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The rate of population growth along the U.S. coast presents many challenges. One of these challenges is to ensure the safety and security of a population that is continually threatened by natural hazards and periodically subjected to catastrophic disasters. Significant initiatives are under way to minimize the impacts from coastal hazards through better preparedness and a more informed public. In an effort to reduce the number of lives lost and the amount of property damaged in coastal areas, methods for predicting hazard events and impacts, mobilizing the public to move out of harm's way, and reducing overall exposure and vulnerability in the highest hazard locations are being improved.

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National Oceanic and Atmospheric Administration (NOAA). 1998 (on-line). "Reducing the Impacts of Coastal Hazards" by Sandy Ward and Catherine Main. NOAA's State of the Coast Report. Silver Spring, MD: NOAA.

URL: http://state_of_coast.noaa.gov/bulletins/html/rtt_06/rtt.html

INTRODUCTION

In 1970, the annual nationwide disaster losses were estimated at approximately $4.5 billion. Today's estimates (in 1970 dollars) generally range from $10 to $20 billion in annual losses. These figures account only for direct costs and do not include the indirect losses such as short and long-term economic and social impacts that many experts believe would more than double these conservative figures. Of the estimated $500 billion in disaster losses between 1975 and 1994, 80% were caused by meteorological events. Only about 17% of the estimated losses were insured.

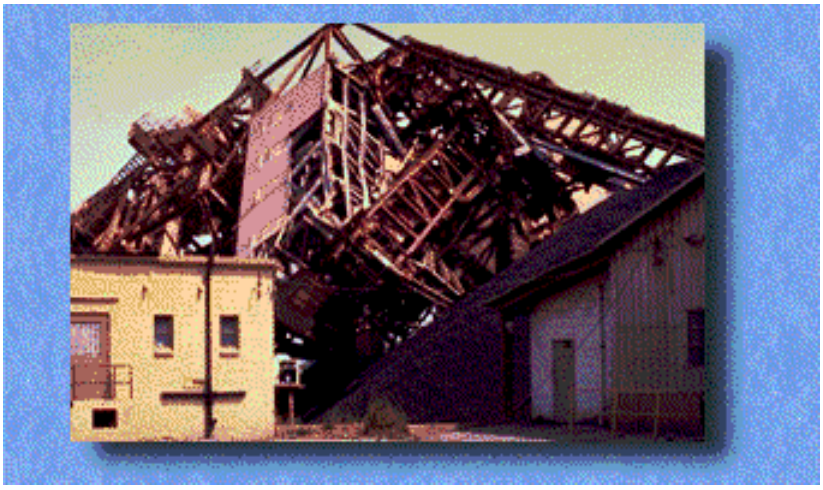

Photo 1. Coastal managers seek to minimize the public's exposure to a hazard risk, such as a hurricane or flood. This is called hazard mitigation.

One of the explanations often provided for the significant increase in the amount of disaster damages is the population increase in hazard-prone locations, including coastal areas. Every year, more and more Americans are at risk from a variety of natural hazards that affect the coastal environment. In the past 30 years, there has been such explosive growth along the nation's coastal margins that today more than 50% of U.S. citizens live in the coastal zone. Many of these citizens build their homes, businesses, schools and hospitals in locations that are particularly vulnerable to catastrophic and chronic coastal hazards, such as hurricanes, severe storms, coastal erosion and tsunamis.

National attention on disaster losses intensified with Hurricane Hugo and the Loma Prieta earthquake in 1989, and the other major catastrophic events that followed in rapid succession, including Hurricane Andrew in 1992, the Midwest floods in 1993 and the Northridge earthquake in 1994. In recent years, several hurricanes, including Opal, Marilyn, Iniki and Fran, have significantly affected the Southeast, Gulf, and Hawaiian and

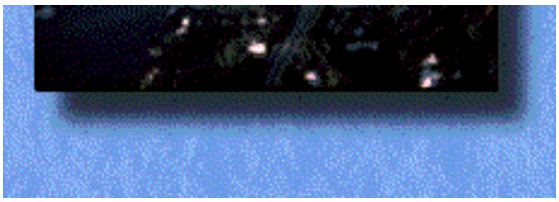

Photo 2. Population is increasing along the coast, putting more people in harm's way.

Caribbean coasts, while numerous storms and El Niño-induced events have pounded the West Coast. In addition, higher than average lake levels and coastal storms have resulted in destructive and costly flooding and erosion along the Great Lakes. The size and scope of these large-scale events have had a profound effect on public policy and perceptions concerning hazards and what can, or should, be done to minimize their impacts.

