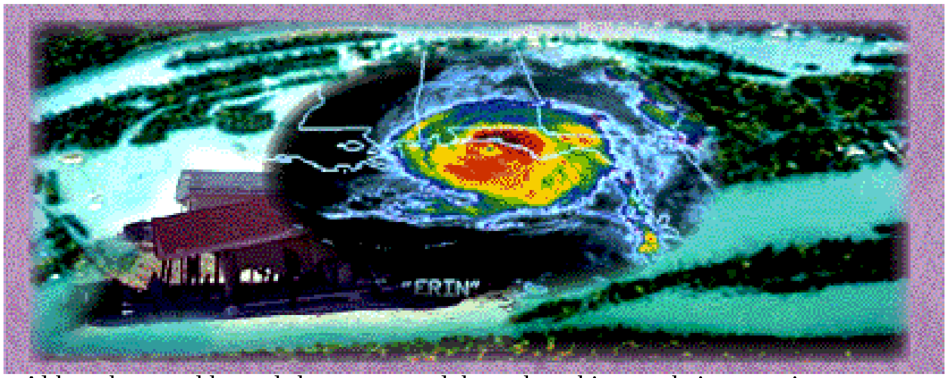
POPULATION AT RISK FROM NATURAL HAZARDS



Although natural hazards have occurred throughout history, their recent impacts have been increasingly devastating. Estimated disaster losses in the United States range from $10 billion to $50 billion annually, with an average cost from a single major disaster around $500 million. One of the primary factors contributing to the rise in disaster losses is the steady increase in the population of high-risk areas, such as coastal areas. The population in coastal counties represents more than 54% of the total U.S. population, but occupies only 26% of the total land area. Coastal areas are particularly vulnerable to the effects of natural hazards.

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INTRODUCTION

Generally, coastal hazards can be defined as episodic or chronic destructive natural system events that affect coastal areas. A variety of such events regularly threaten the nation's coastal inhabitants. Severe meteorological events such as hurricanes, tropical cyclones and northeasters often bring high winds, storm surges, flooding and shoreline erosion that are particularly damaging to coastal areas. Other hazards, while not exclusively coastal, can pose special threats to coastal locations. For example, earthquakes are more likely to incur the catastrophic impacts of liquifaction in some coastal areas due to the unique geologic features of the coasts. Tsunamis, with their potentially devastating floods, are uniquely coastal events resulting from offshore earthquakes or volcanic activity. In addition to these special hazards, many coastal locations are subjected to the more widespread hazards that can have an impact on inland areas, such as riverine flooding, landslides, wildfires and tornadoes.

Photo 1. A hurricane damaged these North Carolina coastal homes.

Coastal hazard events can significantly affect or even alter the natural environment, but their impacts are generally not considered "disastrous" unless they involve damage to the human and built environments. In the absence of people and property, hazards are merely natural processes that alter the environment as they have throughout the earth's history. When people and property are present, however, the primary focus is no longer on the natural processes associated with a major hazard event, but instead on the disastrous results that can be measured by lives lost, property damaged and other impacts.

Photo 2. High-rise developments on the water's edge expose great numbers of people to potential hazard.

Photo 3. Houses built a safe distance from the ocean decades ago are now facing threats from erosion.

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NATIONAL PICTURE

Experts believe that a combination of factors contribute to the continuing worldwide rise in disaster loss totals. These include an increase in hazard events due to either global climate change or natural cyclical trends; improvements in disaster monitoring and loss reporting; and increased human exposure in hazardous locations. Worldwide, each of these factors may come into play, but disaster loss increases in the United States seem to be most closely tied to population growth and investment in high-risk areas.

Growth trends in U.S. coastal areas obviously increase human exposure to natural hazards. The United States has an extensive and diverse coastline that supports a disproportionate percentage of the nation's population. During the last decade, 17 of the 20 fastest-growing counties were located along the coast. In addition, 19 of the 20 most densely populated counties in the nation are coastal counties, as are 16 of the 20 counties with the largest number of new housing units under construction.

Coastal communities were among the first settlements in the United States, and they have always accounted for a major percentage of the overall U.S. population. Their role as primary centers for transportation, tourism, recreation, commercial fishing and other industry has ensured that coastal areas remain a crucial segment of the nation's overall economy. In the past, larger coastal populations generally clustered around the major port cities. Natural hazards that affected these cities were sometimes devastating, but there were fewer locations to be affected. As coastal cities have become larger and more numerous, and as coastal tourism has expanded to fuel economic growth in even the most remote coastal areas, many more coastal locations with significant populations and property resources have become vulnerable to potentially devastating impacts from natural hazards.

Discussed below are three hazards that threaten significant portions of the U.S. coastline.
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Hurricanes

One of the most dramatic, damaging and potentially deadly events that occurs in the United States is a hurricane. Typically, hurricanes form in the tropics and often careen erratically onto the U.S. coast. As they move ashore, they bring with them a storm surge of ocean water along the coastline, high winds, tornadoes, torrential rains and flooding. On average, 10 tropical storms develop over the Atlantic Ocean, Caribbean Sea or Gulf of Mexico each year. About six of these grow strong enough to become hurricanes. Many remain over the ocean with little or no impact on the continental United States; however, an average of five hurricanes strike the U.S. coastline every three years. Of these five, two will be major hurricanes, reaching a category 3 or higher (defined as having winds 111

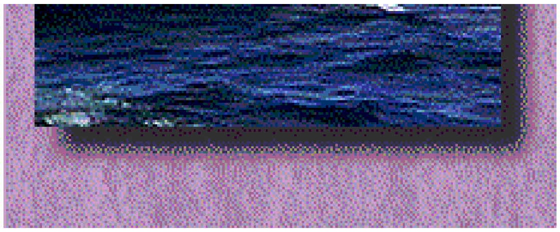

Photo 4. Hurricanes drive high wave energy that destroys coastal structures.

miles per hour or above) on the Saffir-Simpson Hurricane Disaster-Potential Scale (Table 1). These storms ultimately cost the nation billions of dollars in damages.

