A Safer Future: Reducing the Impacts of Natural Disasters

U.S. National Committee for the Decade for Natural Disaster Reduction, National Research Council

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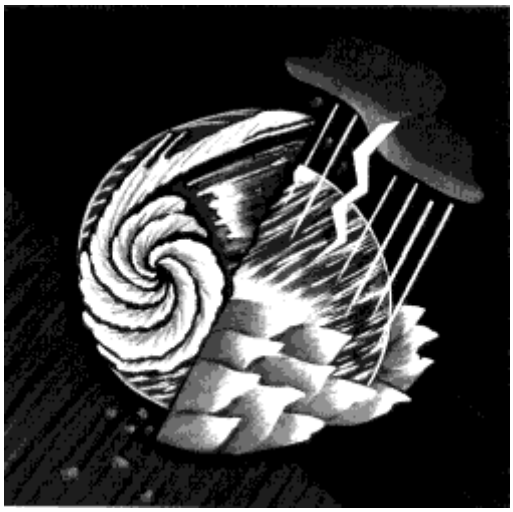

U.S. National Committee for the
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Commission on Geosciences,
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A familiar sight for San Francisco—sections of the city lie in ruins after a massive earthquake. This scene, however, is not from 1989's Loma Prieta quake, but from the great 1906 quake.

Preface

History is punctuated by disastrous events that destroyed lives and obliterated civilizations—the flood and the drought chronicled by the Bible, great earthquakes in China and Japan, the volcanic cataclysm that destroyed Minoan culture. Less spectacular but more frequent disasters such as hurricanes, tornadoes, and landslides have been a chronic drain on individual and public welfare.

In the 1990s, the International Decade for Natural Disaster Reduction provides a new opportunity to confront natural disasters and limit their damage. Science and technology now make it possible to anticipate hazardous events and protect people, property, and resources from their potentially devastating impacts as never before. The United Nations has declared this decade a time for the international community to "pay special attention to fostering cooperation in the field of natural disaster reduction," and many U.S. voices, from the Congress to the American Red Cross, have declared their intention to join in the effort.

Natural disaster reduction requires a complex mix of technical and social endeavors. There is no single prescription to fit every location and every hazard type, nor does any one discipline have all the answers. A distinguishing characteristic of the Decade is its call for all disciplines to work together, consciously seeking the challenges and frustrations of interdisciplinary communication that will yield practical strategies for disaster reduction.

The U.S. National Committee for the Decade for Natural Disaster Reduction is an interdisciplinary group, with members drawn from such diverse fields as meteorology, sociology, civil engineering, and emergency management. For almost two years, we wrestled with the enormous range of disaster reduction needs and capabilities found in the United States and the world. Over time it became clear that rigid criteria and projects would not be adequate to the task. Rather, something more fundamental is needed.

Reducing the impacts of natural disaster will require a shift in attitude and millions of solitary and collective actions. Individuals and governments must begin to think of disasters as literally "natural" aspects of life that must be incorporated in day-to-day decision-making.

The committee has sought to lay out a philosophy and a call to arms for the Decade. It is our hope that as a nation and a world we will now act to ensure a safer future.

RICHARD E. HALLGREN

CHAIRMAN

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Contents

Huge waves caused by severe storms over water, called storm surge, can be as destructive as the storm itself, pounding the shore and washing away soil, roads, bridges, and buildings.

Executive Summary

Each year natural disasters kill thousands of people and inflict billions of dollars in economic losses. No nation or community is immune to their damage. In 1989, two disasters, Hurricane Hugo and the San Francisco area's Loma Prieta earthquake, caused direct losses of approximately $15 billion and indirect losses of $30-45 billion. Ninety people were killed, and more than a year later, thousands remained homeless as a result of these two events.

The World Health Organization estimates that between 1964 and 1983 natural disasters throughout the world killed nearly 2.5 million people and left an additional 750 million injured, homeless, or otherwise harmed. Unless action is taken to reduce the toll of natural disasters, these statistics can only be expected to rise as populations increase and concentrate in vulnerable urban and coastal areas.

The scientific and technological advances of the last half century provide unprecedented opportunities for responding to the urgent need to mitigate the impacts of natural hazards. Recognizing this fact, Dr. Frank Press, President of the National Academy of Sciences, proposed an international decade to address natural disaster reduction at the Eighth World Conference on Earthquake Engineering in 1984. In 1987, the United Nations General Assembly adopted a resolution declaring the 1990s the International Decade for Natural Disaster Reduction (IDNDR), "a decade in which the international community will pay special attention to fostering cooperation in the field of natural disaster reduction." The U.S. Senate and House of Representatives endorsed the Decade concept in resolutions passed the following year. In 1989, the U.S. National Committee for the Decade for Natural Disaster Reduction was formed at the request of the federal government to develop a Decade program for the nation.

The U.S. National Committee believes that the trend of increasing losses to natural disasters can be reversed. This change can be achieved by integrating hazard reduction policy and practice into the mainstream of community activities throughout the nation and the world. The Decade presents an opportunity to reassess the approach to natural hazards and to develop strategies for reducing losses by stressing prevention and preparedness while sustaining and enhancing essential disaster response, relief, and recovery capabilities.

The Committee proposes a multidisciplinary program that integrates the following elements: hazard and risk assessments; awareness and education; mitigation; preparedness for emergency response, recovery, and reconstruction; prediction and warning; strategies for learning from disasters; and international cooperation. These seven elements must be developed in unison so that, collectively, they can provide a framework for hazard reduction over the next 10 years and beyond. This report sets forth recommendations for each element.

Hazard and risk assessments combine information on natural hazards with information on human activity to determine vulnerability to natural disasters. Effective—and cost-effective—disaster reduction must be grounded in a thorough understanding of the physical forces a community faces and their likely impacts on the human, built, and natural envi

ronment. Unfortunately, comprehensive hazard and risk assessments are not universally available.

Grim-faced U.S. volunteers sift through mud an drubble, searching for bodies after rock slides caused by a tropical storm destroyed the Mamayes barrio in Puerto Rico.

The Committee recommends that state and local jurisdictions review, update, and improve their hazard and risk assessments with the assistance of the federal government and use this information in their decision-making processes. The Committee identified four means for improving the quality and availability of hazard and risk assessments:

- the development of computerized multihazard geographic information systems that would make information traditionally stored on paper maps and charts and in books easily accessible to decision-makers,
- research on the physical and biological factors that contribute to and cause natural disasters,
- research on the social factors that govern human response to natural hazards, and
- research on technological and societal strategies for disaster reduction.

Widespread public **awareness and education** is fundamental to reducing loss of life, personal injuries, and property damage from natural disasters. Yet people in many sectors of society remain unaware of the natural hazards they face and the actions they can take to protect themselves and their property. Special efforts should be made to reach sectors of the population that may not have access to traditional education and information media—small children, the elderly, people with disabilities, and those who do not speak English. Because public officials and the news media have crucial responsibilities for disseminating information during a disaster, procedures for their cooperation need to be established in advance of an event.

The Committee recommends that community-wide awareness and education programs about natural disasters be made a national priority. These programs should address the needs of individuals and communities in all the activities and locations where they could be subject to natural disasters:

- at home, provide information on household survival plans, precautionary measures, and emergency supplies;
- in the community, promote planning, education, and preparedness action by hospitals, churches, schools, businesses, neighborhood organizations, and other groups;
- in schools, protect children and their families through information on natural disaster preparedness, warnings, and response;
- in the workplace, ensure safety and security of workers and business assets;

- in colleges and universities, incorporate disaster reduction in the education of all relevant professions;
- for public officials and the press, develop procedures for informing the public before, during, and after a disaster; and
- for professionals, provide continuing education in natural disaster reduction.

Mitigation, actions taken to prevent or reduce the risks from natural hazards, is at the heart of the Decade program. Measures such as the adoption and enforcement of land-use planning practices and building codes must be vigorously pursued if the trend of escalating losses from natural disasters is to be reversed. Communities resist mitigation when they perceive it as incompatible with economic development. All too often, however, when natural disasters strike, the costs to individuals and society far exceed the costs of mitigation measures.

The Committee recommends that every community at significant risk adopt and enforce an appropriate mitigation program, including both near-term goals and a comprehensive long-range plan for reducing the impacts of natural disasters. These programs should include:

- construction and location of all new schools and hospitals to avoid or withstand natural hazards, and strenuous efforts to strengthen existing medical and educational facilities;
- adoption of nonstructural measures for mitigating the impacts of natural disasters;
- incorporation of mitigation into new development;
- protection of cultural properties;
- protection of natural resources;
- leadership by government at all levels in the design, location, and construction of hazard-resistant facilities;
- mitigation training programs;
- research on mitigation strategies for all natural hazards; and
- research on methods for overcoming resistance to mitigation.

Preparedness for emergency response, recovery, and reconstruction can reduce immediate losses caused by natural disasters and minimize the long-term social, economic, and environmental damages they cause. Emergency response can mean the difference between life and death. Well-defined strategies for recovery and reconstruction can reduce human suffering and financial losses by providing for rapid return to normal community functions. The most effective preparedness plans emphasize intergovernmental coordination, use all available human and material resources, and are exercised regularly. All too often, however, response and recovery actions are improvised and uncoordinated.

The Committee recommends that by the end of the Decade, every business and local jurisdiction at significant risk have plans for emergency response, recovery, and reconstruction that have been tested and coordinated with state and federal governments as well as with other local governments. The Committee has identified six means for improving preparedness:

- identification of state and local preparedness needs and capabilities;
- training of interdisciplinary, multijurisdictional teams for response, recovery, and reconstruction;
- improvement of emergency coordination and communication among government, schools, business and industry, volunteer groups, and others;
- development of procedures for managing volunteers and donated resources;
- creation of demonstration preparedness projects; and
- involvement of the utility and other lifeline industries in preparedness planning.

Prediction and warning advances have been a major factor in the decline of disaster-related deaths in the United States over the past half century, particularly those resulting from severe weather, wildfires, and floods. Nevertheless, significant gaps still exist in the capability to predict certain hazards and to deliver warnings to those who are asleep, in the care or custody of others, away from communication sources, hearing-impaired, or non-English speakers. Some technological challenges also remain, particularly that of ensuring communications in the event of power failure.

The Committee recommends that the nation expand and intensify its programs to improve prediction of significant natural hazards and to ensure the effective and timely dissemination of warnings

to all sectors of society. A program to enhance the nation's prediction and warning capabilities for atmospheric, hydrologic, and geological hazards should include:

- modernization of the weather prediction system,
- research to improve the prediction of atmospheric and hydrologic hazards,
- research on the impacts of disasters on natural resources,
- expanded earthquake monitoring and research, and
- increased monitoring of volcanoes. A similar program for dissemination of warnings should include:
- expanded use and coordination of public-private partnerships for dissemination of warnings,
- implementation of new technologies, such as advanced telecommunications capabilities, to ensure broader dissemination of warnings,
- research on the responses of individuals and organizations to warning messages,
- research on techniques for encouraging appropriate responses, and
- research on the organizational networks that disseminate warnings.

By **learning from disasters**, improved safety for tomorrow can be salvaged from today's tragedy. Lessons learned in the postdisaster period can be applied to improve all aspects of natural hazard reduction. The September 1985 Michoacan earthquake that destroyed many buildings in Mexico City, for example, provided the impetus for developing an advanced search-and-rescue capability in the United States and other countries.

The Committee recommends that data on the physical, biological, social, and health aspects of disasters be systematically collected and shared and that the resulting lessons learned be incorporated into policy and practice to reduce the impacts of future disasters. Strategies for learning from disasters include:

- coordination and standardization of data collection by postdisaster investigation teams,
- international sharing of postdisaster data, and
- capitalizing on enhanced awareness in the post-disaster period to advance hazard reduction policies and practices.

International cooperation is essential to the success of the Decade. The United States can both contribute to and benefit from such cooperation; U.S. knowledge and expertise can be applied to reduce the impacts of natural disasters in developing nations,

The haphazard wreckage of buildings blocks roadways and bridges—in this case a complete shack knocked off its foundation by an earthquake.

and the United States will benefit from increased exposure to the research and practice of other nations as well as from the opportunity to engage in new physical, technical, and social research.

The Committee recommends that the United States participate fully in the IDNDR through bilateral and multilateral programs, cooperation with regional and nongovernmental organizations, and support of UN organizational arrangements and program activities. U.S. participants in the IDNDR should include its National Committee, federal agencies, state and local governments, special authorities, business and industry, scientific and technical societies, professional associations, public interest groups, voluntary organizations, and academia. U.S. contributions should be designed to increase the international flow of information, foster the development of hazard management capabilities in other nations, and promote the incorporation of disaster reduction into the development process. Initial emphasis should be given to developing a comprehensive program of natural disaster reduction for the Caribbean-Mexico-Central America region.

An **organizational framework for the U.S. Decade** should recognize that state and local governments have primary responsibility for disaster functions, while providing for strong leadership by the federal government. Decade organization should also include mechanisms for involvement by individuals, professional associations, volunteer organizations, industry, academia, and others. Because of the complexity of the endeavor, it is essential that any structure be flexible enough to accommodate program changes as the Decade proceeds and new priorities arise.

The Committee believes that Decade activities can be built largely upon existing programs and organizations and that no new bureaucracy need be created. The Committee recommends that responsibility for policy direction, planning, and coordination of federal Decade efforts reside in the Office of the President, Office of Science and Technology Policy. It is suggested that the Criminal Justice and Public Safety Committee of the National Governors' Association might serve as a catalyst for Decade efforts at the state and local levels. Further, as called for by the UN resolution, there will be a continuing need for a U.S. National Committee to facilitate the nation's domestic and international programs.

Among the greatest challenges of the Decade will be the development of broad public support and the political will to implement disaster reduction programs. The involvement and commitment of all sectors of society —including individuals; community, voluntary, and professional organizations; business and industry; public interest groups; academia; and federal, state, and local governments—will be crucial to reducing vulnerability to natural hazards. Through the combined efforts of all these participants, we can reduce the toll of natural disasters and create a safer future for all.

Residents have to wait for flood waters to recede to begin reconstruction and recovery efforts after the roads were turned in to rivers and heavy rains swept away cars and other debris.

A few moments of terror—the deadly funnel of a tornado cuts through a community, leaving a snaking trail of devastation along its unpredictable path.

Chapter 1—

The U.S. Decade for Natural Disaster Reduction

The United States is extremely vulnerable to natural disasters. Every state is exposed to one or more of a host of hazards: earthquakes, droughts, floods, hurricanes, landslides, tornadoes, tsunamis, volcanoes, and wildfires. As Hurricane Hugo demonstrated in 1989, natural disasters can undo years of development and devastate natural resources in minutes or hours. The growth of cities; the special vulnerability of such groups as the elderly and the poor; the increased complexity of housing, communication, and transportation systems; and the potential fragility of an increasingly electronic and computer-based economy further increase the potential for catastrophe in the wake of a hazardous event.

The Decade for Natural Disaster Reduction offers an opportunity to create a safer future. The scientific and technological advances of the last half century provide unprecedented opportunities for mitigating the impact of natural hazards. Recognizing this fact, Dr. Frank Press, President of the National Academy of Sciences, proposed an international decade to address natural disaster reduction at the Eighth World Conference on Earthquake Engineering in 1984. In 1987, the United Nations adopted a resolution declaring the 1990s the International Decade for Natural Disaster Reduction (IDNDR). The U.S. Senate and House of Representatives endorsed the Decade concept in resolutions passed the following year.

Direct losses from natural disasters in the United States, currently averaging $20 billion per year, continue to escalate. (See Table 1 for events with insured losses exceeding $5 million each.) The forces that contribute to disaster-related losses are well known. In spite of advances in hazard and risk assessment, vulnerable development continues in disaster-prone areas, often without recognition of the hazard. Although the scientific knowledge exists to forecast where, for example, earthquakes, wildfires, and landslides are most likely to occur, vulnerable new structures are being built in areas that ought to be avoided. Similarly, intensive development is occurring along the hurricane-prone Atlantic and Gulf coasts.

These escalating losses from disasters can be stemmed. Natural hazards are not inevitable calamities. Loss reduction measures can be incorporated into the estimated $4 trillion of new development that will occur in the United States during the 1990s. Steps can be taken to protect natural resources and existing structures. Individuals can take action to protect their lives and their homes.

A NEW APPROACH TO DISASTER REDUCTION

Progress in diminishing the effects of natural hazards in the next 10 years will require a fundamental shift in public perceptions of natural disasters. Hazard reduction policies and practices need to be integrated into the mainstream of community activities throughout the nation. This process should build on successful programs, encourage governmental cooperation, and find new ways to implement decades of research. The result should be the widespread existence of new and expanded hazard reduction pro

grams that are compatible with community goals.

Additional research is needed to further understanding of the physical and social mechanisms of natural hazards and the disasters they precipitate. Research could lead to greater understanding of the causes of disasters, provide a foundation for improved planning, and lead to the development and implementation of cost-effective disaster reduction measures.

