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SUSTAINABLE DEVELOPMENT AND HAZARDS MITIGATION IN THE UNITED STATES: DISASTERS BY DESIGN REVISITED

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Abstract. It has become clear that natural and related technological hazards and disasters are not problems that can be solved in isolation. The occurrence of disasters is a symptom of broader and more basic social problems. Since 1994, a team of over 100 expert academics and practitioners – including members of the private sector – have assessed, evaluated, and summarized knowledge about natural and technological hazards in the United States from the perspectives of the physical, natural, social, behavioral, and engineering sciences. The major thesis of the findings was losses from hazards and inability to comprehensively reduce losses of all types are the consequences of narrow and shortsighted development patterns, cultural premises, and attitudes toward the natural environment, science, and technology. To address these broad and basic problems, the study included proposals for ways in which people and the institutions of the United States can take responsibility for disaster losses, reduce future hazard losses, and link hazard mitigation to sustainable development.

Keywords: disaster, hazard, local sustainability, mitigation, reduction, second assessment, sustainable development

1. Introduction

Over a quarter century ago (*cf.* Mileti 1999), geographer Gilbert F. White and sociologist, J. Eugene Haas published a pioneering report "*Assessment of Research on Natural Hazards*" on the United States' ability to withstand and respond to natural disasters (White and Haas 1975). Noting that physical scientists and engineers dominated research on disasters, White and Haas conducted the first assessment of natural hazards research in the United States in order to better understand the economic, social, and political dimensions of extreme natural events.

White and Haas advanced the critical notion that rather than solely responding to the damage from specific disasters, the nation could employ comprehensive planning, land-use, and other preventive measures at local as well as federal levels to mitigate their toll. As public and private programs and policies advanced into the twentieth century, mitigation was adopted as the cornerstone of the United States' approach to addressing natural and technological hazards.

The 1975 report had a profound impact on the creation and formalization of an interdisciplinary approach to research and management. The first assessment, along with the second national assessment in 1999 (profiled in this paper), have

revolutionized traditional understandings of and perceptions about reducing the social, economic, and environmental impacts of hazards. Today, the "hazards community" comprises people from many fields and agencies who address the myriad aspects of natural disasters. Hazards research now encompasses disciplines such as climatology, economics, engineering, geography, geology, law, meteorology, planning, natural resources management, seismology, and sociology. Professionals in these and other fields investigate how engineering projects, warnings, land-use management, planning for response and recovery, insurance, and building codes can help individuals and groups adapt to natural hazards, as well as reduce the resulting deaths, injuries, costs, and social, environmental, and economic disruption (Mileti 1999). The people of the hazards community have significantly improved our understanding of situations before, during, and after disasters. Yet, at the close of the last century, it was clear that troubling questions remained about why more progress has not been made in reducing dollar losses. The seminal work of White and Haas raised significant issues and questions. Their ground-breaking work was taken up by the second assessment, and their perspectives and approaches, modified by the researchers whose work comprises the second assessment, continue to inform research and practice through the present day.

1.1. Moving forward: the second assessment (1999)

In the late 1990s, it became clear that an updated evaluation of the current research of hazards and disasters in the United States was necessary to both assess the outcomes of recommendations made in the first assessment and determine new directions for research. In 1995, the nation's "Second Assessment of Research and Applications" for natural hazards began, headed by sociologist Dennis S. Mileti (*cf.* Mileti 1999). From the beginning, one of the project's goals was to link hazards mitigation with sustainable development. The genesis for the second assessment began in the early 1990s, when conversations took place among individuals in the Subcommittees on Natural Hazards and Risk Assessment of the Committee on the Environment in the Office of Science and Technology Policy in the White House. The committee's charge came directly from the President of the United States. Following the lead of then Vice President Al Gore, committee members began to consider the importance of recasting the environmental and hazards missions of their agencies in ways to link them more directly with the concepts of sustainability and sustainable development.

