Managing Natural Disasters and the Environment

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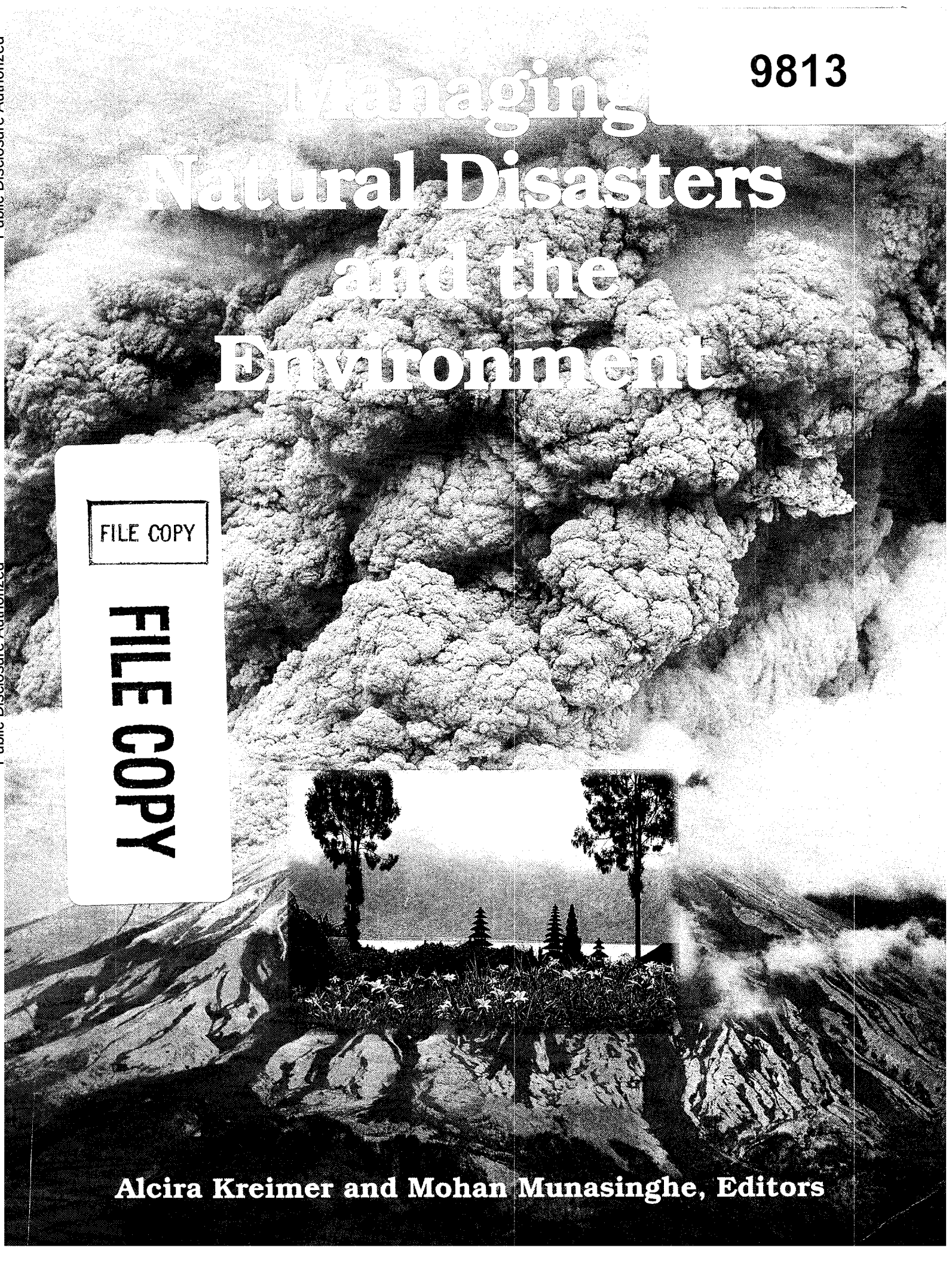

Alcira Kreimer and Mohan Munasinghe, Editors

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Selected Materials from the Colloquium on the Environment and Natural Disaster Management

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Edited by Alcira Kreimer and Mohan Munasinghe

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Foreword

Wilfried P. Thalwitz

The United Nations declared the 1990s the International Decade for Natural Disaster Reduction. The Ad Hoc Group of Experts for the IDNDR saw the Decade as a moral imperative and urged the application of scientific and technical knowledge to alleviate human suffering and improve economic security. Therefore, the World Bank has assembled for this important Colloquium on Disasters and the Environment some of the brightest minds in the fields of development and environmental and disaster management.