Photo 3. Hazard avoidance and reduction are increasingly emphasized as disaster-related costs rise.

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NATIONAL PICTURE

Given the significant costs of the nation's catastrophic natural disasters, the focus of emergency management has expanded in recent years beyond disaster preparedness to include hazard mitigation, an effort to minimize both individual and community vulnerability to future disaster impacts. The primary purpose of hazard mitigation is to ensure that fewer Americans are victims of disaster. Not only will this result in fewer lives lost or affected by disaster, but also it will reduce the overall costs and economic consequences of hazard events. Numerous methods and tools are available for mitigating disaster impacts, including population protection methods (e.g., improved forecasts and warnings) and the use of various construction techniques or land use planning strategies to reduce future property damages.

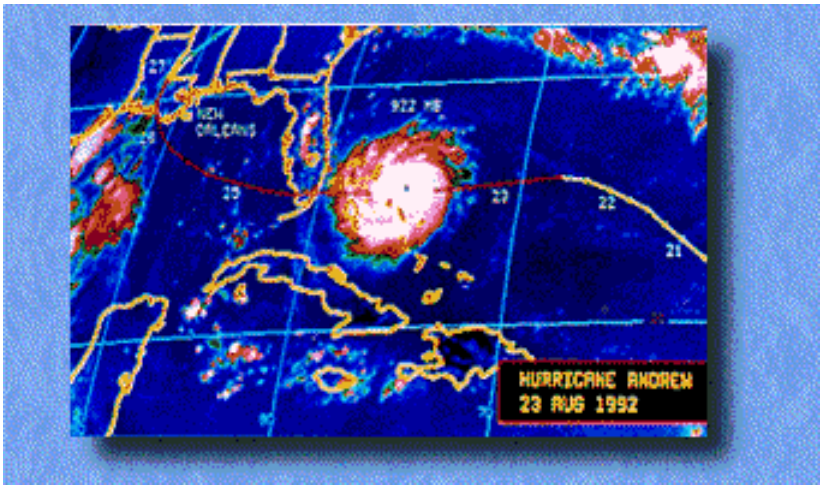

Photo 4. Despite its enormous costs in property damage, Hurricane Andrew caused only a few deaths–evidence of improvements in the science of forecasting severe storms.

The hazard mitigation strategies selected by individuals or communities vary from place to place, depending on the nature and magnitude of the primary hazard threats. In many cases, the decision to take precautions that reduce hazard risks involves an individual choice about where to live or how to protect a home. In other cases, hazard mitigation is a larger community issue involving a long-term commitment to reduce public exposure and expenditures in high-risk areas. While mitigating against future natural hazard damages can increase individual or community costs in the short term, it can prevent substantial disaster losses in the long run.
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Population Protection: Improving Disaster Preparedness and Emergency Response

The better prepared individuals and communities are to deal with hazards, the less devastating a disaster is likely to be in terms of lives lost or damages incurred. All states and most coastal communities have ongoing emergency preparedness programs. Many of the communities utilize disaster plans, public awareness campaigns, and the latest available technologies in risk assessment and hazard forecasting to ensure that residents are informed about their hazard threats and prepared to respond appropriately. These activities not only improve the public's response in emergencies, but also encourage overall preparedness and reduce disaster losses over the long term.

Although emergency planners and response personnel know a great deal about what to do in a disaster, they have not usually become crusaders for long-term hazard mitigation. Their exclusive focus has been on how to respond to disaster events, rather than on how to manage the hazards that can sometimes cause those events. A shift in emphasis from disaster or emergency management to hazards management may help to broaden planning activities so that they address the hazards that always face communities rather than just the disasters that sometimes strike them. Many of the challenges that need to be overcome in implementing local hazard mitigation stem from the fact that hazards receive little attention until a disaster occurs.

Photo 5. Advances in forecasting technology have helped scientists improve predictions of when and where severe weather will strike.

