Hazards and Sustainable Development in the United States

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It has become clear that natural and related technological hazards and disasters are not a problem that can be solved in isolation. Rather, the occurrence of a disaster is a symptom of broader and more basic problems. Since 1994 a team of over 100 expert academics and practitioners—including some from 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 and behavioral, and engineering sciences. The major thesis of the findings from this national project is that hazard losses, and the fact that there seems to be an inability in the US to reduce those losses, are the consequences of narrow and short-sighted development patterns, cultural premises, and attitudes toward the natural environment, science, and technology. A way is proposed for people and the US to take responsibility for disaster losses, to design future hazard losses, and to link hazard mitigation to sustainable development.

Key Words: Hazard mitigation; sustainable development

Introduction

A quarter-century ago geographer Gilbert F. White and sociologist J. Eugene Haas published a pioneering report on the ability of the United States to withstand and respond to natural disasters.[2] At that time, research on disasters was dominated by physical scientists and engineers. As White and Haas pointed out, little attempt had been made to tap the social sciences to better understand the economic, social, and political dimensions of extreme natural events.

White and Haas attempted to fill this void; but they also advanced the critical notion that rather than simply picking up the pieces after disasters, the US could employ better planning, land-use controls, and other preventive and mitigation measures to reduce the toll in the first place. Today, at long last, public and private programs and policies have begun to adopt mitigation as the cornerstone of the United States' approach to addressing natural and technological hazards.

The 1975 report also had a profound impact by paving the way for an interdisciplinary approach to research and management, giving birth to a 'hazards community'—those 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, seismology, and sociology. Professionals in those and other fields have continued to 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 help to reduce the resulting deaths, injuries, costs, and social, environmental, and economic disruption. These people have improved our understanding during and after disasters. Yet troubling questions remain about why more progress has not been made in reducing dollar losses.

One central problem is that many of the accepted methods for coping with hazards have been based on the idea that people can use technology to control nature to make themselves safe. What is more, most strategies for managing hazards have followed a traditional planning model: study the problem, implement one solution, and move on to the next problem. This approach casts hazards as static, and mitigation as an upward, positive, linear trend.

But events in the US during the past quarter-century have shown that natural disasters and the technological hazards that may accompany them are not linear problems that can be solved in isolation. Rather, they are symptoms of broader and more basic problems. Losses from hazards, and the fact that the United States cannot seem to reduce them, result from shortsighted and narrow conceptions of the human relationship to the natural environment.

To redress those shortcomings, a shift is needed to a policy of 'sustainable hazard mitigation'. This concept links wise management of natural resources with local economic and social resiliency, viewing hazard mitigation as an integral part of a much larger context of sustainable development. Many aspects of this strategy were implicit in the recommendations formulated by White and Haas a quarter-century ago. But to head off the continued rise in tolls from disasters, those principles must become more explicit.

This paper, and the report on which it is based,[3] reflect the efforts of over a hundred experts who have worked and debated since 1994 to take stock of the United States' relationship to hazards past, present, and—most importantly—future. Those contributions have been used to outline a comprehensive approach to enhancing society's ability to reduce the costs of disaster.

The roots of the problem

Many disaster losses, rather than stemming from unexpected events, are the predictable results of interactions among three major systems: the physical environment, which includes hazardous events; the social and demographic characteristics of the communities that experience them; and the buildings, roads, bridges, and other components of the constructed environment. Growing losses in the United States result partly from the fact that the nation's capital stock is expanding, but they also stem from the fact that all these systems and their interactions are becoming more complex with each passing year.

Three main influences are at work. First, the earth's physical systems are constantly changing, witness the current warming of the global climate. Scientists expect this warming climate to produce more dramatic meteorological events, such as storms, floods, drought, and extreme temperatures. Second, recent and projected changes in the demographic composition and distribution of the US population mean greater exposure to many hazards. The number of people residing in earthquake-prone regions and coastal counties subject to hurricanes, for example, is growing rapidly. Worsening inequality of wealth also makes many people more vulnerable to hazards and less able to recover from them. Third, the built environment—public utilities, transportation systems, communications, and homes and office buildings—is growing in density, making the potential losses from natural forces larger.