Why is this happening in the Bank? What do natural disasters have to do with an institution that has rather limited involvement in financing relief measures and little technical capability for predicting disasters? The connection is development itself. Poverty in the developing countries limits their resilience in the face of disaster. We have only to remember TV images of the earthquake victims in Iran, flood victims in Bangladesh, and, more vivid still, the emaciated victims of recurrent drought in the Sahel. In all these disasters, many more people died than needed to — and they died because of their poverty. They died for lack of transport, for lack of hospitals, for lack of shelter, for lack of food — they died for lack of means, generally.

You could express it another way: poverty keeps the insurance premium from being paid. There is no risk reduction without development — in the sense of growth and the accumulation of wealth, the ability to save and invest, the creation of functioning institutions, and investments in human capital. Development enables ex-ante precautionary measures to be taken that are an important application and expression of wealth — and makes it possible to cushion the impact ex post, when preventive measures are inadequate.

But development is not enough. Development is a necessary but not a sufficient condition for safety. And one purpose of this colloquium is to focus on ways in which the quality of development must be improved — to examine the important feedback loop between growth and the resource base. We recall that the United States allowed drought conditions — the Oklahoma "dustbowl" of the 1930s — to develop even though the agricultural practices of the time were known to be disturbing the American Prairie's delicate ecological balance. The small farmers lost their land to produce wealth for others.

Even humanitarianism is dangerous when it ignores long-term effects on the ecology. After the first drought in the Sahel, for example, many European agencies rushed to dig wells that would bring water. Cattle herds grew in number, the cattle devoured all available groundcover, and the water table dropped rapidly — because there was nothing to absorb even the little rain that did fall. The herders were worse off than they had been before. All the traditions that had seen nomadic families of the desert through in the past were of no use; the land had lost the ability to sustain animals because of the tube wells.

In short, development is needed to increase

developing nations' resilience in the face of disaster, but development efforts must not result in destruction of the natural resource base.

International efforts to combat global warming and to cooperate on the use of the seas are two components in a major change in resource use. We need to create a fund for poor countries so they can forgo the use of their resources in the short run — as called for in the Montreal Protocol and the Global Environmental Facility. Too often, costs fall on the poor in developing countries while benefits accrue to other, better-off countries.

We must also increase the capacity for scientific research. We can never reach the level of precision with data, or the security of prediction, that an insurance company is capable of — but we must improve our capabilities for measuring the risk of disaster. Better data on risk will allow us to develop policy and incentives to channel the use of our natural resource base in more benign ways. How we use these environmental assets has an impact on the entire world. We must understand the interconnectedness of development and the management of disasters and the environment.

Editors' introduction

The purpose of this volume is to explore the relationship of environmental degradation and vulnerability to disaster and their combined effects on both natural and man-made habitats. In the past three decades, the frequency of natural disasters has increased and the world has become increasingly aware of the relationship between the declining quality of the earth's environment and the frequency and severity of earthly catastrophes.

On June 27-28, 1990, the World Bank sponsored a colloquium in Washington, D.C., to promote the exchange of experiences of and ideas about the environment and disaster management. The colloquium was organized by the Environmental Policy and Research Division of the Bank's Environment Department in collaboration with the Agriculture and Rural Development Division of the Economic Development Institute and the Training Division of the Personnel Operations Department.

The colloquium was attended by about 170 people in a variety of agencies and institutions dealing with the environment and disaster management. The papers gathered here represent the concerns expressed at the colloquium and some of the lessons shared there about how to improve our management of disasters and the environment, through a better understanding of the important relationship between them.

The colloquium was held at the beginning of the International Decade for Natural Disaster Reduction (IDNDR), a time of great concern about reducing environmental degradation and preventing and mitigating disasters. On December 11, 1988, the United Nations designated the 1990s the IDNDR (through Resolution 42/169) in an effort to reduce the impact of disasters on development. The goals of the Decade are to:

- Improve each country's ability to mitigate the effects of natural disasters.
- Devise guidelines and strategies for applying existing knowledge.
- Foster scientific and engineering endeavors to reduce loss of life and property.
- Disseminate existing and new information about the assessment, prediction, prevention, and mitigation of natural disasters.
- Promote programs of technical assistance and technology transfer, demonstration projects, and educating and training tailored to specific hazards and locations.