The members of these subcommittees knew well that to accomplish such a mission the nation's research community would need to be involved in an effort to broaden the current thinking about hazards and disasters. To this end, they requested a comprehensive national assessment of natural hazards that would produce valuable insights and also lead to big-picture thinking on sustainable hazards mitigation.

This article, and the book on which it is based (Mileti 1999), reflects the efforts of over a 100 experts who have worked and debated since 1994 to take stock

of current knowledge and practice in the United States. The effort got underway during a workshop in the summer of 1992 in Estes Park, CO. Attended by over 60 of the nation's leading hazards experts, the workshop participants overwhelmingly agreed that it was appropriate to move forward with a second assessment of hazards in the United States. They also agreed that the unifying theme for the work should be sustainable development. A subsequent workshop in Boulder, CO, in October 1994, brought many of the same people together with others together to detail the specific agenda for the second assessment.

The second assessment's mission was to summarize current knowledge in the various fields of science and engineering that was applicable to natural and related technological hazards and disasters and to make research and policy recommendations for the future. Over 120 leading disaster experts in the United States contributed to the work, and a number of written products resulted from the project (Cutter 2001; Tierney et al. 2001; Burby 1998; Kunreuther and Roth 1998). "Disasters by Design," which was published in 1999, summarizes the project and its findings. Aimed at a general audience, including laypeople, policy makers and practitioners and researchers, the book has a broad focus.

The researchers in "Disasters by Design" called for a significant shift the national culture to stop the ever-increasing spiral of losses from natural and technological hazards and disasters. The main challenge they faced was to formalize the concept of "sustainable hazards mitigation" in the United States. Sustainable mitigation is a concept that links the wise management of natural resources with local economic and social resiliency, and views mitigation as an integral part of a much larger set of issues. This resulted in perhaps the single most important contribution of the second assessment. This study called for a fundamental shift in the character of how citizens, communities, governments, and businesses in the United States conduct themselves in relation to the natural environments they occupy.

The concept of sustainable hazards mitigation stemmed from the central problem that many traditional and accepted methods for coping with problems in the environment were based on the idea that nature can be controlled through technology. Most strategies for managing hazards follow a traditional planning model: study the problem, implement a situation-specific solution, and move on to the next problem. This approach casts hazards as static and mitigation as an upward, positive, linear trend. Continuing losses from hazards have resulted from shortsighted and anthropocentric perceptions of human domination over an unchanging natural environment. Contrary to this understanding, events during the past quarter century demonstrate that natural disasters and the technological hazards that may accompany them are not linear and cannot be solved in isolation. To address these realities, a shift was needed to a policy of sustainable hazard mitigation.

In an effort to head off the continued rise in tolls from disasters, the second assessment sought to nurture and bridge the concept of a sustainability to make the principles of deliberate attention to the larger context of the dynamics of the biophysical and the social more explicit. Many aspects of this strategy were implicit

in the recommendations formulated by White and Haas over a quarter century ago.

The contributions of the experts were used to outline a comprehensive approach to enhancing society's ability to reduce the costs of disaster. The second assessment involved many key players in the federal agencies whose mandates encompassed aspects of hazards mitigation, preparedness, response, and recovery along with academics and practitioners at state and local levels. Key players were involved so that they would "own" the results and recommendations of the second assessment, thereby facilitating action.

2. Challenges in Disaster Mitigation

Many disaster losses – rather than stemming from unexpected events – are the predictable result of interactions among three major systems: the physical environment (the events themselves); the social and demographic characteristics of the communities that experience them; and the buildings, roads, bridges, and other components of the built environment. Growing disaster-related losses in the United States result partly from the fact that the nation's capital supply is expanding and partly from the fact that these systems – and the myriad way in which they interact – are becoming more complex with each passing year.

