



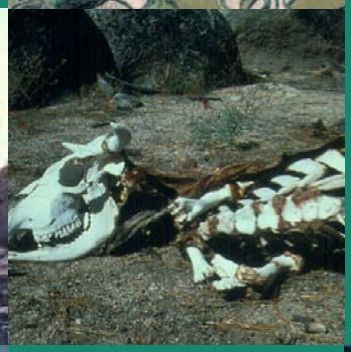


# Natural Hazards and Global Change

A Report of the Aspen Global Change Institute
Elements of Change Series
Susan Joy Hassol
John Katzenberger
Editors

Aspen Global Change Institute


# Natural Hazards and Global Change

A report on the Aspen Global Change Workshop
10 -20 July, 1996
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*Furthering the understanding of Earth Systems and global environmental change*

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# Acronyms

AID: Agency for International Development

BAREPP: Bay Area Regional Earthquake Preparedness Project

CENR: Committee on Environment and Natural Resources Research

CISET: Committee on International Science, Engineering, and Technology Policy

CUSEC: Central United States Earthquake Consortium

DAAC: Distributed Active Archive Center

DIS: Data and Information System

DOD: Department of Defense

EOS: Earth Observing System

EOSDIS: Earth Observing System Data and Information System

FEMA: Federal Emergency Management Agency

GIS: Geographic Information System

GNP: Gross National Product

GPS: Global Positioning System

HUD: Housing and Urban Development

ICMA: International City/County Management Association

IDND: International Decade for Natural Disaster Reduction

NASA: National Aeronautics and Space Administration

NCEP: National Centers for Environmental Prediction

NDR: Natural Disaster Reduction

NHDR: Natural Hazard and Disaster Reduction

NIST: National Institute of Standards and Technology

NMS: National Mitigation Strategy

NOAA: National Oceanic and Atmospheric Administration

NSF: National Science Foundation

# AGCI Session I: Natural Hazards and Global Change

Session Chairs:

Louis Walter
*University of Delaware*
E. L. Quarantelli
*Nasa*

## I. The AGCI Workshop

While we still do not know everything we ought to know, we now know enough to make a significant difference if we purposefully develop and apply that knowledge.

The goal of the AGCI workshop was to produce specific recommendations on public policies and programs that ought to be instituted or expanded to reduce the impacts of future natural disasters. As such, the workshop differed from typical scientific meetings in which the intent is simply to present new research findings and to indicate areas of future research. Here, the premise is that, while we still do not know everything we ought to know, we now know enough to make a significant difference if we purposefully develop and apply that knowledge. Thus, suggestions for high priority research were a secondary objective of the workshop.

While considering the links between disasters (those social occasions involving major disruptions of community life) and hazards (potentially dangerous physical agents which often give rise to disasters), the AGCI workshop focused on what might be done about reducing the negative effects of disastrous occasions, especially those of a relatively sudden nature. This included the full span of disaster planning; that is, mitigation, preparedness, response, and recovery.

The Aspen Global Change Institute provided the ideal format in which persons of differing professional and scientific backgrounds could interact, meld their knowledge and perspectives, and produce proposals for concrete steps that should be taken in the future. There was also an assumption that there can be little progress in implementing disaster programs and policies without a clear understanding of the potentials and limitations of technological and social dimensions involved. Thus, the workshop brought together technologists, physical and social scientists, and representatives of the public and private sectors who have some responsibility for planning and implementation of disaster reduction measures.

Six topics were identified as themes for the workshop. These were:

1. Activities of citizens and public perceptions regarding disaster reduction;

2. Technological innovations/developments and the opportunities and possible impediments they present for disaster reduction;

3. The role of the private sector in disaster reduction;

4. The political aspects and governmental dimensions of disaster reduction;

5. Natural disaster reduction goals and programs: the economic, sociological and technological nexus;

6. Long-term physical and social trends affecting the occurrence and nature of natural disasters and efforts to predict and reduce them.

While the major focus was on natural disasters and their effects in the United States, "human-made" or "technological" disasters were also considered, and attention was given to cross-national and international aspects of disaster reduction.

Prior to the workshop, attendees prepared and submitted working papers which were distributed to the other participants before the meeting. In order to maximize interaction among, and participation from the attendees, discussion at the workshop progressed through several stages:

1. A plenary session in which the goals, objectives and organization of the workshop were discussed (one-half day);

2. Three half-day sets of two concurrent exploratory sessions on the six themes of the workshop;

3. Six two-hour plenary sessions, one on each of the themes;

4. Six simultaneous thematic sessions for detailed discussions and development of recommendations (one day);

5. Joint meeting of theme group chairs to prepare and coordinate observations and recommendations (half-day);

6. Discussion, revision and approval of recommendations in plenary session.

The full span of disaster planning includes mitigation, preparedness, response, and recovery.

The agenda proved an excellent mechanism for maximum discussion and interaction among the participants and for coordination of the observations and recommendations of the several interlocking themes. Numerous activities on weekends and in the evenings provided additional opportunities for interactions and discussion.

The full span of disaster planning includes mitigation, preparedness, response, and recovery.

Participants

Participants were chosen to represent differing perspectives and backgrounds with respect to disaster management and Earth observing relative to natural disasters. These were:

Chairs

1. Prof. E. L. Quarantelli, University of Delaware
2. Dr. Louis Walter, NASA Goddard Space Flight Center

Organizing Committee

1. Dr. Miriam Baltuck, NASA Headquarters
2. Dr. William Hooke, NOAA
3. Prof. Walter R. Lynn, Cornell University
4. Dr. Vincent Salomonson, NASA Goddard Space Flight Center

Attendees

1. Prof. Beningo Aguirre, Texas A&M University
2. Dr. William Anderson, National Science Foundation
3. Mr. Matthew Ashe, Ashe Associates
4. Mr. Richard Bernknopf, U. S. Geological Survey
5. Dr. Robert Brakenridge, Dartmouth College
6. Dr. Caroline Clarke, National Academy of Sciences
7. Mr. Donald Geis, International City/County Management Association
8. Prof. Oscar Huh, Louisiana State University
9. Prof. Fred Krimgold, Virginia Polytechnic Graduate Center
10. Prof. Dennis Mileti, University of Colorado
11. Prof. Joanne Nigg, University of Delaware
12. Dr. Roger Pielke, Jr., National Center for Atmospheric Research
13. Prof. John Rundle, University of Colorado
14. Mr. Frank Thomas, FEMA, ret.
15. Ms. Janet Workman Gorman, Workman Group

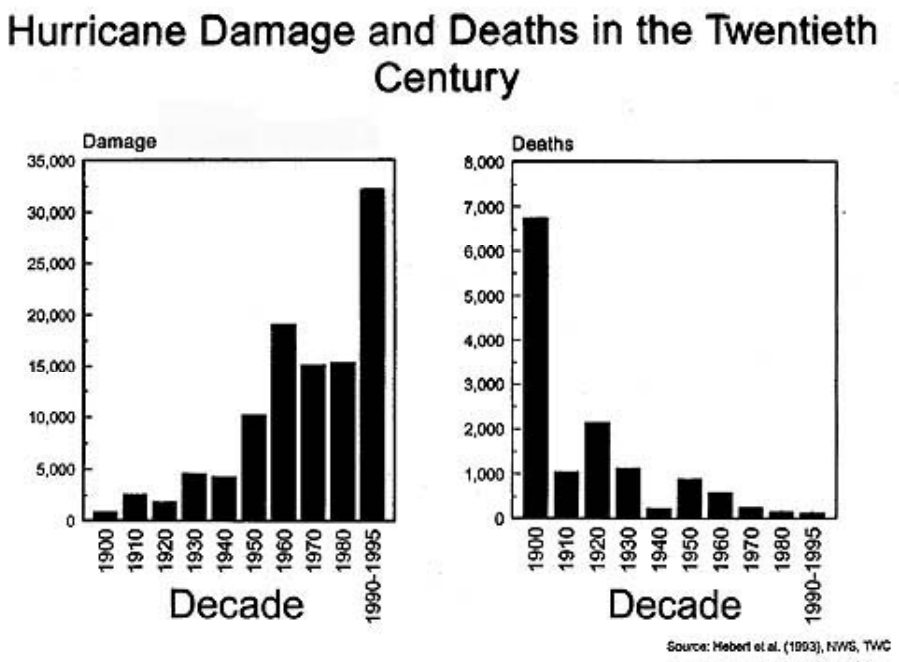
There can be little progress in implementing disaster programs and policies without a clear understanding of the potentials and limitations of technological and social dimensions involved.

The preceding material provides the background for the workshop and this report. The body of the workshop report is contained in Vision and Priorities for Action (Chapter IV) and the Thematic Framework (Chapter V). The Priorities for Action are a result of a valuable plenary discussion of encompassing goals which the workshop participants believe could and should be attained, and include a vision of the future which participants foresee upon achievement of these goals. The Thematic Framework contains detailed observations and recommendations for five of the six themes of the workshop. In that section, the workshop also attempts to identify organizations, or classes of organizations, which should be responsible for developing and/or carrying out the recommendations. Results of the discussion on the “Trends” theme are presented in the following section of this report (Chapter II). The final chapter summarizes the recommendations developed by each of the theme groups.

# II. The Changing Environment

In the realm of natural disasters, there are two contradictory trends. The implementation of effective public policies, assisted by appropriate scientific and technological developments, has resulted in a decrease in the number of injuries and fatalities resulting from natural disasters. On the other hand, ineffective policies, coupled with the failure to develop or adopt appropriate technologies, have resulted in continuing escalation of the economic costs of natural disasters (see Figure 1.1).

While there has been a decrease in the number of injuries and fatalities resulting from natural disasters, there has also been a continuing escalation of their economic costs.




Decadal Hurricane Damages and DeathSource: Hebert, P. J., J. D. Jarrell and M. Mayfield, 1996. The Deadliest, Costliest and Most Intense United States Hurricanes of this Century (and Other Frequently Requested Hurricane Facts) NOAA Technical Memorandum NWS NHC-31 (February). Coral Gables, FL: NHC.
Damage: Millions 1990 US$

In the United States alone, these costs have been estimated to approach one billion dollars a week. It is clear that the well-being of our country, its people and its economy, demands action against this large and increasing drain on its resources. The nation, and indeed, the world, can no longer tolerate the needless costs and loss of life resulting from natural disasters.

The increasing cost of disasters is influenced by other societal, technological and environmental trends. Most serve to escalate this trend while some tend to diminish it.

## Societal Trends

### Expanding population

This increases the number of people, and the size of the infrastructure exposed to risk.

### Urbanization

Concentration of populations in cities greatly magnifies disastrous effects. Cities themselves are often located in areas vulnerable to earthquakes. There is a pronounced growth of coastal cities which are exposed to hurricanes and storm surges. (See Figure 1.2.)

There is a pronounced growth of coastal cities which are exposed to hurricanes and storm surges.

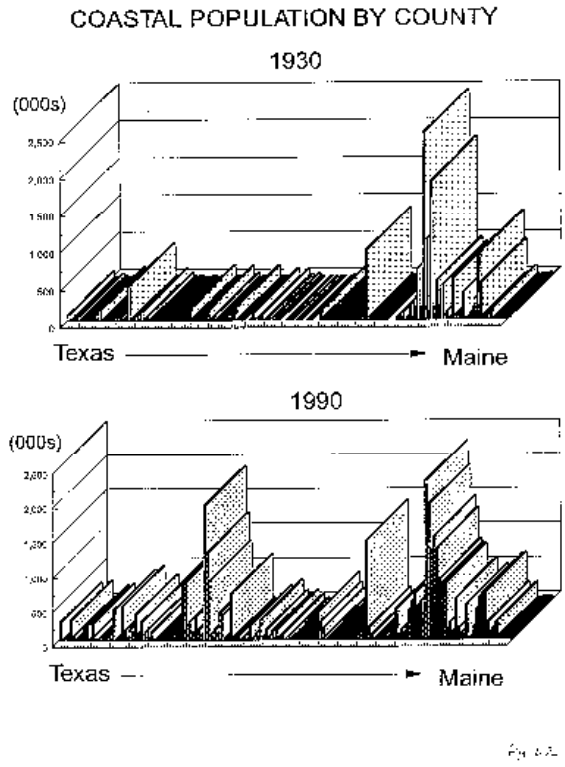



**Figure 1.2**
Coastal Population by County

Source: U. S. Census. Discussed in: Pielke, Jr., R. A. and R. A. Pielke, Sr. 1997 (in press). Hurricanes: their nature and impacts on society, John Wiley & Sons: London.

### Changing demographics

Factors such as aging, poverty and race place large sectors of the population at risk.

### Increased interdependence

Globalization of the economy and international trade considerably broaden the geographic effects and reach of natural disasters.

**Changing values**

What some see as a cultural return to individualism may cause people to take more responsibility for themselves, which may make them more aware of hazards and accepting of their role in avoiding them. This trend is coupled with, and related to, that of increasing environmental awareness, as well as what may be a trend towards increasingly decentralized political authority and power.

## Technological Trends

**Increased understanding**

This is coming about through detailed, synoptic and repetitive observations from space which make it possible to detect and map environmental and cultural change, as well as through the acquisition of other data which are used to improve our understanding of processes and to help model natural phenomena.

Detailed, synoptic and repetitive observations from space make it possible to detect and map environmental and cultural change.

**Improved analytical methods**

These are making it possible to model and understand complex natural and social systems and their interactions by using high performance computation and systems models.

**Enhanced communication**

In order to be of use, both observational and analytical results must be deliverable in a timely, convenient and comprehensible form. Advancing techniques for visualization of these products as well as techniques for their prompt delivery as directly-usable products are making this possible.

**Advanced engineering practices**

Improved understanding of the susceptibility of materials and structures coupled with the development of new engineering approaches and designs can decrease disaster losses.

**Increased reliance on technology**

Technology is often particularly sensitive and vulnerable to disasters. Furthermore, the increasing dependence of society on a variety of interdependent technologies including electric power systems, computer systems, telephone networks, etc., often greatly magnifies the effects of disasters.

## Environmental Trends

**Short-term climate change**

At the seasonal to interannual scale, climate change associated with changes in ocean temperature and currents has been demonstrated to be a significant factor in drought and flooding. The question of the relationship between climate change (at any scale) and the frequency and intensity of tropical storms bears further study.

**Global Change**

We have come to consider the Earth as a system of interacting and interdependent spheres (atmosphere, biosphere, lithosphere, and hydrosphere). It is also now recognized that human beings are an important component of this system. With the growth and concentration of the world's human population and its increased reliance on, and use of, technology, it has become apparent that humanity itself constitutes a major environmental force.

Resources once considered "renewable" resources can indeed become limited when put to the stress of over-utilization. Thus, fertile soils, which may take tens of thousands of years to develop, are wasted through overuse and erosion. Aquifer levels are depleted and rivers dammed and diverted to supply water for human use. Trees and fish are harvested at unsustainable rates.

The range of human impacts on the Earth system includes: changes in the nitrogen cycle, depletion of stratospheric ozone and a resulting increase in ultraviolet radiation at the planet's surface, an increase in tropospheric ozone and other pollutants, human appropriation of a large fraction of the Earth's net primary production and of its fresh water, large scale deforestation, species extinctions, and a reduction in biological diversity.