The organization of this volume

The contributions in this volume have been grouped around four main topics: strategic issues, development (from vulnerability to resilience), risk management, and the coordination of efforts to reduce vulnerability to disaster.

Papers in the first section examine the implications of strategic global, systemic, and survival issues. The magnitude of the problems we face is discussed in papers on the possibility of global climate change and the drastic effects it might have on daily life and national economies. Erik Arrhenius sums up current thinking on the subject: although there is no definite scientific consensus, there is increasing agreement among scientists that the "greenhouse

gases" accumulating in the atmosphere will eventually raise the average worldwide temperature significantly, and such global warming may have profound effects. It is not clear when climate change will occur or what its precise effects will be, but should it take place the consequences could be disastrous. It is clear that we must formulate strategies for confronting potential disaster and measures to reduce our vulnerability to it. William Riebsame emphasizes the need for a prudent stance — not waiting for conclusive proof before making adjustments, and making adjustments that expand rather than limit future options for development, particularly low-cost options. Mary B. Anderson explains how inefficient and wasteful it is not to allocate resources to disaster prevention, now that all societies are potentially capable of forecasting and preparing for disaster. A case history of a Bank-financed project in Rio de Janeiro after Rio's 1988 floods (by Mohan Munasinghe, Braz Menezes, and Martha Preece) illustrates how such disaster mitigation efforts increase the resilience of disaster-prone areas. Neelam Merani emphasizes the link between natural hazards and environmental degradation and Stephen Rattien highlights efforts in this direction being made by the U.S. Committee on the IDNDR.

Papers in the second section of the book explore the continuum of responses to disaster, from vulnerability to resilience, examining different approaches to ensuring the sustainability of development. Some experts discuss options for prevention and mitigation, including adjustment to floods (Frederick Cuny), and indigenous adaptations to drought, locust infestations, and other disasters in Africa (Thomas Odhiambo and Daniel D.C. Don Nanjira). A case study of Pakistan illustrates how to counter environmental damage through income-generating activities that involve the very refugee communities that caused the damage in the first place. Manuel Aguilera Gomez, Michael Cohen, and Jelena Pantelic discuss the important issue of vulnerability in urban settings. Case studies on vulnerability underline the importance of adopting recovery mechanisms that promote the resilience of both man-made environments in Mexico City, Nepal, and China and natural environments in China and Brazil.

The third section focuses on risk management. E.L. Quarantelli and Parviz Towfighi discuss the differences and similarities between natural hazards and man-made emergencies, and identify generic issues that help define how best to organize institutions to deal with them. Other experts discuss some other approaches to managing risk: through market mechanisms (Andrew Natsios), insurance (Lloyd B. Falck), coastal zone management (John R. Clark), disaster preparedness (Idris Nur), and disaster training (Brian Ward). Hassan Hassan and Wayne Luscombe discuss technologies available for assessing risk. Chen Hong describes how technologies are being used to reduce risk in China.

Section four describes local, national, and international efforts to coordinate prevention, mitigation, and recovery efforts. Jonathan Brown and Mohamed Muhsin highlight efforts to coordinate a flood reconstruction program in Sudan. Stephen Bender describes a framework for managing material hazards. Seyril Siegel and Peter Witham describe experiences the UN Development Programme has had in reducing vulnerability, Kenzo Toki describes Japan's efforts to help developing countries, and Austin Fernando, Jurg Vittani, and Charles Sykes discuss the contributions of nongovernment organizations. A case study in Taiz illustrates efforts in prevention and mitigation at the municipal level.

To keep the text readable, footnotes and bibliographical references have been kept to a minimum. References for all papers will be found at the back of the book, as will a key to the acronyms and abbreviations that abound in the fields of development and disaster management.

The Colloquium was organized and coordinated by Alcira Kreimer, Senior Environmental Specialist. Michele Zador (consultant) assisted in the organization. Significant support came from Wilfried Thalwitz, V.N. Rajagopalan, Kenneth Piddington, Jeremy Warford, Alberto Harth, Surinder Deol, Nicholas Wallis, and Ernest Hardy. Cheryl Francis, Olivia McNeal, Mariatu Morton, Gail Thoms, and Marietta Visaya graciously provided administrative support. The thoughtful contributions of the panelists and moderators (listed on page 197), and the provocative questions and comments of those attending the conference reflected the uniqueness of the occasion — the convergence of specialists in two traditionally disparate areas, environmental management and natural disaster management. We are indebted to the World Bank for making possible both the con-

ference and this volume based on it.