Three main influences are at work. First, the earth's physical systems constantly change and these systemic changes directly impact the severity and characteristics of future disasters. Forecasts cannot simply be based upon static projections from the past. For instance, scientists expect a warming climate to produce meteorological events such as storms, floods, drought, and extreme temperatures that were more dramatic than previously experienced. To attempt to predict disasters, forecast financial losses, and plan recovery strategies without an understanding of the dynamic nature of the natural world is shortsighted. Natural hazards mitigation will not be successful in isolation and without considering factors such as climate change and societal adaptation (Pielke 1998). Pielke defines adaptation as referring to "adjustments in individual, group, and institutional behavior in order to reduce society's vulnerability to climate, [in this instance]" (Pielke 1998, p. 159). Secondly, changes in the demographic composition and distribution of the United States population mean a greater exposure to many hazards. The number of people residing in earthquake-prone regions and coastal counties subjected to hurricanes, for example, is growing rapidly. Increasing inequality in the distribution of wealth also makes many people more vulnerable to hazards and less able to recover from them. Finally, the built environment – public utilities, transportation systems, communications, homes, and office buildings – is becoming denser, making the potential losses from natural forces larger.

Another major problem noted in the second assessment is that some of the efforts to head off damages from natural hazards only postponed or displaced their

effects (Mileti 1999). While it is true that communities below dams or behind levees may have avoided losses from the floods those structures were designed to prevent, these communities often had more property to lose when their dams or levees failed, impacting the additional development that had occurred in the protected areas. Such a situation contributed to catastrophic damage from the 1993 floods in the Mississippi basin. Many of the dams, bridges, and other structures in the United States are approaching the end of their design life. Similarly, by providing advance warnings of severe storms, the United States may well have encouraged more people to build in fragile coastal areas. Such development, in turn, made the areas more vulnerable by destroying dunes and other protective natural features.

3. Growing Disaster Losses in the United States

The research conducted for the second assessment found that from 1975 to 1994, natural hazards killed over 24 000 people and injured some 100 000 in the United States and its territories (Mileti 1999). About one quarter of the deaths and half the injuries resulted from events that society labeled as disasters. The rest resulted from less dramatic but more frequent events such as lightning strikes, car crashes owing to fog, and localized landslides.

The assessment found that the United States has succeeded in saving lives and reducing injuries from some natural hazards, such as hurricanes. However, casualties from floods – the nation's most frequent and injurious natural hazard – have not substantially declined. Deaths from lightning and tornadoes remained constant. Meanwhile injuries and deaths are growing from dust storms, extreme cold, wildfire, and tropical storms.

The dollar losses associated with most types of natural hazards in the United States is rising. According to Mileti (1999), a conservative estimate of total dollar losses during the past two decades was $500 billion (in 1994). More than 80 percent of these costs stemmed from climatological events, while around 10 percent resulted from earthquakes and volcanoes. Only 17 percent of the people in these disasters were insured. Determining losses with a higher degree of accuracy is impossible because, the United States had not yet established a systematic reporting method or a data repository. Further, these numbers do not include indirect costs such as downtime for businesses, lost employment, environmental damage, or emotional effects on victims. Most of these losses resulted from events too small to qualify for federal assistance, and most people were not insured, so victims bore the costs.

Seven of the 10 most costly disasters – based on dollar losses – in United States history occurred between 1989 and 1994. Since 1989, the nation has frequently experienced losses from catastrophic natural disasters that averaged about $1 billion per week. This dramatic increase in disaster losses is projected to continue.

However, many of the most severe recent disasters could have been far worse. If Hurricane Andrew had been slower, wetter, or torn through downtown Miami,

it would have wreaked devastation even more profound than what occurred. The second assessment predicted that the most likely catastrophic events, such as a great earthquake in the Los Angeles area, have yet to occur. Such a California disaster would cause up to 5000 deaths, 15 000 serious injuries, and $250 billion in direct economic losses.[1]

4. A Shift in Approach – Sustainable Development

The second assessment resulted in a novel and comprehensive approach toward viewing hazards and their impacts. It called for researchers and practitioners in the hazards community to shift their tactics from simply responding in an ad hoc way to the disasters that confronted them, toward coping is a more holistic way with the complex factors that contribute to disasters in today's – and especially tomorrow's – world. This new approach should include a global systems perspective that recognizes the adapting role of society that contributes to disasters. People and societies must accept responsibility for hazards and disasters and view human actions as the cause of disaster losses. This responsibility stems from the choices we make about where and how human development will occur. For example, multimillion-dollar homes are being on the edge of the ocean, directly in the approach pattern of former hurricanes. Were a hurricane to hit these homes, the economic damage alone would be huge.