It is feared that anthropogenic "greenhouse gases" emitted into the atmosphere may be causing the climate to warm and that some of the effects of this warming could be to increase the frequency of droughts and extreme climatic events as well as coastal inundation due to sea level rise. Questions regarding the detection and attribution of such changes are being addressed in one of the most intense scientific efforts in the world today.

With the growth and concentration of the world's human population and its increased reliance on, and use of, technology, it has become apparent that humanity itself constitutes a major environmental force.

Natural disasters are generally thought to represent the adverse effects of rampaging nature on humanity. A global view of the Earth system indicates that the opposite may be true, at least to a significant degree; humanity can have serious adverse effects on its environment. An important corollary of this view is that survival lies in the ability of our species to understand the Earth system and to adapt to its environment without unduly or irrevocably damaging it.


Northridge earthquake, California, 1994. FEMA photo.

See Side Bar: William Hooke: On the relationship between natural hazards and global change

**Summary**

Absent detailed study and analysis, we can only approximate the financial losses resulting from disasters, but it is clear that these represent a major factor even to the resilient economy of the United States. In countries with less robust economies, disasters can and do have severe effects on sustainable development, making these countries more dependent on external aid and vulnerable to social unrest.

The pronounced trend in the developed countries, in recent years, to decreased loss of life due to natural disasters provides encouraging evidence that, while society cannot control natural hazards, it is able to control some of their more disastrous effects. However, societal and natural trends will inexorably result in even greater economic losses in the future unless we, as a nation, and as a world of nations, take steps to mitigate hazards' disastrous effects.

Survival lies in the ability of our species to understand the Earth system and to adapt to its environment without unduly or irrevocably damaging it.

This will require the combined forces of technological development and social change, carried out against the backdrop of complex systems analysis. It will require interdisciplinary discussion and understanding among specialists from wide-ranging disciplines and various sectors of the social and political structure. It will require commitment as well as the assignment and acceptance of responsibilities for coordinated action by governments at various levels, by business and by communities.

Recent sharp increases in economic losses will be merely warnings of huge losses in the future if we continue to ignore the risks. Even more menacing is the possibility that the adverse trends, if ignored, will result in increased loss of life. The continued personal safety and economic security of future generations will depend on actions taken in the present time. The decisions we make now with respect to land use and construction will determine the vulnerability of future societies.

"...the time has come to mount a nationwide effort focused on reducing the impact of disasters as well as reducing the economic consequences." President Bill Clinton, December 6, 1995

See Side Bar: Joanne Nigg: On the social process of adopting technology

# William Hooke

## On the relationship between natural hazards and global change

Much of the climate data we have today comes from natural hazard monitoring over the past century. The costs of observing systems for global change studies are heavily front-end loaded, while benefits can be realized only after many years. By upgrading our present hazard monitoring networks, we can provide a stream of benefits, completely transforming the cost-benefit equation.

Because we have only one Earth, global change presents the need to make policy decisions right the first time. Yet we are a species that learns only from practice; we can't even cook an egg right the first time. Myriad natural disaster scenarios worldwide represent the global change challenge in microcosm. A floodplain facing repeated inundations, an urban area atop a seismically active fault zone, an agricultural belt facing interannual variability each includes the mix of natural threat, varied impacts, and complex social dimensions that mirror the global change problem. The same physical threats in urban and rural settings, and in a diversity of cultural settings provide literally thousands of scenarios worldwide. The relatively high frequency of natural hazards and the wide variety of scenarios mean that opportunities for trial and error, learning from experience, and testing of hypotheses are virtually unlimited.

Since there are winners and losers in every global change scenario, these issues tend to polarize nations, especially driving a wedge between developed and developing nations. One sore point is that the "haves" also have more data and expertise regarding the causes and likely outcomes of global changes than the "have-nots." Natural hazards, on the other hand, can bring nations together, and sharing data and expertise on natural disaster reduction can help to reduce divisiveness.

If the nations of the world devote the next few decades to building up local resilience to natural extremes, we would likely find that we had built up worldwide resilience to small changes in the global averages.

# Joanne Nigg

## On the Social Process of Adopting Technology

From a community perspective, reducing the impacts of disasters is not a technical problem, it is a social one. Local governments have the primary responsibility and authority to establish land use policies to restrict development in hazardous areas, to enact building codes to lessen the extent to which the built environment is vulnerable to disaster impacts, and to improve preparedness planning and disaster impacts. The perceptions about the risks associated with local hazards, understandings about what can or should be done to reduce their impacts, the availability of existing resources special expertise, adequate personnel, accessible technology, and financial revenues all have implications for the approaches communities take in making decisions about the management of risks to which they are exposed.

While there are many existing technologies that promise exciting new possibilities for monitoring hazards and for managing disasters remote sensing, satellite communications, radar systems, decision support systems, to name a few we should not forget that these are only tools. For tools to be adopted and effectively used, they need to be integrated into existing organizational structures and occupational repertoires of those people who are intended to operate them. Currently, many of these technologies do not have any linkages to existing programs within the majority of local communities that can make use of them.

We should not assume that these technologies will be automatically utilized once local communities are made aware of them. Change in organizational structure and culture occurs slowly in non-crisis times. In order to improve the likelihood of adoption of these technologies and their products, it will be important to develop mechanisms that will translate the information deriving from these innovations into messages and procedures that can be used by local governments to understand the nature of the hazards and the imminence of their risk and vulnerability. In many cases, resistance to the adoption of innovation occurs because the meaning of the new information is ambiguous, the expertise required to use the technology (both hardware and software) does not reside in an existing organizational unit, and the programmatic implications of the resulting information for disaster reduction efforts is unclear. Careful consideration must be given to the operational systems that may eventually use these technologies, because their adoption will be dependent on the ease of their social utility to the local community rather than on their technological sophistication.

# III. Elements of Natural Disaster Reduction

Humanity lives with nature. Seldom able to control it, we must learn to adapt to nature's variability. As increasing population and population density stretch nature's resources to their limits, and as the systems we rely upon become more elaborate and interdependent, humanity becomes increasingly vulnerable to extreme and sudden changes. The attempt to control this vulnerability and our reaction to the failure to control it are embodied in an activity which may be termed "disaster management." This complex enterprise comprises many different functions, organizations and disciplines.

Mitigation is defined as "any sustained action taken to reduce or eliminate long-term risk to human life and property." Mitigation is the backbone of disaster management.

## Disaster Management Functions

### Mitigation

Mitigation is defined as "any sustained action taken to reduce or eliminate long-term risk to human life and property." Mitigation is the backbone of disaster management for it comprises the mechanisms by which societies can avoid the effects of potential disasters. These actions can focus on averting disasters, particularly by avoiding the placement of people and structures in hazardous areas. They may also be attempts to control hazards through various specialized constructions and construction practices. Both of these types of mitigation measures require knowledge of the hazard risk the probability of occurrence of a hazard. For example, Figures 1.3 a, Figure 1.3 b, and Figure 1.3 c map the risks of floods, earthquakes and storm surges in the United States. Knowledge of the vulnerability of existing or planned structures and habitats is also needed in order to adequately mitigate disasters.

### Preparedness

It is, of course, unlikely (or, in the extreme, uneconomical) to protect society from all hazards, so it must be prepared for nature's extreme events. Preparedness includes actions which warn of impending disasters, as well as measures such as stockpiling supplies or designating emergency evacuation routes, by which the disastrous effects can be lessened or even avoided.

### Relief

Disaster relief is the most obvious and dramatic component of disaster management but it can also be considered to represent the failure of mitigation and preparedness. For many, it is considered the only element of disaster management. This has led to a focus on relief efforts and the expenditure of vast resources in ameliorating the effects of disasters, thus drawing attention and funding away from mitigation. While relief is certainly a necessary and profoundly humanitarian activity, there is general agreement among practitioners that truly effective disaster management lies in the development and implementation of mitigation measures.

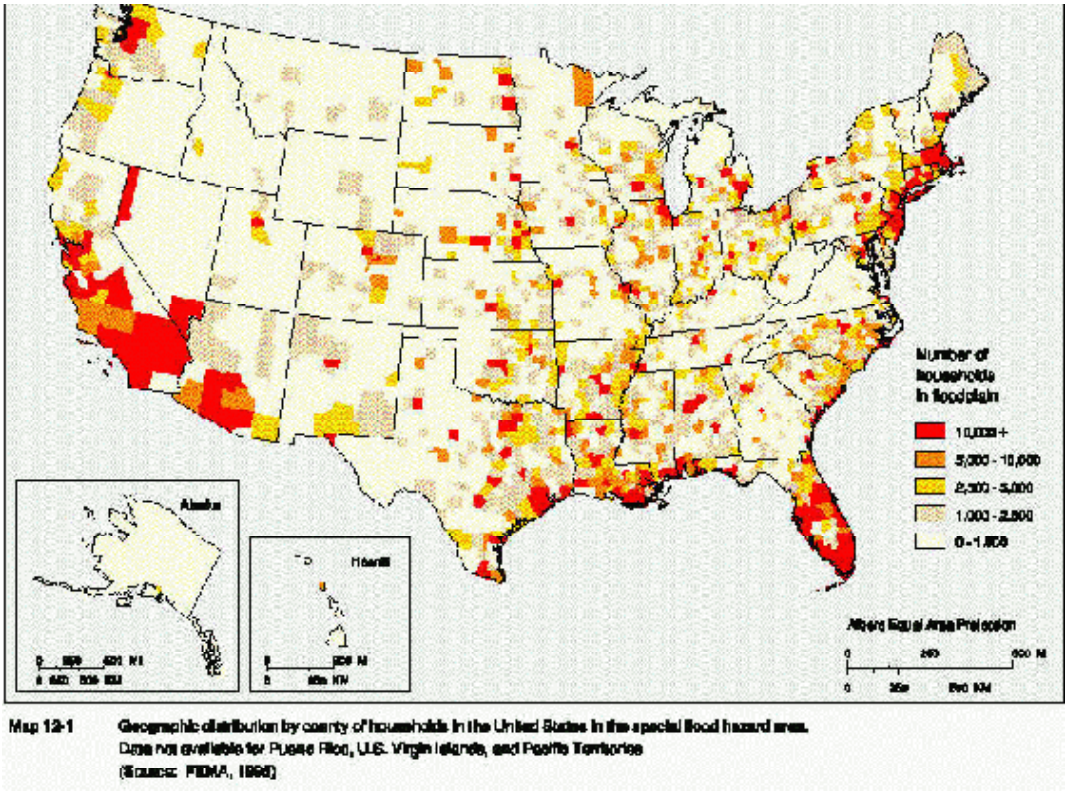



**Figure 1.3a**
Risk of Flooding in the U. S.
Geographic distribution by county of households in the U. S. in the special flood hazard area.
Source: FEMA, 1996

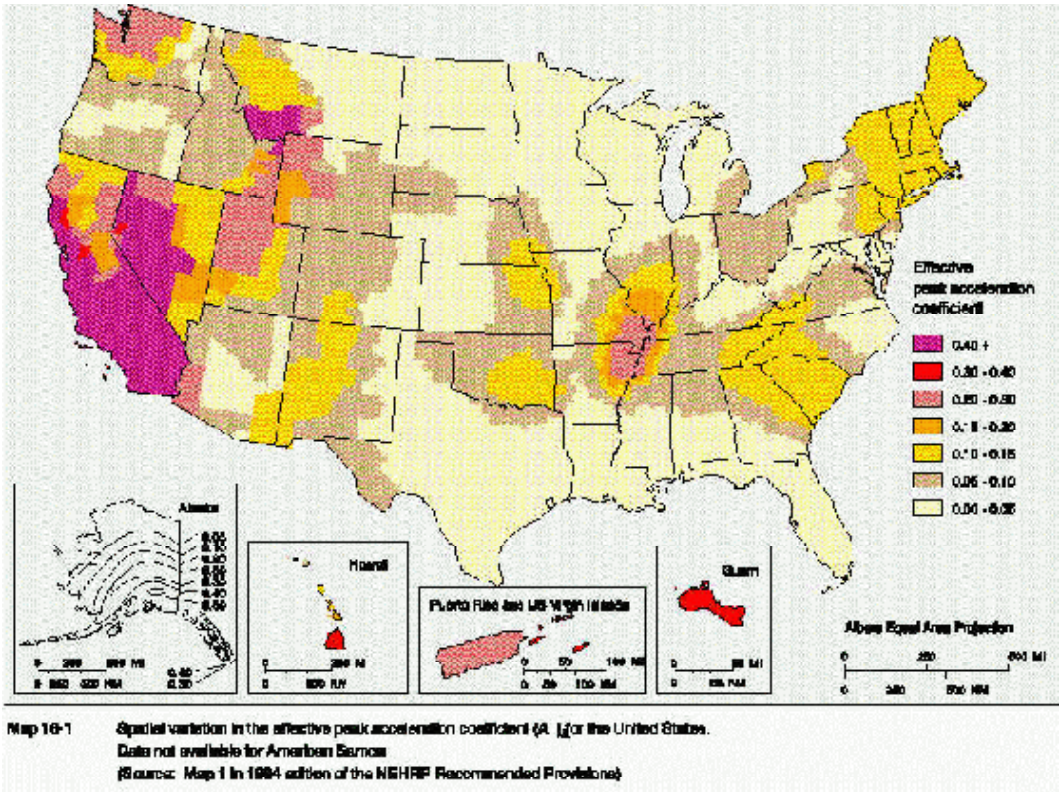



**Figure 1.3b**
Risk of Seismic Activity in the U. S
Spatial variation in the effective peak acceleration coefficient for the U. S.
Source: Map 1, 1994 Edition of the NEHRP Recommended Provisions.

Mitigation measures require knowledge of the hazard risk the probability of occurrence of a hazard.

Preparedness includes actions which warn of impending disasters, as well as measures such as stockpiling supplies or designating emergency evacuation routes, by which the disastrous effects can be lessened or even avoided.

