1	19	18	22.5	12.5	15.0	13.5	17.5	15.0	23.0	29.0
+2	30	25	25.5	15.5	21.0	19.5	24.5	22.0	35.0	37.5
+3	37	32	27.7	18.0	39.0	27.0	45.5	31.5	50.0	54.0
+4	45	38	30.0	19.5	42.0	30.0	49.0	35.0	58.0	60.5
+5	53	42	32.0	20.5	43.5	33.0	50.8	38.5	63.0	64.5
+6	60	50	34.0	21.5	61.5	36.0	71.8	42.0	66.5	68.0
+7	64	60	38.0	23.5	64.5	39.0	75.3	45.5	69.5	70.0
+8	67	61	44.5	27.0	66.0	46.5	77.0	54.3	72.0	72.0
+9	70	62	44.5	35.5	67.5	54.0	78.8	63.0	74.0	74.0
+10	72	65	44.5	39.0	69.0	57.0	80.5	66.5	76.0	76.0
+11	72	67	44.5	40.0	70.5	60.0	82.3	70.0	78.0	78.0
+12	72	69	44.5	40.0	72.0	63.0	84.0	73.5	80.0	80.0
+13	72	70	44.5	40.0	73.5	66.0	85.8	77.0	81.5	81.5
+14	72	72	44.5	40.0	75.0	69.0	87.5	80.5	83.0	83.0
+15					75.0	70.5	87.5	82.3	84.0	84.0
+16					75.0	72.0	87.5	84.0	85.0	85.0
+17					75.0	73.0	87.5	87.0	86.0	86.0
+18					75.0	75.0	87.5	87.5	87.0	87.0

A = ELEVATED BUILDINGS - NO OBSTRUCTION UNDERNEATH
B = ALL OTHER BUILDINGS

In determining the depth-percent damage values above +2 feet, consideration was given to the U.S. Army Corps of Engineers study that the energy in a three-foot breaking wave will virtually destroy brick veneer and wood-frame walls. A three-foot wave crashing against a building wall above the horizontal beam supporting the lowest floor is approximately equivalent to a depth of +5 on the depth-percent damage tables. From a review of the 1978-80 insurance data (data that do not include flood damage from storms that significantly exceed the 100-year storm) and the theoretical likelihood of building wall failure it was deemed prudent to set the percent damage values for depths of +5 and more at least 15% higher than the values suggested by the insurance data from Hurricane Frederic. This approach resulted in values of 63% damage and 64.5% damage at +5 feet for buildings with and without obstructions underneath, respectively. In virtually any coastal storm involving water depths of this magnitude, some of the damage to the building will be a direct result of wind. Depth-percent damage values for flood damage alone that range from 63% at a water depth of +5 to 87% at a water depth of +18 feet appear to be reasonable values for calculating expected flood damage. Future insurance data will be reviewed to ascertain information on wind versus flood loss settlements resulting from any serious storms.

A review of the contents insurance damage data showed that the depth-percent damage relationship for water depths of +2 and higher was similar to that for building damage. The decision was made to derive the depth-percent damage tables for contents from those used for buildings. For contents in buildings free of obstruction underneath, damage is not accumulated until water enters the first floor, i.e., reaches a depth of +2 feet from the bottom of the lowest floor beam. The percent damage accumulated at increasing depths is the same as that selected for the building depth-percent damage tables. For contents in buildings with obstructions underneath, damage is accumulated employing the same depth-percent damage relationship as that used for the building.

Until FIRMs with wave height elevations become effective, an approximate interim procedure for estimating the wave crest elevation at the building site has been incorporated into the process for determining class rates. This procedure is based on concepts established in the 1977 National Academy of Sciences (NAS) report, "Methodology for Calculating

Wave Action Effects Associated with Storm Surges." The interim procedure assumes that waves are depth-limited at all points within the V Zone. Thus, the elevation of the wave crest is assumed to be a function of only the stillwater depth at the site of the structure. The NAS report indicates that the wave crest elevation adjustment for a depth-limited breaking wave will be 0.55 times the stillwater depth. This stillwater depth is defined as the base flood elevation minus the ground elevation.