Improvements in the science of forecasting severe storms and other coastal hazards have resulted in longer warning times and fewer deaths over the years, but technological advances cannot always keep pace with the rate of coastal population growth. For example, the lead time necessary to evacuate many large coastal communities in the event of a hurricane, particularly during peak tourist season, is sometimes far beyond current forecasting capabilities. Evacuation decisions made prematurely to ensure adequate lead times are likely to desensitize the public over time. On the other hand, excessive delay in making evacuation decisions can have catastrophic consequences. Progress in minimizing or reducing disaster losses in the future will require efforts to balance a region's overall population growth with its ability to maintain public safety.
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Hazard Impact Reduction: Strengthening of Structural Integrity

Most coastal states have adopted statewide building codes that incorporate some type of standards for hazard-resistant construction, one of the most cost-effective measures for mitigating disaster damages. A few coastal communities have adopted standards even more stringent than the state codes to ensure that new construction can withstand certain hazards. It is impossible to construct facilities that will endure all types and intensities of natural hazards, but the adoption and enforcement of such building codes can ensure that structures are built to resist the impacts of a community's primary hazard threats. Because most building codes apply only to new or substantially improved structures, the public and private sectors can also encourage residents to retrofit existing structures for hazard resistance, for example, through the use of financial incentives (e.g., reduced taxes or insurance premiums).

Photo 7. A bulldozer pushes sand onto the beach to rebuild the dune that helps protect the property behind it.

Photo 6. This house is being built on pilings to reduce potential damage from flooding and high waves.

In addition to strengthening the structural integrity of facilities, mitigation tools can focus on the nonstructural elements of buildings, utility systems and transportation systems. Simple retrofits such as securing light fixtures to ceilings, installing wind shutters, strapping or bolting mechanical systems to walls, and numerous other actions can prevent injuries and minimize damages and business interruptions. On a larger scale, public infrastructure such as utility systems, roads and bridges, and drainage structures can be designed, built or retrofitted for hazard resistance.

Hazard Avoidance: Planning Land Use

The process of establishing and implementing state and community comprehensive development and land use plans provides a variety of opportunities to mitigate damages caused by natural hazards. Because location is a key factor in determining the risks associated with natural hazards, land use plans are a valuable tool; they can designate low-risk uses for areas that are most vulnerable to natural hazards.

As more information becomes available to local communities about the nature of the hazards that they face, they integrate more detailed hazards data into ongoing planning and decision-making processes. Technology improvements such as geographic information systems (GIS) make it possible to consider numerous factors, including hazards, in making land

use decisions. Although more information is available, there remain numerous obstacles in implementing policies to prohibit, restrict or even discourage development and redevelopment in high-risk areas. Many of these obstacles are political, relating to ongoing debates about the rights of individual property owners versus the rights of government to restrict the use of private property. Even more basic, however, is the frequent difficulty of raising the priority of hazard considerations in the routine planning process.

Recovery and Reconstruction: Starting Over

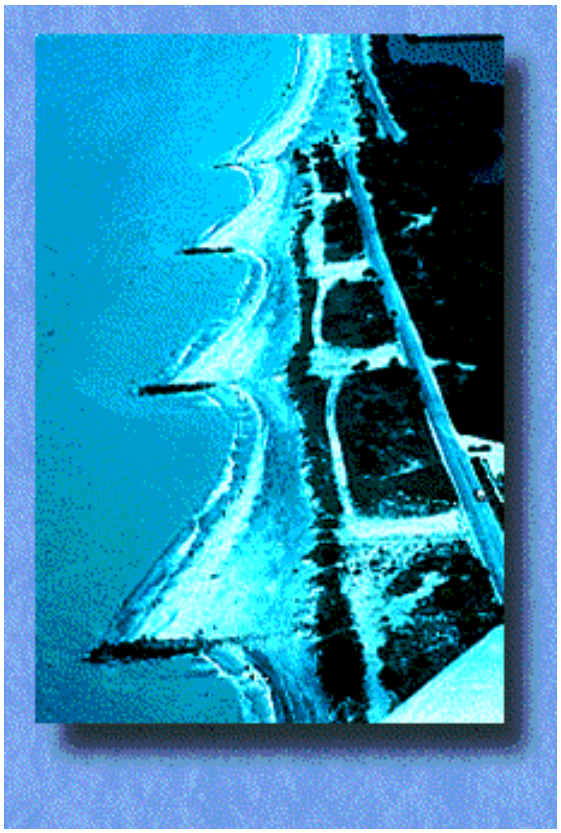

Photo 8. This groin field shows the distinct accretion and erosion patterns typically caused by this type of coastal structure.

The implementation of hazard mitigation actions has been closely linked to the post-disaster recovery and reconstruction phase of emergency management. Not only are hazard vulnerabilities more obvious at this time because of the damages incurred, but also the opportunity exists to rebuild in other locations and in ways that make structures less vulnerable in the future. Furthermore, the availability of money from the Federal Emergency Management Agency (FEMA) and others to help support such initiatives encourages post-disaster hazard mitigation.