The researchers decided to abandon the notion that there was a "final" solution to natural hazards mitigation. Technology cannot make the world safe from all the forces of nature. Technology is not the sole "solution" because elucidations need to be as fluid and interactive as the problem and its participants. Society must take a long-term view that values mitigation, rather than short-term luxury rewards, for example. If disaster losses are to decline, mitigation should emerge as a concept that most, if not all, citizens deem worthwhile.

Contributing researchers were unanimous in their call for a global systems perspective to recognize that disasters arise from the interactions among the earth's physical systems, its human systems, and its built infrastructure, rather than from discrete environmental events. This broad view, a characteristic of mitigation and social adaptation, is necessary to encompass all three of these dynamic systems.

The view of hazards as static had led to the conclusion that any mitigation efforts would reduce the grand total of future losses. The researchers of the second assessment determined that this was erroneous. In reality, changes occur quickly and nonlinearly. The researchers found that human adaptation to hazards must become as dynamic as the issues presented by the hazards themselves.

Societal factors, such as how people view both hazards and mitigation efforts or how the free market operates, play a critical role in determining which steps are actually taken and which are overlooked. Because these social forces are now known to be much more powerful than disaster specialists had previously thought,

growing understanding of physical systems and improved technology alone cannot suffice. To effectively address natural hazards, mitigation must become a basic social value.

The second assessment found that disasters are more likely to occur in tandem with unsustainable development. For example, economically disadvantaged persons may only have the option to live in houses built in flood plains due to their cost and availability. The converse is also true: disasters hinder movement toward sustainability because, for instance, they degrade the environment. The quality of life is undercut; hurricanes erode sandy foundations of houses. Most natural disasters interrupt basic human needs such as housing. With this in mind, sustainable mitigation activities should identify vulnerabilities and strengthen the community's social, economic, and environmental resiliency.

5. People at Risk

The second assessment revealed an underlying inconsistency between how professionals estimate risk from natural hazards and how people and societies perceive and deal with those same risks. Engineers, scientists, statisticians, and some others view risk probabilistically and often presume that people and societies will act rationally to mitigate losses and costs in proportion to the risks faced. This is not always or even often the case. In general, human beings, as individuals and groups – even entire societies – dichotomize risks into those that will be acted on and those that will be ignored. Because human risk perception does not follow objective estimates and definitions, human and societal action to mitigate risk can often be inconsistent with estimated scientific probabilities (Slovic 2000; Tweeddale 1996). Professionals in risk estimation are often frustrated in their attempts to motivate people and group to take what they perceive to be appropriate action (Mileti et al. 1992). Research has shown that people are typically unaware of all the risks and choices they face. We only for the immediate future, overestimate our ability to cope when disaster strikes, and rely heavily on emergency relief.

Hazard researchers have come to recognize that demographic differences play a large role in determining the risks people encounter, whether and how they prepare for disasters, and how they fare when disasters occur. Certain actions intended to mitigate risk and reduce losses in the short-term for select segments of a population have been shown to actually increase losses and shift risk onto others. Society's most vulnerable groups are often the poor, women, racial and ethnic minorities, and those who are members of other disenfranchised groups. Research conducted during the second assessment reinforced the finding that the vulnerability to disaster is unequally distributed. Unsustainable global settlement patterns, resource management, social organization, and political economies increasingly put some population groups more at risk than others from disaster (Enarson and Morrow 1998).