The values for each risk zone were calculated to incorporate the criteria discussed above for depth-percent damage values and the flood stage frequencies underlying the flood risk zone designations. These values for each flood risk zone became the basis for the flood insurance manual rates reflecting only the elevation of the horizontal beam or slab supporting the building's lowest floor. The classification rates were developed for the "average" building. Insurance rating on this "average" building concept would not provide any economic incentive to improve building construction practices or property owner awareness of the risks. The problem was to design an individual risk rating system that avoided the requirement of an NFIP review and evaluation of building plans. The actuarial/engineering committee decided that a building point system keyed to major risk factors offered the most practical approach to solve this problem. Dames and Moore engineers, drawing upon their research in preparing the coastal design and construction manual, arrived at the following relative weights of the major risk factors.

1. Elevation, Site and Environmental Conditions 40%
2. Building Support System 50%
3. General Building Details 10%

Using this information, the V-Zone Risk Factor Rating Form was designed to measure these factors. Since flood insurance manual rates had been developed to reflect the building's elevation and the flood risk zone, it was not necessary to assign building points to that rating factor. The Dames and Moore engineers working with the NFIP actuarial/engineering committee began the assignment of point values to the other criteria. During this process certain building features that substantially increase the risk were identified and assigned negative point values. These undesirable risk elements fell into three categories, namely weak anchoring systems, weak building supports, and obstructions underneath the building at elevations below the base flood elevation.

The building points were then applied to several hypothetical cases and separate depth-percent damage curves were graphed. For buildings with no obstructions underneath, the "average" building had a point total of 130. The depth-percent damage curve is depicted as the solid line on Chart 1. Several other hypothetical cases were reviewed and a 180 building point value was selected to represent good building design. The depth-percent damage value at -2 was set at 5%. A curve was then plotted to follow the same general shape as the solid line (Chart 1) and to approach that line asymptotically at +4. The depth-percent damage values were calculated for several different elevations. On the average a 180-point building produced rates 25% lower than the 130-point building.

The same approach was applied to a 230-point building. A 4% depth-percent damage value was selected for -1 and a curve was plotted as before. Again, indicated rates were calculated for several elevations. The rates for the 230-point buildings averaged about 32% less than those for the 130-point buildings. The process was repeated for buildings where the area below the elevated floor was not free of obstructions.

The "average" building was assigned a 30-point total. Depth-percent damage values at -2' were set at 12% for a 110-point total, 10% for a 130-point total and 5% for a 190-point total at -2'. This time the values were plotted following the general curvature of the broken line on Chart 1 and to approach that line asymptotically at +4. A review of the various rate differences for various elevations were tabulated and graded. This analysis resulted in tables of rate discounts that are keyed to building point totals determined on a V-Zone Risk Factor Rating Form.

The completion of the V-Zone Risk Factor Rating Form is the first step in the individual risk rating plan. Page 2 of the form sets forth instructions on how to obtain the FEMA coastal design and construction manual and the manual for calculating wave crest on a site-specific basis. It should be noted that building point sections of the form offer the design professional two options, 1) certification of certain factual information about the construction, or 2) a professional evaluation of the relative quality of the building support system and general building details. These options introduce into the insurance rating system the flexibility needed to accommodate practical engineering design practices.

The written reports and the questions on page 4 of the form are intended to provide important information that will improve the NFIP's post-storm evalution of the rating system.

Copies of the V-ZONE RISK FACTOR RATING FORM or the FEMA Coastal Design and Construction Manual can be obtained by writing to:

NFIP
P.O. Box 34604
Bethesda, Maryland 20817

Copies of the manual TD-3/April 81 "Flood Plain Management-Ways of Estimating Wave Heights in Coastal High Hazard Areas in the Atlantic and Gulf Coast Regions" can be obtained by writing to:

FEMA
P.O. Box 8181
Washington, D.C. 20024

V-ZONE RISK FACTOR RATING FORM

This is an *optional* insurance rating form. During a severe coastal storm a building's capability to withstand serious flood damage is directly related to several factors in addition to the elevation of the building's lowest floor. The most important of these are: (1) the building site; (2) the building support system; and (3) other construction details related to the building's resistance to wind and wave action. Owners who provide the NFIP with professional certification of information about these factors may qualify for substantial flood insurance rate discounts. A local property/casualty insurance agent or the NFIP V-Zone underwriter can be consulted to obtain additional information on the insurance rating.

To illustrate the benefit of this rating procedure to a prospective flood insurance policyholder, a comparison of insurance premiums using both the manual class rating and the V-Zone Risk Factor Rating form is shown below.