Every major disaster brings new experiences and lessons about the recovery and reconstruction process both from a national and from a local perspective. Most of the responsibility for setting and implementing reconstruction policies lies at the local level, however. While information gained from other experiences can help guide some local decisions, the recovery process is a function of specific local conditions, including the nature and severity of the disaster, local political circumstances, and the degree to which reconstruction planning has already taken place.

In the immediate aftermath of a disaster, there are too many demands on a community to logically and systematically identify the optimal mitigation opportunities and establish a hazard mitigation strategy. It is critical, therefore, that communities consider these opportunities and plan these strategies in their ongoing emergency planning processes. It could be as important for a community to develop and adopt procedures to guide the initial recovery process as it is for them to plan the emergency response process, because for a major disaster, the majority of resources, including time and money, are spent on the recovery process.
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Hazard mitigation strategies differ greatly, depending on a number of factors. These factors include the types of primary hazard threats, as well as the social and political environment for implementing or enforcing hazard mitigation initiatives.

Southeast and Gulf Coasts: Mitigating Structural Hurricane Damage

The Southeast and Gulf Coasts are particularly susceptible to intense hurricanes. During a hurricane, high winds may damage or destroy homes, businesses, public buildings, and infrastructure. Flying debris can break windows and doors, unsealing the building envelope and creating pressure within the structure high enough to blow off the roof. After the roof is gone, high winds and rain destroy the inside of the structure. 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; under the right conditions, they can extend hundreds of miles inland.

Photo 9. This condominium complex built on the shoreline displays damage caused by the high winds of a hurricane.

Fortunately, there are a variety of mitigation measures that can reduce structural vulnerability to hurricane wind damage. One of the primary structural focus areas is a building's roof system. Homes with gabled roofs are particularly vulnerable to wind damage, but bracing the roof trusses and gables can strengthen their ability to withstand hurricane force winds.

Hurricane straps, which are designed to help secure roof systems to the walls of a structure, can strengthen all types of roofs. It is also important to protect exterior doors and windows, often the weakest points in a structure's protection against wind damage. When doors, windows or garage doors are lost, high winds can enter buildings, causing extensive damage and putting pressure on roofs and walls. Strong exterior doorframes, hinges and bolts, along with garage door braces, are often required in hurricane-prone areas. Installing storm shutters over exposed glass, including windows, doors and skylights, can be one of the most cost-effective mitigation measures against hurricane wind damage.

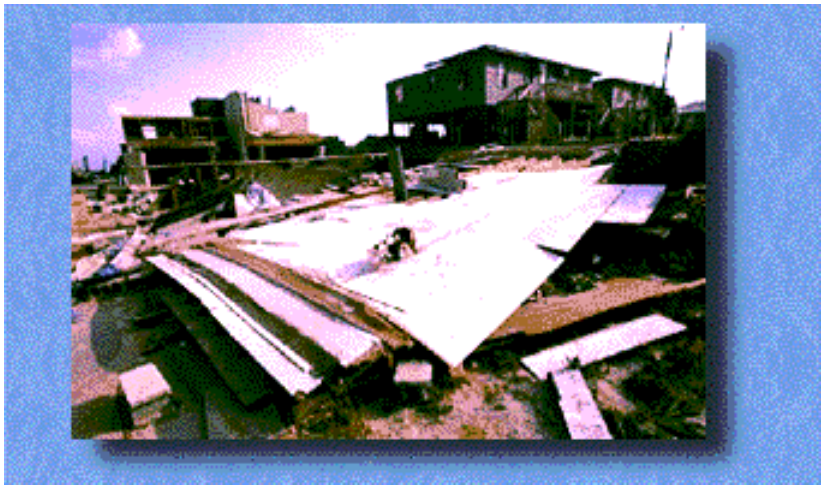

Photo 10. The pile of debris contains the roofs and walls of several homes, blown to this location by hurricane-force winds.

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Great Lakes: Mitigating Coastal Erosion Impacts

The Great Lakes coast has a variety of shore types, ranging from low-lying coastal marshes that are subject to flooding, to high rock cliffs that are essentially nonerodible. Most of the coast, however, is comprised of erodible, glacially deposited sand, gravel, clay and a claylike material called till. The primary forces of coastal erosion are waves, currents and wind. The most dramatic erosion often occurs during storms, partially because storm conditions generate the highest energy waves. Some sections of the Great Lakes coastline are eroding at rates of up to 50 feet per year, and this erosion is destroying, damaging and threatening numerous homes and businesses along the shore.