Women are the most at risk when hazardous conditions unfold as disastrous events (Schroeder 1987). This group is particularly subject to environmental risk through urban displacement and migration, environmental degradation, migration, poverty, and other social limitations and barriers to choice (Anderson 1994; Cutter 1995). As one might expect, the less economic and cultural power women possess before a disastrous event, the greater the suffering in the aftermath. This is largely due to having fewer resources to draw from during the disaster and during the recovery period (Fothergill 2001).

The poor are at greater risk from disastrous events worldwide mainly because they live in lower quality housing, which is more likely to be damaged and is often located closer to technologically hazardous sites (Mileti 1999; Fothergill and Peek forthcoming). Poor families around the world suffer the greatest losses and have access to the fewest public and private recovery assets, both in developing societies and wealthy industrialized nations (Bates 1982; Bolin 1982).

Existing research on race, ethnicity, and disasters during the period of the second assessment suggest that minority group members of a society experience different and more devastating consequences of disastrous events than non-minority citizens (Fothergill et al. 1999). In highly stratified societies, minority group members are often disenfranchised from power and influence, which often results in a long and slow recovery phase after natural disaster strikes.

The second assessment stresses the need for mitigation and response efforts to acknowledge the importance of demographic differences in the United States as we become more diverse. The assessment recommends that further research is needed to shed additional light on how mitigation programs ranging from public education to disaster relief can be rendered equitably.

6. Fostering Local Sustainability

In the context of hazards and disaster studies, sustainability means that a locality can tolerate – and overcome – damage, diminished productivity, and reduced quality of life inflicted by an extreme event without significant outside assistance. To achieve sustainability, communities must become more active in determining where and how development proceeds. Localities should evaluate their environmental resources and hazards, and evaluate the type and extent of possible future losses that they are willing to bear, for example, building in a flood plain. Communities also need to ensure that development and other community actions and policies adhere to those goals.

The second assessment yielded six objectives (Table I) for communities to be aware of when they consider actions for sustainable hazards mitigation.

A long-term, comprehensive plan for averting disaster losses and encouraging sustainability will provide localities with the opportunity to coordinate their goals and policies. Although the actual planning and follow-through occurs at the local

TABLE I
Objectives for local sustainability: United States second assessment findings

Maintain and enhance environmental quality
Human activities to mitigate hazards should not reduce the carrying capacity of ecosystems, in recognition that to do so will increase long-term losses from hazards.
Hazard mitigation activities should link efforts to control and ultimately reverse environmental degradation by coupling hazard reduction to natural resource management and environmental preservation.
Maintain and enhance people's quality of life
A population's quality of life includes, among other factors, access to income, education, health care, housing, and employment, as well as protection from disaster.
Local communities must consciously define the quality of life they want and select only those mitigation strategies that do not detract from any aspect of that vision of sustainability.
Foster local resiliency and responsibility
Resiliency to disasters means taking mitigation actions such that a locale can withstand an extreme natural event with a tolerable level of losses.
Recognize vibrant local economies are essential
Take mitigation actions that foster a strong local economy rather than detract from one.
A diversified local economy, not overly dependent on a single productive force, would be more sustainable over the long-term and less easily disrupted by disasters.
Ensure inter- and intragenerational equity
Select mitigation activities that reduce hazards across all ethnic, racial, and income groups, and between genders equally to avoid shifting the costs of today's advances onto later generations or less powerful groups.
Adopt local consensus building
Demonstrate sustainability by selecting mitigation strategies that evolve from full participation among all public and private stakeholders.
The participatory process itself may be as important as the outcome.

level, a great deal of impetus comes from higher levels. Nothing short of strong leadership from state and federal governments will ensure that sound planning occurs.

7. Mitigation Tools

An array of techniques and practices has evolved to address losses from hazards and disasters (Table II). These include sound land use planning, warning systems, engineering and building codes, insurance, new technology, and emergency preparedness and recovery. When used, these tools can help to save lives and injuries, limit property damage, minimize disruption, and enable communities to recover more quickly.