ANNUAL INSURANCE PREMIUM

Example I $100,000 Building Coverage/$20,000 Contents Coverage
Front-most building line – Free of obstructions below lowest elevated floor

CLASS RATED	V-ZONE RISK FACTOR RATING	
	Certified to be Superior Construction*	**Certified to be Adequate Construction***
$1,174	$ 886	$1,102

Example II $250,000 Building Coverage/$20,000 Contents Coverage
Front-most building line - With obstructions below lowest elevated floor occupying less than 300 sq. ft. (e.g., elevator shaft to ground level)

CLASS RATED	V-ZONE RISK FACTOR RATING	
	Certified to be Superior Construction*	**Certified to be Adequate Construction***
$9,070	$3,813	$5,094

*As determined by certified data on the V-Zone Risk Factor Rating form.

National Flood Insurance Program

federal emergency management agency

V-ZONE RISK FACTOR RATING FORM

OMB-026-R-00025

Flood Program Use Only
V.R.N. No. ______
Date Rec. ______ Init. ______

This V-Zone form is to be used in the determination of the flood insurance rate discount for buildings and contents located in a coastal area designated by the Federal Insurance Administration as Zone V or V1-V30.

Completion of this V-Zone form must be accomplished by individuals or firms fulfilling the following criteria:

1. The individual signing the form must be a registered professional engineer or registered architect duly licensed in the state where the subject structure is located.

AND

2a. The individual or firm has in force a policy of professional liability insurance.

OR

2b. The individual or firm possesses demonstrable experience and competence in the fields of foundation, soils and structural engineering as evidenced by similar and satisfactory service to at least two previous clients.

The completed V-Zone form should be submitted to the National Flood Insurance Program, Post Office Box 34653, Bethesda, Maryland 20817, Attention: V-Zone Risk Discount. Confirmation of the V-Zone Risk Discount and estimated rate for National Flood Insurance coverage will be returned to the submitting agent, engineer and builder/applicant in approximately thirty (30) days.

EXACT LOCATION (LEGAL DESCRIPTION) ______

______ FIRM ZONE DESIGNATION ______

ESTIMATED COST OF CONSTRUCTION ______ POST CONSTRUCTION PROPERTY ADDRESS (if known)

(LABOR & MATERIAL) $ ______ ______

______

DOES THE BUILDING PLAN INVOLVE THE ALTERATION OR CONSTRUCTION OF SAND DUNES, SEAWALLS, BULKHEADS, ETC. TO REDUCE THE EFFECTS OF WAVE ACTION? YES ____ NO ____

HAS THE AVERAGE NATURAL GRADE AT THE BUILDING SITE BEEN ALTERED (OR IS IT TO BE ALTERED) BY MORE THAN TWO FEET? NO ____ YES ____? IF YES, BY (+ OR −) ____ FEET (TO THE NEAREST TENTH OF A FOOT)

Insurance Agent	Registered Professional Engineer or Architect
Name	Name
P.O. Address	P.O. Address
City, State, Zip Code	City, State, Zip Code
Telephone Area Exchange Number	Telephone Area Exchange Number
Agent's Tax ID or Social Security Number	License—State, Number Expires
Builder	**Owner**
Name	Name
P.O. Address	P.O. Address
City, State, Zip Code	City, State, Zip Code
Telephone Area Exchange Number	Telephone Area Exchange Number

FLOOD RISK, ZONE AND RELATED INFORMATION

Local permit officials will have on file a copy of the community's Flood Insurance Rate Map (FIRM).

Your client's property and casualty insurance agent may have a copy of the community's FIRM and is a valuable source of related information.

HOW CAN YOU OBTAIN THE FEMA MANUAL?

A registered professional engineer or architect or coastal builder may submit a written request addressed to:

NFIP
P.O. Box 34604
Bethesda, MD 20817

or in the case of an emergency, a registered professional engineer or architect may call toll free 1-800-638-6620, and ask for the FEMA Coastal Design and Construction Manual.

BASE FLOOD ELEVATION ADJUSTMENT FOR WAVE HEIGHT

The Flood Insurance Rate Maps (FIRMs), published and effective from 1969-1980, set forth base flood elevations without wave height (stillwater level). Prior to 1977, no generally accepted methodology for calculating wave heights had been formulated. In 1977, in response to FIA's request, the National Academy of Sciences evaluated recently developed technical procedures and published the accepted methodology (see below). Therefore, you must ascertain whether or not the BFE on the FIRM includes wave height. The 1981 FIRMs will indicate whether or not wave height is included. If the wave height is included, the following statement appears on the map legend: "Coastal Base Flood Elevations shown on this map include the effects of wave action." The older maps with effective dates prior to January 1, 1981, do not, with a very few exceptions, include wave height.