The new approach must enlist groups and disciplines not currently involved in hazard reduction. Educators, for example, can incorporate disaster preparedness and mitigation into school curricula, thus shaping the thinking of all citizens, including the next generation of engineers, architects, public administrators, and health professionals. Specialists in information technology and communications can contribute to improved emergency response. Local elected and appointed officials can use available research findings to ensure that development and reconstruction in their communities is hazard-resistant.

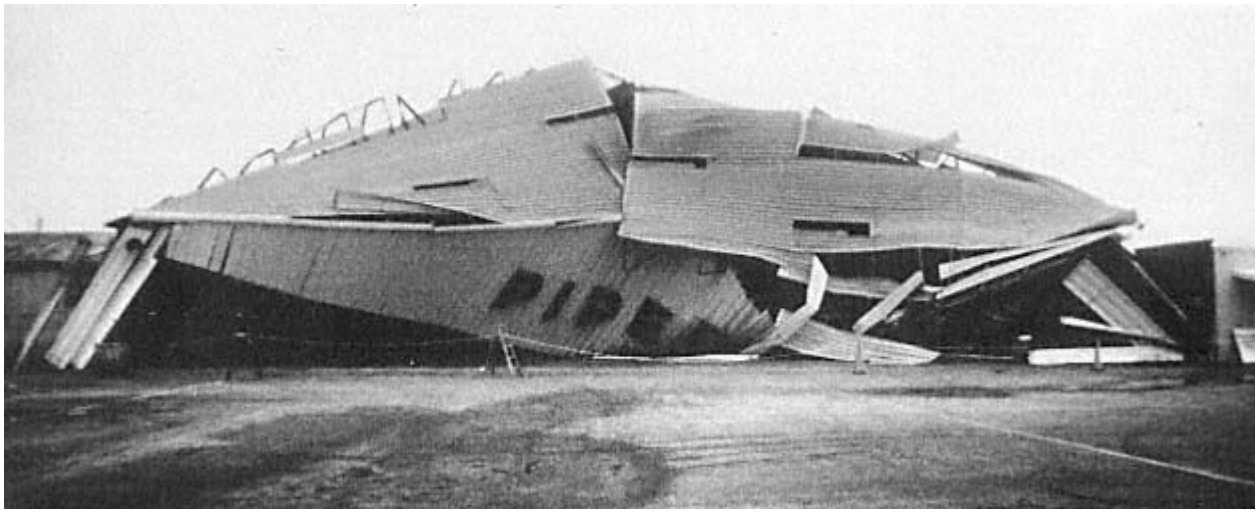
The scientific and technical knowledge—from basic research to implementation—exists to support this effort, but there are also significant constraints on the use of this knowledge. First, multidisciplinary disaster reduction efforts require a level of cooperation and coordination between specialties and organizations that is difficult to achieve. Second, only a limited amount of funding is available for the many

The 1989 estimated insurance payments for catastrophic losses due to high winds, tornadoes, floods, tropical storms, hurricanes, hail, severe winter storms, and earthquakes exceeded $7 billion. More than 15 catastrophic events—defined as events with insured losses exceeding $5 million each—occurred in 35 states, Puerto Rico, and the Virgin Islands. (Source: American Insurance Services Group, Inc., Property Claims Services Division.)

TABLE 1. ESTIMATED NATURAL CATASTROPHE LOSS PAYMENTS BY THE INSURANCE INDUSTRY, 1989

Month of Payment	States and Territories Affected	Estimated Million
January	AK, IL, IN, KY	$ 22
February	CA, CO, MS, MT, NC, OH, OK, TX, WA, WY	115
March	AL, AR, GA, MS	25
April	AL, AR, GA, IA, IL, IN, MO, NC, NE, OH, OK, SC, TX, WV	265
May	AR, GA, IA, IL, IN, KS, LA, MO, MS, NC, NE, NM, OH, OK, SC, TX, VA, WI	675
June	AL, FL, LA, MD, MS, NC, NM, OK, SC, TX, VA	308
July	CT, LA, NJ, NY, OK, TX	137
August	NE, TX	55
September	GA, NC, NM, PR, SC, VA, VI (Hurricane Hugo: $4,195)	4,245
October	CA, TX (Loma Prieta Earthquake: $960)	995
November	AL, AR, CT, DE, GA, IL, IN, KY, LA, MD, MS, NJ, NY, PA, SC, VA	245
December	AL, AR, CT, FL, GA, IL, IN, KY, LA, MO, MS, NC, NY, OH, OK, PA, SC, TN, TX, VA, WV	555
	Total	$7,642

Temporary shelters provide a dry refuge, food, warmth, and friendly faces to the survivors of Hurricane Hugo. Response team sand others providing assistance must take into account the special needs of the very young, the very old, the injured, the handicapped, and non-English speakers when establishing assistance centers.



High winds flattened this airport hangar like the proverbial house of cards when Hurricane Hugo struck Charleston, S. C., with deadly force.

Often under difficult and dangerous conditions, researchers and scientists investigate many different types of disasters to try to understand the nature, cause, and possible effects of each event.

EXAMPLES OF ACHIEVEMENTS BY THE YEAR 2000

- New regional hazard maps and risk assessments for the nation's most vulnerable areas,
- Television programs and school booklets on vulnerability, preparedness, and mitigation measures for each type of hazard,
- Educational programs and materials for non-English speaking populations,
- Increased community adoption and enforcement of building codes,
- More hazard-resistant schools, hospitals, and other public facilities in high-risk areas,
- Guidelines and manuals for land-use practices,
- Improved disaster emergency plans for the most vulnerable communities and regions,
- National and worldwide demonstration prediction projects,
- Postdisaster case studies for all major and selected small disasters,
- Regional consortia for multidisciplinary, intergovernmental emergency response and recovery planning, and
- A cooperative disaster reduction program for North America.

worthwhile disaster reduction efforts that state and local governments as well as nongovernmental participants could undertake. Third, individuals naturally tend to deny that a disaster will strike home, or they adopt the fatalistic view that disasters are inevitable. The public also assumes that if a disaster does occur, the government will provide unlimited assistance in restoring their lives to predisaster normalcy. Thus, successful Decade programs must be founded on the existing scientific and technical expertise while reflecting the social, cultural, economic, and political realities of communities.

A FRAMEWORK FOR HAZARD REDUCTION

The Committee proposes an integrated, multidisciplinary program for the nation to reduce the impacts of natural hazards. Key elements of the Decade program include hazard and risk assessments; awareness and education; mitigation; preparedness for emergency response, recovery, and reconstruction; prediction and dissemination of warnings; strategies for learning from disasters; and international cooperation. Each of these elements is important in reducing the toll of natural disasters. Collectively, they can save lives and limit losses, making the United States and the world a safer place now and for future generations.

The ultimate measure of the Decade's success will be improvements in the patterns of life, property, and natural resource losses. Because disasters occur irregularly and have widely varying impacts, the effects of di saster reduction measures will be clear only over time. The Decade's progress, therefore, should be judged in the short term by using surrogate measures—for example, the number of state and local jurisdictions that improve their hazard and risk assessments, train response teams, develop and exercise emergency response and recovery plans, or take steps to strengthen building codes or their enforcement; documented changes in the awareness and actions of such groups as the media, health workers, architects, engineers, policy makers, and the public; qualitative and quantitative changes in efforts to transfer technology and enhance professional skills through conferences and workshops; and the number of new bilateral and multilateral projects.

STRATEGIES FOR DISASTER REDUCTION

Lives can be saved and losses substantially limited by the year 2000 by:

- identifying the areas of greatest risk to focus limited resources where they are most needed,
- increasing public awareness of vulnerability,
- implementing hazard mitigation policies and practices,
- preparing for emergency response, recovery, and reconstruction,
- improving prediction and warning capabilities,
- learning from disasters to prevent the repetition of mistakes and promote the use of successful techniques, and
- sharing information and experience worldwide.

Each of the following chapters sets forth one major recommendation for a particular aspect of hazard reduction, followed by descriptions of specific program components. The recommendations and descriptions do not necessarily delineate priorities. Instead, the collective framework is intended as a guide for government, industry, business, professionals, health workers, volunteers, educators, researchers, public interest groups, and others to develop their own plans for participating in the Decade. It is expected that the agenda will be revised as these recommendations are translated into actions by these groups. What is important is that the United States move forward without hesitation to reach the common goal of a safer future for all.

Building code sand land-use management can help reduce the number of structures damaged during earthquakes and there sulting landslides, liquefaction, and upheaval.

Chapter 2—

Hazard and Risk Assessments

Decisions that affect vulnerability to natural hazards are made almost daily by individuals, businesses, and communities. If these decisions are to be made wisely, decision-makers must know that hazard and risk information exists, and it must be readily available to them in a clear and usable format.

Hazard assessments identify where a drought, wildfire, landslide, tornado, or other event is likely to occur, how frequently it may occur, and how severe its physical and/or biological effects may be. Although the precision of scientific knowledge varies from hazard to hazard—the recurrence of large floods and major wildfires in a particular area is better understood than the timing and location of major earthquakes, for example—the principal natural hazards facing the nation and the world have been identified. Advances in the basic understanding of hazards will provide more accurate and complete information.

Risk assessments combine hazard information with information on human activity, structures, and natural resources to determine the likely impacts of a hazardous event. They provide estimates of the number of deaths and the extent of injuries, damage, and economic losses that are likely to result. Because activities and environments are continually changing, risk assessments must be updated regularly.

Armed with hazard and risk assessments, individuals, businesses, and communities can make informed decisions on implementation of disaster reduction strategies. The world will never be hazard-free, but choices can be made that will reduce vulnerabilities. The actions taken should be determined by an understanding of the hazards faced, the willingness to take risks, and the resources available for reducing the risks.

The Committee recommends that state and local jurisdictions review, update, and improve their hazard and risk assessments with the assistance of the federal government and use this information in their decision-making processes.

To achieve this goal, the Committee proposes that:

- state governments work with the Federal Emergency Management Agency (FEMA) and other relevant federal agencies to ensure that adequate hazard and risk assessments within their boundaries are produced;
- states, with assistance from the federal government, develop mechanisms for providing hazard and risk information to local decision-makers; and
- the federal government continue to support physical, biological, and social science research on hazard and risk assessments as well as methods for making this information available to decision-makers and practitioners.

A program for enhancing the nation's hazard and risk assessment capabilities should include:

1. *Development of multihazard geographic information systems*. Recent advances in computer communications and geographic information systems (GIS) offer innovative ways to provide hazard and risk information to decision-makers. Information traditionally provided on paper maps and charts and in volumes of text can now be computerized. It can then be retrieved, analyzed, and displayed in two-

and three-dimensional maps for use by a wider range of recipients.

Several GISs could be adapted to process multihazard information. Such systems would make up-to-date hazard and risk assessments available to local decision-makers throughout the nation. This information would enable planners, emergency managers, and other public officials to identify potential disaster vulnerability by integrating data on locations of population, essential facilities, natural resources, and hazards. It would be possible to project the consequences of new development, alternate land uses, and other actions. Business and industry could also benefit from natural hazard information systems when planning for safety and capital investment.

2. *Research on the physical and biological nature of disasters*. Further understanding of the physical and biological processes that cause hazardous events—such as the solid earth processes that generate earthquakes or the ecosystem changes that cause wildfires and outbreaks of insect pests—would contribute to more accurate and useful hazard assessments and to improved prediction capabilities. Risk assessments could be enhanced by research on how a single hazardous event can trigger a sequence of disasters. (See Figure 1.) The interrelationships of natural hazards and short- and long-term environmental changes should be given special emphasis.

   Federal agencies and academic researchers currently conduct such research. Business should participate actively in this research because its actions have profound environmental impacts, many of which increase vulnerability to hazards. In addition, the United States would benefit from collaborating on the excellent work being done in Canada, Japan, Mexico, the United Kingdom, Australia, and other nations.
3. *Research on the social factors that govern response to natural hazards*. As previously noted, lack of technical knowledge is rarely the primary obstacle to disaster reduction. Social, political, administrative, legal, and economic factors are the greatest barriers to implementing loss reduction strategies. Research on means to overcome these barriers will be critical to improving risk assessments and reducing vulnerability. Among the areas that should be studied are the ways that individuals and organizations discover, produce, and use hazard reduction information; barriers to use of disaster information; economic and other incentives to action; and means for marshaling political support for hazard reduction. Factors that govern communication and collaboration among physical, biological, and social scientists and engineers should also be studied.
4. *Research on technological and societal strategies for disaster reduction*. Improved hazard reduction practices should result from understanding incentives for and barriers to technological innovation; incorporating physical, biological, and social science knowledge into the initial stages of development planning; and reducing the costs of implementing technical and social strategies.

Different disasters can produce similar damage. Though it looks like an earthquake rocked this interstate to pieces, this Maine roadway was damaged by floodwaters and the resultant landslides. As is often the case for local-level response, the local National Guard Engineering Group mobilized for clean-up and repair during the state-declared emergency.

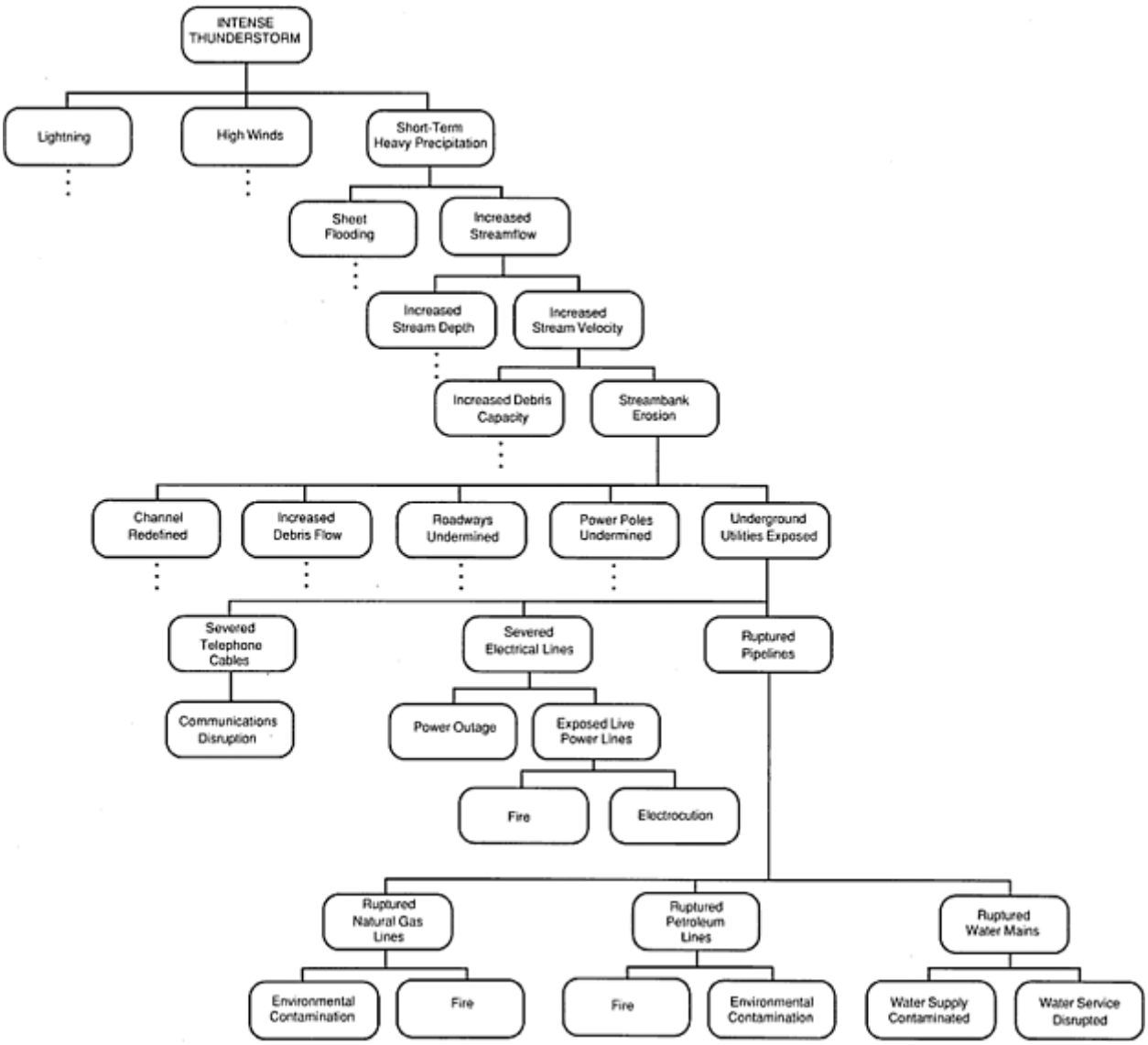


Figure 1.
NATURAL HAZARDS SEQUENCE
A sequence of disastrous results can be triggered by a single hazardous event. For example, an intense thunder storm can cause flash flooding that may lead to power outages, disruption of water supply and telephone service, fire, and environmental contamination.
(Source: F. May, University of Utah.)

Flexible and resilient, youngsters are often eager volunteers for community-aidprojects. Children need to learn about hazards they can face at home and school to make preparation, response, and recovery less traumatic, and to provide valuable lessons that can be applied throughout their lives.