We are grateful to the authors of the papers in this volume not only for preparing the papers but for submitting to the whittling and other editorial changes needed to convert conference papers into a coherent reflection of the main conference themes. Under Bruce Ross-Larson, the staff of the American Writing Corporation — particularly writer-editor Pat McNees — provided invaluable help in shaping these papers into a book that might be useful for readers who could not attend the conference. Alison Strong did a thorough final proofing. Kim Bieler of AWC designed and desktopped the manuscript, but not before its many versions first passed through the hands and word processors of Cheryl Francis and Lydia Maningas.

The papers by Cuny and Quarantelli were not presented at the conference but were prepared for this volume. The case studies were prepared as a result of discussions held at the conference. The authors of the case studies — on which Martha Preece worked particularly diligently — gratefully acknowledge the extensive help provided by the following people: Arne Dalfelt (for the case study of the Da Xing An Ling Forest Fire Rehabilitation Project); Christian Delvoie, S. Kowalski, Jaime Larrazabal, Maryvonne Plessis-Fraissard, and Jerry Vargas Ugalde (the La Paz Municipal Development Project); Ricardo Halperin, Felix Jakob, and Tova Solo (the Mexico Housing Reconstruction Project); William Beattie, Daniel Gross, and Rene Ruivivar (the Minas Gerais Forestry Project); Mary B. Anderson, Iain Christie, Chandra Godivitarne, Linda Lowenstein, Pat McCarthy, Grant Sinclair, and Mateen Thobani (the Nepal Municipal Development and Earthquake Reconstruction Project); Daud Ahmad and Paul Cadario (the North China Earthquake Reconstruction Project); Guy Motha and Michael Saddington (the Pakistan Income Generating Project); Michel Pommier and Mario Zelaya (the Taiz Flood Disaster Prevention and Municipal Development Project); Robert Nooter, Joe Searce, and Ronald Parker (the Sudan Emergency Flood Reconstruction Project). Ronald Parker also prepared a summary of conference proceedings.

Introduction

Managing environmental degradation and natural disasters: an overview

Alcira Kreimer and Mohan Munasinghe

A disaster is said to occur when an extreme event coincides with a vulnerable situation — surpassing a society's ability to control or survive the consequences. Not every crisis is a disaster. Natural crises — fires, floods, earthquakes, and drought — have always been part of the natural cycle; virtually all parts of the world have been at risk from them. But accelerated changes in demographic and economic trends have disturbed the balance between ecosystems, increasing the risk of human suffering, death, and destruction. Rapid population growth increases pressures on natural resources and the natural environment, and raises the consequent risks associated with human activities.

Disasters can be sudden or slow in onset. Sudden-onset disasters such as floods, fires, and earthquakes can destroy a country's infrastructure and commercial, industrial, and housing stock, leaving populations homeless and disrupting the country's productive base. Major disasters not only damage capital assets but are bound to have long-term effects on the economy. In a slow-onset disaster such as drought, the problems created by a scarcity of water are compounded by such long-standing problems as deforestation, rural poverty, soil erosion, and inefficient land-use and tenure patterns. Civil wars may be similar to slow-onset disasters in their impact on population movements. Refugees fleeing war in their own countries can put extraordinary pressures on the countries receiving them, threatening the sustainability of their hosts' natural resource base and severely disrupting the economy and social order.

There is some evidence of causal links between environmental degradation and vulnerability to disaster. Natural disasters are often caused at least partly by the same kind of tampering with the natural environment that concerns ecologists — and their impact on that environment is no less devastating. For example, the worldwide incidence per decade of extreme weather events — defined as events such as typhoons, hurricanes, floods, and drought, that cause more than, say, 20 deaths — has increased about 50 percent on average each decade between 1900 and 1990, accelerating significantly since 1950 (OFDA 1990).

The damage caused by extreme weather events has also escalated — increasing faster than population growth. Beginning with the 1950s (when comprehensive records began to be kept), deaths associated with these events have increased 50 percent each decade, whereas the corresponding population growth rate was only 20 percent. Economic costs per decade have also increased dramatically: from about US$400 billion in 1950-59 to 90 times that value in 1980-89.