Successfully utilizing these tools and practices is a dynamic process that entails shared decision-making and interaction among all stakeholders, households,

TABLE II
Mitigation tools: Overview of United States second assessment findings

Land use planning
Wise planning limits expansion to keep people and property out of the way of hazards and maintain the natural environment.
An overarching leadership to inform development in hazard-prone areas corrects a confusing blend of innumerable federal, state, and local regulations.
Warnings
There is a need to develop a national comprehensive model for how warning systems work as well as providing the model to local communities along with technical assistance.
The model of better local management and decision-making for the long-term proved to be more critical than most future advances in technology.
Short-term warning systems did not significantly limit damage to the built environment, nor did they mitigate economic disruption from disasters.
Engineering and building codes
Disaster-resistant construction of buildings and infrastructure are essential components of local resiliency and play a direct role in determining the casualties and dollar costs of disasters.
Shortcomings in construction techniques and code enforcement need reevaluation in light of the goal of sustainable mitigation.
Insurance
Most property owners are not buying coverage against special perils, and look to federal disaster assistance to function as a kind of hazard insurance.
The insurance industry already has problems providing insurance in areas subject to catastrophic losses because many insurers do not have the resources to pay for a worst-case disaster.
While companies help minimize disruption by compensating their clients during recovery, they could further facilitate mitigation through information, education, helping to create model codes, and offering financial incentives for mitigation.
New technology
Computer-mediated communication systems, geographic information systems, remote sensing, electronic decision-support systems, and risk-analysis techniques have begun to fill the gaps in hazards management decision-support systems by analyzing information from core databases, including data on building inventories, infrastructure, demographics, and risk.
The lack of comprehensive local data to ask "what if" questions about future losses constrains technology systems, but these systems will be important to the processes of evaluating and managing risk as they grow in complexity.
Emergency preparedness and recovery
Create policies for disaster preparedness, response, and recovery.
Recovery evolved to a process that entails decision-making and interaction among all stakeholders.
Vital to communities' ability to become disaster resilient, local disaster plans need to be extended not only to explicitly address recovery and reconstruction but to identify opportunities for rebuilding in safer ways and in safer places.

businesses, governments, and the community at large. These tools are not meant to represent the "final" solution to mitigating hazards. Rather, these are mechanisms that when utilized, were found to aid in a more comprehensive long-term view of strengthening a community's social, economic, and environmental resiliency.

8. Essential Steps

The ongoing shift toward a sustainable approach to hazards mitigation requires extraordinary actions. Presented below are several essential steps that were called for in the second assessment. Since the assessment, many of these recommendations have been enacted, not only in the United States but also around the world.

Build local networks, capability, and consensus. Hazard specialists, emergency planners, resource managers, community planners, and other local stakeholders often seek to solve problems on their own. An integrated approach forges local consensus on disaster resiliency and nurtures it through the complex challenges of planning and implementation. The second assessment was instrumental in conceiving and convincing Congress to fund The Federal Emergency Management Agency's Project Impact, which sought to achieve these very goals. Despite its success, Project Impact has now been abandoned in part as a result of shifts of government.

Establish a holistic governmental framework. To facilitate sustainable mitigation, policies and programs related to hazards and sustainability need to be integrated and consistent. For example, there are over 100 national policies to deal with the drought hazard alone, and many more when other hazards are considered. This myriad of policies is incomprehensible to even those well-versed in hazards programs and policies. A holistic governmental framework would result in fewer, more highly integrated policies. No action on this recommendation has been taken to date.

Conduct a nationwide assessment of hazards and risks. The second assessment revealed that not enough is known about the changes in or interactions among the physical, social, and constructed systems of our nation. It was suggested that a national risk assessment be undertaken to link information from these systems with the goal of estimating hazard losses in a dynamic and comprehensive manner to quantitatively provide support for local efforts on sustainable mitigation. Although this recommendation has not been acted upon with a major effort as was originally conceived, several smaller efforts are now underway. For example, the U.S. Geological Survey in Golden, CO, is now host to an ongoing project to estimate hazards and risk globally by integrating the physical, sociodemographic, and constructed environments.