Photo 11. The truck is towing a home to an area of lower risk for erosion. Relocation of structures is a preventive mitigation strategy.

Mitigation strategies for dealing with coastal erosion include a number of techniques that can be classified as either structural/remedial or nonstructural/preventive. While remedial solutions such as constructing hardened structures (e.g., seawalls, groins or revetments) can prevent or slow the erosion process in some locations, they can be expensive and can sometimes accelerate erosion along the adjacent shoreline. Beach nourishment can replace eroded sand in some locations, but many locations require multiple nourishment projects, making this a sometimes extremely expensive technique. Preventive mitigation strategies, often referred to as hazard avoidance techniques, include relocation of structures out of erosion areas and public acquisition of land in high-risk areas for recreation or preservation uses. Preventive strategies also include regulatory techniques, such as zoning laws to prevent certain types of construction in hazard-prone areas, setback requirements to prevent development within certain distances from the shore, and prohibition of public infrastructure investment in high-risk locations.

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CASE STUDIES

As described earlier, hazard mitigation strategies can involve a wide range of hazard reduction or avoidance activities. The following case studies describe three different types of hazard mitigation initiatives -- structural strengthening, land use planning, and alteration of the environment.

Project Blue Sky

A new research and public education training program, Project Blue Sky addresses ways to increase the use of hazard-resistant materials and construction methods. It is an engineering, research and demonstration program established to reduce hurricane and storm damage to coastal homes and other small buildings. Blue Sky has built construction models demonstrating hazard-resistant building materials and methods, and it offers training to the public. The program also makes available pre-engineered, hazard-resistant materials to builders, designers and members of the public. Retrofitted homes serve as models, while the program trains and educates consumers and the building industry on lessons learned from recent disasters. By developing a package of incentives, Blue Sky hopes to encourage property owners to build stronger coastal homes. Incentives include discounts in property taxes, permit fees, and homeowners insurance. Sponsored by the town of Southern Shores, North Carolina, Blue Sky has the support of FEMA, the North Carolina Division of Emergency Management, and several corporate partners (South Carolina Sea Grant Consortium, 1997).

Photo 12. Project Blue Sky Program Architect Ben Cahoon points out to touring home owners a wall reinforcement detail built into

the Southern Shores Model.

(top)

Photo 13. Hurricane Opal caused less damage in 1995 than it might have had Florida not adopted and enforced stricter building codes beginning in the 1980s.

Florida's Coastal Construction Control Line

The State of Florida has implemented two of the most effective tools for mitigating damages, land use and building code requirements through its Coastal Construction Control Line (CCCL) regulation. During the 1980s, Florida's Department of Environmental Protection established the CCCL to upgrade the standards that guide land use and building construction in high-hazard coastal areas. The CCCL defines the zone along the coastline subject to flooding, erosion and other impacts during a "100-year storm" (a severe storm that has a 1% chance of occuring each year). Properties located seaward of the CCCL setback are subject to state-enforced elevation and construction requirements that are more stringent than National Flood Insurance Program (NFIP) coastal (V-Zone) requirements. Likewise, the wind-load requirements seaward of the CCCL are more stringent than those of the standard building codes.

The test of the CCCL requirements came on October 4, 1995, when Hurricane Opal struck a portion of the Florida coastline as a category 3 hurricane with 111 to 115 mile per hour winds. Coastal flood forces -- storm surge, wind-generated waves, flood-induced erosion and flood-borne debris -- appeared to cause most of the resultant structural damage. Of the 576 major habitable structures located seaward of the CCCL and permitted by the state under the current standard, none sustained substantial damage (Table 1). In contrast, 768 of the 1,366 pre-existing structures seaward of the CCCL sustained substantial damage.

Photo 14. Hurricane-force winds can be very destructive. The CCCL regulations help mitigate the damage from wind and waves with more stringent building standards seaward of the CCCL setback.

Table 1: Major Habitable Structures Seaward of the CCCL: Damages Sustained as a Result of Hurricane Opal

	Structures Built to CCCL Standards (576 Total)	Structures NOT Built to CCCL Standards (1,366 Total)
Structures Not Substantially	576	598

Damaged		
Structures Substantially Damaged	0	768
Percentage of Structures Substantially Damaged	0%	56%

Source: FEMA, 1997 (on-line)

More structures were damaged or destroyed by wave erosion associated with Hurricane Opal than in all other coastal storms that have occurred in Florida over the past 20 years combined. However, the fact that CCCL-permitted structures sustained no damage in Hurricane Opal is an impressive result of the use of hazard-resistant construction requirements (FEMA, 1997).
(top)

Photo 15. Beach nourishment is an option for mitigating coastal erosion.