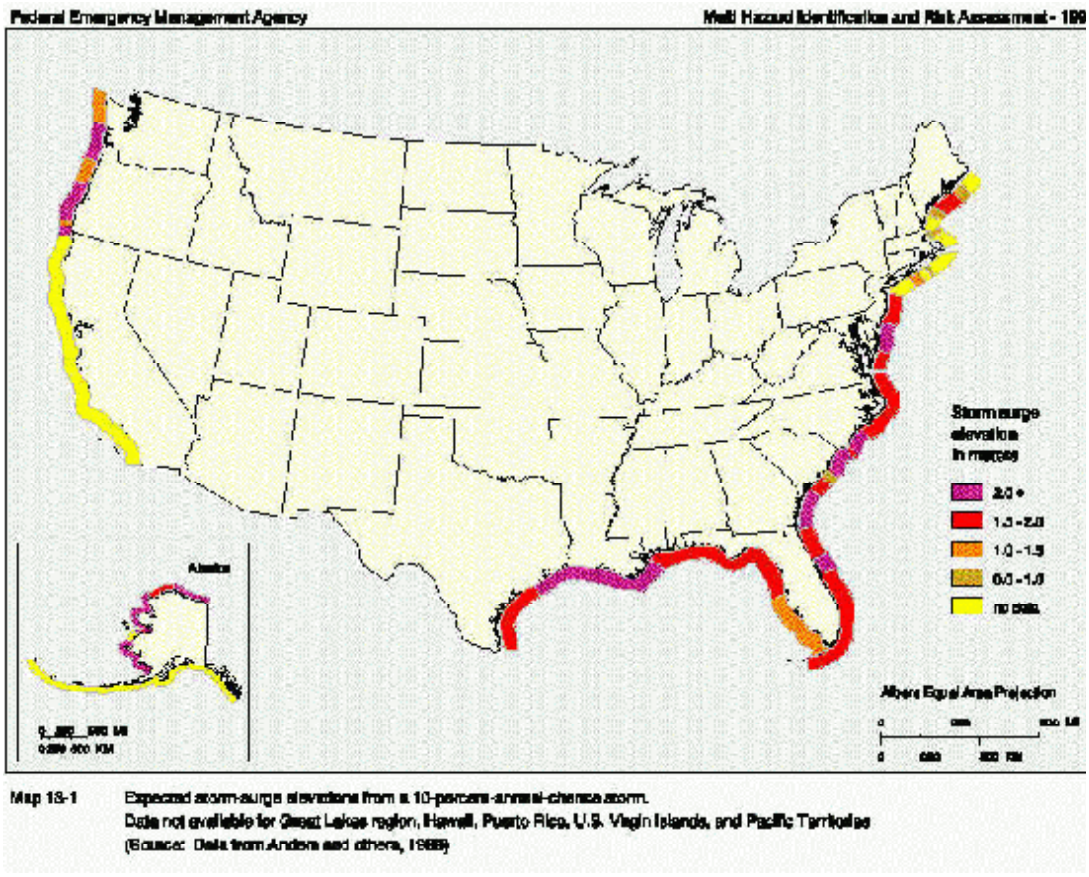



**Figure 1.3c**
Risk of Storm Surges in the U. S.
Expected storm surge elevation from a 10-percent-annual-chance storm.
Source: Data from Andera and others, 1989. FEMA map.

**Recovery**

After the occurrence of a disaster, and the delivery of immediate relief, there will generally be a period of recovery including reconstruction of destroyed or damaged structures. Properly implemented, this will include assessment of the causes of the disaster and, in that light, design and implementation of remedial (mitigation) measures so that future occurrences can be avoided, or at least, the effects minimized.

**Organizations**

The organizations concerned with disaster management are as varied and numerous as the aspects and scale of the subject. They include government agencies, voluntary and academic organizations, business enterprises, and other private sector organizations.

Within the federal government, the Federal Emergency Management Agency (FEMA) has the major responsibility for disaster management. For federally-declared emergencies, it is mandated to draw upon the capabilities of other federal agencies. FEMA has recently focused attention on crafting its National Mitigation Strategy and is now beginning to implement this strategy. Other federal agencies provide operational capabilities in areas such as weather (National Oceanic and Atmospheric Administration, NOAA) and geological (U. S. Geological Survey, USGS) hazards and safe building construction (National Institute of Standards and

Technology, NIST) as well as in research (National Science Foundation, NSF and National Aeronautics and Space Administration, NASA). NASA, NOAA and other federal agencies are also involved in longer term climate forecasting, including snow cover and snow melt forecasts, seasonal drought forecasts and the tracking of such phenomena as El Niño/Southern Oscillation. The Department of Defense, especially through the Army Corps of Engineers and the National Guard, is often involved in disaster response.

**FEMA photo.**

Disaster relief is the most obvious and dramatic component of disaster management but it can also be considered to represent the failure of mitigation and preparedness.

Most states have disaster response or emergency services organizations which have widely different capabilities, organizational positions, and responsibilities. It is at the local governmental level, however, that major disaster management responsibility lies, particularly for mitigation. Of course, the first line of defense for relief lies with the local fire, police and emergency management officials but, for major disasters, this is augmented by personnel and equipment from other echelons. In general, land use and zoning is a prerogative which is strongly guarded by local governments which do not have the resources to generate state-of-the-art risk and vulnerability maps. They must consequently look to state and federal governments for this information which is not always provided at a scale commensurate with the needs of local communities.

Academic institutions play an important role in education, training and research and there are several academic centers and institutes that focus on hazards and disaster studies. Industry plays several direct roles in disaster management. The insurance and banking industries form a key component in disaster mitigation since they cover much of the financial burden of disasters. Further, corporations both large and small have begun to recognize that it is to their advantage to mitigate disastrous effects on their business and employees. Finally, there is a significant enterprise of concerns associated with supplying goods and services for disaster management activities.

**Disciplines**

The variety of occupations and disciplines engaged in disaster management is as broad as the variety of functions served by disaster management. It is not necessary here to describe this in detail but an outline is useful to place into context the discussions and recommendations which follow and in order to understand why questions of disaster management can and must be considered from several perspectives.

Disaster management practitioners can be defined as personnel whose main occupation lies with the implementation of disaster management functions. Thus, the first line of defense during a disaster generally lies with emergency response personnel: fire and rescue, police and medical units and, for larger-scale emergencies, with military units of the state and federal governments. For disaster preparedness and mitigation, immediate responsibility lies with planning officials at various government levels. The work of these practitioners is supported by the efforts of various academic disciplines, businesses, engineering, and the physical and social sciences.

It is at the local governmental level that major disaster management responsibility lies, particularly for mitigation.

The communal response to an existing or potential disaster has, for some time, interested social scientists who have explored the behavior of groups confronted by natural hazards. Sociologists have studied the nature of disaster preparedness and response. Land-use planners, geographers, political scientists and economists consider land use patterns, and political and economic aspects of hazards. On the other hand, physical scientists focus on the hazards in attempts to understand and predict them or at least to identify geographically vulnerable areas. Among the things engineering researchers are concerned with is the performance of buildings and other structures in the face of natural disasters.

Sandbagging during 1993 Midwest floods. FEMA photo by Andrea Booker.

Sandbagging during 1993 Midwest floods. FEMA photo by Andrea Booker.

Unfortunately, social and physical scientists rarely have the opportunity, or have taken the opportunity to work together toward improved disaster management. By their very nature, disasters are a collision of social and physical systems. Improved disaster management requires both improved understanding of the physical system and improved capability of dealing with the social system. This is the fundamental theme of the International Decade for Natural Disaster Reduction.

An opportunity also exists to bring together the goal of community resilience to natural disasters and the goal of worldwide resilience to global change, both gradual and rapid. The goal of sustainability is also concordant with these goals. In short, a society which has worked to become sustainable and resilient to natural disasters will also likely be resilient to global change in its many forms.

See Side Bar: Oscar Huh: On natural disasters and coastal communities

Disasters are a collision of social and physical systems. Improved disaster management requires both improved understanding of the physical system and improved capability of dealing with the social system.

# Oscar Huh

## On natural disasters and coastal communities

An estimated 50 percent of the world's population lives along the coastal fringe of the land masses and this is expected to increase to 75 percent in the next century. A progressive increase in coastal environmental hazards is due to:

1 a population explosion of new residents and visitors, uninitiated to the realities of coastal environments, particularly the infrequent but catastrophic disasters;

2 deterioration of natural environmental buffers: erosion of dunes and beaches, collapses of cliffs, and depletion of fresh water aquifers;

3 expanding organic and pollution loading of the environment, particularly air and water, as a consequence of high density living and an industrial culture.

The global warming trend, and the expected continuation of rising sea levels that come with it, promises to exacerbate the problems of coastal communities. Sea level rise will have considerable impact on people, coastal structures, socio-economic systems, and ecosystems, especially in low -lying coastal areas already subject to erosion and subsidence. Millions of people, in particular those in developing nations with the least developed technologies and sometimes a total lack of financial resources will face a serious threat from rising sea levels.

Of all inhabited coastal environments around the globe, coastal wetlands and barrier islands are most vulnerable. Of particular concern are the developments on the great delta complexes of the world, including the Nile, Yangtze, Yellow, Mississippi, Ganges, Indus, Volga, and Irrawaddy. Architecturally, deltas are complex and fragile assemblages of marshy wetlands, barrier islands, shoals, channels, swamps, estuaries, river mouth bars, tidal flats, tidal ridges, bays, and natural levees. Many deltas are the sites of major coastal cities and are particularly subject to natural disasters including floods from the landward side and storm surges, extreme wave action and storm winds from the seaward side.

Land use zoning is critical, and should be based on environmental realities. For example, barrier islands, which may metaphorically be considered slow or episodically flowing rivers of sand, are quite unsuitable for permanent dwellings and should be zoned "no development" or "disposable development," with the economic or private enterprise charged with self maintenance and damage recovery without public support.

# IV. Vision and Priorities for Action

**Hurricane Fran damage at Topsail Island, NC, September 1996. FEMA photo.**

We simply cannot afford the high costs of unmitigated disasters and still achieve our national goals of debt reduction, adequate health care, full employment, and economic growth.

In order to understand the context of the actions proposed by the workshop, it is necessary to understand the participants' vision of our future attitude, approach and response to disasters. The elements of this vision, as stated below, might be considered as goals which we hope to reach. They are based on the fundamental precept that effective disaster reduction will require strong leadership by governments and the private sector stimulated by citizens' and communities' intolerance for the mounting losses caused by disasters. In this context, the workshop agreed on the following statement of Principle:

"Our society must reduce the needless costs and loss of life resulting from natural disasters. We simply cannot afford the high costs of unmitigated disasters and still achieve our national goals of debt reduction, adequate health care, full employment, and economic growth. We therefore call upon the President, Congress, and state, local, and private sector leaders to serve the people by taking a leadership role in natural disaster reduction."

Based on this Principle, we have the following vision of the future:

- The President and the Nation reaffirm their commitment to the National Mitigation Strategy by focusing attention and energy on natural disasters.

We call upon the President, Congress, and state, local, and private sector leaders to serve the people by taking a leadership role in natural disaster reduction.

• We will develop a coherent approach and policy toward natural disaster reduction, adopting a systems approach, comprehen -sively considering all aspects of natural disaster reduction.

• We will support crucial elements of natural disaster reduction such as the:

  • National Mitigation Strategy

  • Subcommittee for Natural Disaster Reduction

  • U. S. Global Change Research Program

  • Second Assessment of Research and Applications on Natural Hazards (the second comprehensive effort to assess our ability to combat natural disasters, undertaken by the Hazards Center of the University of Colorado and funded by the National Science Foundation; the first assessment was performed a decade ago)

  • International Decade for Natural Disaster Reduction

• We will take every opportunity to instill the importance and merits of natural disaster reduction and sustainable development in children and young people, as well as the general public, throughout the world.

• In assessing risk and developing mitigation strategies and programs in local communities, states and the nation, appropriate attention will be given to inclusiveness and equity.

• We will more effectively bring technological advances to bear on the task of natural disaster reduction. In particular, we will apply new and rapidly developing technologies for information acquisition, storage and dissemination, and encourage the availability and use of capabilities provided by classified satellite observing systems (those used by intelligence agencies).

• We will bridge the gap between research and practice through evaluation of the applicability of existing knowledge and technologies and the formation of applications programs.

• As a nation, as states, as local communities, as private industry and labor, and as citizens, we will make informed decisions regarding risk inherent in our lives, taking into account the future projections of trends.

• Individuals, organizations, and governments will accept responsibility for mitigating natural disasters by making land use and construction decisions which adequately incorporate natural hazard risk management.

• At the local level, we will encourage making decisions and taking actions which consider the long-term consequences of community development with regard to land use and zoning codes. We encourage a long-term view of consequences which often concern the vulnerability of infrastructure to future hazards.

• At the national level, we will develop, provide and evaluate tools and information for risk and hazard assessment at various scales, and for aggregating risks and vulnerabilities from a national viewpoint.

• We will build on the opportunities provided by the increased global concern about and importance of natural disaster reduction, applying what we have learned and implemented in this country, as appropriate, to other nations of the world. We will seize bilateral and multilateral opportunities to make a safer world and increase cooperation and trust among nations.

See Side Bar: William Anderson: On the underserved in natural disaster reduction

We encourage a long-term view of consequences which often concern the vulnerability of infastructure to future hazards.

# William Anderson

## On the underserved in natural disaster reduction

The poor and people of color, especially minority women, are underserved when it comes to society's ability to make resources available for mitigating, preparing for, and recovering from hurricanes, earthquakes, and other natural disasters. Members of these groups are generally at greater risk to disasters, and have fewer resources with which to respond to and recover from them. For example, they are more likely to live in the most vulnerable areas of a community, as was the case in San Francisco where most of the housing units declared unsafe following the 1989 Loma Prieta earthquake were low-cost units.

The underserved are also less likely to have the kind of insurance coverage, savings and employment status that would facilitate recovery from disaster. Additionally, research suggests that their marginality makes it difficult for them to successfully negotiate the disaster relief and recovery system that evolves to assist victims following disasters in the U. S. They also comprise a large percentage of the population in large urban centers, which are particularly vulnerable to natural disasters due to the concentration of people and infrastructure.

A number of actions could help to empower the underserved and link them to the natural disaster reduction subculture. First, efforts could be made to bring the underserved into the research professions relevant to natural disaster reduction, including engineering, the physical sciences and the social sciences. Presently, women and minorities represent a relatively untapped resource in these fields.

Second, more research is needed on the special problems natural hazards and disasters pose for the underserved. Among other things, social scientists should systematically study the barriers to greater involvement of the poor and minorities in natural disaster reduction. For example, it should be determined to what extent barriers are based on factors related to information, income and social stratification. Also, relevant research into the physical sciences and engineering is needed, including studies that can provide the requisite knowledge base for the design and construction of economical, disaster-resistant housing for low income groups.

Third, in addition to the research field, minorities and women need to be recruited in large numbers into those professions, such as engineering, urban planning and emergency management that apply research results to solve natural hazards problems. The importance of increasing the number of practitioners in these fields from underrepresented groups is that they might become champions of hazard reduction actions in the poor and minority segments of the population as well as the larger community.

# V. Thematic Framework

# 1. Citizens

### The Challenge

Citizens have a major stake in the development of disaster resistant communities, and it is almost inconceivable that such communities could come about without the active participation of citizens in disaster mitigation and preparedness activities. Thus, while federal agencies have a major role in natural disaster reduction, goals can be most effectively achieved when these agencies work in partnership with groups of citizens and other sectors of society. The need for such forms of collaboration is reinforced by the democratic values espoused in the United States.

Too often, however, the potential for the involvement of citizens in natural disaster reduction is overlooked, putting the goal of achieving safer communities further out of reach in spite of the often impressive technological advances made in the scientific community and employed by federal agencies. Thus, a major commitment is needed to challenge citizens to increase their involvement in disaster mitigation efforts at the community, state and national levels that would complement the efforts undertaken by agencies and hazard mitigation specialists.


**Midwest floods of 1993. FEMA photo.**

Citizens have a major stake in the development of disaster resistant communities. A major commitment is needed to challenge citizens to increase their involvement in disaster mitigation efforts.

## The Opportunity

The U. S. is noted for its dynamic citizenry, one which believes, for example, in taking a proactive role in problem solving rather than merely waiting for governmental action. Nowhere is this better exemplified than during the emergency period of disasters, when search and rescue efforts are usually carried out by groups of neighbors and friends before the arrival of experts, and when numerous churches, community action organizations and other voluntary groups and organizations from within and outside the affected region mobilize to provide food, shelter and other disaster services for victims. Such citizen groups have always been a vital resource in the U. S. for responding to disasters.