PROCEDURES TO CALCULATE WAVE HEIGHT ADJUSTMENT:

When the existing BFE on the FIRM is based only on the stillwater level, the wave height adjustment must be estimated. The elevation adjustment due to wave height will vary from a maximum of 0.55 times the stillwater depth at the site to a minimum adjustment of 2.1 feet. (BFE including wave height adjustment = stillwater BFE + 0.55 (stillwater BFE - average grade elevation at the building site)). Cases involving estimates less than this wave height adjustment must be technically supported. National Academy of Sciences procedures are outlined in Manual TD-3/April 81 entitled, "Floodplain Management – Ways of Estimating Wave Height in Coastal High Hazard Areas in the Atlantic and Gulf Coast Regions." To obtain a copy of this document, an architect or builder may submit a written request (name the document in the request) to:

FEMA
P.O. Box 8181
Washington, D.C. 20024

COASTAL V-ZONE FLOOD RISK BUILDING POINT CALCULATION SHEET

Record Identification Number ____________________

The submitting registered, professional engineer or architect should complete the calculation sheet using the building points shown below. Elevation certification may be determined by a registered professional surveyor (attach certification). The elevation data and FIRM information may be obtained from the Post Construction Elevation Certificate. If this certificate is not available, the professional certifying this document must determine the required information.

NFIP Community No. ____________________ Base Flood Elevation ____________________

Panel No. ____________________ Elevation including wave height (BFEWH) ____________________

FIRM Effective Date ____________________ Average grade elevation

FIRM Zone ____________________ Bottom of lowest beam elevation __________ (NVGD)

CIRCLE APPROPRIATE POINTS AND ENTER BUILDING POINTS IN APPROPRIATE BOX BELOW.

I. SITE AND ENVIRONMENT CONDITIONS

		CONSTRUCTION PRE-	CONSTRUCTION POST-
A. Distance from shoreline (Mean High Water)			
1. At front-most building line	10 pts.		
2. At least one lot behind	20 pts.		
3. More than 100 yards behind front-most building line oceanside	30 pts.		
B. Adequate dune protection			
1. Adequate dune protection but less than the requirements for B(2) below	5 pts.		
2. Dune Crest at least 20 feet wide and its height is at least equal to half the distance between BFEWH and lowest grade at structure	15 pts.		
3. Dune Crest is at least 40 feet wide and is higher than BFEWH	25 pts.		

II. BUILDING SUPPORT SYSTEM

Complete sections II.A, II.B, and II.C for the usual coastal 1–4 family residential or small commercial buildings with wood pile, pier, or wood post type construction. The point system is based on the minimum guidelines of the FEMA Coastal Design and Construction Manual. The registered professional engineer or architect assigning points should ascertain whether these guidelines are met or, if other sound engineering designs are used, demonstrate (by attaching an engineering report) that the design provides equivalent strength and resistance to damage for the point categories selected.

For other than the usual 1–4 family residential or small commercial buildings, complete sections II.D and II.E and attach a written report describing the components of the building support system and indicating the primary reasons for the building points selected.

CONSTRUCTION

PRE- POST-

A. Pile Embedments (includes posts, piles, piers)
   1. Pile tip is at -5' MSL if BFE including wave height is +10' MSL or less; or pile tip is at -10' MSL if BFE including wave height is above +10' MSL . . . . 75 pts.
   2. Pile tip is at least 5' deeper than required above . . . . 100 pts.
   3. If the pile embedment does not satisfy requirements A.1 or A.2 above . . . . minus 125 pts.

B. Support Strength. (Select only one primary type.)
   1. For wood piles at least 10" X 10" or 8" Tip Round:
      a. With Grade Beam attached and bracing as required . . . . 45 pts.
      b. If less than above requirements . . . . 15 pts.
   2. For Piers:
      a. Pier has adequate strength to resist lateral forces and is properly connected to the foundation . . . . 45 pts.
      b. If less than above requirements . . . . 15 pts.
   3. For Wood Posts:
      a. Post and bracing, if required, has adequate strength to resist lateral forces and is properly connected to foundation . . . . 45 pts.
      b. If less than above requirements . . . . 15 pts.