Table 1. Saffir-Simpson hurricane scale.

Scale Number (Category)	1	2	3	4	5
Central pressure: millibars	≥ 980	979-965	964-945	944-920	≤ 919
Winds: mph	74-95	96-110	111-130	131-155	>155
Surge: feet	4-5	6-8	9-12	13-18	>18
Damage	minimal	moderate	extensive	extreme	catastrophic

Source: Simpson, 1974.

During a hurricane, high winds, storm surge and flooding may damage or destroy homes, businesses, public buildings and infrastructure. Flying debris can break windows and doors, unsealing the building "envelope" and creating high pressure within the structure that can blow off the roof. After the roof is gone, high winds and rain destroy the inside. Roads and bridges can be washed away by flash flooding or blocked by debris. In extreme storms, such as Hurricane Andrew, the force of the wind alone can cause tremendous devastation, as trees and power lines topple and weak elements of homes and buildings fail. These losses are not limited to the coastline; they can extend hundreds of miles inland under certain conditions (FEMA, 1997a).

In addition to placing more property in harm's way, coastal population growth has created life-threatening problems associated with storm warnings and evacuation. It is becoming more and more difficult to ensure that ever-rising numbers of residents and summer visitors can be evacuated and transported to adequate shelters during storm events. In some locations, hurricane evacuation decisions must be made long before hurricane warnings can be issued. Further, a significant percentage of the coastal population has not experienced a hurricane and may be less likely to prepare and respond properly before, during and after such an event. Even the best organized governmental response may be unable to meet the large demands for emergency shelter, food and water in many heavily populated areas.

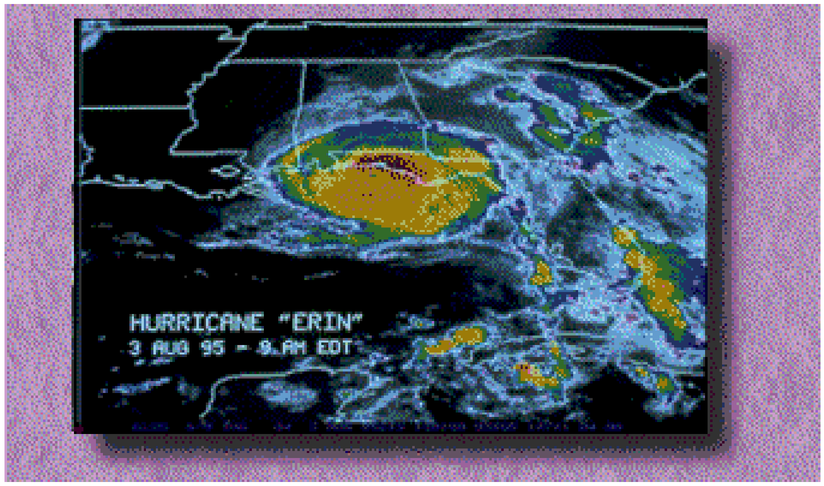

Photo 5. Increasing population in coastal areas means longer evacuation times, and thus, makes prediction tools such as radar even more important.

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Tsunamis

A tsunami is a series of waves generated by an underwater disturbance in the ocean, usually an earthquake on the sea floor. Other geologic disturbances, such as volcanic activity and landslides occurring above or below the sea surface, can also generate tsunamis. Sometimes, tsunamis inflict severe damage to property and pose a threat to life in coastal communities. Although most people imagine a tsunami as a large, steep wave breaking on the shore, tsunamis generally appear as an advancing tide without a developed wave face and produce rapid flooding of low-lying coastal areas (Pacific Tsunami Museum, 1997). Because a tsunami typically consists of a series of waves, the danger can actually last for hours after the initial wave. A tsunami can be incredibly destructive, moving everything in its path hundreds of feet inland with great force. Buildings, automobiles, boats and massive rocks can become dangerous debris, with the potential to injure or kill those stranded in inundation areas. Tsunamis are also capable of traveling up rivers and streams that have openings into the ocean.

When a tsunami approaches a coastline, the wave begins to slow and increase in height; the height achieved depends on the topography of the sea floor. Often, the first sign of a tsunami is a receding water level caused by the trough of the wave. In some instances, however, the first sign of a tsunami is a small rise in the water level just before the recession. In both cases, the incoming wave approaches the shore much like the incoming tide, though much more rapidly. The maximum vertical height of the water in relation to sea level is referred to as "run-up." The maximum horizontal distance is referred to as "inundation." The most vulnerable area for tsunamis, due to the large earthquake threat there, is the Pacific Coast. Hawaii, the highest risk area, averages one tsunami every year with a damaging occurrence every seven years, Alaska, also at high risk, averages one tsunami every 1.75 years and a damaging event every seven years. The West Coast experiences a damaging tsunami every 18 years on average (FEMA, 1997b). Tsunamis can also occur in the Atlantic Ocean, Indian Ocean, Caribbean Sea, Mediterranean Sea, Black Sea and Caspian Sea.
(top)

Photo 6. Erosion occurs not only on sandy

Photo 6. Erosion occurs not only on sandy beaches, but also on these bluffs on the Great Lakes.