Settlement of hazardous areas has also destroyed local ecosystems that could have provided protection from natural perils. The draining of swamps in Florida and the bulldozing of steep hillsides for homes in California, for example, have disrupted natural run-off patterns and magnified flood hazards. And many mitigation efforts themselves degrade the environment and thus contribute to the next disaster; for example, levees built to provide flood protection can destroy riparian habitats and heighten downstream floods.

Another major problem has become clear over the past 20 years: some efforts to head off damages from natural hazards only postpone them. For example, communities below dams or behind levees may avoid losses from floods those structures were designed to prevent. But such communities often have more property to lose when the structures fail, because additional development occurred that counted on protection. Such a situation contributed to catastrophic damage from the 1993 floods in the Mississippi basin. And many of the dams, bridges, and other structures in the US are approaching the end of their designed life, revealing how little thought their backers and builders gave to events 50 years hence. Similarly, by providing advance warnings of severe storms, the US may well have encouraged more people to build in fragile coastal areas. Such development, in turn, makes the areas more vulnerable by destroying dunes and other protective natural features.

Who is at risk?

Research has shown that citizens of the US are typically unaware of all the risks and choices they face. They plan only for the immediate future, overestimate their ability to cope when disaster strikes, and rely heavily on emergency relief.

Hazard researchers now also 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. For example, non-minorities and households with higher socio-economic status fare better, while low-income households are at greater risk, mainly because they live in lower-quality housing, and because disasters exacerbate poverty.

The need for mitigation and response efforts that acknowledge the demographic differences among US citizens will become even more critical as the population becomes more diverse. Research is also needed, to shed further light on how mitigation programs ranging from public education to disaster relief can be equitably delivered.

Disaster losses are growing in the United States

From 1975 to 1994, natural hazards killed over 24,000 people and injured some 100,000 in the United States and its territories. About one-quarter of the deaths and half the injuries resulted from events that society would label 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 US has succeeded in saving lives and reducing injuries from some natural hazards, such as hurricanes, over the last two decades. However, casualties from floods, the nation's most frequent and injurious natural hazard, have failed to decline substantially, while deaths from lightning and tornadoes have remained constant. Meanwhile, injuries and deaths from dust storms, extreme cold, wildfire, and tropical storms have grown.

The dollar losses associated with most types of natural hazards in the US are rising. A conservative estimate of total dollar losses during the past two decades is $500 billion (in 1994 dollars). More than 80 per cent of these costs stemmed from climatological events, while around 10 per cent resulted from earthquakes and volcanoes. Only 17 per cent were insured. Determining losses with a higher degree of accuracy is impossible, because the US has not established a systematic reporting method or a single repository for the data. 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 result from events too small to qualify for federal assistance, and most are not insured, so victims must bear the costs.

Seven of the 10 most costly disasters in US history (based on dollar losses) occurred between 1989 and 1994. In fact, since 1989 the nation has frequently entered periods in which losses from catastrophic natural disasters averaged about $1 billion per week. The dramatic increase in disaster losses is expected to continue.

Many of the harshest recent disasters could have been far worse; had Hurricane Andrew been slower and wetter, or torn through downtown Miami, for example, it would have wreaked devastation even more profound than the damage it did inflict. And the most catastrophic likely events, including a great earthquake in the Los Angeles area, have not yet occurred. Such a disaster would cause up to 5000 deaths, 15,000 serious injuries, and $250 billion in direct economic losses.

A new approach to hazards

We have called upon researchers and practitioners alike in the hazards community to shift their strategy to cope with the complex factors that contribute to disasters in today's—and especially tomorrow's—world. The main guidelines for improving our ability to mitigate hazards are set out below.

Adopt a global systems perspective
Rather than resulting from surprise environmental events, disasters arise from the interactions among the earth's physical systems, its human systems, and its built infrastructure. A broad view that encompasses all three of these dynamic systems and interactions among them can enable us to find better solutions.

Accept responsibility for hazards and disasters
Human beings, not nature, are the cause of disaster losses, which stem from choices about where and how human development will proceed. Nor is there a final solution to natural hazards, since technology cannot make the world safe from all the forces of nature.

Anticipate ambiguity and change
The view that hazards are relatively static has led to the false conclusion that any mitigation effort is desirable and will in some vague way reduce the grand total of future losses. In reality, change can occur quickly and non-linearly. Human adaptation to hazards must become as dynamic as the problems presented by hazards themselves.