With effective planning and integration into the "socio-technical system," which includes scientists who provide information and hazard specialists who design mitigation programs, citizens can play a similarly important role in disaster reduction activities. This is most likely to happen when citizens, either as individuals or members of groups, acquire resources, such as timely and understandable information about the nature of natural hazards and how to respond to them, and have an opportunity to influence decisions about hazard mitigation programs in their communities, states or on the national level.

The U. S. is noted for its dynamic citizenry, one which believes, for example, in taking a proactive role in problem solving rather than merely waiting for governmental action.

Citizens become involved in all of the four tasks associated with hazards and disasters: mitigation, preparedness, response, and recovery. However, the emphasis here is on the need for their involvement in natural disaster reduction, i. e., mitigation. Such actions may involve self or household protection such as hazard avoidance, insurance purchase and the adoption of home safety measures, or actions that citizens can take in groups or organizations that benefit the neighborhood, the community or nation, including hazard information dissemination and educational efforts.

**FEMA photo.**

Our vision is that U. S. citizens:

a. will acquire knowledge and understanding about the natural hazards they face;

b. will acquire the requisite organizational and institutional linkages, such as partnerships with professional hazard specialists, for coping with natural hazards; and

c. will take significant steps on a continuing basis to reduce the impacts of natural disasters on their lives and on their households, neighborhoods, and communities. We believe that such actions will complement the efforts of other stakeholders, including those in the scientific community, government, and the private sector, and thus further the development of disaster resistant communities throughout the nation.

Our vision is that U. S. citizens will take significant steps on a continuing basis to reduce the impacts of natural disasters on their lives and on their households, neighborhoods, and communities.

The following recommendations for enhancing citizen involvement in natural disaster reduction are based on several principles:

1. Although at times it may be necessary to create special organizations, one of the most effective ways of involving people in mitigation activities is through existing groups and organizations. Such an approach could facilitate the incorporation of mitigation into the broader concerns of citizens and organizations and result in hazard reduction receiving more sustained attention.

2. Similarly, disseminating educational materials on natural hazards in conjunction with existing, related educational efforts, such as science courses, is often a very effective way of distributing such information. At other times, however, special programs may be needed.

3. In devising mechanisms to increase citizen involvement in natural disaster reduction, primary attention should be given to those regions of the country characterized by relatively high hazard risk and salience.

4. As the future generation, young people are a key resource in advancing citizens' contributions to mitigation. For example, as children learn in their schools about safety and the need for citizen involvement, they become a gateway to their households for such ideas.

5. Given the diversity in our society, special attention needs to be given to equity issues to ensure that no groups remain marginalized with regard to involvement in natural disaster reduction activities. For example, in minority communities, the high credibility of churches and community action organizations make them especially effective in mobilizing citizens around hazard reduction issues.

6. Federal agencies working in the hazards field need to work in closer partnership with citizen groups, enabling their development and nurturing their continuity.

7. Efforts to build citizen participation in natural disaster reduction activities should be a central feature of the National Mitigation Strategy planning process being developed under the leadership of FEMA.

**Recommendations**

1. In areas of high risk, regional organizations should be formed, and existing ones strengthened, that can provide a full range of hazard information dissemination and mitigation planning services to private citizens as well as to schools, government and civic organizations, and private sector groups. This concept is similar to the extension service program operated by the Department of Agriculture. The Southern California Earthquake Preparedness Project (SCEPP) and the Bay Area Regional Earthquake Preparedness Project (BAREPP) are examples of previously successful, but discontinued efforts, while the Central United States Earthquake Consortium (CUSEC) is an example of a continuing effort.

FEMA should take the lead in the development of such regional organizations, but they should be true partnerships in which states and local communities share financial and other obligations with the federal government.

One of the most effective ways of involving people in mitigation activities is through existing groups and organizations.

2. Private citizens should be integrated into the decision making structures of federal, state, and local government organizations involved in natural hazard mitigation in order to make them more effective. This will provide citizens with the opportunity to express their needs and help shape the programs in such organizations, balancing a tendency toward top-down decision making. The California Seismic Safety Commission is a success story of including citizen participation in a decision making body at the state level.

Advisory committees can serve as one of the mechanisms for the involvement of citizens in decision making in hazards-related organizations at all levels of government. At the federal level, FEMA has sought advice from citizens in such a fashion in the past and should be encouraged to continue to do so and to expand such efforts. We also recommend that other relevant federal organizations such as NASA, NOAA, and USGS use this mechanism as part of their outreach to the public and as a way of receiving feedback from the public on the agencies' informational products.

**FEMA's James Lee Witt in the field. FEMA photo.**

3. Outstanding individuals who champion natural hazard mitigation have emerged in many high risk areas in the nation. However, many more such activists are needed to boost natural disaster reduction activities. Several years ago a successful program was developed by USGS, which included holding local and regional workshops and the mentoring of potential citizen activists, that significantly increased the number of such champions for natural hazard reduction throughout the country. Unfortunately, that program is no longer being carried out by USGS due to a lack of funding and changing agency priorities.

The USGS model for developing natural disaster reduction champions was a viable approach and is still needed. We recommend that USGS consider reviving this approach and entering into partnership with community, regional and state groups to create another generation of mitigation champions in high risk areas.

4. There are several public interest groups that have strong ties to local community and state organizations. Such groups include the International City/County Management Association (ICMA), the National Governors Association, the National League of Cities, and the Conference of Mayors. For several years, ICMA has been particularly active in the hazards field, producing documents tailored to the needs of local officials and carrying out other projects to encourage them to consider the challenges of hazard reduction and the significance of the concept of the disaster resistant community. Thus ICMA has significant credibility regarding these issues.

In areas of high risk, regional organizations should be formed, and existing ones strengthened, that can provide a full range of hazard information dissemination and mitigation planning services.

Given their history of involvement with natural disaster issues at the local level, we recommend that ICMA take the lead in developing a coordinated program with other public interest groups to further citizen involvement in natural disaster reduction through such groups as churches, PTAs, neighborhood associations, and community action organizations. Such a program would have the potential for integrating citizen groups and local and state government groups, which make up the constituency of public interest organizations like ICMA, around issues of natural disaster reduction.

5. There is a body of knowledge on the involvement of citizens in pre-disaster and post-disaster activities. However, significant gaps remain in our understanding of such behavior, especially the role played by individual citizens and groups in pre-disaster activities. Thus additional research is needed to provide information that could serve as part of the basis for maximizing the involvement of citizens in natural disaster reduction activities, including those groups that have traditionally tended to be less involved in such activities even though they may have an important stake in their outcome. We recommend that the National Science Foundation give attention to the need for such research efforts.

Private citizens should be integrated into the decision making structures of federal, state, and local government organizations involved in natural hazard mitigation in order to make them more effective.

# V. Thematic Framework

# 2. Technology

**The Challenge**

Many existing technologies and technologies under development have considerable potential for application to natural hazards or disaster -related activities. However, there are limitations and obstacles that can and will limit the use of technology for these purposes. If technology is to be used effectively, it is clear that a "technology push" must be accompanied by a "demand pull." The "technology push/demand pull" theme is discussed in the context of Figure 1.4.

Many existing technologies and technologies under development have considerable potential for application to natural hazards or disaster-related activities.

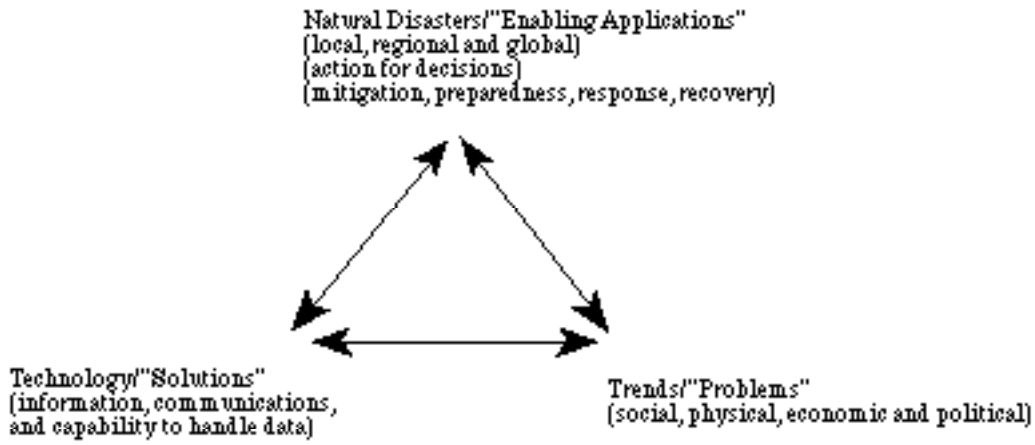



**Figure 1.4**
Technology Push/Demand Pull

The recommendations which follow are aimed at building a better bridge between "demand pull" and "technology push." This means that there should be a "pull" from the end users of technology who have particular needs as well as a "push" from scientists and engineers in academia, private industry and federal agencies who generate technological innovations that they think have relevance to the end user. There must be interaction and dialogue between the developers and the users of technologies.

There should be a "pull" from the end users of technology who have particular needs as well as a "push" from scientists and engineers in academia, private industry and federal agencies who generate technological innovations.

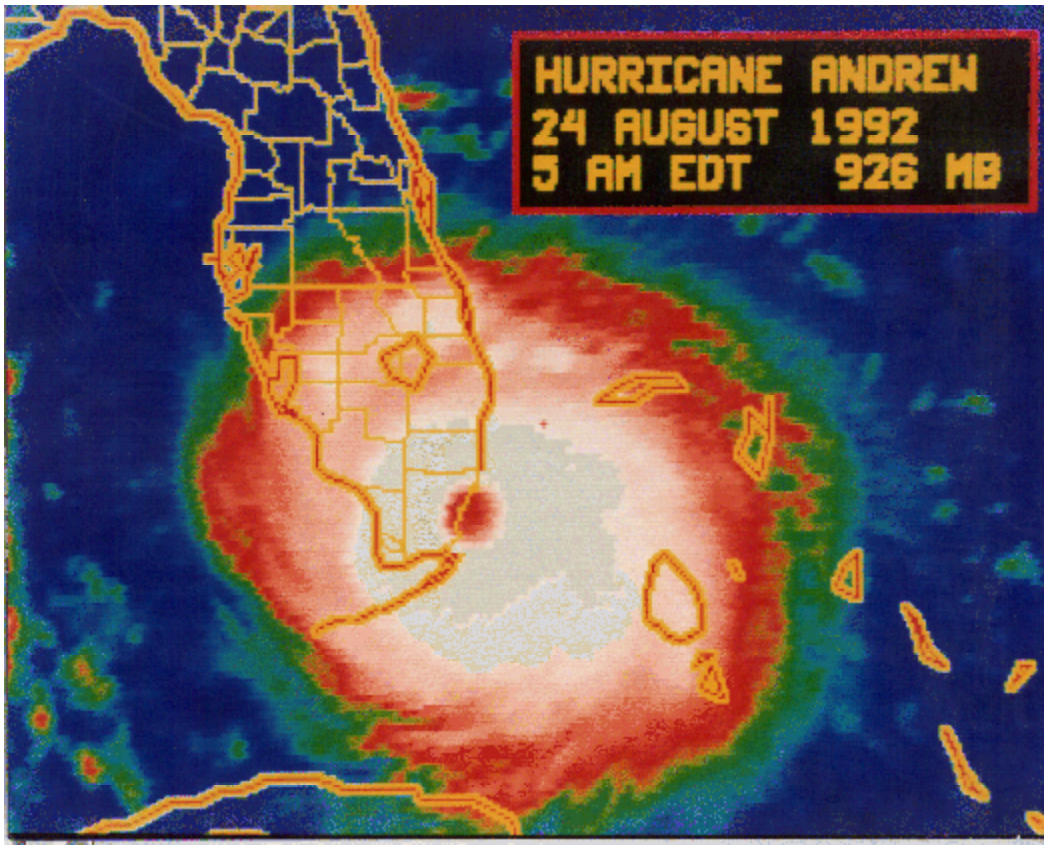
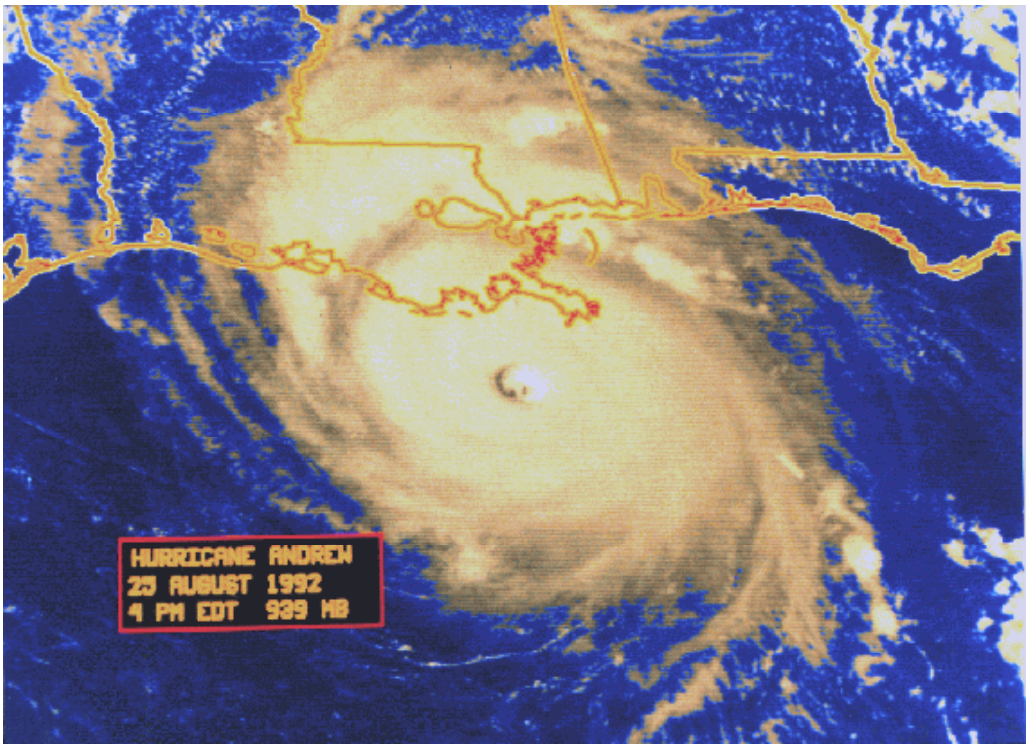



**Figure 1.5**
Caption: As this infrared image of Hurricane Andrew demonstrates, modern remote sensing capabilities help with early warnings that can save lives. However, with more property in harm's way, property damages continue to climb. (National Hurricane Center of NOAA)

**The Opportunity**

For our purposes, "technology" is meant to broadly refer to tools, techniques, and facilities being developed by agencies ( e. g., NASA, NOAA, etc.), academia, and private industry that can possibly be used by operational decision makers such as those in FEMA to improve their understanding of and/or responses to natural hazards. In this report, such technologies are approached as solutions that may be applied to natural hazard administrative activities or to document and interpret problems revealed in appropriate data analyses. Technologies are to be considered as a means to an end and not an end in themselves. Some examples of technologies that are potentially relevant are:

- Communication technologies such as the World Wide Web, search software, cellular telephones, various warning systems, etc.;
- Material science and software for the design and construction of buildings and other structures;




Technologies are to be considered as a means to an end and not an end in themselves.