C. Connection of floor beams
   1. Connection has adequate strength to resist forces imposed . . . . 30 pts.
   2. If less than above requirements . . . . 10 pts.

OR

D. Foundation, Footing and Anchorage System (in lieu of the Pile Embedments criteria for 1–4 family residential)
   1. superior . . . . 125 pts.
   2. adequate . . . . 100 pts.
   3. inadequate . . . . minus 125 pts.

E. Strength of Building Supports to Resist Lateral Forces
   1. superior . . . . 45 pts.
   2. adequate . . . . 15 pts.
   3. inadequate . . . . minus 75 pts.

III. GENERAL BUILDING DETAILS

Complete sections III.A and III.B for the usual coastal 1–4 family residential or small commercial buildings with wood pile, pier, or wood post type construction. For other than the usual coastal 1–4 family residential or small commercial buildings, complete III.C, III.D, and III.E, where appropriate to the building involved.

A. Substantially meets or exceeds recommendations of the FEMA Coastal Design and Construction Manual (if area below building is not free of obstruction, this cannot be met) . . . . . . 25 pts.

B. Area below building
   1. Free of obstruction . . . . 0 pts.
   2. Unenclosed equipment or equipment enclosed by screening or breakaway lattice work . . . . minus 25 pts.
   3. Solid breakaway walls below building enclosing area less than 300 sq. ft. . . . . minus 50 pts.
   4. Solid breakaway walls below building enclosing area 300 sq. ft. or more . . . . minus 110 pts.
   5. Solid non-breakaway walls below building . . . . minus 210 pts.

OR

C. Area below building is free of obstruction . . . . 25 pts.

D. Equipment and/or enclosure below the lowest elevated floor is resistant to flood damage and would not adversely affect the ability of the other parts of building to withstand velocity waters and wave action and:
   1. Occupies an area of less than 300 square feet . . . . minus 5 pts.
   2. Occupies an area of 300 square feet or more . . . . . . minus 30 pts.

C. AND D. – DISCOUNT IS APPLIED TO INSURANCE RATES FOR "FREE OF OBSTRUCTION"

E. Area below building is not free of obstruction
   1. Equipment and/or enclosure is not resistant to flood damage but obstruction would not adversely affect the ability of the other parts of building to withstand velocity waters and wave action and:
      a. Occupies an unfinished area of less than 300 square feet . . . . minus 40 pts.
      b. occupies an unfinished area of 300 square feet or more . . . . minus 175 pts.
      c. occupies a finished area . . . . minus 250 pts.
   2. Equipment and/or enclosure would adversely affect the ability of the building to withstand velocity waters and wave action . . . . minus 250 pts.

E.1.a – DISCOUNT IS APPLIED TO INSURANCE RATES FOR "WITH OBSTRUCTION"
E.1.b – SUBMIT TO NFIP
E.1.c and E.2 – NO DISCOUNT. SUBMIT TO NFIP TO DETERMINE ELIGIBILITY.

WHEN CRITERIA DIFFERENT FROM THOSE SET FORTH UNDER SECTION III ABOVE ARE USED, ATTACH A WRITTEN REPORT INDICATING PRIMARY REASONS FOR THE BUILDING POINTS SELECTED.

IV. BUILDING POINT TOTAL

INFORMATION PERTAINING TO THE BUILDING

The following twenty-one questions are being asked in place of submitting detailed design and plans.
(If a question is not applicable, indicate by n/a and include a short explanation.)

1. How far is the building from the mean high water line? ______
2. Is the structure located behind a primary dune system? ______
3. a.) If yes, what is elevation of top of dune? ______ b.) What is width at top of dune? ______
4. What is expected depth of scour or erosion at building line? ______
5. What measures, if any, have been taken to prevent scour or erosion? ______
6. What type of soil is at the site? ______
7. What type of foundation is used? ______
   (If helpful, attach sketch showing arrangement and spacing, etc.) Label as figure 1.
8. Supports used? (Wood, reinforced concrete, etc.) ______