Chapter 3—

Awareness and Education

The key to reducing loss of life, personal injuries, and damage from natural disasters is widespread public awareness and education. People must be made aware of what natural hazards they are likely to face in their own communities. They should know in advance what specific preparations to make before an event, what to do during a hurricane, earthquake, flood, fire, or other likely event, and what actions to take in its aftermath.

Equally important, public officials and the media—television, radio, and newspapers—must be fully prepared to respond effectively, responsibly, and speedily to large-scale natural emergencies. They need to be aware, in advance, of procedures to follow in a crisis that threatens to paralyze the entire community they serve, and they need to know how to communicate accurate information to the public during a natural disaster.

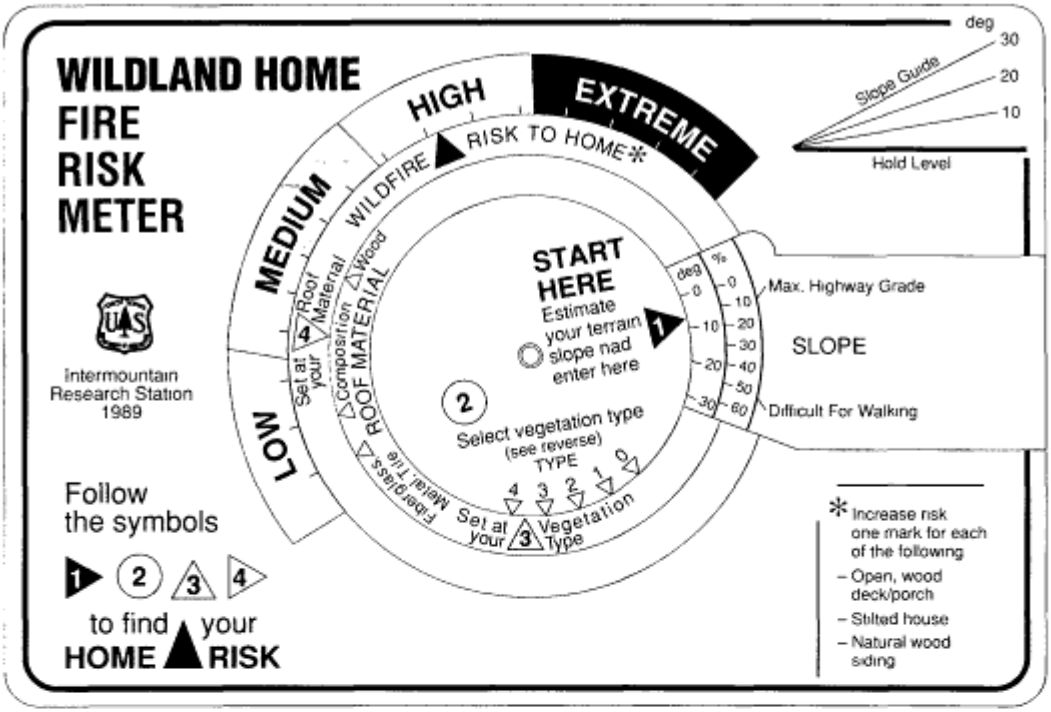
Special efforts must also be made to reach and plan for the care of particularly vulnerable segments of the population—latch-key children, the elderly, individuals in health care and correctional facilities, people with disabilities, and those who do not speak English—with information about possible disasters and what to do in an emergency.

The Committee recommends that community-wide awareness and education programs about natural disasters be made a national priority.

To achieve this goal, the Committee proposes that information campaigns and educational efforts be developed and that their effectiveness be evaluated and, where possible, continually improved:

1. *Home*. Household survival plans should provide basic information on what hazardous events are most likely to occur in particular communities, what emergency equipment and supplies should be on hand, what precautions should be taken to limit damage, and what preparations should be made for escape and evacuation. Such information might best be conveyed graphically, both in print and on television. Dramatic, easily recognizable graphic symbols signifying each natural hazard should be created and widely publicized to identify impending emergencies and quickly alert the public to the degree of seriousness and the imminence of danger.

   To stimulate public awareness, brochures, posters, games, calendars, museum exhibits, public service announcements (for print, radio, and television), and even entertainment programming should be used. Materials produced by the American Red Cross, FEMA, the National Weather Service (NWS), the U.S. Forest Service (USFS), and other government agencies as well as insurance companies and other private sector entities are already available for such campaigns. (See Figure 2.) Organizations in the private sector, including the Advertising Council, public utilities, public relations firms, advertising agencies, and voluntary organizations, should be enlisted to create, produce, and disseminate new information materials.
2. *The community*. Community-wide planning and education should be encouraged. Schools, government organizations, community and church groups, business and neighborhood organizations,



Evaluate Vegetation For At Least 100 Feet From Your Structures

TYPE	VEGETATION DESCRIPTION
0	Open water, bare rock, watered lawn, cultivated field, etc.
1	Continuous grass, weeds, shrubs less than 2 feet, few trees (very open).
1	Evergreen (conifer) or hardwood (maple, oak, hickory) forest, with many tops touching (closed), with only leaf or needle litter, but *no* vegetation that allows fire to spread from lower vegetation to the tree tops (ladder fuels). Move to TYPE 2 if conifers are a major part of a hardwood stand.
2	Grasses/shrubs/young evergreen trees/dead branchwood 2-4 feet; open forest, very few tree tops touching.
2	Dense young green shrubs with *no* dead branchwood.

TYPE	VEGETATION DESCRIPTION
3	Medium dense evergreen forest having some tree tops touching, lower vegetation comprised of live and dead herbaceous with patches of young evergreens.
3	Medium dense shrubs 2-6 feet tall, tree density vanes from open to many tops touching.
4	Dense evergreen forest having many tree tops touching with lower vegetation that will carry fire into the tree tops.
4	Thick tall grass over 3 feet, including fountain grass in Hawaii, meadow foxtail in Oregon, and sawgrass in Florida.
4	Mature shrubs 6 or more feet tall, with dead branchwood; situations include mixed chaparral of California, high pocosin of the south and east, and high southern rough.

Figure 2.
WILD LAND HOME FIRE RISK METER
Practical easy-to-use materials can give people the information they need to protect their homes and possibly save their lives. By turning a series of dials, rural residents can determine their homes risks from wildfire. The reverse side of the meter provides information on reducing those risks. (Source: U.S. Forest Service.)

hospital and medical groups, and the news media should all be involved. Checklists, information handouts, and training videos should be created and widely distributed to convey such information as the location of nearby emergency resources and appropriate use of the 911 system both during and after a disaster. Regional and community demonstration programs, disaster day exercises, volunteer courses, and conferences should be undertaken and evaluated for their effectiveness.

3. *School*. Educational materials about preparedness, warnings, and self-protection should be distributed to schools for use in kindergarten through the 12th grade. Teachers should be given training on integrating the materials into the regular curricula so that all children receive the information they need to protect themselves from disasters. Similar training initiatives should be directed to teachers at day-care centers and preschools as well as to caretakers of the elderly. These steps will also raise the level of awareness and preparedness at home.
4. *The workplace*. Awareness and education for disaster mitigation and preparedness should be encouraged in the workplace. Labor unions, industry management, government employers, and business groups should work with disaster specialists and community agencies to produce and acquire the necessary training and information materials. Existing work safety and security programs should be expanded to include disaster preparedness measures and emergency response procedures. Workplace safety drills and disaster exercises are essential to ensure that procedures are followed in an emergency. Prime movers of this effort should include insurance companies, labor unions, Chambers of Commerce, public utilities, and Industrial Crisis Conference participants.
5. *Colleges and universities*. Community colleges as well as other colleges and universities should be encouraged to include disaster management training in their curricula. Materials on mitigation and preparedness should be made part of geoscience, meteorology, forestry, health, engineering, architecture, education, planning, public administration, and business school programs. Preparation of books, articles, and teaching aids, and research by faculty and students should be encouraged and supported.
6. *Public officials and the press*. Special attention should be given to raising the level of knowledge and expertise of public officials and the press, both of whom have central responsibilities for dealing with natural disasters. There is a need to develop procedures, protocols, and priorities for disseminating information to the public. Contingency plans should be put in place so that vital emergency services and key elements of the press are prepared to function even when electricity, transportation, telephone transmission, and other communications and production capabilities are severely disrupted. Community emergency procedures, warning signals, disaster resources, and relief facilities and responsibilities should be spelled out in advance and reviewed and tested periodically by public officials and the press.

   Journalism schools and press think tanks such as the Gannett Center for Media Studies and the Annenberg Center for Communications, as well as professional organizations such as Sigma Delta Chi and the Radio-Television News Directors Association, should be encouraged to investigate the specific challenges of providing information and news coverage in time of disaster.
7. *Professionals*. Disaster education is essential in the training of the government and private sector professionals, emergency management personnel, and emergency service providers who have the major responsibility for mitigation and emergency response. Professional continuing education programs on mitigating the effects of natural disasters should be made widely available through colleges, universities, and professional associations. Development of advanced materials for use in curricula, workshops, conferences, and similar activities should be encouraged. Continuing education requirements should be built into the certification, licensing, and evaluation of professionals in the field. Courses in hazard-resistant land-use, design, and structural techniques should be included in engineering, architecture, and construction curricula. Special attention should be given to planning for reconstruction and other elements of community recovery. Schools of medicine, nursing, and public health should offer courses on disaster preparedness and response as they relate to individual and community health.

The spectacular damage caused to the highway and bridge systems of the San Francisco Bay area during the Loma Prieta earthquake is being studied for applications to updating building and safety codes.

Chapter 4—

Mitigation

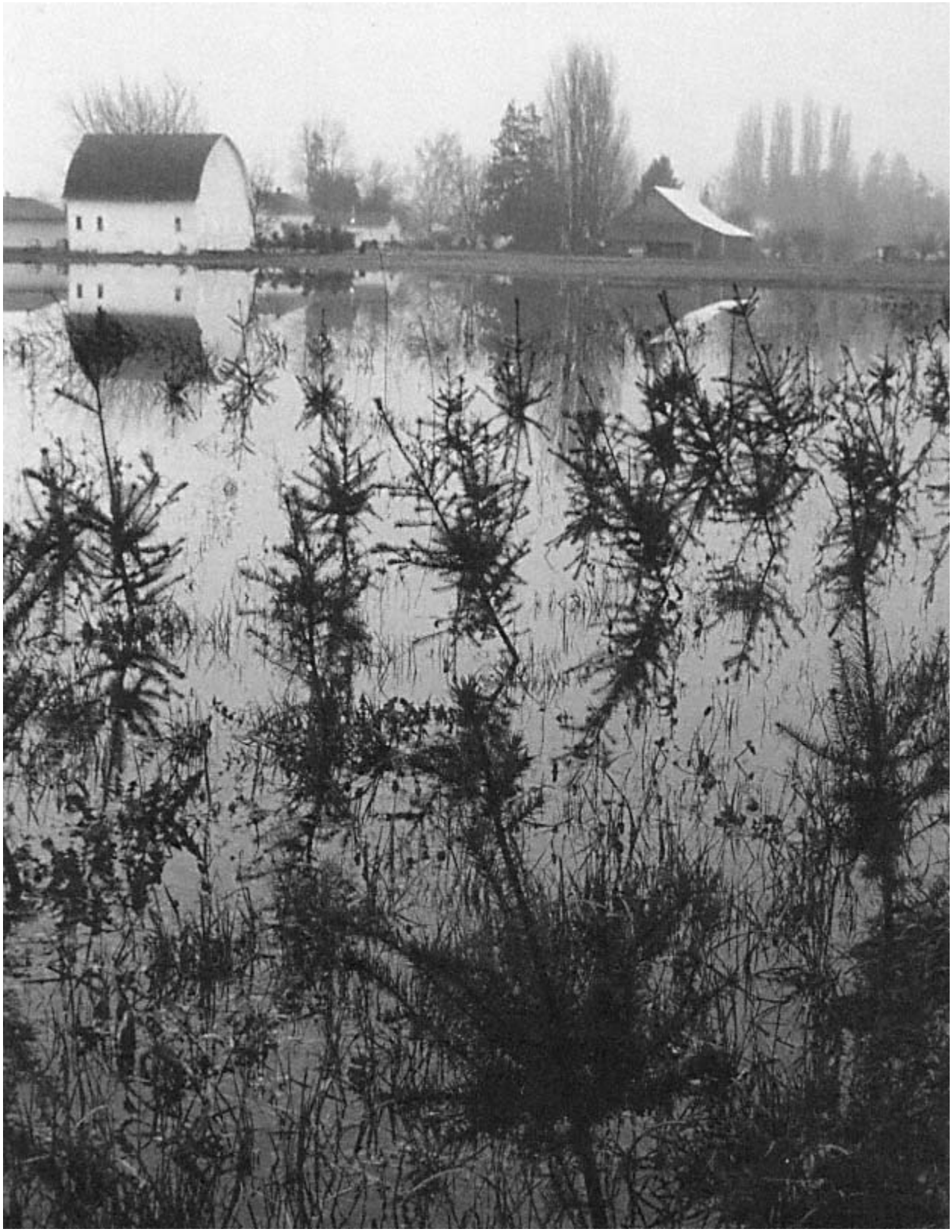
Mitigation—actions taken to prevent or reduce the risk to life, property, social and economic activities, and natural resources from natural hazards—is central to the Decade initiative. Awareness, education, preparedness, and prediction and warning systems can reduce the disruptive impacts of a natural disaster on communities. Mitigation measures such as adoption of zoning, land-use practices, and building codes are needed, however, to prevent or reduce actual damage from hazards. Avoiding development in landslide-and flood-prone areas through planning and zoning ordinances, for example, may save money in construction and reduce the loss of life and damage to property and natural resources. Postdisaster studies continue to confirm the fundamental fact that community investment in mitigation pays direct dividends when a disaster occurs.

Development trends in the United States underscore the need to instill a new commitment to mitigation. The National Institute of Standards and Technology (NIST) projects a national investment of $4 trillion during the 1990s in new construction and infrastructure. Advances in the fields of hazard and risk assessments are providing decision-makers with increasingly accurate and useful information on the potential impacts of natural disasters on society. The challenge is to apply this information and translate current understanding of natural hazards into meaningful action at the community level to protect the substantial investments in new and existing development. Equally important is the human side of mitigation; programs should reflect the needs of an urban, aging, technologically oriented society.

Despite increasing vulnerability to natural disasters, many communities resist adopting mitigation programs. The barriers are economic, social, and political, and mitigation is often perceived as restrictive, costly, and incompatible with the community's economic development goals. Mitigation may involve solutions that are technically sound but politically unpopular. In this context, elected officials are often reluctant to pursue mitigation programs vigorously.

Progress toward adoption of mitigation practices will require community commitment, recognition of constraints and barriers, and innovative solutions. Flood-prone areas, for example, could be incorporated into community-enhancing open space, wildlife and recreation attractions, or hiking and physical fitness trails. New awareness and education programs need to be developed to foster incorporation of the lessons learned from disasters and the findings from social research into mitigation practice.

Mitigation initiatives, above all, need to involve the key groups that participate in developing, adopting, implementing, and enforcing mitigation—public officials, finance and insurance specialists, engineers, planners and architects, civic groups, marketing specialists, educators, and researchers. To be effective, mitigation requires a multidisciplinary team approach free from domination by any one special interest group; each discipline has a role and contribution to make. Close communication and coordination among researchers, practitioners, and policymakers increase the likelihood that effective mitigation programs will be implemented.



December 1990 flood sin Washington state destroyed acres of young Christmas trees. The financial effect of the loss on this a typical agricultural crop may not be felt for a few years.

A program for enhancing the nation's hazard mitigation capabilities should capitalize on opportunities for immediate and near-term success and sustain progress into the next century. Numerous cost-effective mitigation programs should be recognized and profiled. Transferable solutions need to be closely examined. At the same time, a balanced Decade program should address the fundamental problems associated with mitigation—the economic, social, and political barriers.

The Committee recommends that every community at significant risk adopt and enforce an appropriate mitigation program, including both near-term goals and a comprehensive long-range plan for reducing the impacts of natural disasters.

To achieve this goal, the Committee proposes that local jurisdictions take the following steps:

- incorporate both structural and nonstructural mitigation measures in new development,
- examine ways to reduce the vulnerability of existing structures,
- take steps to reduce the vulnerability of natural resources, and
- undertake mitigation training with support from state and federal governments.

A program for enhancing the nation's hazard mitigation capabilities should include:

1. *Protection of schools and hospitals*. All new schools and hospitals should be located and constructed to ensure that high-hazard areas are avoided and that special provisions are made to reduce the potential for damage by natural hazards. In addition, existing school and hospital buildings should be surveyed to determine their levels of resistance to relevant hazards. Strenuous efforts should be made to strengthen facilities that would fail in a disaster. In some instances, legislation may be required to ensure that mitigation actions are taken.