Reject short-term thinking
Mitigation as frequently conceived is too short-sighted. In general, people have a cultural and economic predisposition to think primarily in the short term. Sustainable mitigation will require a longer-term view that takes into account the overall effect of mitigation efforts on this and future generations.

Account for social forces
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, which are overlooked, and thus the extent of future disaster losses. Because such social forces are now known to be much more powerful than disaster specialists previously thought, a growing understanding of physical systems and improved technology cannot suffice. To effectively address natural hazards, mitigation must become a basic social value.

Embrace sustainable development principles
Disasters are more likely where unsustainable development occurs, and the converse is also true: disasters hinder movement toward sustainability because, for example, they degrade the environment and undercut the quality of life. Sustainable mitigation activities should strengthen a community's social, economic, and environmental resiliency, and vice-versa.

Fostering local sustainability

Sustainability means that a locality can tolerate and overcome damage, diminished productivity, and reduced quality of life from an extreme event without significant outside assistance. To achieve sustainability, communities must take responsibility for choosing where and how development proceeds. Toward that end, each locality evaluates its environmental resources and hazards, chooses future losses that it is willing to bear, and ensures that development and other community actions and policies adhere to those goals.

Six objectives must simultaneously be reached to mitigate hazards in the US in a sustainable way, and to stop the trend toward increasing catastrophic losses from natural disasters.

Maintain and enhance environmental quality
Human activities to mitigate hazards should not reduce the carrying capacity of the ecosystem, for doing so increases losses from hazards in the longer term.

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. To become sustainable, 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.

Foster local resiliency and responsibility
Resiliency to disasters means a locality can withstand an extreme natural event with a tolerable level of losses. Mitigation actions are taken consistent with achieving that level of protection.

Recognize that vibrant local economies are essential
Communities should take mitigation actions that foster rather than detract from a strong local economy.

Ensure inter- and intra-generational equity
A sustainable community selects mitigation activities that reduce hazards equally across all ethnic, racial, and income groups, and between genders, now and in the future. The costs of today's advances are not shifted onto later generations or less powerful groups.

Adopt local consensus-building
A sustainable community selects mitigation strategies that evolve from full participation among all public and private stakeholders. The participatory process itself may be as important as the outcome.

A long term, comprehensive plan for averting disaster losses and encouraging sustainability offers a locality the opportunity to coordinate its goals and policies. A community can best forge such a plan by tapping businesses and residents, as well as experts and government officials. And while actual planning and follow-through must occur at the local level, a great deal of impetus must come from above. Nothing short of strong leadership from state and federal governments will ensure that planning for sustainable hazard mitigation and development occurs.

Mitigation tools

Over the past few decades an array of techniques and practices has evolved to reduce and cope with losses from hazards and disasters. These and other tools will be vital in pursuing sustainable hazard mitigation.

Land use

Wise land-use planning that limits expansion into sensitive areas is essential to sustainable hazard mitigation. Indeed, land-use planning, hazard mitigation, and sustainable communities are concepts with a shared vision, in which people and property are kept out of the way of hazards, the mitigating qualities of the natural environment are maintained, and development is resilient in the face of natural forces.

Unfortunately, no overarching guidance informs development in hazard-prone areas of the United States. Instead, a patchwork of innumerable federal, state, and local regulations creates a confusing picture, and often reduces short-term losses while allowing the potential for catastrophic losses to grow. This scattershot approach, as well as the federal and state trend to cut risk and assume liability, have undermined the responsibility of local governments for using land-use management techniques to reduce exposure to hazards.

Warnings

Since the first assessment was completed, significant improvements in short-term forecasts and warnings (hours to days ahead of a hazardous event) have dramatically reduced loss of life and injury in the United States. Yet many communities lag behind in their ability to provide citizens with effective warning messages. The nation needs to make local warning systems more uniform, develop a comprehensive model for how they work, and provide this information, along with technical assistance, to local communities. Better local management and decision-making are now more critical than most future advances in technology.

It is also important to remember that short-term warning systems do not significantly limit damage to the built environment, nor do they mitigate economic disruption from disasters. Long-range forecasts that help define the risks to local communities years to decades ahead of potential hazards could assist local decision-makers in designing their communities to endure them.