Coastal Erosion

Because of regional differences in geology and environmental factors such as winds, tides, storm waves and storm frequency, the United States has a great variety of erosion problems (USGS, 1997)–a situation with long-term economic and social consequences. All 30 states bordering an ocean or the Great Lakes have erosion problems, and 26 are presently experiencing net loss of their shores. Storm impacts and long-term erosion are threatening developed areas with potential loss of life and billions of dollars in property damage. In addition to the natural processes that cause erosion, human alterations are affecting erosion rates. Some of the engineering solutions designed to protect certain portions of the shoreline accelerate the erosion of nearby areas by impeding beach sand supplies. Clearance of dune-stabilizing vegetation and destruction of the dunes themselves remove a substantial source of protection against high water and storm waves.

While coastal erosion affects all regions of the United States, erosion rates and potential impacts are highly localized. Average coastline recession rates of 25 feet per year are not uncommon on some barrier islands in the Southeast, and rates of 50 feet per year have occurred along the Great Lakes. Severe storms can remove even wider beaches, along with substantial dunes, in a single event. In undeveloped areas, these high recession rates are not likely to cause significant concern, but in some heavily populated locations, one or two feet of erosion may be considered catastrophic. Therefore, the impacts of erosion are not necessarily measured in terms of the highest recession rates, but may be measured against the social and economic costs to the areas affected.
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Photo 7. Forecasting tools are improving, yet the public often does not heed warnings of impending danger.

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REGIONAL CONTRASTS

The risks from coastal hazards vary throughout the United States, depending on such factors as susceptibility to severe weather events, local geologic conditions, and the vulnerability of coastal populations and property. One of the most difficult aspects of addressing hazards on a national scale is this variability of hazard risk from one region of the country to another.

Pacific Northwest: Oregon

Of the 96,002 square mi in Oregon, the coastal county land area is 22%. There are 296 mi of coastline in the state. In 1990, Oregon's total population was 2.8 million; 56% of this population resided in the coastal counties of the state.

Severe storms causing major flooding, erosion and landslides batter the Oregon coast every winter. Breaking wave heights of 25 to 30 feet are common. The Pacific Northwest has also experienced many violent windstorms, including the 1964 Columbus Day storm, the November 1981 storm, the Inauguration Day storm of 1993 and most recently, the storm of 1995. The National Oceanic and Atmospheric Administration's (NOAA) National Weather Service forecast the windstorm of 1995 well in advance, and this early warning gave state and local emergency management offices, utility companies, communities, governmental offices, schools and other entities time to prepare and brace for the winds that arrived. Nevertheless, the storm caused significant destruction to coastal communities and severely damaged emergency response service centers and other structures along the central coast.

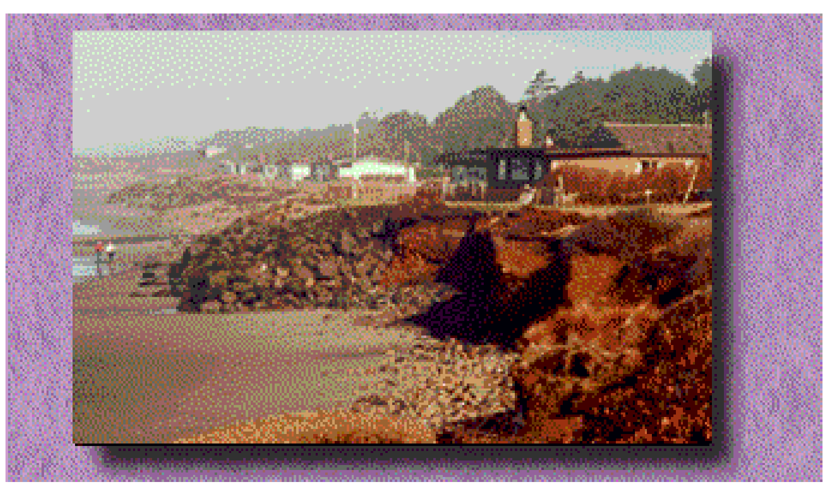

Photo 8. Winter waves batter the Oregon coast every year, causing severe erosion at some sites.

While tsunamis are relatively uncommon in Oregon, they are, nevertheless, a threat to much of the coast. The Cascadia Subduction Zone is an active fault located 20 to 40 mi off the Oregon coast. The 1993 earthquakes in Scotts Mill and Klamath Falls, which caused significant property damage, demonstrated its seismic activity (Oregon Sea Grant, 1994). A large Cascadia Subduction Zone earthquake can trigger tsunamis, as well as sustained ground shaking, liquefaction, regional subsidence, landslides and associated flooding.

Tsunamis caused by earthquakes in other areas of the Pacific Ocean's "ring of fire" can also hit Oregon. The March 1964 Alaska earthquake generated a tsunami that caused many casualties and extensive damage in Alaska, then traveled the great distance to the U.S. West Coast and Hawaii, where it caused additional fatalities and damage. In Oregon, for example, logs carried by the unexpected high water of the advancing tsunami crushed four campers on the beach. For tsunamis generated by earthquakes in distant locations, the Pacific Tsunami Warning System notifies people in coastal communities when it is necessary to evacuate to higher ground.

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Northeast: New Jersey

The State of New Jersey has more than 7.7 million residents in its 7,419 sq mi area, making it the most densely populated state in the nation. The state has 127 mi of ocean coastline. New Jersey's coastal counties contained 95% of the state's overall land area and were home to nearly 99% of its total population in 1990. With intense development along the coast, New Jersey is especially vulnerable to damage from coastal storms and hurricanes. Even minor storm events are contributing to a long-term coastal erosion problem.

Photo 9. The population of New Jersey is especially vulnerable to coastal hazards because of the intense development along the coast.

Historical records show that two of the most devastating storms in New Jersey occurred in the 1800s, before development was widespread. The hurricane of September 3, 1821 traversed the entire coastline and caused the highest storm surge ever recorded in New York Harbor. The waves from the blizzard of 1888, a storm that lasted four days, reportedly overtopped the barrier islands and marshes.