The Committee believes that special emphasis should be placed on implementing mitigation measures in schools and hospitals because of their critical role in community life and their heightened importance during disasters. One of this nation's greatest resources—children—spends a large portion of time in school buildings. Schools also serve as primary shelters for evacuees during disasters. All too often, however, school buildings are neither constructed nor maintained to withstand the physical effects of natural hazards, and in many states they are exempt from building codes. As a result, they are potential death traps for the students or evacuees within them. Hospitals and other health care facilities minister to the sick and injured and are the locus of the medical technology and expertise that are essential in a disaster. When hospital facilities fail during a disaster, as they have in numerous recent earthquakes and hurricanes, not only are patients and medical personnel killed or trapped within them, but stricken communities are also deprived of needed medical resources, equipment, and supplies.

Wherever economically feasible, communities should strengthen other essential facilities such as emergency operations centers, police and fire stations, utilities, and telecommunications and transportation networks, all of which are critical to emer

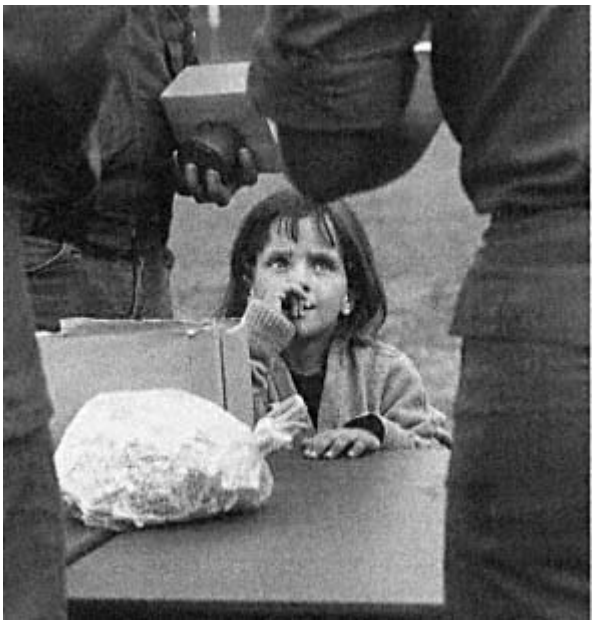
gency response and recovery. Museums, convention centers, theaters, and other places of public assembly should also be included in a program to strengthen buildings. Plans are also needed to include the private sector in mitigation activities for both public and private structures.

2. *Adoption of nonstructural measures*. Businesses and homes should incorporate nonstructural mitigation measures to minimize injuries and property damage from natural disasters. Furniture and equipment, for example, can be easily secured to reduce injuries and damage from earthquakes. Other non-structural measures are management of vegetation to reduce damage from wildfires and location of structures away from high-hazard areas.

Nonstructural mitigation represents a major opportunity for immediate low-cost action to reduce the impacts of natural hazards on the home and the workplace. The private sector can contribute significantly to promoting nonstructural mitigation. Lending institutions are ideally positioned to incorporate mitigation provisions as conditions for loans, and the insurance and reinsurance industries can adjust underwriting rate structures as an incentive for mitigation.

3. *Incorporation of mitigation into new development*. Local jurisdictions should ensure that new development is located, designed, and constructed to withstand natural hazards. They should use information from hazard and risk assessments, land-use plans, and zoning regulations to limit development of hazard-prone areas. Compatible uses of floodplains and other hazardous areas should be incorporated into local planning and zoning so that losses are reduced. Such areas could have a high value for recreation, fish and wildlife reserves, open space, or other community use.

Building codes that set minimum specifications for design and construction can be a powerful tool for mitigating the effects of natural hazards; lives were saved in the Loma Prieta earthquake as a direct result of seismic design and construction practices implemented two or more decades earlier. Fire codes, dam safety standards, and emergency provisions (e.g., ensuring that power is cut off to broken utility lines) have significantly reduced the damage from natural events. Building codes should be a central part of a mitigation strategy for new construction. Barriers to the adoption and enforcement of modern codes should be identified and strategies developed that



Response and recovery plans need to be in corporated into communities' disaster preparedness. Family plans should include specified meeting places in case family members are separated before or during an event, and local schools need to make plans for protecting and accommodating children until they can be reunited with family.

include incentives and other mechanisms to overcome community and industry resistance.

Although land-use planning, zoning ordinances, and building codes and regulations are the responsibility of local and state government, technical and financial assistance will be needed to adopt and implement these mitigation measures. This assistance should be provided through NIST, FEMA, and professional organizations such as the Applied Technology Council, the Building Seismic Safety Council, and the Earthquake Engineering Research Institute.

4. *Protection of cultural properties*. Protection of libraries, monuments, historic buildings, works of art, and other cultural resources should be incorporated into mitigation planning and action. Losses in the historic district of Charleston, South Carolina, from Hurricane Hugo show the particular vulnerability of cultural properties to natural disasters.

There is a need for both information and practical assistance to reduce this kind of loss. Following a disaster, preservation of historic sites can be an emotional and costly aspect of recovery and reconstruction. Mitigation training should include the issue of preservation to promote informed decision-making and community involvement.

National and international groups are working under the aegis of the United Nations Educational, Scientific, and Cultural Organization (UNESCO), the International Council of Museums, and other organizations to raise awareness of the threat of natural hazards to cultural properties and to mitigate or prevent damage and losses. Foundations and private groups can contribute to these efforts.

5. *Protection of natural resources*. Particularly valuable natural resources such as endangered species of wildlife, fish, and plants should be identified in mitigation plans and protection measures included in disaster response plans. Such natural resources are found not only in the wild, but in zoos and parks as well.

Mitigation plans might include particular attention to the location and design of facilities so that a fire or windstorm does not act as a conduit for unexpected damage to important natural resources. For example, pipelines and power lines frequently traverse important natural resources areas. In such cases, it is possible to anticipate probable damage to adjacent natural resources caused by rupture of a pipeline or a broken power line. Automatic flow controls, special breakers, and other features are readily available and can dramatically reduce damage. For particularly valuable and endangered populations of wildlife and plants, prudent planning might include relocating a portion of the population so that a natural event does not result in the loss of the entire population.

6. *Government leadership of mitigation implementation*. Government at all levels should set an example by requiring that new facilities that it funds, regulates, or leases be designed, built, and located in accordance with modern building codes and sound

Whether sparked by lightning or by powerlines downed in a storm, the path of forest fires is unpredictable, leaving behind a stark land scape, here including the blackened remains of achimney and cement foundations of a cabin.

land-use practices. On the national level, in January 1990, the President issued an executive order requiring that federal agencies design and construct all new buildings to be earthquake resistant. Similar directives, supported by active enforcement programs, are needed at the state and local levels, and they should encompass all relevant natural hazards. Such standards should be considered for all publicly funded infrastructures and lifelines such as highways and bridges. As resources permit, the requirements should be extended to existing buildings in a phased program that reflects their vulnerability.

7. *Mitigation training*. Training programs that focus on contemporary challenges associated with implementing mitigation should be developed and offered. A national training program, supported by the federal government and fully integrated with the preparedness training proposed here, should be developed for this purpose. Its curriculum would include land-use planning, zoning, building codes and regulations, tax incentives, and nonstructural mitigation measures. Case studies from throughout the nation and around the world should be included. Mitigation training programs offered by FEMA and USFS should include more participants, disciplines, and subjects.

Mitigation training should be highly interactive, reflecting real problems and issues. For example, how can hazard and risk data be used to promote mitigation at the community level? How can hazard-prone land be used in ways that are important to communities but less vulnerable to natural disasters? How can a local emergency manager or other official develop a cost-effective mitigation program? How can mitigation policy and practice be moved up on the political agenda? How can local commitment to hazard reduction be developed? How can historic structures be cost-effectively protected to avoid expensive salvage attempts following a disaster? These and other issues need to be addressed in a nationwide training program.

8. *Hazard-specific research*. Recent disasters have demonstrated the benefits of mitigation efforts while pointing out the need for research to improve mitigation practice. Although all hazards would benefit from such study, research agendas for earthquakes, landslides, and extreme winds are illustrated below.

Earthquakes: There is a need to complete a national seismic monitoring network and establish a cooperative international program in strong-motion measurement and data analysis. Local networks should be established, as needed, to determine the effects of local site conditions on ground motion and the relationship between specific ground motion parameters and the degree of structural damage.

The behavior of structures founded on different soil types is another area of research opportunity. The damage distribution in the Marina District during the Loma Prieta earthquake dramatized the effects of soil properties on structures and underscores the need for additional research in this area.

Research is needed to develop cost-effective methods for strengthening existing buildings and structures, especially unreinforced masonry and brittle reinforced-concrete buildings. Federal and state governments should encourage the development and implementation of active and passive control systems and other new techniques to improve the seismic resistance of both existing and new buildings. Additional research should be conducted to improve techniques for controlling damage to nonstructural elements such as ceilings, windows, the electrical supply, and domestic gas pipes. Research to improve the design and construction of lifeline systems should be accelerated.

Landslides: Each year, landslides in the United States cause approximately $2 billion in damage. Better understanding of the conditions that generate landslides would significantly improve hazard and risk assessments by local jurisdictions. Research is needed to develop designs that mitigate ground deformation and damage to structures, provide a technical base for mitigation measures such as landslide zoning, and test and evaluate innovative landslide stabilization techniques.

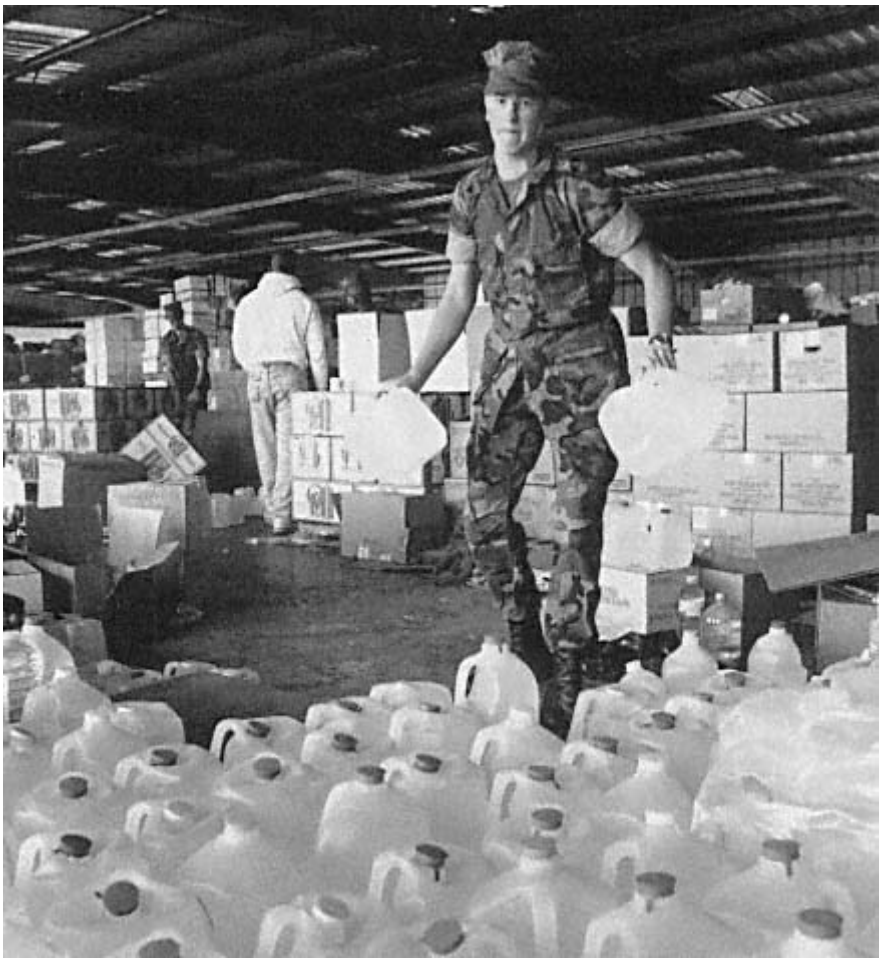
The application of new techniques in satellite remote sensing, geophysics, and geotechnical engineering for delineating landslide hazard areas should be accelerated. Research is needed to identify the economic, political, and social processes that encourage or impede landslide mitigation programs. This information could be valuable when landslides are considered in insurance programs and local planning and zoning, including the location of key facilities.

Extreme winds: Knowledge about wind-force effects on buildings is critical to developing wind speed provisions in building codes and designing wind-resistant structures. Research in this area is lacking; measurements of wind speeds at the height of mid- to high-rise buildings are rarely available.

The stucco facade of this building shattered like an eggshell as lava flowing around the base of the three-story structure applied such pressure that the walls shifted and collapsed.

A national wind hazard reduction program, modeled on the National Earthquake Hazard Reduction Program, is needed to improve building performance in high winds and severe weather. The program should emphasize mitigation. Schools and medical facilities, in particular, should be subject to stringent building codes. Home and business owners should be provided with "do-it-yourself" instructions on how to strengthen individual structures to withstand winds. High winds can cause substantial property damage and economic loss. Research needs to focus on whether current mitigation practice, including the wind-resistance provisions of building codes, is responsive to the potential magnitude of the problem.

9. *Overcoming resistance to mitigation*. Barriers to the adoption of mitigation measures need to be clearly identified and innovative strategies developed to overcome resistance. Success stories, computer models, and simulations should be components of such a program. Real experiences can provide both insight into the factors that contribute to successful mitigation programs and the means for communities to capitalize on opportunities that follow a disaster. Computer simulations and other tools that incorporate the tax base, revenues, loss estimates, and other key variables can provide government and industry with information critical to their decision-making. Simulations of past recovery and reconstruction efforts, including decisions and trade-offs, may contribute to appreciation of the value of mitigation.



Response and recovery need to be a coordinated effort of local, state, and federal government, private voluntary organizations, and community volunteers. During and after Hurricane Hugo, U.S. Marine Corps volunteers worked with the Salvation Army to move bottled water and other requisite supplies through relief centers and to appropriate locations in a timely manner.

Chapter 5—

Preparedness for Emergency Response, Recovery, and Reconstruction

Preparedness is the process of turning awareness of the natural hazards and risks faced by a community into actions that improve its capability to respond to and recover from disasters. Recent disasters, such as the tornadoes that struck Saragosa, Texas, in May 1987, illustrate the destructive potential of natural hazards and the long-term societal disruption that is felt well beyond the boundaries of the communities that are directly affected. The onset of a natural disaster can be sudden; recovery and reconstruction may take years and even decades.

Emergency response is rapidly evolving. (See Table 2.) Prior to the 1985 Mexico earthquake, for example, search and rescue was seldom a part of community response plans; it is a major intergovernmental initiative today. Advances in warning and communications technology in the United States provide new opportunities for emergency responders. Mobile and cellular telephones, donated by industry, were instrumental in coordinating the Loma Prieta earthquake response. Perhaps the greatest change in response planning and practice in the past decade, though, has been the integration of new groups and disciplines. In addition, the federal government has become more active in response planning, and business and industry are taking more responsibility for augmenting community emergency response capabilities. The Decade can build on these technological developments and cooperative trends.

It is not only built structures that are threatened by natural hazards. Damage to natural resources may have great economic and environmental impacts—for example, when an earthquake ruptures a pipeline that spills oil into marine and estuarine systems or a wildfire destroys a major forest. Natural resources should be fully covered in emergency preparedness plans.

Preparedness plans need to address not just the immediate response, but also the longer-term recovery and reconstruction. The recovery process is multifaceted and complex. A systematic approach would reduce human hardship; yet, typically, the process is improvised. Moreover, there is relatively little analysis or documentation of successful community recovery and reconstruction efforts. The recovery phase is an opportune time for local leadership to reexamine community goals, select recovery strategies that are compatible with revised goals, and incorporate mitigation measures into both long-range planning and immediate decision-making.

The Committee recommends that by the end of the Decade, every business and local jurisdiction at significant risk have plans for emergency response, recovery, and reconstruction that have been tested and coordinated with state and federal governments as well as with other local governments.

To achieve this goal, the Committee proposes that:

- the federal government help state and local governments assess and improve their preparedness planning capabilities and expand planning efforts to incorporate recovery and reconstruction,
- demonstration projects be initiated in selected cities throughout the nation to showcase regional models and preparedness programs, and
- studies be undertaken that address interorgani

zational decision-making in an emergency, information flow and exchange, and identification of factors critical to emergency management decision-making.

WHAT DIFFERENCE DOES A DECADE MAKE? A survey conducted in Southern California between 1976 and 1979 (Ralph Turner, Joanne M. Nigg, and Denise Heller Paz) concluded that "most households are unprepared for an earthquake." A similar survey conducted approximately 10 years later (James Goltz and Linda B. Bourque) showed significantly higher levels of preparedness. During the intervening years, public interest in preparedness was galvanized by the eruption of Mount Saint Helens and several large earthquakes in the United States and abroad. Capitalizing on this interest, local, state, and federal governments created programs to promote preparedness for a major earthquake.