   Type: ______

   Size: ______

   Depth of penetration into ground? ______

   Bottom tip elevation ______
   If piles, are they driven or jetted? ______
9. How are supports connected to foundation? ______
   Sketch connections to floor beams, grade beams, etc. and label as figure 2.
10. Is bracing used? ______ Sketch bracing parallel to beach and label as figure 3. Sketch bracing perpendicular to beach and label as figure 4. Sketch other bracing and label as figure 5. ______
11. Building width ______, length ______, number of stories ______.
12. Is building parallel to shoreline or diagonal? ______
13. Are hurricane clips or joist anchors used to connect floor joists to floor beams? ______
14. Are hurricane straps used to connect exterior stud walls to floor joists or floor beams? ______
15. Are all details of the structure in conformance with the governing building code? ______
16. Has design wind speed been determined from governing building code? ______
17. What is design wind speed? ______
18. Have water and wave forces been considered in the design of the structure? ______
19. Is plywood wall sheathing used? ______ Or is diagonal wall sheathing used? ______
20. Are hurricane clips, joist anchors, or metal straps used to connect roof joists or roof trusses to top of exterior wall stud? ______
21. Specify equipment and/or enclosed area uses below the first floor level. ______

BUILDING COVERAGE

*Rate Discounts Applicable to
1981 Post-FIRM V1-V30 Zone Rate Table, Sections I and III

BUILDING POINT TOTAL	ELEVATION OF BUILDING RELATIVE TO BFEWH -3.5 or Greater Less than -.5	-.5 or Greater Less than +1.5	+1.5 or Greater
Less than 120	+5%	+7%	+10%
120–139	0	0	0
140–159	5%	7%	10%
160–179	9%	12%	16%
180–199	23%	26%	31%
200–219	26%	29%	35%
220–239	29%	32%	38%
240–259	32%	35%	40%

*See Rating and Discounting Instructions to determine when rate discounts are applicable.

1981 POST-FIRM V1-V30 ZONE RATE TABLE
SECTION I (For FIRMs That Include Effect of Wave Action)
Annual Rates Per $100 of Insurance
Elevated Buildings Free of Obstructions Below the
Beam Supporting the Building's Lowest Floor

1981 POST-FIRM V1-V30 ZONE RATE TABLE
SECTION III (For FIRM Where BFE is Adjusted for Wave Height at Building Site)
Annual Rates Per $100 of Insurance
Elevated Buildings Free of Obstructions Below the
Beam Supporting the Building's Lowest Floor

CONTENTS COVERAGE

*Rate Discounts Applicable to
1981 Post-FIRM V1-V30 Zone Rate Table, Sections I and III

BUILDING POINT TOTAL	ELEVATION OF BUILDING RELATIVE TO BFEWH -3.5 or Greater Less than -.5	-.5 or Greater Less than +1.5	+1.5 or Greater
Less than 120	0	+1%	+3%
120-140	0	0	0
140-159	1%	1%	3%
160-179	2%	2%	5%
180-199	3%	4%	7%
200-219	3%	5%	9%
220-239	4%	7%	11%
240-259	5%	8%	15%

*See Rating and Discounting Instructions to determine when rate discounts are applicable.

BUILDING COVERAGE

*Rate Discounts Applicable to
1981 Post-FIRM V1-V30 Rate Table, Sections II and IV

BUILDING POINT TOTAL	ELEVATION OF BUILDING RELATIVE TO BFEWH -3.5 or Greater Less than -1.5	-1.5 or Greater Less than +.5	+5 or Greater Less than +2.5	+2.5 or Greater
Less than 40	0	0	0	0
40--59	3%	5%	6%	8%
60--79	6%	9%	12%	16%
80--99	10%	13%	18%	24%
100--119	13%	18%	24%	31%
120--139	16%	22%	30%	38%
140--159	20%	28%	37%	46%
160--179	25%	33%	43%	53%
180--199	40%	50%	60%	70%
200--219	46%	56%	67%	76%

*See Rating and Discounting Instructions for when rate discounts are applicable.

1981 POST-FIRM V1-V30 ZONE RATE TABLE
SECTION II (For FIRMs That Include Effect of Wave Action)
Annual Rates Per $100 of Insurance
Elevated Buildings With Obstructions Below the
Beam Supporting the Building's Lowest Floor

1981 POST-FIRM V1-V30 ZONE RATE TABLE
SECTION IV (For FIRM Where BFE is Adjusted for Wave Height at Building Site)
Annual Rates Per $100 of Insurance
Elevated Buildings With Obstructions Below the
Beam Supporting the Building's Lowest Floor