Photo 10. Hurricane Andrew was the most costly natural disaster up to that time, causing $25 billion in damage.

On March 6, 1962, one of the most damaging northeast storms in history struck the coast of New Jersey. Although it did not produce record surge levels, it was responsible for more loss of life and greater overall damage than any other storm of its kind. This storm was responsible for the loss of 22 lives, total destruction of 1,853 homes, and damages to an additional 2,000 homes.

The 1982-1983 winter storm season saw 19 storms, striking New Jersey one after another without sufficient time for the beaches to repair themselves naturally. The northeasters of March 1984, October 1991 and January 1992 also caused severe beach and dune erosion, widespread damage to oceanfront roads and extensive flood damage (State of New Jersey, 1993).
(top)

Southeast: Florida

In Florida, 97.4% of the population live in coastal counties that make up 93% percent of the land. The state covers an area of 53,937 sq mi, and has 1,350 mi of coastline. The population of the state is 12.9 million; this population increased 163% between 1960 and 1990. During this time of rapid population growth, Florida was spared major hurricane activity. Since 1992, however, Florida has experienced numerous major events, including floods, tornadoes and hurricanes. In the past five years, the President has declared Florida to be a disaster area 10 times, including for three hurricanes and two tropical storms.

Hurricane activity in the southern peninsula of Florida has a long and varied history. Approximately 28 hurricanes affected South Florida during the 1900s. The hurricane of 1928, a category 4, made landfall around Palm Beach; it resulted in flooding that took 1,836 lives, making it the most catastrophic for Florida in terms of total lives lost. The Labor Day hurricane of 1935, a category 5 storm that struck the Florida Keys, resulted in the loss of 408 lives and damages of $50 million. The storm surge of that hurricane piled water to a height of 20 feet in some portions of the Keys. In 1960, Hurricane Donna crossed the Florida Keys and then moved northeast across the state from the Fort Myers area to near Daytona Beach. It claimed 13 lives in Florida. Although not the deadliest, it is thought to have been the most financially destructive hurricane ever experienced in South Florida prior to Hurricane Andrew, as it caused an estimated $305 million in damages. Hurricane Donna claimed 13 lives in Florida.

Nearly half of all Florida hurricanes this century struck between 1920 and 1950. In the 1940s, Florida recorded 10 hurricanes. The last major hurricane to strike South Florida before Hurricane Andrew was Hurricane Betsy, which struck 27 years ago. Hurricane Andrew struck southern Florida and Louisiana in late August 1992, causing 23 deaths and $25 billion in damage, becoming the most costly natural disaster in U.S. history at that time.
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CASE STUDIES

The following case studies illustrate the impacts of natural hazards such as a hurricane, a tsunami and chronic erosion on coastal communities.

Hurricane Fran: North Carolina

On September 5, 1996, Hurricane Fran struck the North Carolina coast. The torrential rain accompanying Fran caused widespread and record-breaking riverine flooding. Although the center of the storm passed over the Cape Fear area, the high winds extended over much of the North Carolina coast. At landfall, high maximum sustained surface winds were an estimated 115 miles per hour.

Photo 11. High winds from Hurricane Fran caused most of the damage associated with this storm.

Wind damages from Hurricane Fran varied along the storm track. The most significant damages from the wind itself occurred along the coast. As the storm moved inland, most damages resulted from falling trees. The winds caused tress to fall on more than 4,000 homes, businesses and other structures. While hurricane-force winds often decline rapidly as a storm moves over land, Hurricane Fran sustained fairly high winds across the state. For example, wind gusts of up to 69 miles per hour were measured as far inland as the Raleigh-Durham airport.

Hurricane Fran produced a coastal storm surge that was measured at heights of up to 12 feet. The storm surge caused flooding as far north as the Pamlico River. Stillwater surge heights reached 5 feet. The areas most severely impacted by the storm surges were the coastal barrier islands. Not only did the surges and heavy waves hit them severely, but also the highest winds occurred there. The surges and breaking waves that reached heights of over 10 feet devastated North Topsail Beach. Many structures constructed to pre-1985 building standards, including those that had not been built on elevated, reinforced piers, frequently collapsed due to the combined effects of erosion, flood loads and the impact of debris. Collapsed structures, in turn, added to the large quantity of debris, which, when carried by the storm surges and wind-driven waves, had devastating effects on adjacent and landward structures.

Photo 12. The storm surge from Hurricane Fran collapsed many buildings built prior to 1985.

Hurricane Fran dramatically redefined the shoreline and eroded the protective dune system, further exposing already vulnerable coastal communities to future storms. Changes in the established dune vegetation line reduced the size of buildable lots along the shore. For many of the buildings that were substantially damaged, the state's Coastal Area Management Act (CAMA) setback requirements may make rebuilding impossible (State of North Carolina, 1997).
(top)

Tsunami: Prince William Sound, Alaska

On March 28, 1964, an earthquake occurred in Prince William Sound of Alaska, triggering a Pacific-wide tsunami. The earthquake had a surface-wave magnitude of 8.4 and a depth of 23 km. The earthquake, local tsunamis due to landslides, and the regional tsunami were responsible for taking the lives of more than 122 people and causing more than $106 million (1964 dollars) in damage.

Photo 13. This 1964 tsunami event in Alaska killed 132 people, and destroyed millions of dollars in property.

The state that suffered the greatest amount of damage as a result of the 1964 tsunami was Alaska, where 106 people died and $84 million in property damage occurred. Within Alaska, the run-up measurements varied; they reached 24.2 m at Blackstone Bay, 27.4 m at Chenega, 9.1 m at Valdez and 6.1 m at Kodiak. It took more than 5 hours for the first wave to arrive at Hilo, Hawaii, where the run-up was measured at 3 m. Crescent City, California experienced a 4.3-mr run-up more than 4 hours after the earthquake triggered the tsunami (Prince William Sound Tsunami Web Page).