TABLE 2. PREPAREDNESS ACTIONS TAKEN BY LOS ANGELES COUNTY RESIDENTS 1979-1989

	1979	1989
Emergency Supplies		
Water	17.1	65.1
Food	26.8	66.9
Radio	54.6	76.4
First-aid kit	54.1	67.9
Flashlight	71.5	86.3
Mitigation		
Structural[a]	11.1	12.3
Rearrange cupboards	16.3	22.2
Cupboard latches	10.2	11.6
Planning/Training		
Family procedures[b]	34.1	51.6
Reunion of family[b]	22.1	44.3
Instruct children[b]	50.4	71.2
Neighbor contacts	19.5	20.8
Neighborhood plan	12.2	6.0
Attend meetings	8.5	4.6
Earthquake insurance[a]	18.0	26.2

[a] Calculated for homeowners only.
[b] alculated for respondents with dependent children only.

A program for enhancing the nation's preparedness capabilities should include:

1. *Assessment of needs and capabilities*. In cooperation with other federal agencies, FEMA should assist state and local jurisdictions in assessing community awareness, training, and preparedness. State and local emergency planners will need several tools for such an evaluation: a self-assessment mechanism for determining the strengths and weaknesses of current emergency response planning; a model community asset inventory to identify the human and material resources available or missing; guidelines for assigning response, recovery, and reconstruction responsibilities; a model emergency response exercise guide; and recovery and reconstruction planning guidelines, checklists, and model plans. These tools should be adapted for use by business and industry, schools, hospitals, correctional facilities, and neighborhood organizations. Videotapes, slide presentations, workshops, and brochures should be developed for this purpose.

The federal government should also support interdisciplinary teams to assist communities directly in preparedness for response, recovery, and reconstruction. For example, flood-, wildfire-, and earthquake-prone communities would benefit from the advice of a team of urban planners, geologists, soil scientists, environmental engineers, structural engineers, city administrators, and communications specialists. Such a program should emphasize direct field assistance by experienced teams that can tailor their expertise to a community's needs.

2. *Training for response, recovery, and reconstruction*. Many individuals responsible for local disaster management have limited training in the field and need increased access to training programs and materials. Interdisciplinary, multijurisdictional training is especially valuable because it encourages mutual understanding and lays the foundation for cooperation in emergencies. Nongovernmental agencies should be included in this program.

The federal government should take the lead in developing a national training program. FEMA's National Emergency Training Center (NETC), located in Emmitsburg, Maryland, should be a focal point

Recovery begins soon after a tornado sweeps through a midwestern town as survivors sift through the debris that used to be their home to recover belongings and start the lengthy process of inventorying their losses.

for developing courses that incorporate the lessons from recent disasters and for identifying additional research needs. It would also be beneficial to examine federal, state, and local training programs, compile a database of good programs, and disseminate information on their availability. Mechanisms are needed to promote broader access to preparedness training, including additional funding for attendance at NETC and traveling training courses. Universities throughout the nation should continue to develop courses.

Without the sign, there would be no indication that a bridge crossed this stretch of river before rising water completely submerged the structure. After floodwaters recede, the structure will have to be checked for damage from erosionas well as from floating debris.

The Decade offers an opportunity for trainers to work with their counterparts from other countries. International sharing of materials and experience will improve course content to the benefit of all participants. By supporting regional centers abroad, the United States can increase the number of participants who take advantage of training adapted to their situations.

Specialized training is also needed. For example, search and rescue is a highly specialized emergency function that requires coordination among several disciplines. Training programs need to be developed for emergency responders, construction personnel, medical specialists, and volunteers. Training modules, courses, and standards should be developed for professional and volunteer urban search-and-rescue personnel and private heavy-equipment operators. A basic self-help program for community groups needs to be developed and made available nationwide. Health service managers and medical personnel would benefit from training in both initial handling and treatment of the injured and hospital management of mass casualties.

Training programs to enhance recovery and reconstruction should be developed and delivered. Professional associations such as the American Planning Association, the American Institute of Architects, and the American Society of Civil Engineers could be partners in developing a national training curriculum that focuses on recovery and reconstruction policy, strategies, and options. Training programs should provide guidance on priorities for the restoration of services, assessment of damage, policy and procedures for reentry of damaged structures, debris removal, and other immediate recovery issues.

Long-term reconstruction goals are equally important. Community-based training programs should be designed to bring together city administrators, elected officials, urban planners, finance specialists, engi

neers, and contractors, all of whom are in a position to shape land-use policy and the reconstruction process. Mitigation opportunities should be featured in a national training initiative to facilitate reconstruction after a disaster.

3. *Improving coordination and communication*. There is no substitute for predisaster planning and practice. When a disaster strikes, it is essential that government, business and industry (particularly utility companies), and volunteer groups have tested the plans and procedures that will guide them. Further, coordination depends on operable communications systems. Facsimile machines and cellular telephones have considerable potential for this purpose.

Pre-event agreements between local jurisdictions and telecommunications companies can facilitate emergency assistance and restoration of service. For example, state and federal governments should consider signing contracts for the provision of satellite communication links in an emergency.

Standard maps should be available to local jurisdictions throughout the country to facilitate emergency planning and response. These maps should have uniform symbols for key information and a common grid for locating points.

Adapting advances in information technology to

Centralized distribution centers need to be established, staffed, and organized to over see the donations—of both desperately needed good sand in appropriate items—that flood in from around the world following a major disaster:

emergency response needs is another significant area for coordination and communication. The Decade can bring together specialists in emergency management and information technology and communications to develop prototype projects. Ways need to be devised to test emergency plans and programs by simulating disasters or exercising such plans and programs in small events.

Forces of almost in comprehensible strength come into play as a piece of construction equipment is melted and twisted around a slab of stone when it is struck and carried along by lava flowing from a near by volcano.

The Committee identified a need for further research to address interorganizational decision-making in an emergency, with emphasis on factors critical to emergency management coordination. For example, what types of organizational framework facilitate enlightened decision-making during emergencies? Research shows that a key question disaster managers have to answer is not who is in charge but how the coordination of every function can be ensured or facilitated.

4. *Management of volunteers and donated resources*. Recent major disasters demonstrated both the importance of volunteer resources and the potential for logistic nightmares. Spontaneous volunteers are invaluable in emergency response. In the first hours after an earthquake, tornado, or wildfire, bystanders make the majority of rescues, and volunteers and local citizens are often active in cleaning up. Yet the convergence of people and goods on a disaster area presents a challenge to emergency management officials—to use resources where they are most needed while restricting those that would be in the way. Response, recovery, and reconstruction plans should incorporate systems for managing donated resources and training for coordination of spontaneous volunteers.

A federally sponsored task group comprising representatives of federal agencies, the American Red Cross, private industry, the media, and state and local governments, for example, should develop strategies and model awareness campaigns to educate and determine how best to inform the public of specific needs following a disaster. This group would supplement the work of the federal Interagency Donations Task Force by formulating federal policies and mechanisms for handling postdisaster donations. Its goal should be to match available resources with immediate needs. Official communication that calls for urgently needed resources and discourages unneeded items is an essential part of emergency response and recovery planning.

5. *Demonstration projects*. Demonstration projects raise the visibility of natural hazard reduction and can broaden the base of government, industry, and public participation in preparedness activities. A number of successful preparedness programs are bringing together researchers, practitioners, government, business,

community groups, and others, including multiple disciplines. These programs are tailored to their communities but have in common their participants' desire to coordinate disaster preparedness, work together, communicate with one another, and share resources to save lives and reduce losses. Information on these successful approaches to preparedness, recovery, and reconstruction should be disseminated throughout the country, and new regional demonstration projects should be undertaken. Possible project locations include Boston, Chicago, Charleston, Honolulu, Houston, Los Angeles, Memphis, Minneapolis, New Orleans, New York City, Salt Lake City, San Juan, and Seattle.

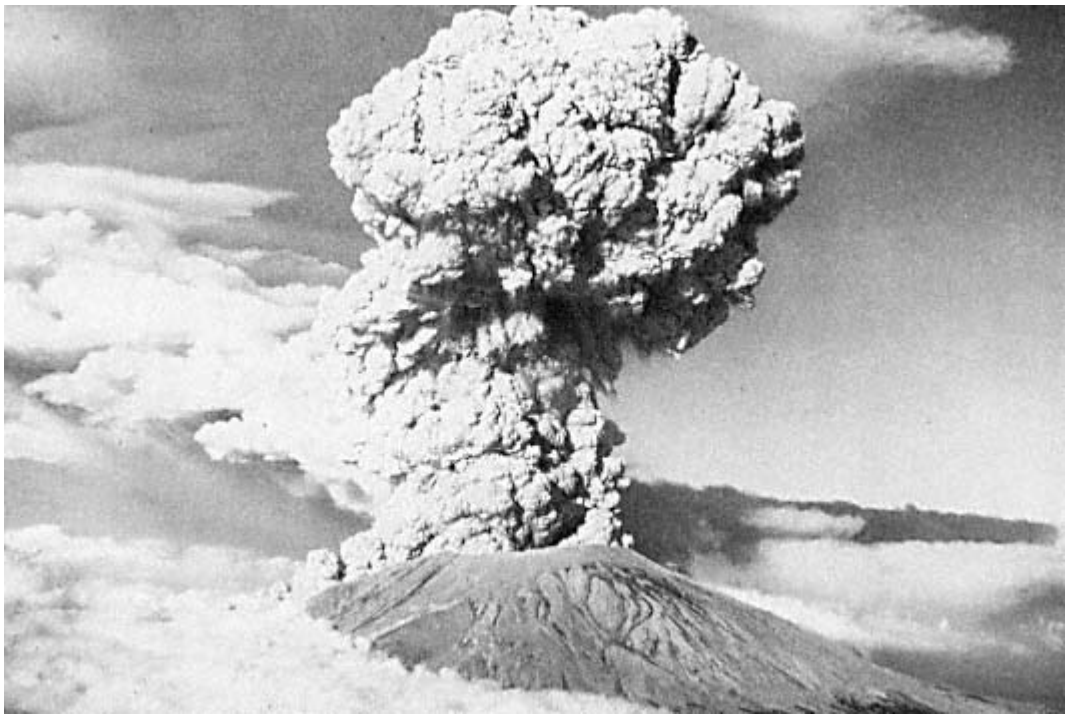
Locally or internationally, the safety of family, livestock, and property are prime concerns in every culture. In rural locations, people often refuse to evacuate with out their livestock. Here, cattle take on a ghostly appearance as ash coats them and their drivers en route to what is hoped to be a safer location during the preliminary eruptions of a volcano.

Workshops and teleconferences should be held to showcase model programs such as those of the Business and Industry Council for Emergency Planning and Preparedness (BICEPP) in Los Angeles and of the Central United States Earthquake Consortium (CUSEC). Transferable products and transferable approaches to preparedness should be shared with localities throughout the nation.

6. *Involvement of the utility and lifeline industries in preparedness planning*. In any large-scale natural disaster, utilities and lifelines—electricity, water, natural gas, the telephone, radio, television, and transportation—are vulnerable to failure; yet they are essential to response and recovery. At particular risk are the deteriorating infrastructure systems in many large cities.

The utility and lifeline industries often have well-developed emergency plans, and they should be major partners in all program areas of the Decade. Emergency management teams from the utility and lifeline industries should be involved in predisaster planning for response and recovery and in local, state, and regional training programs.

In particular, three initiatives should be considered: the establishment of joint government-utility emergency coordination groups for planning and training; predisaster identification of emergency equipment such as portable generators, and training in their transport and use; and joint government-utility public information programs coordinated in advance with the local media to inform the public on what to do and what not to do in an emergency.



Presently, certain hazards are easier to predict than others. Improvements are being made, but rapid advancements are needed. Predicting earthquakes and volcanic eruptions is still an inexact science. In some cases, volcanoes will vent steam and ash long before erupting with lava; in others, they steam and smoke before settling back down with no other activity or severe effects.

Chapter 6—

Prediction and Warning

Good predictions and warnings save lives. With only a few minutes' notice of a tornado or flash flood, people can act to protect themselves from injury and death. Predictions and warnings can also reduce damage and economic losses. When notice of an impending disaster can be issued well in advance, as it can for some riverine floods, wildfires, and hurricanes, property and natural resources can be protected.

Hurricane Hugo illustrates the benefits of an effective natural hazards warning system. Without successful prediction, warning, and evacuation, the loss of life could have reached the thousands, but actual deaths numbered 28. By contrast, when a hurricane struck Galveston, Texas—which had no warning system—on September 8, 1900, 6,000 people were killed and 5,000 injured.

Scientific and technological advances in recent decades have greatly improved the nation's capability to predict most natural hazards and disseminate warnings based on those predictions. However, prediction accuracy and lead times vary with the type of hazard. Prediction capabilities for atmospheric and hydrologic events are generally more advanced and specific than those for their geologic counterparts.

The federal government operates several systems to monitor natural hazards and make predictions. For example, an extensive weather monitoring and forecasting network covers the nation. Warnings are disseminated through a joint public-private partnership. Continuous radio and television broadcasts make both routine weather forecasts and severe weather warnings accessible to everyone. Televised weather programs have improved through the use of meteorologists and advanced presentation technology. Wildfire potential is closely monitored, and newspapers such as *USA Today* publish maps of daily and weekly fire danger. A system of observatories monitors volcanoes in Alaska, Hawaii, and Washington and issues warnings that have led to evacuation of surrounding areas, rerouting of air traffic, and other actions.

The technological capabilities for prediction are considerably better than social and organizational capabilities to disseminate warnings. For example, warnings of an impending natural hazard may not reach all potential victims. A concerted effort is needed to improve dissemination networks and the content of warning messages.

The Committee recommends that the nation expand and intensify its programs to improve prediction of significant natural hazard events and to ensure the effective and timely dissemination of warnings to all sectors of society.

To achieve this goal, the Committee proposes:

- the upgrading of natural hazard prediction and warning systems through application of state-of-the-art science and technology;
- augmentation of research programs on the basic physical and biological processes of natural hazards, models to predict their occurrence, and technology to detect and monitor them and to disseminate warnings; and
- expansion of research on the social aspects of effective warning messages.

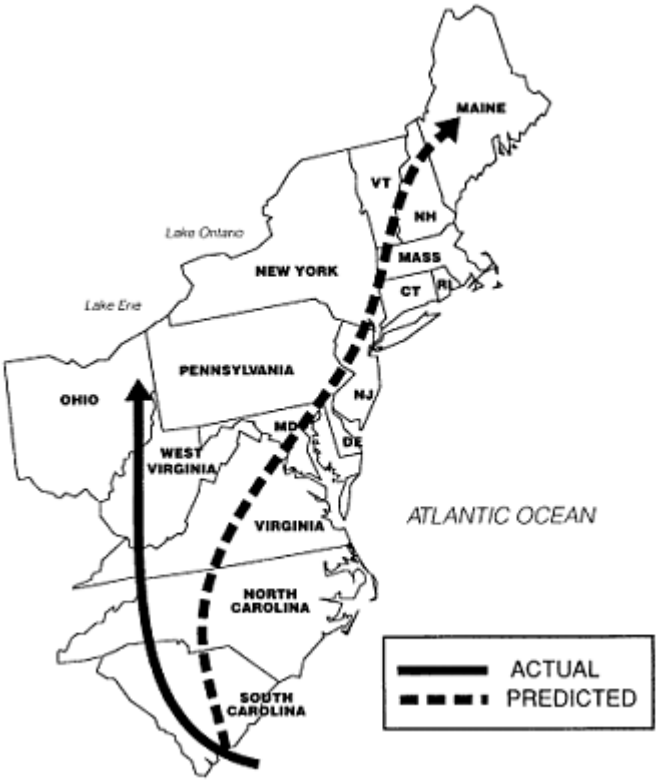


Figure 3.
PREDICTED AND ACTUAL PATH OF HURRICANE HUGO
The track of Hurricane Hugo on September 22, 1989, was more westerly than expected because the storm came ashore faster and at greater intensity than had been forecast. Although prediction capabilities for meteorological hazards have increased in recent decades, further research and modernization of weather prediction facilities should provide the accuracy and lead time critical to decision-makers who need to activate evacuation plans.
(Source: National Weather Service.)

PREDICTION

A program for enhancing the nation's capability to predict atmospheric, hydrologic, and geological hazards should include:

1. *Modernization of the weather prediction system*. New observation and information technologies can improve the prediction of severe weather, floods, wildfire potential, and other weather-related hazards. NWS is currently deploying several new systems that will improve detection and prediction of severe weather and flooding. (See Figure 3.)

The observation systems being implemented as part of the modernization include advanced geostationary and polar orbiting satellites, doppler radars, automated surface observing systems, and doppler wind-profiling systems. Information systems include interactive computer, display, and storage systems for local weather stations and large central supercomputing facilities at national centers. These systems should be deployed by the National Oceanic and Atmospheric Administration (NOAA), the Department of Defense (DOD), and the Federal Aviation Administration (FAA) by the mid-1990s.

2. *Research to improve the prediction of atmospheric and hydrologic hazards*. Research is needed to increase understanding of the physical processes associated with the generation of severe storms and to develop advanced numerical models to predict their characteristics. With the NWS modernization, such a research program is scientifically and economically feasible. The effort would increase prediction accuracy and the lead time for flash floods, landslides, tornadoes, microbursts, and intense winter storms.