Sea Island, Georgia Beach Nourishment Project

Sea Island, Georgia is a small resort island with beaches that attract numerous vacationers and new residents. Since the late 1980s, beach erosion has been chronic, primarily as a result of coastal storms and northeasters. The erosion persisted until it was difficult to walk on the beach at high tide. The owners of the resort island concluded that the best way to preserve the primary attraction of the resort, the beach, was to carry out a beach nourishment project along the shore. Although the project was expensive and the resort owners funded it themselves, they considered it an economic necessity for the development.

In 1990, the beach on Sea Island was nourished, and two groins were constructed to alleviate the chronic erosion problem. Since then, the resort has continued the beach nourishment project by moving sand from time to time, planting vegetation and using snow fences to hold the sand in place. The project has thus far proved successful in maintaining a beachfront for residents and vacationers, and in preventing the erosion that was threatening beachfront homes on the island. After eight years, sand dunes and vegetation are thriving on the beach, and the threat of encroachment on the beachfront homes has greatly diminished.
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EXPERT INTERPRETATION

The two individuals below are experts on the topic of Reducing the Impacts of Coastal Hazards. Here they voice their opinions on two questions relevant to that topic.

Question 1 – Why do you believe that hazard mitigation and risk reduction have become such high priorities in disaster management?

Question 2 – What kinds of things could help to ensure that risk reduction will become a major factor in public and private sector decision-making processes?

	
Donald Geis	**Harvey G. Ryland**

Donald Geis

Founder, Geis Design–Research Associates

Mr. Geis specializes in the development of sustainable and disaster-resistant communities. His professional experience includes four years as Director of Community Planning Programs for the International City/County Management Association; eight years on the faculty of the Urban and Environmental Planning Department and the School of Architecture at the University of Virginia; and eight years as Program Director for Community and Environmental Design Research at the American Institute of Architects Foundation.

Response to Question 1

Response to Question 2

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Question 1. Why do you believe that hazard mitigation and risk reduction have become such high priorities in disaster management?

Click here for audio response

The most important reason for the growing emphasis on hazard mitigation in disaster management is that the costs associated with extreme natural events are increasing exponentially. Economic losses reached an all-time high of $60 billion in 1996, according to the World Watch Institute. All natural disasters cost the American taxpayers nearly $70 billion in the 12 years between 1983 and 1994, with the annual costs growing five times since 1983. These losses are not necessarily the result of more or larger weather-related events, but rather, primarily, of rapidly growing and often inappropriate development in vulnerable areas, such as coastlines and flood plains. There is also a growing consensus among scientists that human-caused climate change in the form of global warming may be increasing the frequency and severity of disasters. The point can be made that many of these natural disasters are not natural, but rather human-made, the result of the inappropriate settlement patterns and poorly planned communities that we have built in these high-risk areas. Our greatest challenge is to learn how to design and build disaster-resistant and sustainable communities.

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Question 2. What kinds of things could help to ensure that risk reduction will become a major factor in public and private sector decision-making processes?

ick here for audio response

Everything we do in the area of risk reduction and mitigation should be framed by the core contextual goal of risk reduction–to minimize the human, property, environmental and socioeconomic costs caused by extreme natural events. Within this context, there are two primary steps we can take to emphasize risk reduction in the decision-making process. The first is to help communities and their decision-makers better understand that it is in their own best interest to pursue risk reduction through the principles and techniques of mitigation. By doing so, communities not only become safer and healthier, but they also become more economically, environmentally and socially viable. The second is to help community leaders understand that there is a direct relationship between the day-to-day decisions they make, particularly in the planning-development process, and the capacity of their communities to be sustainable and disaster-resistant. This can be accomplished through a number of actions, including awareness building and education, and by assisting communities to use the principles and techniques of mitigation effectively. It is essential to keep in mind that the proverbial ounce of prevention in today's historical context is worth many, many pounds of cure.

(top)

Harvey G. Ryland

President and Chief Executive Officer,

Institute for Business and Home Safety

Mr. Ryland has worked in the field of emergency management for more than 30 years. He has served as Deputy Director of the Federal Emergency Management Agency, where he helped to develop a new strategy for emergency management in the United States that emphasizes loss reduction through mitigation. From 1989 to 1993, Mr. Ryland was Executive Director of the Central United States Earthquake Consortium.