**Figure 1.6**
Caption: Hurricane Andrew approaching Louisiana. (National Hurricane Center of NOAA)

- Remote sensing technologies such as that associated with NASA satellite and aircraft missions, National Oceanic and Atmospheric Administration (NOAA) satellites and other facilities, Department of Defense (DOD) activities, and private industry (aerospace) efforts;
- Analytical capabilities and tools for data analysis, data set assembly and comparison such as those associated or included in Geographical Information Systems (GIS);
- Data archiving and access technologies such as high density tapes, discs, etc.;
- Modeling of complex systems (e.g. , watersheds, general circulation of the coupled land/ocean/atmosphere systems, social systems, etc.) facilitated by increased computing power available through increasingly powerful personal computers, workstations and other computing systems;
- Global Positioning Systems (GPS);
- Doppler Radar such as that associated with the “Nex-Rad” system operated by NOAA and the total National Weather Service modernization; and
- Low-technology approaches that are too often underutilized such as wind shutters and fasteners applicable in hurricanes.

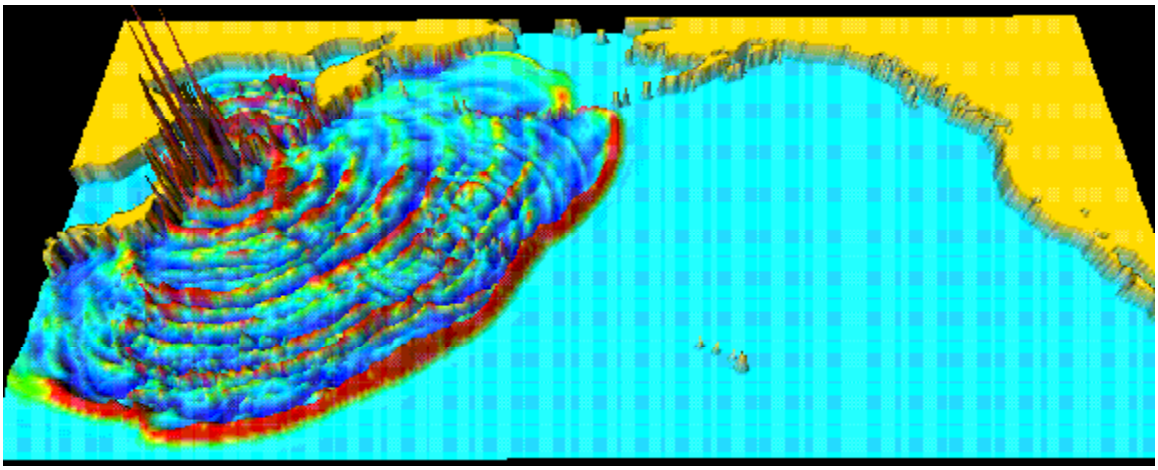


**Figure 1.7**
Caption: Tsunami simulation. (Y. Tanioka, University of Michigan web site)

Our recommendations will help to build a bridge between those having technologies useful for natural hazards and those that could use such technologies if they were more familiar with them and had an opportunity to evaluate their capabilities.

This list is meant to be illustrative, not comprehensive. All relevant research and development agencies and physical and social science groups should be encouraged to continue research on technologies that are applicable to natural hazard activities.

The recommendations that follow will help to build a bridge between those having technologies potentially useful for natural hazards and those that could use such technologies if they were more familiar with them and had an opportunity or environment in which they could evaluate these capabilities. NASA technologies that have been developed in conjunction with their Mission to Planet Earth and the associated U. S. Global Change Research Program are good examples and a good starting place to build these bridges. Pilot or prototype projects are suggested as they are focused efforts that would allow the dialogue between technology developers and users to occur and facilitate the joint and in-depth evaluation in real-life contexts that is needed.

The following matrix (see Figure 1.8) shows the existing or near -term capabilities of remote sensing technologies for several natural hazards and the natural hazard activities that involve various administrative and decision-making activities. Like the examples above, this listing is illustrative, not comprehensive; there are other technologies that should also be evaluated and utilized as appropriate. Focusing, however, on remote sensing technologies almost automatically includes computing, data distribution, data analysis, archiving, and communications technologies. It is also clear that the existence of the remote sensing capabilities, or any other technology for that matter, is not a sufficient condition for effective use by decision makers.

The essence of the approach suggested is to pick a few natural hazards and follow the implementation and eventual evaluation of various technologies for natural hazard mitigation, preparedness, response, and recovery.

| Hazard | Mitigation | Prepardness | Response | Recovery |
|---|---|---|---|---|
| **Earthquake** | SPOT, Clark, Radarsat, Landsat (Culture Mapping tools) | Space-based geodesy, SAR Interferometry | SPOT, Clark, EarlyBird*, Radarsat (Damage Assessment and relief) | SPOT, Clark, EarlyBird*, Radarsat (Culture Mapping) |
| **Floods** | Landsat, EOS-AM, SPOT, Radarsat, ERS-2 (Watershed Conditions) | NOAA, GOES, DMSP (Flood Warnings) | Aircraft SAR**, Radarsat, Clark, EarlyBird*, ERS-2, SPOT, Landsat, EOS-AM (Flood Mapping) | SPOT, Clark, Aircraft Interferometric SAR, EarlyBird*, Radarsat (Culture Mapping) |
| **Hurricanes** | SPOT, Clark, Early-Bird*, Radarsat (Culture Mapping) | NOAA, GOES, DMSP (Hurricane Tracking & Status) | Aircraft SAR**, Radarsat, Clark, EarlyBird*, ERS-2, SPOT, Landsat, EOS-AM (Damage Assessment) | SPOT, Clark, EarlyBird*, Radarsat (Culture Mapping) |
| **Wildfires** | AVHRR, Landsat, EOS-AM, Lewis (Vegetation moisture status) | NOAA, GOES, DMSP (Detection; Climatic data) | EOS-AM, Landsat, Lewis, Clark, SPOT (Fire Mapping) | Clark, SPOT, Landsat, EOS-AM (Burnt Lands Mapping) |
| **Tornadoes** | n.a. | NOAA, GOES, DMSP | Clark, EarltBird*Radarsat, ERS-2, Aircraft SAR** (LandslideMapping) | n.a. (Damage Assessment) |
| **Landslides** | SAR Interferometry, Radarsat, SPOT, Landsat (Susceptible area mapping) | NOAA, GOES, DMSP, EOS-AM (Soil Moisture Modeling) | Clark, EarlyBird*, Radarsat, ERS-2, Aircraft SAR** (Landslide Mapping) | n.a. |
| **Drought** | Landsat (Wide-area landuse) | AVHRR, Landsat, EOS-AM, Lewis, (Vegetation moisture status) | Landsat, SPOT, Lewis, EOS-AM (Crop Damage) | Landsat (Wide-area landuse) |
| **Volcanoes** | SPOT, Clark, Radarsat, Landsat (Culture Mapping tools) | Space-based geodesy, SAR Interferometry (Precursor seismic activity) | TOMS, AVHRR, Landsat, Clark, GOES, SPOT, EOS-AM (Eruption; Damage Observation) | SAR Interferometry, SPOT, Clark, Radarsat (Land Surface Mapping) |
| **Tsunamis** | SPOT, Clark, Radarsat, Landsat (Culture Mapping Tools) | n.a. | Clark, EarlyBird*, SPOT (Damage Assessment) | SPOT, Clark, EarlyBird*, Radarsat (Culture Mapping) |

Notes

* EarlyBird (1 meter resolution) is listed as an example of several commercial sector, high resolution imaging satellites scheduled for launch in 1997 by competing U. S. companies. No endorsement of this satellite is implied.

** Aircraft SAR** is listed because of its present function within NASA as a precursor to satellites in development such as LITESAR

**a** communications technology is excluded

**b** "culture" refers to the built environment

**c** hazards are listed vertically in approximate yearly damage order.

**d** Clark and Lewis are NASA satellites scheduled for launch in 1997.

**e** The European Space Agency will soon Launch Envirsat, an SAR satellite, to replace ERS-2, and NASA is proceeding with plans to launch its own SAR satellite, LITESAR.

**Recommendations**

1. More effectively bring technological advances to bear on the natural disaster reduction task. Evaluate technologies for documenting and interpreting trends and specific problems related to natural hazards.

The intent of this recommendation is to use technology to help establish the bases/trends that lead to the improvement or better focus of natural hazard activities on all levels. In essence, the purpose is to better identify what the real, as opposed to perceived problems are, and to document and interpret these problems as carefully as possible. Prototype or pilot projects that focus on specifics rather than generalities are suggested, so as to obtain detailed insights that would guide more general or widespread applications in the future. The intent is to identify those areas of vulnerability where available resources should be directed in order to expend fiscal and personnel resources most effectively.

Develop or improve complex systems models of physical and social systems so as to more rigorously identify vulnerability and thresholds that would guide the application of natural hazard-related resources.

The recommended activities have a strong research flavor to them, but the proposed research is expected to be part of the process of decision making and is intended to be directed toward facilitating disaster reduction activities. It is suggested that the Subcommittee on Natural Disaster Reduction (SNDR) and the Subcommittee on Global Change Research (SGCR) provide general guidance and coordination for the recommended technologically-related activities.

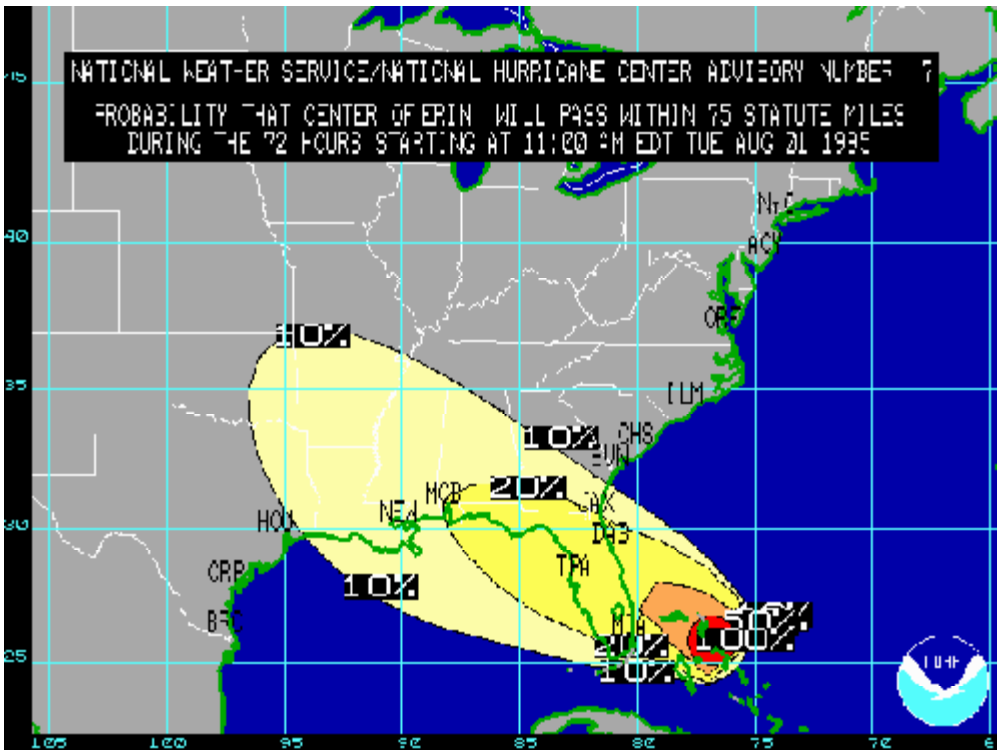



**Figure 1.9**
Caption: Hurricane Erin strike prediction. (NOAA)

- Develop or improve complex systems models of physical and social systems so as to more rigorously identify vulnerability and thresholds that would guide the application of natural hazard -related resources. For example, the resilience of societal lifelines (e. g., highway systems) might be assessed through such models. In this effort,

selected academic participants working with natural hazard agencies such as FEMA, HUD, and USGS should be involved to analyze the trends. The funding should come from R&D agencies (e. g., NASA, NOAA and NSF) with their guidance as to what technologies ( e. g., complex systems models, remote sensing systems, computing and analysis systems) should be employed and evaluated.

- Develop data sets specifically directed toward natural hazard problems utilizing the wealth of data planned for science-related purposes such as that included in the EOSDIS and the national Global Change DIS. In addition, efforts should be implemented to increase the effective use and availability of data from commercial satellite users. One existing example is an inventory of structures in a flood plain basin. The Scientific Assessment and Strategies Team (SAST) focused at the EROS Data Center of the U. S. Department of Interior is a subcommittee of the Federal Interagency Flood Plain Management Task Force focusing on the survey of flood plain conditions in the Upper Mississippi watershed.

- Develop a nationwide data set at a resolution exploiting Landsat, Synthetic Aperture Radar (SAR), and commercial satellite data. This data set should be updated periodically (annually, at minimum) so as to show differences before and after disasters.

The operational agencies should evaluate the utility of the data set and provide at least the "in-kind" resources for this purpose. The R&D agencies (e. g., NASA, NOAA and NSF) should provide funding for facilitators (academia, private industry, government research personnel and resources) to allow the construction of the data sets and associated formatting).

- · Develop real-time capabilities that would feed high-technology data closer to real-time, or near real-time into the decision making process. For instance, the presidential disaster -declaration process might be enhanced with more rapid access to data and other inputs. As in the other recommended actions, the primary support for the development and application of the technology should come from R&D agencies. A selected team of R&D agency personnel, facilitating personnel (academia and private industry), and decision making personnel should be involved. The activity should be illustrative, but probably not comprehensive due to funding limitations.

Develop real-time capabilities that would feed high -technology data closer to real-time, or near real-time into the decision making process.

2. Develop pilot projects related to technology, natural hazards and effectiveness of administrative activities.

This recommendation focuses on the conduct or implementation of pilot or prototype projects that explore the applicability of technology from the point of view of an entity with day-to-day, pragmatic or statutory decision making responsibilities for natural hazard or disaster administration and management. These suggested pilot projects should have the intent and purpose of finding spin-off applications of research and development, or "big science" activities already being conducted by NASA, NOAA, DOD, and private industries such as aerospace. The pilot projects should be focused on natural disasters/hazards that cover a spectrum of hazard types and a variety of different responsible agencies or industries. The hazard types can or should include floods, earthquakes or seismic events, weather-related phenomenon such as tornadoes, and interannual climate change events such as El Niño and related predictive capability for mid-latitude weather occurrences.

Develop data sets specifically directed toward natural hazard problems utilizing the wealth of data planned for science-related purposes such as that included in the EOSDIS and the national Global Change DIS.

The operational/pragmatic entities involved may include the National Centers for Environmental Prediction (NCEP) of NOAA, FEMA, the insurance industry, various state and local governmental agencies, academia, etc. The R&D entities should include NASA, NOAA, and NSF due to their involvement in the national and international global change programs and the fact that there are many technological capabilities being developed therein that have a high potential for application to natural hazard activities. As in the previous recommendation, it is suggested that the SNDR and the SGCR have the responsibility for providing guidance and coordination for the suggested projects. The pilot projects should be implemented and evaluated relative to the four major natural hazard activities: mitigation, preparedness, response, and recovery. Specifically, the pilot projects should include the following:

- A "descriptive" approach should be applied to ascertain what technologies are now being used operationally and with what level of effectiveness.