Whittier, Alaska, with a population of 70, lost 13 people and incurred $10 million in property damages. The waves destroyed two saw mills; an oil company tank farm, wharf and building; a railroad depot; and numerous residences.
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Coastal Erosion: Folly Island, South Carolina

Over the past century, Folly Island, South Carolina, has eroded at a rate of approximately 24 feet per year -- 9 feet per year at the east end and 15 feet per year at the west end. The reduction in longshore sediment supply due to the construction of the Charleston Harbor jetties may be partly responsible for the barrier island's high rate of erosion. Jetty construction has also played a role in changing wave patterns, which resulted in the erosion of shoals that once protected the island from wave attack. In addition, Folly Island has been subjected to the erosional impacts of coastal storms, including Hurricane Hugo in 1989. After the failure of hard stabilization structures to arrest the erosion, a 50-year nourishment plan was begun in 1993. The initial beach fill volume was 2.48 million cubic yards of sand and cost $12 million. The plan requires five additional renourishment projects -- one about every eight years (Katuna et al., 1995).

Photo 14. Folly Beach, South Carolina is plagued with erosion problems.

Unfortunately, the 1993 nourishment did not last the estimated eight years. More than 75% of the sand placed on the island had eroded by 1995. The Army Corps of Engineers had predicted erosion and transport of sand to the east and west ends of the island, but not this much sand and not this rapidly (Katuna et al., 1995). In 1997, the west end of the island underwent a separate beach nourishment project to make up for sand lost to heavy localized erosion. Because of Folly Beach's high annual and long-term erosion rate, continued beach nourishment projects are likely to be necessary to prevent continuing recession of the beachfront. As in many beachfront communities, additional sand and beach loss could have profound localized impacts on the economic and recreational value of the island. Conversely, costly and continuous beach nourishment projects may offer only temporary protection for some areas against the inevitable ocean erosion processes.

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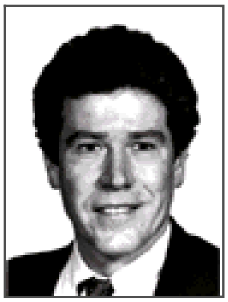
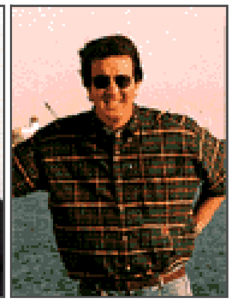
EXPERT INTERPRETATION

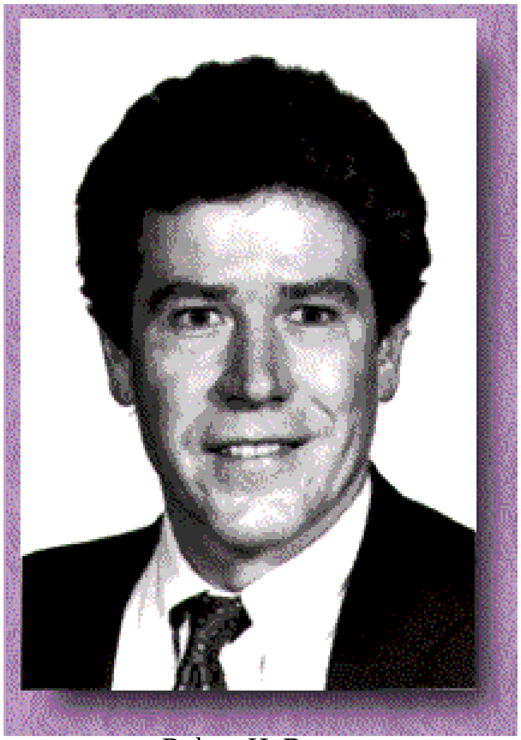
The four individuals below are experts in the topic of Population at Risk from Natural Hazards. Here they voice their opinions on two questions relevant to that topic.

Question 1. What are your major concerns about coastal population growth as it relates to natural hazards risk?

Question 2. What, if anything, do you believe can be done to minimize the impacts of natural hazards on coastal population?

Experts

			
Robert H. Bacon	**John Donahue**	**Phillip Hinesley**	**Orrin H. Pilkey**



Robert H. Bacon

Program Leader, South Carolina Sea Grant Extension Program

Mr. Bacon is a principal investigator for Sea Grant HazNet, a Sea Grant National Outreach Initiative and, since 1992, has served as Coordinator of the South Carolina Sea Grant Hazards Outreach Program. He is a co-founder of the South Carolina Hazard Mitigation Roundtable, a bimonthly discussion group of building and emergency management officials, insurers, flood plain managers, engineers and planners. Mr. Bacon is also a founding member and secretary of the South Carolina Association for Hazard Mitigation.

Response to Question 1

Response to Question 2

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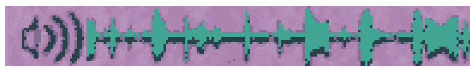
Question 1. What are your major concerns about coastal population growth as it relates to natural hazards risk?

Click here for audio response

My first concern is the demographic trend of new residents moving to coastal areas, who have little or no knowledge of, or experience with, hurricanes or other coastal hazards. A second concern is the ability of homes in high-risk areas to resist hazards and the substantial public and private costs associated with these hazards. While the most dramatic images of storm damage are those of devastation along the beaches, by far the greatest losses occur inland. The majority of coastal residents live in urban and suburban areas, where many buildings receive relatively minor damage, mostly to roofs, windows and doors. The breach of the building "envelope" allows rain inside, causing substantial damage to walls, floors and building contents. Minor damage, magnified by the entry of rainwater occurring on a wide scale, produces enormous property loss. More suburban development to accommodate population growth along the coast only increases the potential for these kinds of losses.