A coordinated national program involving the National Science Foundation (NSF), NOAA, the National Aeronautics and Space Administration (NASA), FAA, and DOD, with full collaboration of research laboratories, academia, and operational fore

casters, should be initiated. Such a program offers an excellent opportunity for bilateral and multilateral cooperation with other nations during the IDNDR.

Even with prediction capabilities, sometimes property damage cannot be avoided. Like so many fish washed upon a beach, this mixture of pleasure boats and fishing craft fell victim to the raging forces of Hurricane Hugo.

Predictions of where Hurricane Hugo would strike the coast were issued 24 hours in advance of the expected landfall, permitting orderly evacuation of the affected barrier islands and coastal areas. However, for Key West, New Orleans, Galveston, and other areas, 24 hours is not long enough. Longer lead times are generally beyond the capability of the existing hurricane prediction system. Consequently, there is a need for concentrated research to improve numerical models for predicting the track and intensity of hurricanes and, correspondingly, to improve the observational network spanning the Gulf of Mexico, the Caribbean, and adjacent parts of the Atlantic.

Among the federal agencies that should fund or undertake this research are NOAA and the Office of U.S. Foreign Disaster Assistance (OFDA). Because the same hurricanes strike the United States, Mexico,

the Caribbean, and Central America, joint efforts should be conducted with nations in the region. Collaboration with Japan and other Pacific Rim nations on numerical modeling may be useful.

Response teams have to be trained to be ready at any time, often facing the worst conditions under the worst time constraints. Often, support for the rescue workers helps to keep operations underway.

3. *Research on the impacts of disasters on natural resources*. Disasters can have major impacts on natural resources. They may obliterate threatened and endangered species, inflict heavy damage on aquatic resources, flatten what might have been billions of board feet of timber, harm watersheds that supply major metropolitan areas, and damage air quality. Secondary impacts of natural disasters such as broken pipelines, streams blocked by debris, and emergency action to remove landslides can substantially increase damage to economically and environmentally important natural resources.

An expanded research program is needed to improve prediction and reduce these impacts. With improved prediction come better mitigation, response, and recovery strategies to protect or restore both the quality and quantity of renewable natural resources. USFS, the Department of the Interior (DOI), comparable state agencies, and universities should conduct research in this area.

4. *Expanded earthquake monitoring and research.* Reliable predictions and seismic zonation would permit individuals and communities to take actions that would reduce the devastation of ground shaking, landslides, and other physical effects.

Although long-term earthquake prediction is now possible in California, the ultimate goal must be predictions for the short (24-48 hour) and intermediate (6-12 month) terms. The former will make immediate self-protection actions possible, and the latter will permit communities to take mitigation actions preceding a major earthquake. To achieve this goal, monitoring and research are required. Extensive observations of physical factors that may change prior to a large earthquake are now being carried out mainly in the vicinity of Parkfield, California. Intensified monitoring networks should be established in other areas with a moderate-to-high probability of experiencing large earthquakes during the next 10-30 years. Among them are Southern California and the San Francisco Bay area, the Pacific Northwest, Nevada, the Wasatch Front in Utah, the New Madrid seismic zone in the Central Mississippi Valley, Charleston, South Carolina, the Northeast, and the Puerto Rico-Virgin Islands region. Alaska, which experiences a magnitude 8 earthquake or greater approximately

once each decade, should receive special attention.

In addition to predicting earthquakes, understanding their consequences is also important. Seismic zonation, which identifies how the ground is expected behave in specific locations during an earthquake, is one way to predict the consequences. The information provided by seismic zonation is useful to communities deciding on land-use planning, building codes, enforcement of construction practices, strengthening of existing buildings, and other mitigation strategies. Progress in seismic zonation can be accelerated through international cooperation. An international pilot study should be undertaken to select 10-20 countries expected to experience a damaging earthquake during the 1990s. These regions should be paired with earthquake-prone regions of the United States on the basis of analogous earthquake sources and soil conditions to develop cooperative seismic zonation projects.

5. *Monitoring of volcanoes*. The unique record of each volcano's activity makes prediction of impending eruptions difficult without research and extensive monitoring. In the United States, the Hawaiian Volcano Observatory has for years monitored volcanic seismicity, swelling and rifting, outgasing, and changes in local electrical and magnetic fields as precursors of eruptions. During the 1980s, the Cascades Volcano Observatory and the Alaska Volcano Observatory began monitoring high-risk volcanoes in the Pacific Northwest. These efforts should be extended to additional Alaskan volcanoes.

Because eruptions of any one volcano or of volcanoes in any one country are too infrequent to reveal all potential precursors and hazards, intensive multidisciplinary, multinational study of selected high-risk volcanoes should be undertaken.

WARNING

A program for enhancing the nation's capabilities for the dissemination of warnings should include:

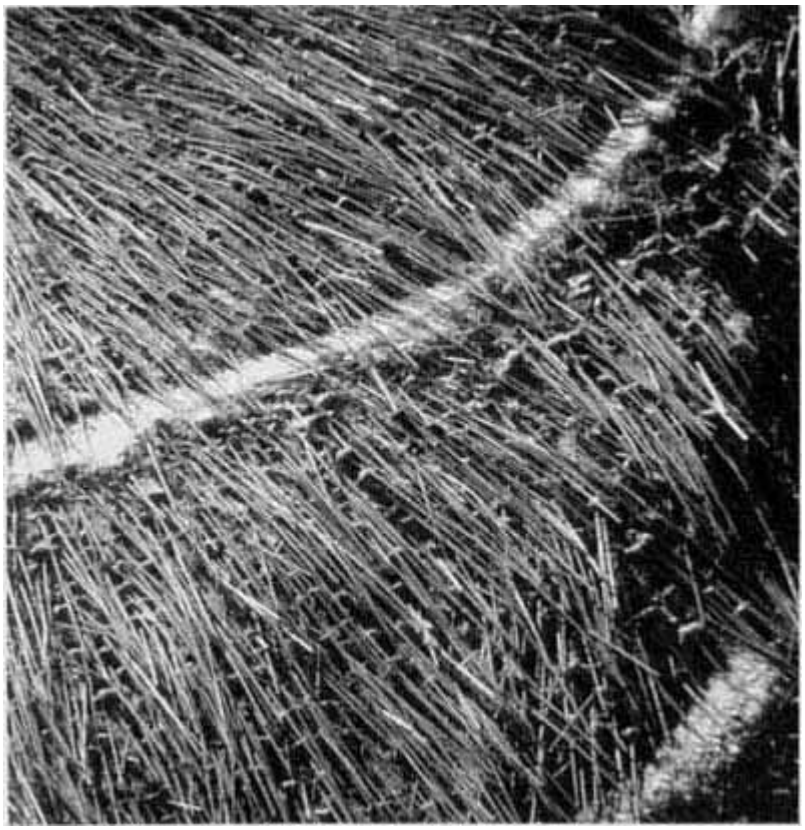
1. *Public-private partnerships for dissemination of warnings*. Because of their universality, radio and television broadcasts are particularly effective in issuing warnings. Recognizing this potential, the broadcast media have arranged to disseminate NWS severe weather and flood warnings. The Emergency Broadcast System can be activated in virtually any emergency. Meteorologists at most television stations and some radio stations ensure the quality and timeliness of predictions. The 24-hour cable-television weather channels provide continuous national and local weather coverage. NOAA Weather Radio broadcasts continuous weather and flood information across the country.

Despite the many successes in public-private partnerships for dissemination of warnings, several problems remain. Radio and television programming is not always interrupted when emergency messages are released, and the vast broadcast range of cable television makes it a difficult medium through which to issue local warnings.

The current partnership should be extended to facilitate the dissemination of warnings for all natural hazards. The feasibility of modifying NOAA's Weather Wire and Radio Systems to include additional hazard types should be explored by NOAA, the U.S. Geological Survey (USGS), USFS, and other agencies. Weather broadcasters should be trained to interpret and present any new hazard information. Further, present gaps in the dissemination system should be examined through joint efforts of the media and federal agencies, including the Federal Communications Commission.

2. *New technologies for dissemination of warnings*. The ideal warning system would ensure that all potential victims are alerted to an incipient disaster as quickly as possible, irrespective of the time or their location. Present systems often alert people unnecessarily and generally do not reach those who are asleep or out of range of the electronic media.

New technologies could solve some of these problems—special tone alerts such as those provided by NOAA Weather Radio that activate radio receivers only in the areas where a natural hazard has been predicted; the capability to send specifically addressed information using satellite communications to designated emergency management officials; an alert broadcast capability built into the local telephone network to provide a special ring accompanied by a recorded alert message to all telephones in a designated geographic area; and localized television displays of predicted severe weather and flooding. Attention should be given to developing and using sensors that automatically trigger warning systems; in the Swiss Alps, for example, thin wires stretched across avalanche-prone slopes are broken by the first large movements of snow and ice, electronically triggering



A side effect of volcanic explosions, billions of board feet of timber—and woodland habitat—are lost as the repercussion of eruption strips and flattens trees down the mountainside, leaving it looking like so many pick-up-sticks tossed by an angry child.

red warning signals on vulnerable roads below. Incorporating these and other technologies into the U.S. warning system will require further public/private partnerships among telephone companies, the news media, manufacturers of electronics equipment, and federal agencies.

3. *Research on behavioral response to warnings*. When individuals and organizations respond to warnings, their behavior stems from the interaction of the type of message they receive, their confidence in the source, their knowledge of the risks they face, their fears for the safety of loved ones and possessions, and other factors. People may feel, for example, that the possibility of looters is more threatening than an approaching flood, although research shows that looting seldom occurs in community disasters.

Despite the body of knowledge from research on behavioral response to warnings, advanced studies are needed. A particular gap exists in understanding the response of people at manufacturing plants, offices, hotels, schools, sports stadia, and other places of public assembly. Many businesses are reluctant to close or let employees leave unless the threat is quite certain. The factors that move organizations to act on warnings need to be systematically ascertained.

In addition, perceptions of risk differ considerably among population sectors; cultural and economic factors appear to influence what individuals and organizations think they should do. Social research similar to that for nuclear and chemical hazards should be conducted on the risk perceptions of different segments of the U.S. population. With such information, warning messages could be tailored to particular groups.

4. *Research on appropriate responses to warnings*. What should individuals and organizations do to protect themselves and their property? Although considerable research has been conducted in this area, further study is needed. Is it always safer to evacuate than to stay at home when a hurricane threatens? How should the tourist population be considered in disaster planning? Should all businesses simultaneously release their employees, even when a massive increase in traffic will result? What are the special problems of warning and evacuating hospitals, prisons, nursing homes, dormitories, zoos, arenas and other places of public assembly, wilderness and other remote areas, large demonstrations, parades, and other holiday celebrations? The development of educational campaigns, models of organizational response, and warning message content would all be improved by a systematic study of these and related questions.

Warning messages need to elicit appropriate actions. But they do not always do so. To make warning messages more effective, further research is needed on typical responses to warnings and techniques for encouraging appropriate responses from individuals, households, organizations, and communities. This problem lends itself well to a progression from laboratory research to demonstration projects to large-scale comparative studies.

5. *Improving the transmission of warning messages*. Communication follows many complex paths from the first monitoring of a threat to transmitting the warning to acting on that warning at homes, work, and schools. A better understanding of the multiple communication networks, which involve a variety of public and private organizations, is needed. How do they work? What affects the information flow? Which entities are given more credence and legitimacy? Where are the blocking or distorting points?

Cable television, which now reaches more than one half of the households in the country, improves the technological capability to reach those who need to be warned. But there remains the problem of reaching cable viewers who are tuned to distant stations. Studies are needed to ascertain the magnitude of the problem and its consequences, the implications for community disaster planning, and approaches to the issue of local warnings.

Disasters have been a part of life throughout history. San Francisco residents, circa 1906, examine the angle of list on a row of town houses damaged in the famous magnitude 8.3 quake.

Chapter 7—

Learning from Disasters

Disasters are tragedies. Yet they can serve as laboratories for understanding the physical and social factors governing them. Valuable information gathered during the hours, days, months, and years following a disaster can lead to policies and practices that reduce the risk of loss of life, property, and natural resources. This information can be used to enhance the effectiveness of hazard and risk assessments, awareness and education, preparedness, prediction and warning, and mitigation.

Because disasters have both immediate and long-term impacts, postdisaster studies should be conducted so that lessons can be learned at all phases. Much information on the immediate effects of disasters on people, buildings, personal property, lifelines, economic activities, and natural resources must be gathered within the first few hours to days because evidence is rapidly lost during rescue, clean-up, and recovery. As experience has shown, however, human suffering and other damage do not end with the event itself. Thus research should focus on the complicated processes of recovery and reconstruction in the months and years following a disaster.

The postdisaster period provides the opportunity for immediate hazard reduction action in the political, legal, and administrative arenas. Immediately after a disaster, heightened awareness of damages eases the usual difficulty of adopting and enforcing hazard reduction legislation.

The Committee recommends that data on the physical, biological, social, and health aspects of disasters be systematically collected and shared and that the resulting lessons learned be incorporated into policy and practice to reduce the impacts of future disasters.

To achieve this goal, the Committee proposes that:

- guidelines for documenting the effects of natural disasters be developed and adopted,
- information resulting from postdisaster studies be shared, and
- disaster reduction programs and legislation be developed for rapid implementation after an event.

A program for enhancing the nation's capabilities to learn from disasters should included:

1. *Postdisaster data acquisition*. Efforts should be made to coordinate and standardize the type of data collected by postdisaster investigation teams. Data should relate to the physical, biological, and social phenomena leading to the disaster; numbers and patterns of injuries and deaths; performance of buildings and lifelines; and response of individuals and organizations. Successful efforts to reduce damage and loss of life should also be included.

During the past few decades, the National Research Council, the Earthquake Engineering Research Institute, the Centers for Disease Control, OFDA, and other public and private organizations have sent multidisciplinary teams to analyze the immediate impact of disasters throughout the world. Extending this practice to all presidentially declared disasters should be considered. Academic researchers and others have conducted a few intermediate-term studies, focusing on recovery and reconstruction in

the first few years. Additional studies of this process would provide valuable lessons for improving hazard assessments, mitigation, disaster planning, recovery, and reconstruction. (See Figure 4.) Also needed is long-term research on the effects of disasters 10 or more years after their occurrence.

Coordination of the type of data collected and the format in which it is presented would enhance all these research efforts. Databases and analysis programs should be improved to facilitate the collection and sharing of information, the translation of lessons learned into improved disaster preparedness and mitigation measures, and their transfer to policymakers and practitioners.

It is important that data be collected immediately after a disaster. Still more important is that rescue, relief, and clean-up operations not be hindered by the convergence of investigation teams. Experience shows that the arrival of many teams can divert local officials from the job of disaster response and recovery to that of reluctant host. Clearly, agreements should be made to ensure that disaster sites are not overrun by investigators.

Workshops should be held to develop guidelines on the acquisition, analysis, and use of data from postdisaster investigative teams and to establish agreements for mobilizing these teams. In the United States, workshops may be organized under the auspices of universities, professional associations, and others. At the international level, they can be implemented through relevant UN system organizations—the IDNDR Secretariat, UNESCO, the World Meteorological Organization (WMO), the World Health Organization (WHO), the United Nations Development Programme (UNDP), the Office of the UN Disaster Relief Co-ordinator, and other bodies. Guidelines should be reviewed periodically and revised as appropriate.

2. *Postdisaster data sharing*. Information is useful when it is shared and applied, and mechanisms for exchanging information from postdisaster analyses and other research are needed. Because major disasters in any one nation are infrequent, international cooperation is necessary to derive the benefits of the volume of knowledge and experience that can be gained only by working in the global laboratory.

Sharing postdisaster data increases their potential to help improve disaster reduction practices, particularly when disciplines come together. Geologists, geophysicists, seismologists, architects, engineers, biologists, sociologists, urban planners, financial institutions, public officials, and medical personnel working together are more likely to devise practical natural hazard reduction strategies than would any of these groups acting singly.

National and international sharing of postdisaster information should be accomplished through news releases, briefings, newsletters, conferences, workshops, and other means. Sponsors of these activities should include organizations involved in both research and application.

3. *Capitalizing on enhanced awareness*. A disaster brings risk reduction to the forefront of community priorities. Public sensitivity to the risks associated with natural hazards is especially high for about six months after a major event. This awareness leads to a corresponding will to take life-and property-saving actions. The postdisaster environment also brings public officials face to face with liability issues. As a result, political support for preparedness and mitigation programs increases during this time—the introduction and implementation of all types of hazard reduction policies and practices become possible.

This brief opportunity cannot be bypassed. Concerned individuals, professional and community groups, and policymakers must be ready. Hazard information and proposed legislation, regulations, and enforcement guidelines should be prepared in advance, using the lessons from postdisaster investigations and other research. Plans should be made for rapid incorporation of experience into the decision-making process.

Model legislation and guidelines for incorporation of disaster reduction into community practice should be developed. Professional organizations such as the American Bar Association, the American Society for Public Administration, the American Public Works Association, and the American Planning Association should establish task forces to develop and disseminate these models. Local task forces should adapt them to the risks and characteristics of their communities and devise strategies for promoting them at the first opportunity.