Homeowners wade to retrieve belongings during 1993 Midwest floods. FEMA photo by Andrea Booker.

- A "prescriptive" approach should be used to evaluate what technologies are not now being used but appear to have high potential for being useful in the context of benefit to cost ratios or increasing cost effectiveness with regard to existing facilities and personnel.

- An effort should made to develop increased public awareness of NHDR-relevant data or capability in NASA, NOAA, and DOD R&D activities.

- Include education, training and developmental activities that make existing technologies (data archives, analysis software, models, etc.) more amenable to use by the appropriate operational users and/or individual citizens. This effort should particularly focus on those technologies shown to be useful in the pilot efforts.

More specifically, and referring to the matrix of technologies provided earlier (see Figure 1.8), it is suggested that an initial set of pilot projects (the number limited primarily by available funding) be conducted for floods, earthquakes, tornadoes, and drought. A brief sketch of each proposed pilot project follows:

The pilot projects should be focused on natural disasters/ hazards that cover a spectrum of hazard types and a variety of different responsible agencies or industries.

Floods-

In this pilot project the technologies to be implemented and evaluated are shown in the matrix. A possible team would include the U. S. Army Corps of Engineers, USGS, FEMA, selected state and local emergency managers (decision makers), NASA and NOAA (R&D), academia (social and physical scientists), and private industry (facilitators). The pilot project would focus on a representative basin such as the Colorado River, Missouri River Basin, Ohio River Basin, or smaller basins, as selected by the decision makers.

Earthquakes-

This project would also use the technologies suggested in the matrix. The team involved might include USGS, FEMA, selected state and local emergency managers, NASA, NSF and selected academic (social and physical scientists) and/or private sector facilitators. Some representative site (most likely in California) would be identified by the decision making/operational agencies.

Tornadoes-

This project should involve NOAA, FEMA and other decision makers (including local and state personnel) working with NASA and NOAA technologies and other personnel such as those suggested above. Given the rapid-response, real-time nature of the preparedness and recovery aspects, the guidance for implementation should come from NOAA.

Drought-

This project involves long-term prediction for mitigation and preparedness activities that use remote sensing technology and coupled ocean/atmosphere/land models. The suggested focus is on the implications for the insurance industry, i. e. , the principal decision making entity is the insurance industry working with appropriate agencies ( e.g., U. S. Department of Agriculture). For the "technology-push" funding, NASA, NOAA and NSF would be involved.

Holistic Pilot Project Focused on Communities-

Rather than focusing specifically on one hazard as in the above, this project would instead choose a community or several communities wherein the utility of technologies would be evaluated in terms of a community being able to mitigate the full range of hazards they might be expected to face. Working with the community might be selected county, state and local agencies along with the R&D entities and social and physical scientists.

These pilot projects should occur in the form of cooperative agreements between the R&D and operational entities wherein there will be a close examination of the decision and operational processes and the effectiveness of technologies when used in these processes. The collaboration or cooperation should involve substantive contributions from both sides, but with the "technology push"/R&D side having the principal responsibility for facilitating the pilot project efforts so as to minimally impact the conduct of operational activities. On the other hand, the operational entities must devote requisite resources and attention to ensure that those technologies shown to be clearly useful in the pilot projects can be implemented as appropriate over the long term. The process requires two-way collaboration.

Include education, training and developmental activities that make existing technologies more amenable to use by the appropriate operational users and/or individual citizens.

3. Inventory Technologies and Their Utilization by Communities and the General Citizenry

In support of the recommendations and actions discussed above, a review should be made of technologies relevant to natural hazards reduction with the view of explaining the availability of these technologies, the status of their development and applicability to natural hazards decision making activities, and the accessibility (along with costs, etc.) of educational and training programs that would enable the general citizenry to use these technologies. This material should be written and widely disseminated. It is suggested that NASA be tasked with this responsibility, and should work with the SNDR and SGCR to obtain their review and guidance.

As a final note, the issue of data cost and how to reduce it should be examined carefully. Experience indicates that this issue often affects many of the considerations involved in the above recommendations.

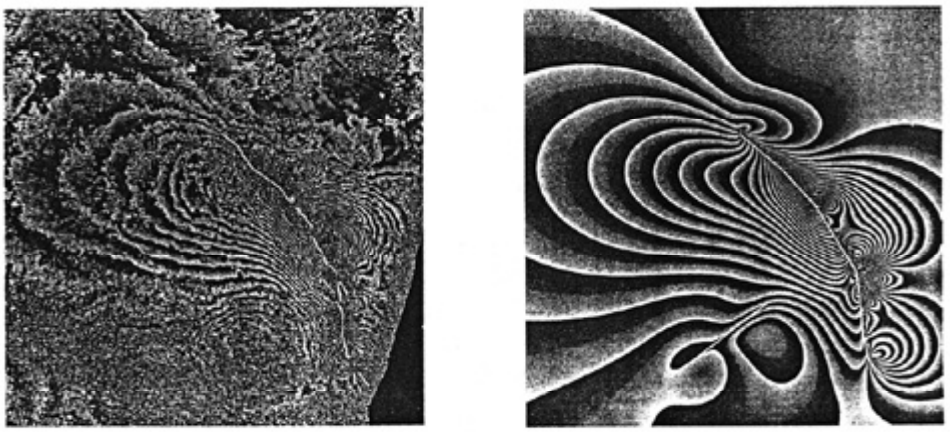


**Figure 1.10**

Caption: An example of technology brought to bear in understanding ground deformation due to seismic activity. The image on the left shows interferometric fringes obtained from a before/after pair of synthetic aperture radar (SAR) images of the 1992 earthquake in Landers, California. The image on the right is a synthetic interferogram from an elastic model by Massonnet et al. as shown at AGCI by Miriam Baltuck in a presentation about the use of remote sensing in natural hazards research. For more on this technique see Massonnet et al., Nature 364:138-141 (1993).

# V. Thematic Framework

## 3. Private Sector

**The Challenge**

The private sector is comprised of thousands of organizations, large and small, which provide goods and services to the American public through commercial or non-profit channels. They range in size from family businesses and neighborhood social service providers to multi - national corporations, international religious denominations and disaster relief organizations.

Private sector organizations are at once victims and resources when disasters strike.

Examples of private sector organizations include:

- Businesses
- Shareholder-owned utilities
- Trade associations
- Labor unions
- Chambers of commerce
- Professional societies
- Community based organizations
- Non-profit disaster service agencies
- Schools and libraries

They are inextricably intertwined with the public sector in creating and protecting regional assets such as:

- The built environment
- Local productivity
- Regional “brand value”
- Legacies such as the natural environment, arts and culture, and R&D

Because of this integration, the impact of natural disasters, technological accidents, or acts of terrorism is felt by all sectors. The resulting breakdown in community systems is manifested as:

- Loss of function (businesses, housing, mobility)
- Loss of value (property damage and devaluation, productivity, tax base)
- Loss of reputation (tourism, business retention, regional financial ratings)
- Loss of economic viability (diversion of funds, jobs, insurability, gross regional product)

Private sector organizations are at once victims and resources when disasters strike. There are laudable cases of independent action among businesses and non-profit organizations in which the impact of natural disasters is being mitigated through corporate or even industry-wide preparedness, employee training, or response planning. However, the disaster management

community has traditionally underestimated both the dysfunction that can result when the private sector is among the victims, and the benefit that could result if private sector resources and capabilities were better integrated with public sector efforts. In turn, the private sector has traditionally underutilized the valuable findings of disaster researchers, the disaster mitigating or hazard monitoring technologies of physical scientists, and opportunities to minimize their losses and liabilities by changing operational practices, materials or training.

These disconnects and dysfunctions may be attributed to any of several reasons. Some of the constraints include:

· Private sector decision makers are often unaware of hazards and vulnerabilities they face.

· They are unaware of the short or long term implications of those risks.

· They are unfamiliar with alternative procedures or options.

· They are familiar with options, but have not yet seen a valid business case for change.

· Natural disaster reduction (NDR) principles have lacked a champion or cohesive leadership to set a new standard.

· Government has misconceptions about the role of businesses in emergencies.

· Legal constraints have blocked efforts of businesses, labor and non-profits to fulfill their potential role in disaster mitigation, preparedness, response, and recovery.

· Technologies have been insufficiently integrated into systems and applications to seem relevant or cost-effective in the minds of decision makers.

We have traditionally underestimated both the dysfunction that can result when the private sector is among the victims, and the benefit that could result if private sector resources and capabilities were better integrated with public sector efforts.

**The Opportunity**

Recent events have brought the issues and costs of unmitigated natural and technological disaster to the attention of private sector managements. These include: the publicity about catastrophic financial losses incurred in recent disasters; the manifestation of these losses in the insurance market; incidents of terrorism in the U. S. and abroad; and the operational impact of distant events such as the Kobe earthquake.

In addition, some disaster-mitigating systems and technologies have successfully entered the market and have begun to prove their effectiveness. These include weather reporting systems, GIS and GPS systems, disaster-resilient building materials and practices, and non -structural household mitigation systems in seismic environments.

In response to the challenges of major urban environments, where lifeline industries and complex technological systems are jeopardized by major dysfunction from natural or technological disasters, local business alliances are now emerging and applying inter-corporate planning processes to reduce the ripple effect of system failure.

Finally, the publication of the National Mitigation Strategy in December 1995 provides a cohesive statement of goals and organizational frameworks for building successful public/ private partnerships on behalf of safer communities. This document has provided several of the integrating principles upon which some of the following recommendations are based.

**Recommendations**

**Land Use**

1. Advocate development of a national policy to identify, define and allocate responsibility associated with any natural hazard risk inherent in the ownership of property. Form a Presidential commission to evaluate and prioritize the options for achieving this goal.

2. A prerequisite to mitigation is the land owner's knowledge of hazards and mitigation opportunities. Land owners should seek, and state and local governments must assure the availability of the most current data on natural hazards. To this end, state and local governments should promote exchange of information from all available public and private sources regarding relevant hazards.

FEMA photo.

Local business alliances are now emerging and applying inter - corporate planning processes to reduce the ripple effect of system failure.

3. Every participant in the land purchase transaction has a responsibility to effectively make known in a timely fashion all natural hazards that exist with regard to a property to enable buyers to make informed decisions and take all necessary steps to reduce risks. Therefore, in all real estate transactions as well as in construction and rehabilitation of structures, local governments should adopt a formal process for the identification and disclosure of hazards analogous to the National Environmental Protection Act (NEPA) process. The federal government should provide an incentive for adoption of such a process through its Federal Disaster Assistance Program. This process should include:

· real estate agents disclosure of all known hazards in offering documents;

· mortgage lenders inclusion of all known hazards in loan documents;

· insurance companies inclusion of all known hazards in policy documents; and

· appropriate local authorities' requirement that the best available hazard information be attached to all property deeds.

**Education**

In all real estate transactions as well as in construction and rehabilitation of structures, local governments should adopt a formal process for the identification and disclosure of hazards.

4. We underscore the importance of public awareness, training and education as described in the National Mitigation Strategy and suggest it also include preparedness, response and recovery. Appropriate related messages should be developed and specifically tailored to decision makers and "influencers" in the private sector including but not limited to:

· executives and decision makers with the ability to decide on and fund activities which promote NDR goals;

· students of the physical, social, business, and technical sciences so that they are able to incorporate NDR goals into their future professional decision making;

· "influencers" with capability to network, including the media, chambers of commerce, labor unions, and trade associations;

· multi-nationals with potential to carry NDR practices/values abroad.

Since mitigation involves preparedness, response and recovery activities, the mission of the National Multi-Hazard Mitigation Council should be expanded to include the development of education and information programs to meet the needs of the categories of decision makers described above.

**Utility Role**

5. Private sector "lifeline" organizations that are common to all communities, notably utilities that provide energy, water and communications, should take the leadership role in communicating hazard risks and responsibilities and organize members of the private sector for a collective educational, mitigation and recovery planning effort. National level organizations that represent lifeline industries, such as the Electric Power Research Institute (EPRI), should take the leadership in establishing local/regional coalitions to advance the National Mitigation Strategy and recovery aspects of the federal response plan, with a goal of establishing a demonstration organization within each FEMA region.

**Operational practices**

6. There are many ways in which individual organizations and coalitions can advance NDR goals. These practices should include:

· Mitigating risks within the internal operations of companies;

· Ceasing, minimizing or mitigating activities that pose or aggravate risks to others;

· Taking part in and supporting regional and national coalitions fostering inter-organizational disaster mitigation programs;

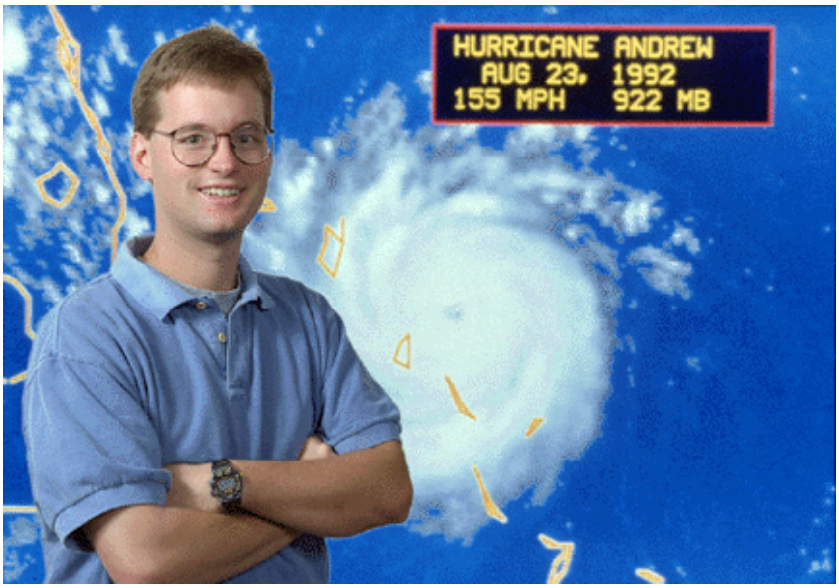
· Responding to market needs to provide goods and services that foster disaster mitigation and preparation.

Regional organizations should identify and acknowledge best practices. Best practices should be submitted to the National Multi -Hazard Mitigation Council for consideration for national awards and then disseminated through the educational programs recommended above.

7. Professional associations comprise an important resource to further natural disaster reduction. Such associations include American Society of Civil Engineers, Earthquakes Engineering Research Institute (EERI), the Seismological Society of America, and the Research Committee on Disaster of the International Seismological Association. EERI should take the lead in forming a national coalition to develop coordinated programs for hazards research, hazards reduction practice, and hazards policy.

See Side Bar: Roger A. Pielke, Jr.: On assessing societal exposure to hurricanes Roger A. Pielke, Jr.

"Lifeline" utilities should take the leadership role in communicating hazard risks and responsibilities and organize members of the private sector for a collective educational, mitigation and recovery planning effort.




Roger A. Pielke, Jr.

# On assessing societal exposure to hurricanes

In recent decades, hurricane damages in the United States have risen while the frequency of storms in the Atlantic has decreased. This implies that the level of societal preparedness has become a more important factor in our vulnerability. Consequently, it is of utmost importance to develop skills in assessment of societal exposure, if we are to effectively identify actions that can be taken to reduce that exposure.