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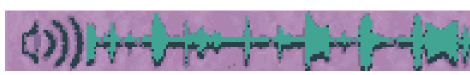
Question 2. What, if anything, do you believe can be done to minimize the impacts of natural hazards on coastal population?

Click here for audio response

There are four items that I think could minimize the impacts of natural hazards on coastal populations: public education, better building codes, improved code enforcement and the incorporation of hazards into land use planning decisions. First, public education is needed to create an awareness of hazard risks. It can encourage a greater acceptance of personal responsibility for individual decisions about where to live and will help to create a market demand for more hazard-resistant new homes and for cost- effective, retrofit methods and materials to help reduce hazard risks in existing homes. Finally, public education is needed to encourage support for public policies that reduce personal and societal vulnerability to hazard losses. Second, building codes in high-hazard areas should be strengthened to ensure a greater level of performance in critical nonstructural elements of the building envelope, including windows, window coverings, doors and roof coverings. Third, building codes are only as good as the effectiveness of their enforcement. Better code enforcement means more and better trained local building officials and more public resources devoted to code enforcement. Well trained, licensed and certified private sector building inspectors, working with public inspectors, may be another possible solution. Finally, vulnerability to hazards should be given a greater weight in the local land use planning process.

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John Donahue

President, Hartford International Financial Services Group

Mr. Donahue joined The Hartford in 1954, serving in various field underwriting positions before moving to the company's Hartford headquarters in 1965. He has held a series of positions in the company and was appointed to his present position in 1996. Mr. Donahue has served as chairman of numerous commercial insurance industry pools and associations. He currently serves on the board of directors of the American Red Cross.

Response to Question 1

Response to Question 2

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Question 1. What are your major concerns about coastal population growth as it relates to natural hazards risk?

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The primary concern we should have with regard to coastal population deals with the potential loss of lives in the event of a natural disaster. The concentration of people along the coast of the United States has exceeded expectations in the past 25 years and will most likely exceed population projections for the next 25 years. Therefore, the concerns expressed today will only become greater in the years ahead, as the population continues to move to the coast. The build-up of property value, the potential extraordinary loss of property and the resultant impairment of the insurance system itself are all potential concerns. The risk of financial ruin and loss of life is very real, and the potential impact of a hurricane striking one of our very populated areas could be devastating. In summary, I would say that my major concerns are a potential extraordinary loss of life due to the lack of proper safeguards, such as evacuation programs, and the potential negative impact on either the ability of the people to obtain insurance or the ability of the insurance companies to withstand a catastrophic loss.

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Question 2. What, if anything, do you believe can be done to minimize the impacts of natural hazards on coastal population?

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Clearly, the minimization of the impacts of natural hazards on coastal populations is going to require an extreme amount of cooperation between governments at the federal, state and local levels; the insurance industry; and the people living in coastal areas. It is not only necessary to strengthen the local building codes, but we must also devote enough resources for enforcement to ensure adherence. For example, the Institute for Business and Home Safety, a nonprofit, insurance industry-sponsored organization, is beginning to make good progress in promoting property loss reduction. Its stated mission is to reduce deaths, injuries and property damage, as well as economic loss and human suffering, caused by natural disasters. This is an overwhelming mission and would be difficult for any single organization to achieve without the cooperation mentioned above. In conclusion, the time is probably past due for us to formulate a concerted effort, bringing together all the interested parties, and focus on the myriad solutions and recommendations that are needed in order to mitigate both loss of life and loss of property, and the devastating impact this loss would have on communities and businesses in the coastal United States.

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Phillip Hinesley

Coastal Program Manager, Alabama Department of Economic and Community Affairs

Mr. Hinesley served as the Community Development Director for the City of Foley, Alabama for a number of years before joining the Alabama Department of Economic and Community Affairs (ADECA) Planning and Economic Development Section in 1989. In 1990, he joined the Coastal Area Management Program Section of ADECA and, in 1996, was promoted to Coastal Program Manager.

Response to Question 1

Response to Question 2

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Question 1. What are your major concerns about coastal population growth as it relates to natural hazards risk?

Click here for audio response

During the period between 1975 and 1995, the population in Alabama's coastal counties increased by 29%. Much of this growth occurred along the Gulf of Mexico shoreline and around low-lying areas along coastal rivers and bays. It appears as if most coastal residents want to live as close to the water as possible. This presents a major problem to coastal and emergency planners as they try to address both pre- and posthazard mitigation needs. It is not a secret that the current hazard mitigation plans have not kept pace with the development trends along the Alabama coastline.
(top)

Question 2. What, if anything, do you believe can be done to minimize the impacts of natural hazards on coastal population?

Click here for audio response

We must address natural hazards and coastal populations on a regional and comprehensive level. This effort will require that local governments and state and federal agencies work together with coastal citizens in the development of a comprehensive shoreline erosion and hazard mitigation plan for coastal Alabama. The Coastal Management Program in Alabama has initiated a project to develop such a plan with the assistance of the State Emergency Management Agency, the Federal Emergency Management Agency, NOAA and its Coastal Services Center, and the local regional planning commissions.