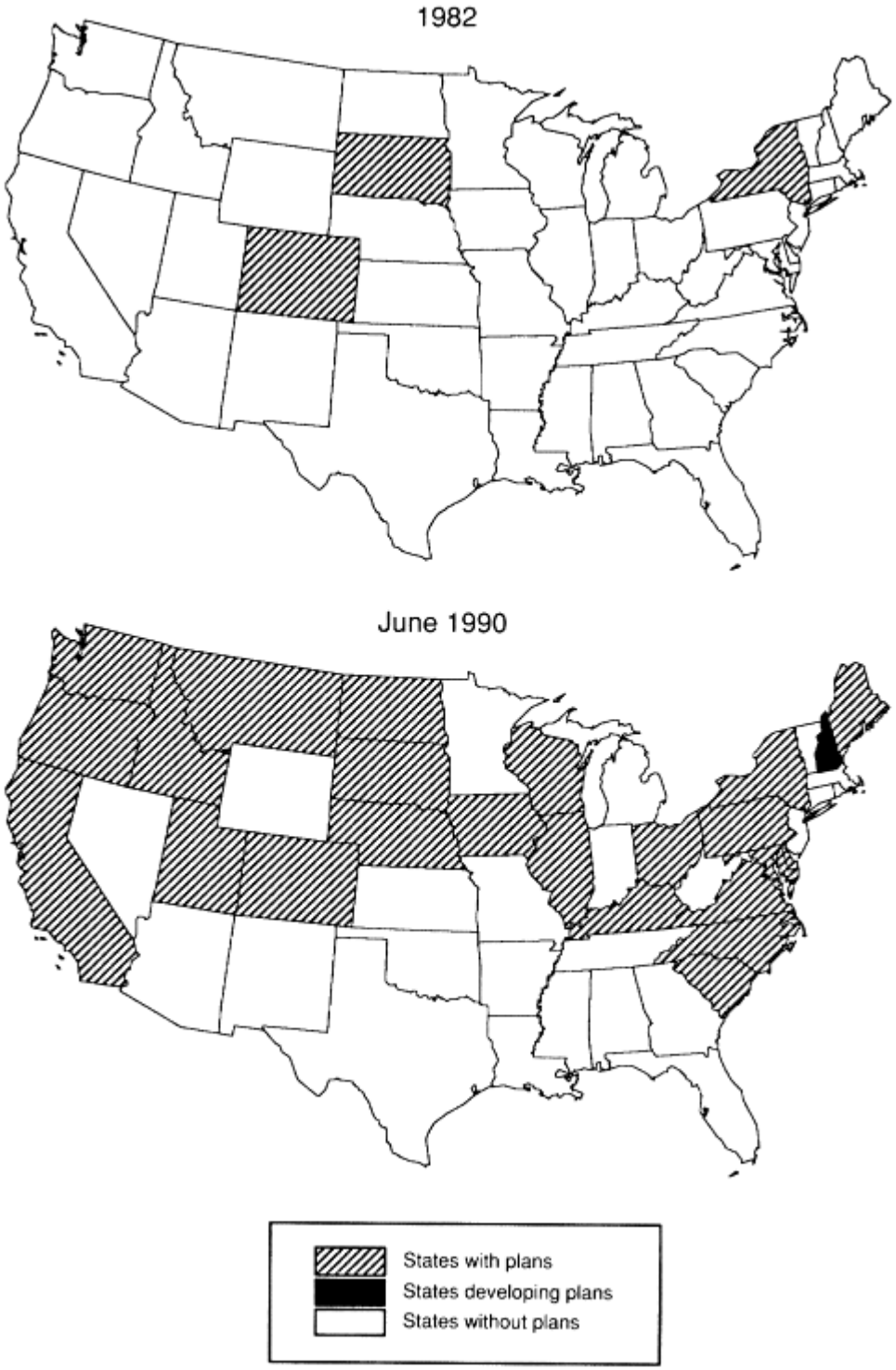


Figure 4.
CHANGES IN THE STATUS OF DROUGHT PLANNING, 1982-90
A 1982 survey of all 50 states showed only 3 with drought plans. The droughts of 1986-88 gave states a new appreciation of their vulnerability to severe water shortage sand the effects of their poorly coordinated responses. By June 1990, 23 states had plans and another had begun the planning process. (Source: D. Wilhite, International Drought Information Center.)

The first few days after a disaster see the in flux of relief efforts—volunteers, government assistance, and organized private voluntary organizations. A strong working knowledge of the area struck is needed to ensure that appropriate supplies are delivered and that the special needs of the community — such as possible cultural or language barriers—are anticipated.

Chapter 8—

U.S. Participation in the International Decade for Natural Disaster Reduction

The U.S. Decade for Natural Disaster Reduction is an outgrowth of the IDNDR, formally adopted by the United Nations General Assembly on December 22, 1989. The objective of the IDNDR is "to reduce through concerted international action . . . the loss of life, property damage, and social and economic disruption caused by natural disasters." The goals of U.S. participation in the IDNDR are to broaden the application of natural disaster reduction information and technology and to foster their incorporation into practice, particularly in developing countries. The United States, through the National Academy of Sciences, was a key participant in establishing the IDNDR, and it should continue to be a leader in developing and fostering disaster reduction activities both globally and at home.

The Committee recommends that the United States participate fully in the IDNDR through bilateral and multilateral programs, cooperation with regional and nongovernmental organizations, and support of UN organizational arrangements and program activities.

Active participation in the IDNDR will directly benefit the United States. Through cooperative programs, experience from recent disasters can be applied to domestic programs for mitigation, prediction, response, and recovery. The IDNDR also offers numerous opportunities for new research through international cooperation. Conversely, the United States has a considerable reservoir of applied research and technology that can be adapted to other nations' needs.

BROAD-BASED U.S. PARTICIPATION IN THE IDNDR

U.S. participants should include the National Committee, federal agencies, state and local governments, special authorities, business and industry, scientific and technical societies, professional associations, public interest groups, voluntary organizations, and academia.

The United States should develop and foster a mutually beneficial working relationship with IDNDR arrangements established by the UN. More specifically, this association should include full U.S. cooperation with the IDNDR Special High-Level Council, which will seek to mobilize support for the IDNDR and serve the UN Secretary-General in an advisory capacity; the Scientific and Technical Committee, which will develop and evaluate bilateral and multilateral Decade programs; and the IDNDR Secretariat, which will provide support for these two bodies, serve as a clearinghouse for disaster reduction information, and be responsible for day-to-day coordination of Decade activities. The U.S. National Committee, through the UN and other direct contacts, should communicate regularly with the IDNDR committees of other nations to identify potential areas of cooperation.

The federal government supports many international disaster reduction projects. OFDA provides direct predisaster and postdisaster assistance to other nations. The Department of State leads U.S. cooperation with the specialized organizations of the UN

Common, beautiful, and often deadly, lightning can ignite wildfires that destroy wilderness or communities, endangering the occupant sand causing massive losses.

system; individual agencies collaborate with their UN counterparts, such as USGS cooperation with UNESCO and UNDP, NOAA work with the WMO, U.S. Department of Agriculture participation in the Food and Agriculture Organization, and the Department of Health and Human Services work with the WHO. Several federal agencies also participate in bilateral and multilateral programs of technology transfer, research, and training. These activities should be coordinated and broadened to strengthen existing programs and facilitate inclusion of projects identified during the Decade.

Many state and local governments have considerable experience and expertise in emergency response, preparedness, and mitigation—a collective experience that should be applied to the IDNDR. Through pairing arrangements such as sister-city programs and international state-to-state partnerships, states and local jurisdictions can benefit from and contribute to the exchange of information and expertise.

Nongovernmental organizations in the United States have a wealth of resources and expertise that should be applied to the IDNDR. Business and industry, particularly multinational corporations, can take a leading role in implementing mitigation practices at facilities in the United States and abroad. Scientific and technical societies should be active participants in the Decade programs planned by the International Council of Scientific Unions, the World Federation of Engineering Organizations/Union of International Technical Associations, and other influential international bodies. Professional associations such as the American Society of Civil Engineers, the American Public Works Association, the American Medical Association, and the American Society for Public Administration should make their expertise available through cooperation with their international counterparts. Voluntary organizations such as the American Red Cross and Volunteers in Technical Assistance have hands-on experience that is readily adapted to IDNDR initiatives. Cooperative programs may be facilitated by computerized volunteer registries that can match international disaster reduction needs with available resources. Further, the U.S. natural hazard research community is engaged in several international projects that relate to mitigation, response, postdisaster reconstruction, geophysical research, and other aspects of disaster reduction. Such efforts should be supported and expanded in the spirit of international cooperation.

DEVELOPING NATIONAL HAZARD MANAGEMENT CAPABILITIES

Although the UN resolution calls for most Decade activity to be undertaken at the national level, many developing nations will require technical assistance to initiate programs. The United States should support the establishment or strengthening of regional institutions that can coordinate hazard reduction programs within their regions. Again, priority should be given to developing and sustaining a local hazard management capability. The types of assistance of particular value include support for regional and national efforts to establish or improve early warning systems, training for disaster response, and technical assistance for hazard mitigation through land-use planning, building standards and design, reduction of economic vulnerability, training in rapid health assessments following natural disasters, and wildfire prevention.

Early in the Decade, the United States should participate in projects chosen for their potential to reduce the vulnerability of high-hazard areas and to serve as models for other regional and national activities. Several projects have been suggested: cooperative international programs such as the World Weather Watch to improve prediction of atmospheric hazards; flood hazard and risk assessments, monitoring, and prediction systems; regional models and test sites for earthquake prediction and seismic zonation; international strong-motion instrumentation network data collection; world landslide hazard mapping; regional networks for wind speed data collection; awareness and education programs; study of the media role in disseminating warning messages; and models of organizational response during the emergency phase of disasters.

Figure 5.
NATURAL HAZARDS OF NORTH AMERICA
North America and the Caribbean are subject to drought, earthquakes, floods, hurricanes, landslides, tornadoes, tsunamis, volcanic eruptions, and wildfires. Hazardous events often cross political boundaries, making cooperative disaster reduction efforts in the region of particular value. (Source: M. Terman, Circum-Pacific Council for Energy and Mineral Resources.)

Battered by high winds and storm surge, this coastal community was devastated by the forces of Hurricane Hugo. Though similar areas are hit regularly by severe storms, community members rebuild the same types of structures in the same location.

Hazard reduction projects should be developed and implemented in a manner that is consistent with and supportive of regional or national development goals. In essence, hazard reduction should become an integral feature of the development process. Hazard reduction criteria should be factored into development programs administered by UNDP, the World Bank, regional development banks, and bilateral aid agencies. The IDNDR can be a catalyst in initiating cooperative hazard reduction programs that emphasize national and regional hazard management capabilities that are compatible with development programs.

A NORTH AMERICAN PROGRAM

An early thrust of U.S. participation in the IDNDR should be the development of a program of natural hazard reduction for North America. A comprehensive program with Canada, Mexico, the Caribbean, and Central America, which could serve as a model for other regional activities during the Decade, is described below.

Natural disasters often cross North America's political boundaries, and this fact has provided the impetus for regional cooperation. (See Figure 5.) Existing programs include hurricane prediction and warning, wildfire prevention and control, seismic monitoring and zonation, volcano monitoring and warning, flood prediction and warning, building code development and upgrading, and regional disaster preparedness programs. Several of these projects could be models for international cooperation.

For years, the United States and Canada have operated flood prediction and monitoring programs on two common water bodies, the Columbia River and the Great Lakes system. The two countries also provide mutual assistance in forest fire prevention and suppression. Additional cooperation is needed for storm monitoring and research undertaken through the Cooperative Atlantic Storms Program, earthquake monitoring and mapping programs for the seismically active western and eastern fault zones, a proposed program for landslide mapping, and other programs.

Cooperation on natural hazard reduction is traditional between the United States and Mexico, and bilateral agreements have facilitated mutual support in emergencies. In the aftermath of the 1989 Loma Prieta earthquake, for example, Red Cross teams from Mexico assisted in search-and-rescue operations; several U.S. organizations responded to the 1985 Michoacan earthquake that killed thousands and severely damaged some modern buildings in Mexico City. This disaster led to a series of joint research projects in earthquake engineering and emergency response sponsored by NSF and Mexico's National Council for Science and Technology. These institutions should fund comparable projects during the Decade.

Within the framework of a North American strategy, emphasis should be placed on reducing the impacts of natural hazards in the Caribbean, Mexico, and Central America. In recent years, the region has been devastated by natural disasters that exacted heavy tolls in human life and social and economic disruption. During 1988-89, Hurricanes Gilbert, Hugo, and Joan caused scores of deaths and hundreds of millions of dollars in damage to countries in the Caribbean basin. Wildfires are a frequent source of substantial damage. Earthquakes strike frequently, killing tens of thousands and inflicting economic damage that represents a substantial part of the countries' gross national products. Floods, droughts, and hurricanes affected 16 million people and killed 25,000 during the past three decades.

Programs in Canada, Mexico, the United States, and U.S. territories in the Caribbean could easily be expanded to include all the Caribbean and Central America. OFDA, USGS, NWS, NASA, the Canadian International Development Agency, the Organization of American States (OAS), the Pan American Health Organization (PAHO), the Pan Caribbean Disaster Preparedness and Prevention Project, and the World Bank have made a significant effort to assess and mitigate natural hazards in the region. Extending these and other activities would benefit both recipient and donor nations and produce an abundance of much-needed data on emergency preparedness, response, and mitigation for use by all.

A comprehensive program of natural hazard reduction for the Caribbean-Mexico-Central America region should provide for continuity and further development of ongoing activities while drawing new participants. It should stimulate both informal and formal cooperation in the region, facilitate communication among providers and practitioners, and promote consideration of hazard reduction in development planning.

To plan and implement such a program, the Committee proposes the creation of three consortia that would assess the needs and capabilities of their geographic areas and work on cooperative projects. One should be formed in the United States, Canada, and Mexico, another in the Caribbean, and the third in Central America. They should comprise representatives of the public and private sectors, international organizations, the scientific and engineering community, and users of disaster reduction information and technology.

National IDNDR committees should also be key participants in these consortia. Some Decade entities have already been formed. The U.S. National Committee urges all Central American and Caribbean

Drifts of ash pile on rooftops, collapsing buildings by sheer weight, igniting fires, and burying entire towns.

nations to form committees, either alone or with neighboring nations.

The consortia should facilitate the flow of information and services from hazard assessment through implementation of mitigation mechanisms—from strengthening local and regional agencies to training their personnel to transferring relevant technologies. The consortia should foster coordination of activities in the region and be a point of contact and principal means of communication for participants. Each consortium would require a secretariat housed in an appropriate regional institution of multinational scope. Through their secretariats, the consortia could also serve as information clearinghouses.

Projects undertaken within a regional program should be selected for their potential to reduce vulnerability immediately and their enhancement of training and other institution-building programs that will contribute to long-term hazard reduction. The projects should provide for direct local participation and should reflect local customs, language, administrative structures, and attitudes toward risk. Operational groups both in and outside government should be involved to help identify problems and priorities and to implement programs. As regional—that is, multinational—activities are agreed upon, resources should be directed to appropriate-level institutions within countries.

Examples of the types of projects to be undertaken in the Caribbean-Central American program are:

- *Regional training programs for natural hazards management*. Regional efforts such as the OAS program in natural hazards management training and technical assistance should be expanded and offered to mid-level professionals and their agencies. Regional training programs should build on knowledge derived from sectoral assessments and hazard reduction programs to develop training manuals, training courses for practitioners and trainers of trainers, and regional seminars for policymakers.
- *Public awareness and community preparedness*. Existing community-oriented programs to increase hazard awareness and self-reliance should be expanded. They should center on important community facilities such as schools and water supplies. Building on shared community interests, programs can promote individual and collective actions for preparedness and mitigation to safeguard essential community infrastructure.
- *Urban population and essential facilities vulnerability reduction* . Further hazard and risk assessments of landslides, wildfires, droughts, floods, hurricanes, and seismicity should be undertaken, building on existing databases and hazard mapping, technical assistance training, and technical transfer. These assessments would permit identification of population concentrations and lifeline networks for formulating short-, medium-, and long-term vulnerability reduction programs and emergency response plans.
- *Sectoral hazard assessments and development of loss reduction programs* . Further hazard and risk assessments should be developed for energy, agriculture, transportation, tourism, and other economic sectors. These assessments should form the basis for developing the loss-reduction strategies that each sector would fund and implement. The programs should encourage these sectors to exchange information and coordinate actions.
- *Improved hurricane prediction*. The region's observational network capability should be enhanced by increasing the number and reliability of upper-air and surface reporting locations that could survive hurricanes and other severe storms. A pilot project should deploy automated surface observation stations, additional wind profilers and other upper-air systems, and aircraft observing systems. The resulting data would help improve regional hurricane prediction.
- *Improved communications and natural hazards monitoring*. Data sources should be connected for all natural hazards affecting the region. Using a personal computer-based work station connected to a two-way satellite delivery system, national meteorological services and others could access and analyze real-time data from meteorological and geological information centers in the United States, in Canada, and throughout the region. Local observations, soundings, and other data sets as well as warnings would be relayed by satellite to meteorological and geological centers.