This may to some extent reflect improved observation and reporting of weather as well as increasing economic and population growth. But it is hard to ignore the apparent correlation between the frequency and severity of such natural disasters and growing local and global environmental degradation, especially in the

second half of the twentieth century. It is also clear that developing countries are far more vulnerable than developed countries to both catastrophic events and deterioration of the environment.

Why are developing countries so vulnerable to disasters? As a result of poverty and population growth, the continual, uncontrolled alteration of environmental systems weakens the resistance of many countries to natural hazards. Vulnerability and poverty go hand in hand, and it is not easy to find quick fixes for them. Low agricultural output in depressed economic conditions forces farmers to increase the burden on agricultural resources and hence the likelihood of drought, floods, and landslides. Rangelands are heavily overgrazed and forest lands severely degraded by overexploitation and neglect. Acute shortages of firewood have accelerated the rate of deforestation, which, together with destruction of the vegetative cover on natural pastures, has increased the threat of floods and the deterioration and desertification of previously fertile land. Similarly, rapid population growth, especially in urban areas, has overburdened public services and natural resources. Many urban settlers are poor and cannot afford properly serviced homesites. They have become a great threat to the natural environment of cities. Landless squatters concentrate in fragile, often marginal areas, increasing the cost and magnitude of natural crises.

How environmental degradation intensifies disasters

One disaster often leads to another: high windstorms are followed by floods and landslides, floods by drought, and drought by pest epidemics and famines. Such chains of disaster result partly from the tendency of natural disasters to debilitate the environment; they are aided in this by some human activities. The same cycle results whether the cause of degradation is natural or springs from human effort. But environmental degradation intensifies the effects of disaster.

Floods are generally considered to be fast-onset disasters, but their root cause may be partly a history of progressive environmental degradation. Floods are generally triggered not by exaggerated rainfall but by the silting up of rivers, the reduced absorptive capacity of soil, flawed infrastructure planning, and inadequate maintenance of existing facilities. Uncontrolled deforestation, which contributes heavily to soil erosion and water runoff, sets the stage for flash floods and landslides.

Similarly, the unrestrained felling of trees and grazing of livestock that often accompany rapid population growth accelerate the degradation and increase desertification of overgrazed arid and semiarid ranges. In urban areas, poor planning, inappropriate design, faulty construction, inadequate maintenance, and squatter settlements on disaster-prone land all contribute to both environmental degradation and increased vulnerability to catastrophic events.

In many developing countries, overcrowding, congestion, poverty, unemployment, and inadequate infrastructure and services further weaken urban resistance to natural hazards. As a result of inadequate policies, accumulated garbage and human waste often turn a flooded area into an open, overflowing sewer.

Extensive development on high-risk sites, combined with deforestation and the dumping of solid wastes in rivers and canals, increases susceptibility to the landslides that often follow floods. Clogged drains are worse than no drains at all in flood-prone areas — and silted-up drains or riverbeds exacerbate a flood's impact on precarious soil. The geology and climate of some areas contribute to the prevalence of landslides. The warm, wet climate of the Caribbean, for example, makes it susceptible to landslides. In China, limited knowledge about landslide identification and prevention led to excavations on and the reactivation of ancient landslides. Numerous landslides occurred during the construction of the Baocheng railway (1954-57).

Drought is often attributed to nature's capriciousness — the uncontrollable, unpredictable lack of rain — but experts now question this association. Drought-induced famine has occurred in North Africa, with desertification of the Sahel, yet no evidence exists that rainfall levels in the past 100 years have declined there, in the Sahara (to its south), or in the Middle East. The Caribbean pseudodroughts in the midst of tropical rainfall reinforce the popular association of rainfall and drought. But lack of groundwater — not rainwater — appears to be the central cause of drought.

In Haiti, deforestation has reduced the soil's capacity to absorb water. Despite steady rainfall, waters run off the razed hillsides and offer little benefit to crops. To all intents and pur-

poses, the effect is that of a drought, despite normal rainfall. Even in flat areas — such as rice paddies in the Philippines — pseudodrought has been traced to deforestation through traditional slash-and-burn agriculture. Overgrazing, overcultivation, and the inappropriate use of mechanized agricultural methods also contribute to the cycle of erosion and drought. The U.S. "dust bowls" in the 1930s came about after the prairies of the Great Plains were transformed into wheat farms. In the Soviet Union, the substitution of cereal crops for the natural groundcover of the Central Asian steppes in the 1950s led to desertification and drought in the mid-1960s. In the Sahel, overgrazing, deforestation, and overcultivation reduced the amount of topsoil and compacted what soil remained, leading to the rapid superficial runoff of waters that the soil barely absorbs. Whether torrential runoffs are considered floods or not, when waters slide over topsoil without penetrating it, the effect is drought or pseudodrought.