This regional comprehensive approach will identify potential hazard risks; develop and recommend upgrades to existing local ordinances, code standards and land use regulations; and establish local hazard mitigation plans. The plan will also look at state regulations, laws and policies related to coastal hazards and recommend improvements. The overall goal of this effort is to reduce the potential for personal injury and the loss of property value along the Alabama coast.
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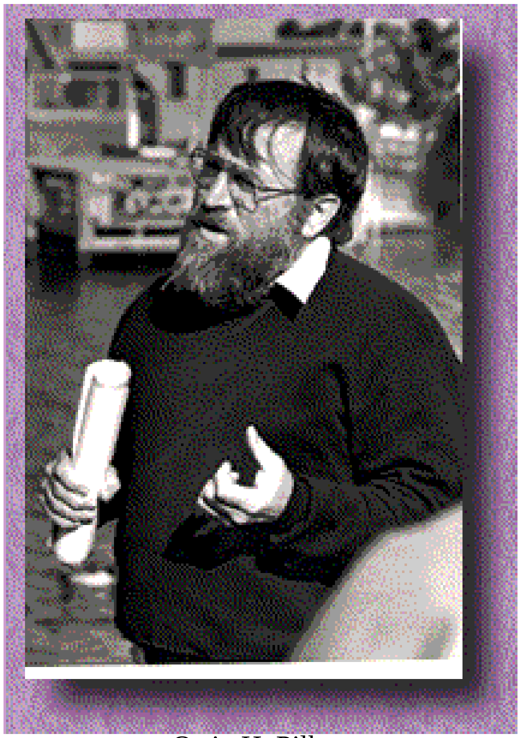


Orrin H. Pilkey

James B. Duke Professor of Earth Sciences, Division of Earth and Ocean Sciences, Duke University; and Director, Duke University Program for the Study of Developed Shorelines

Dr. Pilkey has taught and conducted research at Duke University for more than 30 years. Prior to joining the faculty at Duke, he spent three years at the University of Georgia Marine Institute. His expertise centers on both basic and applied coastal geology, primarily on barrier island coasts. Specific topics of Dr. Pilkey's research include beach nourishment, validity of mathematical models in predicting beach behavior, and hazard mapping.

Response to Question 1

Response to Question 2

(top)

Question 1. What are your major concerns about coastal population growth as it relates to natural hazards risk?

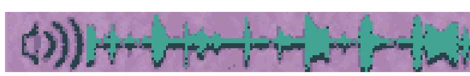

Click here for audio response

The most important concern about population growth relating to risk is the increased number of people who are at risk. For example, looking at a barrier island right after a storm–the sand that comes onto the island and the waves that roll over it–is a beautiful sight to behold. These are parts of an island's evolution.

An island or coastal area that is covered with houses and that has just suffered a storm is disastrous to see. However, more than just people are involved. As population increases, there is pressure to create more navigation channels and to deepen existing channels. Navigation channels cause the shoreline to retreat. They cause the loss of sand supply on either side of the channel, creating more problems for buildings along the shoreline. We find more dune gaps that lead to the sea so that people can have more access to it. However, during a storm, dune gaps act like access ways to the island for storm waves and increase the danger to the population and to property.

In addition, roads act as overwash passes, and with increased population, there are naturally more roads. Maritime forests are very protective of buildings that are tucked within them, but unfortunately, development involves removal of the forest. So, in two ways, population growth will increase hazards. One is how we alter the environment, making it more dangerous. The other is when you increase the number of people close to the beach or shoreline, then an increased number of people will get hurt in the next storm, either by property damage or by evacuation problems.
(top)

Question 2. What, if anything, do you believe can be done to minimize the impacts of natural hazards on coastal population?


Click here for audio response

There is a lot that can be done. The best way to minimize the impacts of natural hazards would be to halt growth in the coastal zone. Since that seems to be unlikely, we have to look at the second best. That would be to hold down the density of population. That means sticking with single-family homes or duplexes and trying to avoid large condominiums, which increase the population of the nearshore area, making evacuation much more difficult and, at the same time, the potential for property damage much greater.

Third best is to learn how the coastal area works in a storm. Assume that the worst will happen, and learn how to best live around this major hazard. For example, on barrier islands you can avoid building structures in potential inlet zones. Avoid building structures in overwash zones. If there are dune gaps, plug them. When dunes are missing, rebuild the dunes altogether. We learned in Hurricane Hugo that artificial dunes, if they are at least 100 ft wide at the base and 15 ft high, were quite good at preventing damage to buildings behind them or preventing a direct attack by the waves.

We can, in some cases, move buildings that are located in dangerous areas, such as potential inlet sites, or buildings that are against an eroding shoreline. We can renourish the beach, which is a good way to prevent storm damage. However, it is very expensive and very temporary. We could build seawalls to prevent storm damage, but this is prohibited by most states because seawalls eventually destroy the beach.
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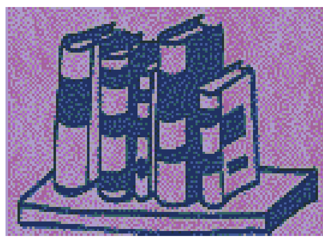

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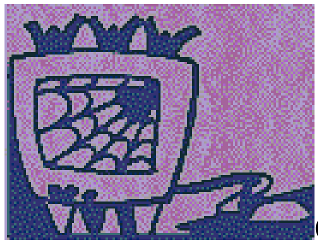

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Coastal Hazards

Federal Emergency Management Agency. Hurricane Background and Preparedness Information.

http://www.fema.gov/hu97/hurinfo.htm

Contains links to FEMA publications about hurricanes. Topics include new hurricane and flood downloadable pdf documents, preparedness information, background information, and recovering flood-damaged property. Links to fact sheets on hurricanes and hurricane mitigation provide survival information such as explanations of safety measures and precautions to take before a hurricane.

U.S. Geological Survey, Western Region Coastal and Marine Geology. USGS Western Region Kiosk.

http://online.wr.usgs.gov/

Supplies links to considerable data through image-map navigation. It links information on the following topics: volcanoes, landslides, earthquakes and floods; maps; press releases; what's new; fact sheets; other links; and a Menlo Park tour.