Response to Question 1

Response to Question 2

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Question 1. Why do you believe that hazard mitigation and risk reduction have become such high priorities in disaster management?

Click here for audio response

The first half of this decade has seen a regular occurrence of high-profile natural disasters. The Oakland, California wildfires in 1991; Hurricanes Andrew and Iniki in 1992; the Malibu, California wildfires in 1993; the Northridge earthquake in 1994; Hurricane Opal in 1995; Hurricane Fran in 1996; and Northwest floods and snowstorms in 1997 are some of the events that have made national headlines. But this list does not reflect the *thousands* of windstorms, snowstorms, floods and the like that occurred in the same time frame, but were not given the same degree of national attention. On a local scale and in the realm of personal experience, these are, indeed, significant events.

We live in a society where many types of risk have moved into the realm of public values: fire safety, auto safety, smoking and other issues related to our personal well-being, to name just a few. The member insurance companies of the Institute for Business and Home Safety believe that America can reduce the heavy emotional and financial toll that natural disasters take on our nation each year by making natural disaster mitigation as important a public value as the others I named. And we'll know that we've succeeded when people ask if their homes and businesses are as safe as possible from natural catastrophes and press for action to make that a reality.

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Question 2. What kinds of things could help to ensure that risk reduction will become a major factor in public andprivate sector decision-making processes?

Click here for audio response

Despite all that Nature has thrown our way in the last several years, we still remain undereducated about the natural hazards that can alter lives. Public outreach, therefore, is critical. We must ensure that everyone understands the risks associated with natural hazards and knows how to protect themselves, their families, their homes and their businesses. Through greater understanding, people will want to reduce their level of risk. They will only build, buy and use structures that are disaster-safe. In addition, all stakeholders will understand incentives for and the benefits of mitigation.

We must also consider where and how we build. We can reduce risk by locating communities or structures out of areas that are subject to floods, wildfires, earthquakes and windstorms. We can design, engineer and build structures using up-to-date techniques and materials that mitigate natural disaster risks. Finally, we must continue to develop new hazard-resistant construction materials, testing and certification capabilities, and structural design and engineering techniques.

One of the best ways to reduce potential harm is the adoption of statewide building codes. Adherence to and enforcement of building codes for both residential and commercial buildings are essential to making coastal

communities more resilient.

Last is the need to retrofit existing structures. Given the vast numbers of existing buildings, we must develop cost-effective techniques for strengthening existing structures and establish incentives that encourage all stakeholders to apply them.

Making our coasts more resilient to natural hazards can diminish the loss of life and property, and preserve the long-term socioeconomic health of our communities. America can–and should–plan and construct homes, businesses and public buildings that enable people to live and prosper in an atmosphere of personal safety and financial security.
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Federal Emergency Management Agency–Mitigation. National Mitigation Strategy: Partnerships for Building Safer Communities.

http://www.fema.gov/mit/ntmstrat.htm

Contains The National Mitigation Strategy: Partnerships for Building Safer Communities document. The national mitigation strategy was developed to provide a conceptual framework to reduce the unacceptable losses of life and property from recent disasters, and the prospect of even greater catastrophic loss in the future. The document can be viewed on-line or ordered from FEMA.

National Center for Atmospheric Research, Environmental and Societal Impacts Group. Home page for Roger Pielke, Jr. website.

http://www.dir.ucar.edu/esig/HP_roger.html

Focuses on the use of scientific research in the decision-making processes of public and private individuals and groups. Roger Pielke's substantive areas of interest are weather impacts on society, global climate change policy, and science policy. Site includes publications such as academic papers and flood reports, as well as ordering information for publications not on-line. Site also includes links to related web references.

State Coastal Hazards

Oregon Department of Land Conservation and Development. The Oregon Coastal Management Program: Coastal Hazards Strategy.

http://www.lcd.state.or.us/coast/workprgm/curntwrk.htm#Hazards

Explains the Oregon Coastal Hazards Strategy framework and three Statewide Planning Goals: Areas Subject to Natural Disasters and Hazards, Coastal Shorelands, and Beaches and Dunes. Also included are detailed descriptions of related projects and plans for the future.

Center for Coastal & Land-Margin Research. Science for Society: Impact of Tsunamis on Oregon Coastal Communities.

http://www.ccalmr.ogi.edu/projects/oregonian/

Offers background information about tsunamis off of the Oregon Coast. Site includes background information, current understandings and uncertainties, scenarios, images, and animations.