Although an early thrust of U.S. participation should be natural disaster reduction for North America, the United States should not confine its efforts to this region. Opportunities for international cooperation exist elsewhere as well. Programs similar to those suggested for the Caribbean and Central America can and should be undertaken in other regions. In particular, the Pacific Rim is a possible additional focus for bilateral and multilateral activity.

Even with advance warning, sometimes there are still devastating losses to natural disasters. Homes—often whole communities—are destroyed and disrupted, leaving traumatized survivors to cope and rebuild.

Chapter 9—

Organization of the U.S. Decade

Organizational arrangements for the U.S. Decade must be able to draw all potential participants and use their capabilities and resources. A successful Decade requires strong government leadership and commitment at all levels—local, state, and federal. It also depends on the participation of individuals, professional associations, volunteer organizations, industry, academics, and others. The structure must be flexible enough to accommodate changes in programs and priorities as the Decade proceeds. The Committee believes that creating a new bureaucracy is counter to these goals. Instead, the Decade should build on existing organizations and seek to improve communication and coordination among them. New partnerships for disaster reduction should be forged and refined throughout these 10 years.

Similar flexibility should characterize U.S. interaction with the IDNDR. An international structure has been designed to allow for the widest possible variety of activities undertaken by scientific and technical associations, voluntary and nongovernmental organizations, governments, international organizations, and others. U.S. structures for international participation should parallel the letter and spirit of these arrangements.

Notwithstanding the need for flexibility, identification of responsibility for U.S. Decade activities is essential. Political philosophy and practice would place that responsibility squarely with government. Virtually irrespective of political ideology, citizens' fundamental expectations of government include protection against threats to safety, basic health, and well-being. Natural disasters are clearly that kind of threat, and government has assumed much of the duty of preparing for and responding to them. It then follows that government would take responsibility for Decade action, with active involvement of heads of government at all levels.

Within the federal government, the overall Decade program involves most departments and many independent agencies. It must receive the highest possible attention if it is to make a qualitative difference in reducing vulnerability to natural disasters. For these reasons, the Committee recommends that the President's Office of Science and Technology Policy take responsibility for policy direction, planning, and coordination of federal Decade efforts.

Federal agencies have made an important contribution to establishing the U.S. Decade through the efforts of the Subcommittee for Natural Disaster Reduction (SNDR) of the President's Science Advisor's Committee on Earth Sciences. The SNDR supports the National Committee and is developing a plan of action for federal science and disaster reduction agencies. As the Decade's national and international activities increase, the Federal Coordinating Council on Science, Engineering, and Technology should consider establishing a committee at a higher level focusing solely on the Decade and formally involving all key departments and independent agencies with responsibility for disaster reduction activities. The committee could build on the work of the SNDR to develop an action program that addresses science and technology, domestic implementation, and international cooperation. A primary goal would be to foster partnerships for action among the U.S.

The line of action is the local community, and often mitigation and preparation are most useful in their most basic form, such as a brigade of volunteers filling and stackings and bags to hold back rising river waters.

government and all participants in national and international disaster reduction efforts. Department of State and Agency for International Development representation is critical to integration of international efforts in the U.S. program.

Irrespective of the location of oversight responsibility, the work of saving lives and limiting loss should begin. Adequate funding is crucial to this endeavor; thus federal disaster reduction programs and budgets should be defined by 1991, and coordinated budget requests should begin in FY1993.

The federal role in disaster reduction cannot be discussed without specific mention of FEMA. FEMA has significant national responsibilities in most areas of hazard reduction, particularly for awareness, education, mitigation, preparedness, and recovery. The agency operates under various statutes dealing with multihazard emergency management. By law, the civil defense program may support all natural and technological hazards, provided that implementation does not detract from attack preparedness. The Committee believes that attack preparedness—even as implemented under the dual-use (nuclear attack and natural disaster) concept—has consumed a high percentage of the agency's budget and a similarly disproportionate share of the human resources. With the recent diminution of Cold War threats and the important changes in world affairs, the nation is now in a position to enable FEMA to redress this imbalance, and a change in legislation should be considered.

By law and tradition, state and local governments are primarily responsible for many disaster functions. For example, responsibility for land-use planning and implementation of building codes—both key elements of mitigation efforts—rest primarily at the state and local levels. Most preparedness plans must be developed and implemented at the local or state level. Thus it is essential that officials and professionals at these levels participate in the Decade. The many existing disaster reduction programs in local and state agencies should form the nucleus of their Decade activities, with governors and mayors providing leadership. A high level of coordination will be required for the many agencies involved.

Natural hazards do not respect state borders but tend to affect multistate regions. One way to promote an effective response to these shared threats is through regional consortia that could provide a focal point for disaster reduction projects and information. They could also strengthen and forge relationships between the public and private sectors as well as with hazard reduction researchers and practitioners. The Criminal Justice and Public Safety Committee of the National Governors' Association could be the catalyst for creation of the consortia. A model consortium should be created as a pilot project within the first three years of the Decade. Adjustments in the model should be based on this initial experience and then replicated with regional adaptations.

Business and industry should also be partners in state and local disaster reduction efforts. Their expertise and resources should be called upon for planning and incorporated into preparedness and mitigation activities. When appropriate, multinational corporations may also participate in IDNDR activities.

Of course, business and industry's primary obligation is to their employees and shareholders. Thus it is essential that they have disaster reduction programs to protect their employees, physical plants, assets, and profits. Many businesses and industries also perform necessary functions during a disaster and in the recovery phase. The extensive work now done by industry in safety and quality assurance could be extended to emphasize natural disasters. Strategies to foster this objective include national and regional conferences of business and industry leaders and awards for disaster reduction excellence. Public disaster plans must also provide for continued functioning and recovery of vital business and industry.

There is a continuing need for a U.S. National Committee to be the facilitator of the nation's domestic and international Decade programs. Such a committee would provide a forum for all participants and would ensure the incorporation of sound scientific and technical practice. The Committee should have three principal roles: to advise the federal government on its Decade program; to facilitate coordination and communication among government agencies, the private sector, professional associations, academia, and others; and to represent nongovernmental and, as appropriate, intergovernmental international Decade activities.

Appendix—

Hazard Reduction Checklist

HAZARD AND RISK ASSESSMENTS			
COMMUNITY ACTIONS	COMMUNITY PROGRESS		
	NO ACTION	ACTION STARTED	ACTION COMPLETED
Identify natural hazards (location, intensity, frequency)			
Map hazard-prone areas, environmentally sensitive areas			
Inventory structures, areas vulnerable to hazards (e.g., unreinforced masonry, mobile homes)			
Inventory critical facilities and resources (e.g., hospitals, schools, utilities, endangered species)			
Inventory sites with hazardous and toxic materials, determine vulnerability			
Inventory special needs groups (e.g., elderly, people with handicaps)			
Conduct hazard and risk assessments (vulnerability of population and natural resources to specific hazards)			
Prepare hazard overlay maps to depict vulnerable areas and populations			
Digitize hazard and risk assessments (e.g., geographic information systems)			
Develop procedures and schedule for updating hazard and risk assessments			
Translate hazard and risk assessments into recommendations for action (e.g., community public awareness, mitigation, preparedness programs)			

AWARENESS AND EDUCATION

COMMUNITY ACTIONS	COMMUNITY PROGRESS		
	NO ACTION	ACTION STARTED	ACTION COMPLETED
Develop target groups/areas			
Develop family and neighborhood awareness, education, preparedness campaigns			
Work with local media, coordinate emergency public information			
Educate public officials on their role and responsibilities, including legal aspects, prepare and distribute checklists for CEOs during emergencies			
Develop a workplace hazard awareness and education campaign, collaborate to identify safety problems, increase business survivability			
Promote school awareness, education, and preparedness; encourage safety drills; distribute materials through schools			
Prepare elderly, disabled, and special needs groups by providing materials on steps to take, telephone numbers, etc.			
Promote awareness and education among professional groups (e.g., engineers, educators, city managers), work with professional associations			
Incorporate information into a community-wide awareness and education campaign, promote hazard awareness week, use local and voluntary organizations to assist in implementing programs			

MITIGATION

COMMUNITY ACTIONS	COMMUNITY PROGRESS		
	NO ACTION	ACTION STARTED	ACTION COMPLETED
Property acquisition (enables local government to manage development of hazardous areas)			
Zoning and subdivision regulations (restrict/guide new development and reconstruction)			
Building codes (establish structural standards for new construction)			
Tax credits (provide owner incentives to limit development or build in mitigation)			
Structural measures (dams, building retrofit)			
Nonstructural measures (minimize injuries and property damage, e.g., by securing equipment)			
Training programs (for multidisciplinary audience, should include technical and scientific programs)			
Technical assistance (for local government, business, utilities, should address mitigation policy and practice)			
Awareness and education (for general public)			

PREPAREDNESS FOR EMERGENCY RESPONSE, RECOVERY, AND RECONSTRUCTION			
COMMUNITY ACTIONS	COMMUNITY PROGRESS		
	NO ACTION	ACTION STARTED	ACTION COMPLETED
Conduct Hazard and Risk Assessments			
Prepare Emergency Operations Plan			
Notification and warning procedures			
Direction and control			
Communications (among responders)			
Emergency public information			
Resource management			
Emergency medical services			
Fire and hazardous materials			
Shelter and mass care			
Law enforcement and security			
Management of volunteers/unsolicited resources			
Prepare Plan for Recovery and Reconstruction			
Damage assessment procedures			
Restoration of communications, utilities, other essential services			
Inspection, condemnation, demolition of unsafe buildings			
Debris removal (including toxic materials)			
Business and industry coordination			
Long-term economic recovery and reconstruction			
Economic recovery			
Community development goals			
Hazard mitigation opportunities			
Utility-industry-government coordination			
Conduct Training and Exercises			
Business and industry			
Public officials			
Volunteers/Non-government			
Emergency responders			
Computer/information specialists			

Note: See FEMA CPG 1-8, *Guide for Development of State and Local Emergency Operations*, for detailed guidance.

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Too much or too little rain can have dramatically different ejects that are equally destructive.

Forest fires are often in remote are as with difficult access where little can be done to limit damage. As natural events, fires clear areas for new growth to occur, but when the flames turn to ward communities, are as housing endangered species, or historic locations, the losses can be devastating.

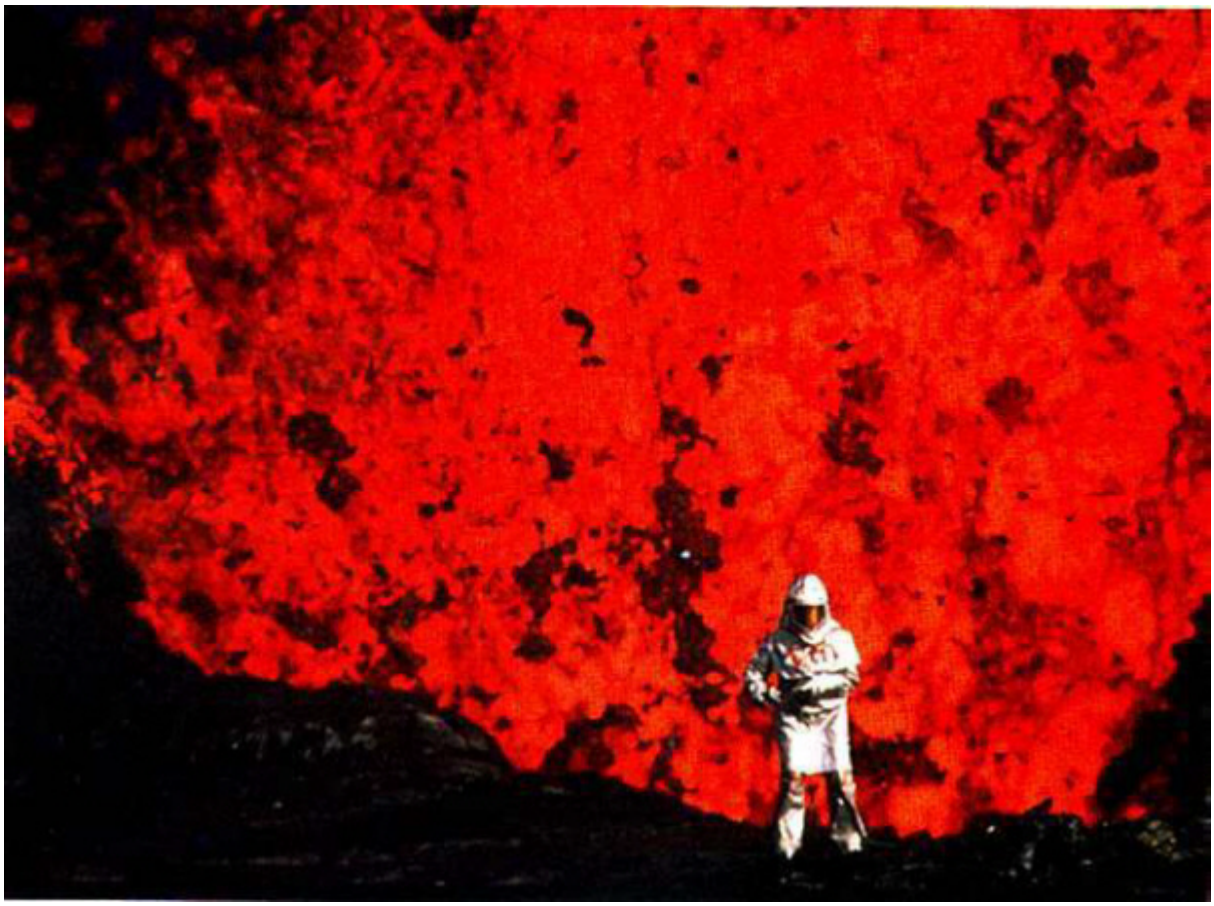
Volunteers of every age are put to work filling sand bags as the basic battle of man versus nature takes place yet again.

Live stock wanders through an abandoned village where trees and houses have collapsed from the explosive eruption of Mr. Colo (Indonesia) and from the weight of the ash.

Urban or rural, similar events provoke similar reactions. In these two scenes, ashfall from impending volcanoes impedes the progress of refugees.

In an attempt to save the building and divert the lava flow, water is sprayed on the ground and the leading edge to cool and harden the lava.

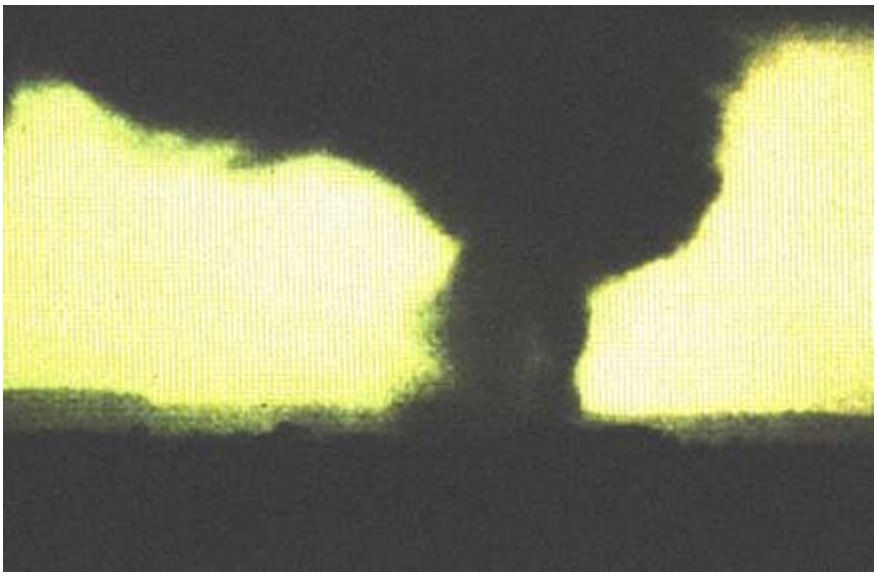
In a scene worthy of a science fiction movie, a researcher takes a variety of measurements from a flowing stream of lava.



Wearing protective clothing and equipment, scientists try to learn from events in progress to further prediction and warning capabilities.

Controlling or predicting a wildfire is impossible, as shown by the "jumping" pattern of burn locations left behind. Note the burned-outhouse in the lower righthand corner.

Fireworks of sparks and fountains of lava backlight an abandoned town in the path of a volcano's destructive eruption.



The sky turns eerie color sand local residents take cover as the funnel-shaped cloud of a tornado drops from the sky with wind speeds of more than 150 miles per hour.

The twisted destruction left behind after a tornado can be scattered for miles from its point of origin.

A whole village would be missing if not for stark steeple of the tallest building in the town as an erupting volcano buries everything in sight under lava an dash.

A black river of death stands frozen in time as lava hardens after dragging cars for miles along its heated steams.

A single bolt of lightning can fork to strike numerous locations, igniting fires, downing utility lines, and causing other damage.