Tsunamis

University of Washington Geophysics Program. Tsunami: an interactive, on-line, tsunami information resource.

http://www.geophys.washington.edu/tsunami/welcome.html

Provides general information about tsunamis and extensive background information about the mechanisms of tsunami generation and propagation, past tsunamis (including the 1964 Prince William Sound tsunami), the impact of tsunamis on humans, tsunami mitigation, and the Tsunami Warning System. It also contains detailed information about recent tsunami events and research projects, and related websites.

Planet Hawaii. The Pacific Tsunami Museum.

http://planet-hawaii.com/tsunami/

Describes the mission of the Pacific Tsunami Museum, which is to promote public education about tsunamis for the people of Hawaii and the Pacific Region. This site includes new information, museum vision and purpose, frequently asked questions, programs, archives, membership, museum store, related tsunami links.

Coastal Erosion

USGS Coastal and Marine Geology Program.

http://marine.usgs.gov/natplan97.htm#coastal_erosion

Provides the March 1997 version of the updated five-year plan for geologic research on environmental, hazard and resource issues affecting the nation's coastal and marine realms. The section on Coastal and Nearshore Erosion describes the scope of the problem for the nation, program objectives, establishment of study priorities and, briefly, current and future studies.

Tsunamis in Oregon

Oregon Department of State Police. Tsunamis in Oregon: Be Informed, Be Prepared.

http://www.das.state.or.us/OEM/tsuinor9.htm

Explains the risks of tsunamis in Oregon, general tsunami information, dangers, facts, safety tips, precautions, contacts for more information, and related sites.

David See-Chai Lam Centre for International Communication: Provincial Emergency Program. Tidal Wave.

http://hoshi.cic.sfu.ca/~pep/Zeballos64/tidalwave.html

Describes personal stories about the Alaskan Tsunami of 1964 on Northern Vancouver Island, British Columbia. Detailed personal account and several images are included.

Hurricane Andrew

National Hurricane Center Tropical Prediction Center. Preliminary Report: Hurricane Andrew 16-28 August 1992.

http://www.nhc.noaa.gov/andrewpr.html

Provides a thorough preliminary technical report on Hurricane Andrew. It includes synoptic history, meteorological statistics (minimum pressure over Florida, maximum wind speed over Florida, storm surge, tornadoes, and rainfall), casualty and damage statistics, forecast and warning critique, references, tables and images.

Miami Herald. Andrew's Legacy.

http://www.herald.com/dade/archive/andrewleg/

Provides an eight-part newspaper article discussing the changes to South Dade County in the five years since Hurricane Andrew. Article discusses attitude changes since the storm, Nature's triumphs, homes and lives being rebuilt, emotional traumas still suffered by children, preparation for another hurricane, new insurance policies and building inspections. It also provides links to related articles dealing with building standards, population change, restoration projects, and survival stories. Images and diagrams are included.

USGS Marine and Coastal Geology Program. Hurricane Impacts on the Coastal Environment.

http://marine.usgs.gov/fact-sheets/hurricane/hurricane-txt.html

Contains specific information about hurricane damage from four major hurricanes in 1992, including Hurricane Andrew. It discusses environmental losses and explains the Louisiana Barrier Island Erosion Study research project, which uses historical data to show that Louisiana is rapidly eroding and Hurricane Andrew's relationship to this erosion.

Hurricane Fran

Rice University. Hurricane Fran.

http://www.owlnet.rice.edu/~cnoble/

Explains history of Hurricane Fran, the setting, anatomy of the storm, and details tracking the storm. Also includes images, a bibliography, and related websites.

US Geological Survey. USGS Open-File Report 96-674: Preliminary Mapping of Overwash from Hurricane Fran, September 5, 1996, Cape Fear to Bogue Inlet, NC.

http://coastal.er.usgs.gov/hurricanes/OFR.html

Offers background information about Hurricane Fran. Also explains current research investigations relating to erosion potential of major hurricanes, including survey method, maps, before and after images, and future research efforts. Document is available in pdf format.
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GLOSSARY

beach nourishment: the process of replenishing a beach, either naturally by longshore transport or artificially by the deposition of dredged materials (National Research Council, 1990).

chronic hazard: an enduring or recurring hazard, such as beach, dune and bluff erosion; gradual weathering of sea cliffs; and flooding of low-lying lands during major storms.

coastal zone: coastal waters and the adjacent lands of the coastal states, including islands, territories and the Great Lakes states.

erosion: the loss of sediment from the beach, dunes and bluffs.

hard stabilization: the installation of seawalls, riprap revetments or jetties along developed portions of an eroding coastline.

hurricane categories: see Table 1, Saffir-Simpson hurricane scale.

jetty: massive, constructed rock structures built to stabilize and protect harbor entrances, usually built perpendicular to the shore to stabilize a river mouth (Oregon Sea Grant Consortium, 1994).

natural hazards: episodic and chronic destructive natural system events such as hurricanes, beach erosion, tsunamis and severe storms

natural processes: physical processes that have an environmental impact and may damage property.

storm surge: a rise in sea level caused by water piling up against a coast under the force of strong onshore winds such as those accompanying a hurricane or other intense storm. Reduced atmospheric pressure may contribute to the rise.

tsunami: a series of waves generated by an impulsive disturbance in the ocean, usually an earthquake occurring near or under the sea.

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About the Authors

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Catherine Main has been with the NOAA Coastal Services Center for more than two years. She is a Coastal Planner and works primarily with the Coastal Hazards team on issues relating to planning, policy and management. Prior to working at the Coastal Services Center, she spent several years in environmental education and received her M.S. in Environmental Studies with an emphasis on coastal planning and policy.

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