Engineering and building codes

The ability of the built environment to withstand the impacts of natural forces plays a direct role in determining the casualties and dollar costs of disasters. Disaster-resistant construction of buildings and infrastructure is therefore an essential component of local resiliency. Engineering codes, standards, and practices have been promulgated for natural hazards, and local governments have also traditionally enacted building codes. However, investigations after disasters have revealed shortcomings in construction techniques and code enforcement. Codes, standards, and practices for all hazards must be reevaluated in light of the goal of sustainable mitigation, and communities must improve adherence to them.

Insurance

The US public increasingly looks to insurance to compensate for losses from many types of risk-taking behavior. However, most property owners do not buy coverage against special perils, notably earthquakes, hurricanes, and floods. For example, nationwide only about 20 percent of the homes exposed to floods are insured against them. Many people assume that federal disaster assistance will function as a kind of hazard insurance; but such aid is almost always limited, and even when larger amounts are available, they are usually offered in the form of loans rather than outright grants.

Insurance does help minimize some disruption by ensuring that people with coverage receive compensation for their losses as they begin to recover. The insurance industry could facilitate mitigation by providing information and education, helping to create model codes, offering financial incentives that encourage mitigation, and limiting the availability of insurance in high-hazard areas.

The 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. Furthermore, the current regulatory system makes it difficult for an insurance company to aggregate adequate capital to cover low-frequency but high-consequence events.

New technology

Computer-mediated communication systems, geographic information systems (GIS), remote sensing, electronic decision-support systems, and risk-analysis techniques have developed substantially during the last two decades, and show great promise for supporting sustainable hazard mitigation. For example, GIS models enable managers to consolidate information from a range of disciplines, including the natural and social sciences and engineering, and to formulate plans accordingly.

Remote sensing can be used to make land-use maps and show changes over time, to feed information to GIS models, and to gather information in the wake of disasters. Finally, decision-support systems can fill a gap in hazards management by analyzing information from core databases, including data on building inventories, infrastructure, demographics, and risk. The systems can then be used to ask 'what-if' questions about future losses, to inform today's decision-making. Such systems are now constrained by the lack of comprehensive local data, but they will become more important as the process of evaluating and managing risk grows in complexity.

Emergency preparedness and recovery

Even if encouraged by more holistic state and federal policies, sustainable hazard mitigation will never eliminate the need for plans to address the destruction and human suffering imposed by disasters. In fact, one way to progress toward sustainable hazard mitigation is by creating policies for disaster preparedness, response, and recovery that support that goal.

Since the 1975 assessment, a great deal of research in the US has focused on pre-disaster planning and response. Studies have found that pre-disaster planning can save lives and injuries, limit property damage, and minimize disruptions, enabling communities to recover more quickly.

Recovery was once viewed as a linear phenomenon, with discrete stages and end products. Today it is seen as a process that entails decision-making and interaction among all stakeholders, households, businesses, and the community at large. Research has also shown that recovery is most effective when community-based organizations assume principal responsibility, supplemented by outside technical and financial assistance. A shift even further away from an exclusive focus on restoring damaged structures toward effective decision-making at all levels may be needed. Outside technical assistance can help strengthen local organizational and decision-making capacity.

Local leaders too often fail to take advantage of the recovery period to reshape their devastated communities to withstand future events. Most 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.

Fortunately, revisions to disaster legislation in the last several years have allowed a greater percentage of federal relief monies to fund mitigation programs. Pre-disaster planning for post-disaster recovery is vital to communities' ability to become disaster-resilient.

Essential steps

The shift to a sustainable approach to hazard mitigation will require extraordinary actions. Several essential steps are set out below; many initial efforts are already under way in the United States.

Building local networks, capability, and consensus

Today, hazard specialists, emergency planners, resource managers, community planners, and other local stakeholders seek to solve problems on their own. An approach is needed to forge local consensus on disaster resiliency, and to nurture it through the complex challenges of planning and implementation.

One potential approach is a 'sustainable hazard mitigation network' in each of the nation's communities, which would engage in collaborative problem solving. Each network would produce an integrated, comprehensive plan linking land-use, environmental, social, and economic goals. An effective plan would also identify hazards, estimate potential losses, and assess the region's environmental carrying capacity. The stakeholder network especially needs to determine the amount and kind of damage that those who experience disasters can bear. These plans would enable policymakers, businesses, and residents to understand the limitations of their region and work together to address those limitations. Full consensus may never be reached, but the process is key because it can generate ideas and foster the sense of community required to mitigate hazards.