In 1992, Hurricane Andrew served as a dramatic assessment of Dade County's level of exposure to hurricane winds. While extreme damages occurred as might be expected in areas of greatest wind speed, extreme damages also occurred outside the area of greatest wind speed, which was not expected. With building codes the toughest in the nation, why did Dade County see such extreme damages in unexpected areas? A number of studies found that in spite of the tough codes on the books, implementation and enforcement of the codes was not adequate. Insurance industry estimates suggest that poor compliance with building codes accounted for about 25-40 percent, or about $4-6.5 billion, of the insured losses in south Florida due to Hurricane Andrew.

If we are to identify actions needed to improve a community's preparedness, then we must focus attention on ways of exposing a community's exposure before a hurricane strikes. For example, as explained above, Hurricane Andrew taught the insurance industry that a successful building code was as much a matter of effective implementation (compliance and enforcement) as it was having a strong code on the books. Thus, one insurance group has begun to evaluate building codes according to the level of implementation ( e. g., through enforcement budgets, frequency and quality of inspections) rather than simply through the words of the code.

Since hurricanes cannot be prevented, and since population and property at risk to hurricanes is large and expected to stay that way, there is a need to identify opportunities to improve preparedness. One important way that analysts can lend their particular skills to improving hurricane preparedness is to apply their existing tools and techniques to assess the health of preparedness plans and processes in various locales.

**Figure 1.11**
**Costliest Hurricanes in the U. S. from 1900 to 1996**

| | Hurricane | Year | Category | Damage |
|---|---|---|---|---|
| 1 | ANDREW (SE FL/SE LA) | 1992 | 4 | $26,500,000,000 |
| 2 | HUGO (SC) | 1989 | 4 | $7,000,000,000 |
| 3 | FRAN (NC) | 1996 | 3 | $3,200,000,000 |
| 4 | OPAL (NW FL/AL) | 1995 | 3* | $3,000,000,000 |
| 5 | FREDERIC (AL/MS) | 1979 | 3 | $2,300,000,000 |
| 6 | AGNES (NE U.S.) | 1972 | 1 | $2,100,000,000 |
| 7 | ALICIA (N TX) | 1983 | 3 | $2,000,000,000 |
| 8 | BOB (NC and NE U.S.) | 1991 | 2 | $1,500,000,000 |
| 9 | JUAN (LA) | 1985 | 1 | $1,500,000,000 |
| 10 | CAMILLE (MS/AL) | 1969 | 5 | $1,420,700,000 |
| 11 | BETSY (FL/LA) | 1965 | 3 | $1,420,500,000 |
| 12 | ELENA (MS/AL/NW FL) | 1985 | 3 | $1,250,000,000 |
| 13 | GLORIA (Eastern U.S.) | 1985 | 3* | $900,000,000 |
| 14 | DIANE (NE U.S.) | 1955 | 1 | $831,700,000 |
| 15 | ALLISON (N TX) | 1989 | T.S.@ | $500,000,000 |
| 16 | ALBERTO (NW FL/GA/AL) | 1994 | T.S.@ | $500,000,000 |
| 17 | ELOISE (NW FL) | 1975 | 3 | $490,000,000 |
| 18 | CAROL (NE U.S.) | 1954 | 3* | $461,000,000 |
| 19 | CELIA (S TX) | 1970 | 3 | $453,000,000 |
| 20 | CARLA (TX) | 1961 | 4 | $408,000,000 |
| 21 | CLAUDETTE (N TX) | 1979 | T.S.@ | $400,000,000 |
| 22 | GORDON (S & Cent. FL/NC) | 1994 | T.S.@ | $400,000,000 |
| 23 | DONNA (FL/Eastern U.S.) | 1960 | 4 | $387,000,000 |
| 24 | DAVID (FL/Eastern U.S.) | 1979 | 2 | $320,000,000 |
| 25 | NEW ENGLAND | 1938 | 3* | $306,000,000 |
| 26 | KATE (FL Keys/NW FL) | 1985 | 2 | $300,000,000 |
| 27 | ALLEN (S TX) | 1980 | 3 | $300,000,000 |
| 28 | HAZEL (SC/NC) | 1954 | 4* | $281,000,000 |
| 29 | BERTHA (NC) | 1996 | 2 | $270,000,000 |
| 30 | DORA (NE FL) | 1964 | 2 | $250,000,000 |

**ADDENDUM (non-Atlantic or non-Gulf coast systems)**

| | | | | |
|---|---|---|---|---|
| 8 | INIKI (Kauai, HI) | 1992 | Unk | $1,800,000,000 |
| 8 | MARILYN (U.S. Virgin Islands/E Puerto Rico) | 1995 | 2 | $1,500,000,000 |
| 13 | HUGO (U.S. Virgin Islands/E Puerto Rico) | 1989 | 4 | $1,000,000,000 |
| 15 | HORTENSE (Puerto Rico) | 1989 | 4 | $500,000,000 |
| 24 | OLIVIA (CA) | 1982 | T.D.& | $325,000,000 |
| 25 | IWA (Kauai, HI) | 1982 | Unk | $312,000,000 |
| 26 | NORMAN (CA) | 1978 | T.D.& | $300,000,00 |

*: Moving more than 30 miles an hour.

@: Only of Tropical Storm intensity but included because of high damage.

&: Only a Tropical Depression.

Unk: Intensity not sufficiently known to establish category.

Taken from The Deadliest, Costliest, and Most Intense United States Hurricanes of this Century (and other frequently requested hurricane facts) [NOAA Technical Memorandum NWS TPC-1] updated in February, 1997. Last updated April 7, 1997.

**Figure 1.12**

**Deadliest Hurricanes in the U. S. from 1900 to 1996**

| | Hurricane | Year | Category | Deaths |
|---|---|---|---|---|
| 1 | TX (Galveston) | 1900 | 4 | 6000+ |
| 2 | FL (Lake Okeechobee) | 1928 | 4 | 1836 |
| 3 | FL (Keys)/S TX | 1919 | 4 | 600# |
| 4 | NEW ENGLAND | 1938 | 3* | 600 |
| 5 | FL (Keys) | 1935 | 5 | 408 |
| 6 | AUDREY (SW LA/N TX) | 1957 | 4 | 390 |
| 7 | NE U.S. | 1944 | 3* | 390@ |
| 8 | LA (Grand Isle) | 1909 | 4 | 350 |
| 9 | LA (New Orleans) | 1915 | 4 | 275 |
| 10 | TX (Galveston) | 1915 | 4 | 275 |
| 11 | CAMILLE (MS/LA) | 1969 | 5 | 256 |
| 12 | FL (Miami)/MS/AL/Pensacola | 1926 | 4 | 243 |
| 13 | DIANE (NE U.S.) | 1955 | 1 | 184 |
| 14 | SE FL | 1906 | 2 | 164 |
| 15 | MS/AL/Pensacola | 1906 | 3 | 134 |
| 16 | AGNES (NE U.S.) | 1972 | 1 | 122 |
| 17 | HAZEL (SC/NC) | 1954 | 4* | 95 |
| 18 | BETSY (SE FL/SE LA) | 1965 | 3 | 75 |
| 19 | CAROL (NE U.S.) | 1954 | 3* | 60 |
| 20 | SE FL/LA/MS | 1947 | 4 | 51 |
| 21 | DONNA (FL/Eastern U.S.) | 1960 | 4 | 50 |
| 22 | GA/SC/NC | 1940 | 2 | 50 |
| 23 | CARLA (TX) | 1961 | 4 | 46 |
| 24 | TX (Velasco) | 1909 | 3 | 41 |
| 25 | TX (Freeport) | 1932 | 4 | 40 |
| 26 | S TX | 1933 | 3 | 40 |
| 27 | HILDA (LA) | 1964 | 3 | 38 |
| 28 | SW LA | 1918 | 3 | 34 |
| 29 | SW FL | 1910 | 3 | 30 |
| 30 | ALBERTO (NW FL/GA/AL) | 1994 | TS& | 30 |

**ADDENDUM (Pre-1900 or not Atlantic/Gulf Coast)**

| | | | | |
|---|---|---|---|---|
| 2 | LA | 1893 | Unk | 2000 |
| 2-3 | SC/GA | 1893 | Unk | 1000-2000 |
| 3 | GA/SC | 1881 | Unk | 700 |
| 9 | San Felipe (Puerto Rico) | 1928 | 4 | 312 |
| 13 | U.S. Virgin Islands, Puerto Rico | 1932 | 2 | 225 |
| 17 | DONNA (St. Thomas, VI) | 1960 | 4 | 107 |
| 24 | Southern California | 1939 | TS& | 45 |
| 24 | ELOISE (Puerto Rico) | 1975 | TS& | 44 |

+: May actually been as high as 10,000 to 12,000.

#: Over 500 of these lost on ships at sea; 600-900 estimated deaths.

*: Moving more than 30 miles an hour.

@: Some 344 of these lost on ships at sea.

**&**: Only of Tropical Storm intensity.

**Unk**: Intensity not sufficiently known to establish category.

Taken from The Deadliest, Costliest, and Most Intense United States Hurricanes of this Century (and other frequently requested hurricane facts) [NOAA Technical Memorandum NWS TPC-1] updated in February, 1997. Last updated April 7, 1997.

# V. Thematic Framework

## 4. Politics

**The Challenge**

The United States (and other nations) simply cannot afford the continued costs of unmitigated natural disasters and still hope to achieve its goals of debt reduction, adequate health care, full employment, and economic growth. For a number of reasons, natural extremes pose an enormous challenge to political institutions and politicians. Some of these reasons are:

Some nations periodically experience losses up to 25 percent of GNP in a single year due to natural disasters.

**Violence/scope**

Worst-case scenarios for many nations can amount to a significant fraction of GNP. In the case of the Peoples Republic of China, for example, this fraction has been estimated to average several percent per year. Some nations periodically experience losses up to 25 percent of GNP in a single year. A repetition of the Great Kantoi earthquake of 1923 would today produce a $1.3 trillion loss. Events of such magnitude overwhelm the governmental planning process.

**Localized in space and time**

Though the causal linkages that trigger natural hazards often begin as subtle, almost unnoticeable disequilibria distributed over vast domains, and initially build slowly, they culminate in events of terrifyingly swift onset. Events of this type are inherently difficult for governments to handle. In their initial stages, or between events, their urgency is obscured by other issues competing for attention the economy, unemployment, education, health care, drug abuse, and so on. In their final, climax stages, natural extremes are highly localized. Where and when they hit, they completely disrupt all established order.

**Require vertical integration of federal, international, state, local, private sector**

By their nature, natural extremes challenge all levels of government and society, so that it is impossible to compartmentalize the needed response and mitigation activities into single organizations or a few entities. The problem of coordination and control quickly becomes overwhelming.

**When they do occur, the imperative is to rebuild as before.**

In the immediate aftermath of natural disasters, the overwhelming societal imperative is to restore people to precisely the circumstances that prevailed before. Only in a minority of cases does the emotional and political atmosphere demonstrate the resolve and insight needed to break the so-called cycle of disasters.

**Technology advance introduces new vulnerabilities faster than they can be anticipated.**

With each new societal advance (urbanization, new methods of construction, new dependence on lifelines such as electrical power and communications systems), society creates vulnerabilities that defy a priori assessment of changed risk.

**Mistaken societal paradigm**

For millennia, societies have used as a figure of merit the extent to which they have succeeded in making nature irrelevant. Since nature always proves its relevancy, the ultimate effect of this paradigm has been to postpone disaster and to increase the scale and scope of disaster. Instead, nations and peoples need to affirm nature's relevance and attempt to build resiliency into society.

See Side Bar: Dennis Mileti: On the current U.S. natural hazards paradigm

FEMA photo.

# On the current U. S. natural hazards paradigm

## Dennis Mileti

The current emphasis is on reducing disaster losses through directed actions to overcome nature. Natural hazards are viewed as extreme, low probability phenomena that have the potential to cause disasters when they strike human communities that have not done enough to keep harm away. The favored remedy is a built environment that has been sufficiently hardened to resist nature's extreme forces. Examples include steel frame construction thought to be resistant to structural collapse in earthquakes, shutters for windows thought to keep a hurricane's harm at bay, and flood control works perceived to be able to keep back excessive amounts of water.

A range of societal adjustments that fall under the headings of mitigation, preparedness, response, and recovery are also thought to help us conquer environmental extremes. The prevailing perspective ends up pitting such hazards reduction adjustments against other, often conflicting, powerful societal forces. These forces, which constrain a more effective natural hazard adjustment, include the decentralized character of the American system with its long list of involved actors, the low salience of natural hazards on most people's agendas until a disaster happens, the limited resources available for mitigation, and legal and economic constraints regarding restrictions on land use.

Another constraint in the contemporary natural hazards paradigm is our culture's infatuation with technological fixes for problems. Technology that is perceived to be an appropriate adjustment actually allows us to build, live and work where we want to despite the hazards to which our land is subject. For example, using technology to improve our ability to forecast disaster impacts and construct safer buildings could lull people into a false sense of security into thinking that the problem has been solved.

The nation's definition of appropriate loss reduction actions could be shifted such that we stop using mitigations with short-term payoffs that are not sustainable and actually create greater hazards in the long term. Engineered mitigations that exacerbate degradation and alter natural systems negatively could be abandoned. Land use planning for hazards mitigation could also enhance environmental stability and rehabilitation. Building codes could reduce future losses but also encourage energy efficiency and be in keeping with local environments.

The prevailing paradigm foretells increased frustration because we have the knowledge to guide effective societal adjustment to natural hazards and we are informed about the societal constraints that impede our action, but dollar losses continue to increase. A shift in perspective is needed that provides natural hazards mitigation with relief from many of the constraints that retard action. There is a need to design a hazards paradigm and loss mitigation strategies that serve both the manifest function of reducing losses, but which also increase the sustainability of interactions between humans and the natural environment .

**The Opportunity**

**Growing awareness**

The growing scope of the costs and impacts of disasters has succeeded in raising societal awareness of many new threats and has set into motion the chain of actions needed to address the challenges. For example, the insurance industry has begun to focus more attention on alerting the public to the problem. This increased public awareness builds the political climate and consensus needed to allow governments to act.

**New technologies**

While technologies have provided new risks, they have more than compensated by providing an arsenal of new tools for coping.

While technologies have provided new risks, they have more than compensated by providing an arsenal of new tools for coping. Many technologies come to mind in structural design, warning and forecasting, etc. but nowhere is technology more critical than in the area of information. The computer and communications infrastructure now being put in place completely transforms the opportunities governments can draw upon to identify hazards and assess risk, to design new structures and new materials for structures, to educate the public, to warn of imminent danger, to respond to crises, and to provide relief and recovery in the aftermath of disasters.

**Matches with other societal trends (partnerships, self-reliance)**

New societal trends occasioned by the federal budget crisis in the United States are in keeping with the actions needed to reduce natural disasters. The requirements that individuals shoulder the risks attendant upon their actions, and that action should concentrate at the state and local levels when hazards hit, are consistent with good government policy.

**Recommendations**

**National**

1. The citizens of the United States should "declare independence" from the needless loss of life and other costs resulting from natural disasters. The citizens should encourage the President, Congress, and state, local, and private sector leaders to serve the people by taking a leadership role in natural disaster reduction.