LaBelle, R. and P. Rubinoff. 1996. Providence Journal Bulletin: Business as Usual Doesn't Work with Mother Nature. Coastal Resources Center.

http://brooktrout.gso.uri.edu/ProJoHazMit.html

Summarizes the threat of hurricanes in the state of Rhode Island. The article includes details on past damage estimates and the Federal Emergency Management Act's new approach to hazard mitigation, a new framework for developing strategies to minimize damage caused by natural hazards.

Rhode Island Sea Grant. Outreach Projects: Planning for Natural Hazard Risk Reduction.

http://brooktrout.gso.uri.edu/riseagrant/haz_summ.html

Briefly summarizes a joint effort in the state of Rhode Island to help local communities mitigate threats from natural hazards (including hurricane, earthquake, fire, wind and flooding) and to minimize financial and human costs associated with these disasters. The initiative–funded by Sea Grant and the Federal Emergency Management Agency (FEMA)–will guide communities in developing local hazard mitigation plans, and will work with key institutions and individuals to complete a statewide hazard mitigation strategy. Included are strategy objectives and contact names.

South Carolina Department of Natural Resources: Water Resources Division. Regulations for Floodplain Management.

http://water.dnr.state.sc.us/water/envaff/flood/floodregs.html

Summarizes the minimum specifications of local floodplain management ordinances in South Carolina. It describes the National Flood Insurance Program, defines floodplain functions and zones, and explains permit requirements.

South Carolina Department of Natural Resources: Land Resources and Conservation Districts Division. The Floodplain Manager 4(2), July 1997.

http://water.dnr.state.sc.us/water/envaff/flood/flood797.html

Focuses on state floodplain management issues. Included are articles on Risks of Flooding, Property Not Covered Under My Flood Policy, and Floodproofing. This site also contains a brief summary of the South Carolina Association for Hazard Mitigation Annual Conference.

Case Studies

Federal Emergency Management Agency. Report on Costs and Benefits of Natural Hazard Mitigation: Land Use and Building Codes: Florida's Coastal Construction Control Line.

http://www.fema.gov/mit/cb_land.htm

Describes how the state of Florida has successfully reduced building damage due to hurricanes through land use and building code requirements. It also discusses Florida's hurricane mitigation measures and details the use of the Coastal Construction Control Line (CCCL) regulation and its effectiveness during Hurricane Opal in 1995.

Databases

Duke University Program for the Study of Developed Shorelines. The U.S. Beach Nourishment Experience: New England, East Coast Barrier Islands, Gulf of Mexico, and Great Lakes Shorelines.

http://www.geo.duke.edu/psds_tables.htm

Provides coastal planners, legislators, communities and researchers with the most complete set of data on beach nourishment possible. The database includes the location, cost, sand volume, source of funding, and disposal length associated with every historically known nourishment episode. It is divided into regions and then into tables by state, New England, East Coast Barrier Islands, Gulf of Mexico and Great Lakes. Also included is a

complete list of references.
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GLOSSARY

beach nourishment: the process of replenishing a beach either naturally by longshore transport or artificially by 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.

hazard avoidance: minimization of exposure to risk by managing development through land use planning, land acquisition, economic incentives, location of capital investments, and restriction of development of high-hazard areas through various regulatory authorites.

hazard mitigation: actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects (FEMA, 1995).

hazard reduction: strengthening structures and providing safeguards to reduce the amount of damage caused by natural hazards, including altering the coastal environment through erosion control devices, beach nourishment, flood control works, floodproofing, windproofing, or elevating (Godschalk et al., 1989).

hurricane categories: see Saffir-Simpson hurricane scale, below.

hurricane straps: clips at the intersection of the roof and the top of the wall used to keep the roof in place under high wind conditions.

mitigation strategies: actions taken to prevent or reduce the impacts of natural disasters.

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

northeaster: severe winter storm.

retrofit: strengthening of structures to mitigate natural disaster risks.

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.

storm shutters: coverings for windows to protect them from flying debris during a storm event.

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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CREDITS

About the Authors

Sandy Ward is the Hazards Program Manager for the Coastal Services Center (CSC) of the National Oceanic and Atmospheric Administrations (NOAA). Before joining NOAA, she worked in planning at the local, state, and federal levels, focusing on land use and disaster planning. She also served as the State Hazard Mitigation Specialist for the State of Alabama.

Catherine Main has been with the NOAA CSC for three 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 CSC, she spent several years in environmental education and received her M.S. in Environmental Studies with an emphasis on coastal planning and policy.