This kind of holistic approach will also situate mitigation in the context of other community goals that, historically, have worked against action to reduce hazards. Finally, the process will advance the idea that each locality controls the character of its disasters, forcing stakeholders to take responsibility for natural hazards and resources and realize that the decisions they make today will determine future losses.

Federal and state agencies could provide leadership in this process by sponsoring, through technical and financial support, a few prototype networks, such as model communities or regional projects.

Establish a holistic government framework

To facilitate sustainable mitigation, all policies and programs in the United States related to hazards and sustainability should be integrated and consistent. One possible approach toward this goal is a conference or series of conferences that enable federal, state, county, and city officials to reexamine the statutory and regulatory foundations of hazard mitigation and preparedness, in light of the principles of sustainable mitigation. Potential changes include limiting the subsidization of risk, making better use of incentives, setting a federal policy for guiding land use, and fostering collaboration among agencies, non-governmental organizations, and the private sector.

Other efforts to foster a comprehensive government framework could include a joint congressional committee hearing, a congressional report, a conference by the American Planning Association to review experiences in sample communities, and a joint meeting of federal, state, and professional research organizations.

Conduct a nationwide hazard and risk assessment

Not enough is known about the changes in or interactions among the physical, social, and constructed systems that are reshaping the nation's hazardous future. A national risk assessment should meld information from those three systems, so that hazards can be estimated interactively and comprehensively to support local efforts on sustainable mitigation.

Local planning will require multi-hazard, community-scale risk assessment maps that incorporate information ranging from global physical processes to local resources and buildings. This information is not now available, and will require federal investment in research on risk-analysis tools and dissemination to local governments.

Build national databases

The United States must collect, analyze, and store standardized data on losses from past and current disasters, thereby establishing a baseline for comparison with future losses. This database should 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. A second database is needed to collate information on mitigation efforts—what they are, where they occur, and how much they cost, to provide a baseline for local cost-benefit analysis. These archives are fundamental to informed decision-making and should be accessible to the public.

A central repository for hazard-related social science data is also lacking. This third central archive would speed development of standards for collecting and analyzing information on the social aspects of hazards and disasters.

Provide comprehensive education and training

Today, hazard managers in the United States are being called upon to tackle problems they have never before confronted, such as understanding complex physical and social systems, conducting sophisticated cost-benefit analyses, and offering long-term solutions. Education in hazard mitigation and preparedness should therefore expand to include interdisciplinary and holistic degree programs. Members of the higher education community will have to invent university-based programs that move away from traditional disciplines toward interdisciplinary education that solves the real-world problems entailed in linking hazards and sustainability. This will require not only new degree programs but also changes in the way institutions of higher education reward faculty, who now are encouraged to do theoretical work.

Measure progress

Baselines for measuring sustainability should be established now, so the US can gauge future progress. Interim goals for mitigation and other aspects of managing hazards should be set, and progress in reaching those goals regularly evaluated. This effort will require determining how to apply criteria such as disaster resiliency, environmental quality, intra- and inter-generational equity, quality of life, and economic vitality to the plans and programs of local communities.

Also important is evaluating hazard-mitigation efforts already in place before taking further steps in the same direction. For example, the National Flood Insurance Program, which combines insurance incentives, and land-use and building standards, has existed for 30 years, yet its effectiveness has never been thoroughly appraised.

Each disaster yields new knowledge relevant to hazard mitigation and disaster response and recovery, yet no entity collects this information systematically, synthesizes it into a coherent body of knowledge, and evaluates the nation's progress in putting such knowledge into practice. Systematic post-disaster audits, called for in the 1975 assessment by White and Haas, are still needed.

Share knowledge internationally

The United States must share knowledge and technology related to sustainable hazard mitigation with other nations, and be willing to learn from those nations as well. In the US and elsewhere, disaster experts also need to collaborate with development experts to address the root causes of 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.

The key role of the hazards community

To support sustainable mitigation, researchers and practitioners need to ask new questions, as well as continue to investigate traditional topics. Important efforts will include interdisciplinary research and education, and the development of local hazard assessments, computer-generated decision-making aids, and holistic government policies.

Future work must also focus on techniques for enlisting public and governmental support for making sustainable hazard mitigation a fundamental societal value. Members of the hazards community will play a critical role in initiating the urgently needed national and global conversations on attaining that goal.

Notes

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