Build national databases. The second assessment found that there is no existing repository for the collection, analysis, and storage of standardized data on losses

from past and current disasters. Such databases will help establish a baseline for comparison with future losses, which is crucial to gauge trends and possible progress. Such a data repository needs to include information on the types of losses, their locations, their specific causes, and the actual dollar amounts, taking into account problems of double-counting, comparisons with gross domestic product, and the distinction between regional and national impacts. The second assessment also found that a second database was needed to collate information on identifying mitigation efforts, where they occurred, and how much they cost in order to provide a baseline for local cost-benefit analysis. These archives would be fundamental to informed decision-making and should be made accessible to the public. Two efforts immediately began to explore this idea further. The National Research Council (1999) began one database and the other database was started by the Heinz Center (2002). Both of these projects sought to catalogue the full range of factors that would be included in such a database.

Provide comprehensive education and training for hazards practitioners. Due to the increasingly complex interactions between physical and social systems, contemporary hazard managers are called upon to tackle problems they may have never before confronted. The second assessment recommended that education in hazard mitigation and preparedness should be expanded to include interdisciplinary and holistic degree programs at universities to make them better prepared to address the real-world problems associated with linking hazards and sustainability. Major advances on this recommendation have been achieved. For example, the Federal Emergency Management Agency's Higher Education Project has established an educational program in every state, and created degree programs at the Associate, Bachelor, Master, and Ph.D. levels.

Measure the progress of hazard mitigation efforts. Baselines for measuring sustainability need to be established so the nation can gauge future progress. It was recommended that interim goals for mitigation and other aspects of managing hazards be set, and progress in reaching those goals regularly evaluated. This effort requires determining how to apply criteria such as disaster resiliency, environmental quality, intra and intergenerational equity, quality of life, and economic vitality to the plans and programs of local communities. Each disaster yields a new and unique knowledge relevant to hazard mitigation and disaster response and recovery, yet at the time of the assessment, no entity collected this information systematically, synthesized it into a coherent body of knowledge, and evaluated the nation's progress in putting knowledge into practice. Systematic post-disaster audits, called for in the 1975 assessment by White and Haas, are still needed. Although some progress toward this recommendation has been achieved – for example, the Federal Emergency Management Agency created "sustainability desks" in its Disaster Field Offices – no real progress to achieve this recommendation has occurred thus far.

Shift Toward a Sustainable Approach to Hazards Mitigation and the International Sharing of Knowledge. The second assessment recognized that the United States

needs to share knowledge and technology related to sustainable hazard mitigation with other nations, and be willing to learn from those nations as well. In the United States and abroad, disaster experts also need to collaborate with those in the community as well as development experts to address the root causes of social vulnerability to hazards, including overgrazing, deforestation, poverty, and unplanned development. Disaster reduction should be an inherent part of everyday development processes, and international development projects must consider vulnerability to disaster. Based on the recommendations of the second assessment, hazards mitigation and sustainable development are now clearly linked in the minds of researchers and practitioners. Moreover, the World Bank quickly moved on the advice of the second assessment to require hazards mitigation plans as part of development loans to lesser-developed nations.

9. Conclusion

The second assessment of hazards and disasters, undertaken in the late 1990s, establishes that to support sustainable mitigation, researchers and practitioners need to ask new questions as well as continue to investigate traditional topics. Ongoing efforts should include interdisciplinary research and education, and the development of local hazard assessments, computer-generated decision-making aids, and holistic government policies.

Future work also needs to focus on techniques for enlisting public and governmental support for making sustainable hazard mitigation a fundamental social value; that is something that every citizen desires and supports. “Complex, overlapping, plural, interdependent civic institutions embodying diverse combinations of several basic strategies extend capabilities to develop in a sustainable fashion, even – especially – when confronted with surprise” (Rayner and Malone 1997). Members of the hazards community play a critical role in initiating the urgently needed national and global conversations on attaining this goal.

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Note

1. See *Natural Hazards Observer* January 2004 for an engaging invited scenario exploring this "Disaster Waiting to Happen."

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