2. The President should "declare war" on natural disasters and reaffirm the nation's commitment to a national mitigation strategy (NMS). The President would highlight FEMA's NMS in order to mobilize the country's efforts and would use a suitable opportunity to make such a declaration. Such declarations can contribute significantly to expanding public understanding and involvement in an effort of national importance.

3. The President should establish a Council on Natural Disaster Reduction. In order to further the NMS goal of developing partnerships, such a Council would be made up of national leaders from business, labor, academia, civic organizations, and government. The President's Council on Sustainable Development (PCSD) might serve as an example.

4. Each Governor should establish a "council" that seeks to ensure that within each state, mitigation receives increased emphasis. Local, state and federal governments should work with

industry, labor and the public to integrate natural disaster reduction with/into other objectives. FEMA should work with the National Governors Association to accomplish this. We endorse the recommended actions of the NMS Mitigation Action Plan for state and local governments:

· Develop strategic mitigation plans and identify funding sources to support them.

· Adopt and enforce all-hazards building codes.

· Adopt incentives and disincentives to encourage mitigation.

· Develop administrative structures to support implementation of mitigation programs and priorities.

· Incorporate mitigation of natural hazards into land use management plans and programs.

· Develop, support and conduct ongoing public information campaigns on natural hazard mitigation.

(The Mitigation Action Plan can be found on pp. 25-26 of the National Mitigation Strategy, FEMA, Washington, D. C., 1995.)

5. The CENR/SNDR should develop a national program of demonstration projects to evaluate current efforts to implement NDR, accelerating the adoption of research projects. The CENR/SNDR should merge its efforts to develop research priorities for NDR with the NMS research and applications elements. As conclusions from the Second Assessment of Research and Applications on Natural Hazards become available, they should be incorporated into this process. Priorities of the merged R&D effort should focus on providing needed linkages between basic research and current practice. Demonstration projects should be supported to allow the testing and integrating of new and current practice.

6. The CENR/SNDR should serve to convene the defense and civilian sectors of government to define and clarify their respective roles in natural disaster reduction.

**International**

1. The CENR/SNDR and CISET, in collaboration with the President's Council on Natural Disasters should develop and articulate international policies with respect to natural disaster reduction. As the U. S. is party to the United Nations' International Decade for Natural Disaster Reduction (IDNDR), it should take a more active leadership role. Furthermore, while the U. S. is also involved in a range of bi- and multi -lateral agreements, it is timely and useful to review and express the national agenda in international collaboration and assistance in NDR. Current policies often inhibit and restrict agencies from involvement in such matters to the disadvantage of U. S. interests.

2. The U. S. Department of State should take the initiative to encourage other nations to work together to converge their observing and information management strategies for global change and natural hazard monitoring. The IDNDR may also contribute a useful framework here.

The requirements that individuals shoulder the risks attendant upon their actions, and that action should concentrate at the state and local levels when hazards hit, are consistent with good government policy.

# V. Thematic Framework

# 5. Nexus of All System Elements

While there are substantial scientific findings and an array of technological tools already in existence to address NDR issues, there are not adequate mechanisms to synthesize and integrate them to meet decision makers' special needs, capacity and understanding at all levels.

**The Challenge**

Decisions that affect safety, including those regarding natural hazards, are made continuously by businesses, organizations, communities, and individuals. Each decision is a "nexus," a situation that brings together the factors that influence the framing of the problem, the solutions considered, and the action that is taken. The conceptualizations of natural disaster reduction problems are influenced by disciplinary perspectives, existing organizational structures and arrangements, values, and economic and political considerations.

The increasing range of disciplines and organizations participating in research on natural disaster-related issues has resulted in an increasingly complex challenge to integrate findings in the form of specifically applicable tools and methodologies. While there are substantial scientific findings and an array of technological tools already in existence to address NDR issues, there are not adequate mechanisms to synthesize and integrate them to meet decision makers' special needs, capacity and understanding at all levels: households, organizations, communities, regions, states, and countries.

**The Opportunity**

An opportunity exists to enhance the likelihood that safety-related decisions will:

· incorporate current information on natural hazards into these decisions;

· be informed by existing information ( e. g., hazard characterizations, risk assessments, vulnerability assessments, projections, etc.);

· use available technologies and methodologies as tools to better understand and deal with the nature of natural hazards and their potential impacts;

· understand and incorporate considerations of societal implications and economic consequences for any proposed course of action.

The recommendations which follow will lead to a more integrated, informed approach to NDR which will expand both the participants in and the considerations of NDR concerns outside of the traditional hazards communities and to other issue areas (e. g. , housing, economic development, health care provision, and education.

**Recommendations**

1. Develop systems integrating mechanisms for natural disaster mitigation that will identify and assemble tools and information to improve decision making processes that meet NDR objectives.

It is the federal government's role to stimulate and facilitate the development of these mechanisms, perhaps on a regional basis. FEMA's Council on Multi-Hazard Reduction could lead this activity. Possible models for integrating mechanisms include regional organizations such as the Southern California Earthquake Preparedness Project (SCEPP) and the Bay Area Regional Earthquake Preparedness Project (BAREPP), academic/government partnerships, and private sector systems integrators such as EQE, Inc.

2. Recognizing the complexity of and changes in NDR issues, there is a need to establish and sustain long-term interactive relationships between research/technology providers and actors at all levels of decision making in order to make effective use of available knowledge and technologies.

Develop systems integrating mechanisms for natural disaster mitigation that will identify and assemble tools and information to improve decision making processes that meet NDR objectives.

Such relationships would provide assistance on an iterative basis through sustained, interactive communication and contact. In addition, they would provide a way to identify new research problems or needed modifications in tools and methodologies from the actors' perspectives. A possible model for such relationships can be found in the Cooperative Extension Service programs.

3. Foster the development of disaster-systems professionals who can manage systems integration and work between academic/scientific communities, governmental systems, the private sector, and community groups.

Skills needed by such professionals include discipline-spanning capabilities, knowledge translation abilities, and the ability to identify and demonstrate useful "tools." Existing university programs in Environmental Management/Policy and related fields or those that have centers for applied research should be identified and encouraged to develop these training/educational opportunities. FEMA and NSF should stimulate these efforts. Funding research assistantships in these programs would enhance the development of these professionals. Relevant agencies could also provide internships for students in these programs.

4. Assess the ability and capacity of actors and specific decision environments (in households, organizations, and local governments) to use existing knowledge and technologies for application to NDR issues.

Multidisciplinary research teams should be solicited to address this issue for specific types of actors. Funding for these efforts could come from FEMA, NSF, USGCRP, USGS, the private sector, etc., depending on the actors.

5. Continuously incorporate information from the U. S. Global Change Research Program to provide decision makers with information on changing patterns of natural hazard and risk.

Natural science tools and methods from the global change research community promise a significant contribution to the improvement of the societal functions of disaster mitigation and response. The USGCRP will benefit from this interchange with the natural hazards community

in policy development and program implementation to enhance appropriate mitigation behavior at the local level and within the private sector. The USGCRP should develop mechanisms to transfer and translate their information for hazards-application purposes.

6. Take the lead in promoting NDR globally with a plan to disseminate materials, methodologies, and programs internationally.

Recognize that the broad approach the U. S. has taken in addressing NDR issues from an integrated, multi-disciplinary perspective can be used to enhance both concerns about and the technical capacity for disaster reduction through organizations concerned about international development. FEMA and the Office of Foreign Disaster Assistance (OFDA) have taken the lead role in this effort for response and preparedness, and now the emphasis should shift to mitigation. This can be done by funding joint collaborative projects by OFDA, AID, USIA, CISET, the World Bank and other international development institutions.

Natural science tools and methods from the global change research community promise a significant contribution to the improvement of the societal functions of disaster mitigation and response.

See Side Bar: Don Geis: On creating sustainable and disaster-resistant communities

# On creating sustainable and disaster-resistant communities

**Don Geis**

How can we most effectively keep hazards from becoming disasters? To make progress toward this goal, we must begin to see disaster mitigation as part of a much bigger picture, something broader and more integral to the way we think and do things in this society. The best way to start this process is to begin thinking of natural hazard mitigation as the foundation and first important step in the context of planning and developing sustainable communities.

Natural hazards such as earthquakes, floods and hurricanes are very much part of the natural functioning of the Earth and are not problems in and of themselves. They become very serious problems however when they impact our human settlements. It is here, at this point of interface, that our concern begins. Still, even at this point, a natural hazard doesn't have to become a disaster. It is fair to say that many natural disasters are not really natural, but rather human-made disasters, less the result of an extreme natural event than of the inappropriate settlement patterns and poorly planned communities humans have built where these natural forces converge.

Almost all property damage, loss of life, and socioeconomic disruption associated with natural disasters occurs as a result of the built environment, or rather of the failure of the built environment to resist the physical forces of natural hazards and to provide the functional and social support framework necessary for recovery. A variation on the old adage goes that earthquakes don't kill people, buildings kill people ... as do collapsed freeways, ruptured gas lines, and other inadequate development and infrastructure. It is at the local level that this problem is most effectively solved. This can be achieved through planning and development decisions that are integral to the process of mitigating natural disasters and creating disaster resistant communities.

A sustainable community is one that uses its resources to meet current needs while ensuring that adequate resources are available for future generations. It seeks improved public safety and generally, a better quality of life for all its residents by limiting waste, preventing pollution, maximizing conservation and promoting efficiency, striving for social-cultural viability and developing local resources to enhance the local economy. This approach calls for local governments to respect and learn from ecological and geological systems and develop a community built environment that compliments these systems rather than interferes with them.

A sustainable community is a disaster resistant community. Sustainable communities and disaster resistant communities are natural partners; both must be concerned with the workings of nature, the relationship between the built and natural environment, and the associated social and economic implications.

# VI. Summary Recommendations and Actions

"Many natural disasters are not really natural, but rather human-made disasters, less the result of an extreme natural event than of the inappropriate settlement patterns and poorly planned communities humans have built where these natural forces converge."

The following is a distillation and summary of the recommendations made by the workshop groups that explored the five themes discussed in the previous chapter. Essentially, they call for citizens to re-think the way we live and how we shape our human settlements; to consider how our settlements are threatened by natural hazards and how they contribute to disasters. At the same time, we must recognize that while all levels of government have important roles to play, the roots of effective mitigation must occur at the local level. On the other hand, disaster mitigation is a global priority. The U. S., together with other disaster-prone nations of the world, should share the benefits of extensive disaster experience and broad interdisciplinary disaster mitigation research. Collaboration of international mitigation efforts at all levels should form a major component of U. S. development and humanitarian efforts.

It is important to once again emphasize the connection between natural disasters and global change. A society resilient to natural hazards is likely to be more resilient to longer time scale hazards such as those which fall under the heading of global change. Increasingly, the global change and natural hazards communities can benefit from each others' thinking and technologies in building a more sustainable society.

The recommendations that emerge from the AGCI workshop are addressed to specific individuals or groups of individuals. Most often they are targeted to large governmental organizations. That is often because larger organizations are easier to target. However (and this is stated repeatedly in this document), disaster management begins with the individual citizen. These citizens, acting individually, are responsible for developing and implementing disaster mitigation at home and in the workplace. More importantly, acting in concert, they are responsible for demanding of their political leaders the same protection from disasters which governments at various levels afford from war, hunger and disease.

Responsibility for disaster management cannot be polarized between government and citizens, however. Many other types of organizations are, or must increasingly be, involved. We find that, in order to protect their economic interests and employees, corporations and unions must be aware of, and mitigate, their exposure to natural hazards. Specific industries such as insurance, construction, transportation, health, and utilities, have a direct stake in disasters and their effects. Their voices supporting disaster mitigation are becoming stronger and more persistent.

Citizens groups, environmental organizations and disaster volunteer organizations are also among the growing list of supporters of disaster reduction for, as stated before, "We simply cannot afford the costs of unmitigated disasters and still achieve our national goals of debt reduction, adequate health care, full employment and economic growth." At the same time, we must realize that the distribution of risk and access to mitigation and recovery resources are elements of equality of opportunity. Public policies must address the social equity component of natural disaster reduction.

**Citizens**

1. In areas of high risk, form, or strengthen existing regional organizations to disseminate a full range of hazard information (FEMA).

2. Integrate citizens into decision-making processes at all levels (NASA, NOAA, USGS).

3. Partner with community, regional and state groups to create a new generation of champions for mitigation (USGS and others).

4. Develop a coordinated program of public interest groups to further citizen involvement in natural disaster reduction (ICMA).

5. Develop understanding of citizens in pre- and post-disaster activities to maximize citizen involvement in natural disaster activities (NSF).

**Technology**

1. More effectively bring technological advances to bear on the natural disaster reduction task. Evaluate technologies for documenting and interpreting trends and problems related to natural hazards (SNDR, SGCR). This could be achieved by: developing or improving complex systems models of physical and social systems so as to more rigorously identify vulnerability and thresholds that would guide the application of natural hazard related resources; developing data sets specifically directed toward natural hazard problems; and developing real-time capabilities that would feed high-technology data into the decision making process.

2. Carry out specific pilot or prototype projects for floods, earthquakes, tornadoes and drought mitigation, preparedness, relief and recovery (NASA, NOAA, NSF, and others).

3. Inventory technologies relevant to natural hazards reduction and their utilization by communities and the general citizenry (NASA, SNDR and SGCR).

**Private Sector**

1. Form a Presidential Commission to develop a national policy to identify, define, and partition responsibility for natural hazard risk (Office of the President).

2. Promote exchange of information from all available public and private sources regarding relevant hazards and provide for increased disclosure of risks during real estate transactions (state and local governments).

3. Include development of education and information programs for decision makers in disaster preparedness, response and recovery activities (National Mitigation Council).

4. Establish local/regional coalitions to advance the National Mitigation Strategy (lifeline industries associations such as EPRI).

5. Identify best practices and recommend them to the National Mitigation Council for recognition and educational dissemination (regional organizations).

Individual citizens are responsible for developing and implementing disaster mitigation at home and in the workplace. Acting in concert, they are responsible for demanding of their political leaders the same protection from disasters which governments afford from war, hunger and disease.

**Politics**

1. The President should establish a national Council on Natural Disaster Reduction (PCNDR) (Office of the President).

2 Governors should establish state-level Councils on Disaster Reduction (state governments).

3. Develop/carry out a national program of demonstration projects; evaluate NDR efforts and accelerate adoption of research progress (CENR/SNDR).

4. Convene civil and defense sectors of government to define and clarify respective roles in NDR (CENR/SNDR).

5. Develop and articulate international NDR policies (CENR /SNDR, CISET).

6. Encourage other nations to collaborate in observational and information management strategies for global change and NDR (State Dept.).

Our recommendations call for citizens to re-think the way we live and how we shape our human settlements; to consider how our settlements are threatened by natural hazards and how they contribute to disasters.

**Nexus of all System Elements**

1. Identify and assemble tools and information to improve decision making for mitigation (FEMA and FEMA Regions).

2. Establish long-term relationships between research/technology providers and decision makers at all levels.

3. Develop disaster-systems professionals who can manage systems integration work (NSF, FEMA).

4. Assess ability and capacity of actors to use existing knowledge and technologies (FEMA, NSF, USGCRP, USGS).

5. Incorporate information from global change research on changing patterns of hazard and risk (USGCRP Office).

6. Disseminate materials, methodologies, and programs internationally (OFDA, AID, World Bank, CISET).

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