Deforestation leads to drought both directly and indirectly. In Nepal, the lack of firewood has led farmers to burn cow dung for cooking fuel, reducing the amount of available fertilizer and thus reducing the fertility of the agricultural land — increasing erosion even in areas far removed from forested areas. Continuation of the present trend may create a semi-desert ecology in the hilly region.

Asia Ram (1987) writes of how environmental degradation, especially deforestation, has fed drought in India:

> On bare slopes, rainfall is no longer held back to soak into the land and replenish the water table. Instead it steams off rapidly into rivers and back to the sea. Paradoxically, India is one of the wettest countries in the world...yet people still go without water.

Sometimes introducing a water supply system to semiarid lands causes environmental degradation because herds grow more rapidly and destroy the local vegetation that helps maintain topsoil.

One disaster often leads to another. The risk of a naturally ignited fire becoming an uncontrollable disaster is viewed increasingly as a function of the degradation of the forest environment. Forest areas are particularly susceptible to wildfire, a quick-onset form of disaster that may be set off by a volcano, lightning, or human carelessness. Furthermore, uncontrolled fires cause extensive environmental damage, altering ecosystems, increasing the potential for erosion and water runoff, and thus increasing a region's vulnerability to other hazards. The rapid destruction of forests by uncontrolled conflagration has been known, for example, to spark virus epidemics that outlive deforestation. Poor people clear lands illegally for farming, using slash-and-burn techniques that denude forests and escalate the risk of fire. Even settling in a wooded area increases the damage wildfires may cause. Uncontrolled fires can cause significant losses of life and economic resources; their catastrophic consequences cannot be discounted or ignored.

Earthquakes are natural, but the amount of damage they cause is largely a function of development decisions. The growth of cities — particularly the rapid expansion of slums and squatter settlements, where vulnerability is highest — has increased the cost and magnitude of earthquake disasters. Significant losses are often the result of inadequate design, poor building techniques, poorly supervised construction, and the effects of poverty — often compounded by years of neglected maintenance and reduced public and private investment. Physical and social preventive measures can save many lives, the main goal of hazard reduction. Some of the mechanisms available to reduce losses from and vulnerability to earthquakes are fiscal incentives (or disincentives) and the prevention of construction on vulnerable sites through land-use planning and the enforcement of reasonable zoning regulations. The challenge is to manage development, not constrain it.

Disaster prevention and mitigation

Both disasters and environmental degradation threaten human and natural habitats, but disasters are often seen as motors of natural change quite beyond human control — which is not true. Prevention does not mean halting such trigger events as earthquakes and cyclones but rather minimizing their impact on our environment.

Disaster experts often say there is no such thing as a natural hazard — that a disaster is not a physical happening but a communal event, the result mainly of human actions. In other words, catastrophes could not exist without social

actions and human decisions. Floods, landslides, wildfires, earthquakes, drought, and other so-called natural disaster agents have social consequences only because of individual and community activities before, during, and after an extreme event. Social action or inaction — allowing dense populations on a floodplain or allowing poor or unenforced building codes in earthquake zones, delaying evacuation from flood or fire areas, allowing the degradation of natural resources — is as likely as a natural event to cause casualties, property and economic losses, and the disruption of everyday life.

What this implies is the need for proactive measures, not passive reaction. Rather than wait for a disaster to occur, countries and communities must take appropriate action beforehand. It may be impossible to prevent the earth from shaking, but we can discourage or forbid human settlements on unstable sites. We can encourage farming practices that will not degrade the land, thereby decreasing the risk of floods and landslides and reducing the incidence of drought. Planning fiscal incentives, and control of land use can be major instruments for disaster mitigation. Public policies and programs can reduce social vulnerability. Making disaster prevention and mitigation integral parts of development requires action.

Recent years have brought increased awareness of the need to reduce vulnerability to natural disasters by limiting the harmful effects on the environment of economic activities. In developing countries, losses from disasters impose a significant burden on governments, institutions, and human communities. Policies and projects that strengthen local capabilities to reduce losses can only strengthen development and sustainable growth.

Recognizing the important relationship between disasters and environmental degradation, the Bank has increasingly supported prevention and mitigation programs to reduce the vulnerability of disaster-prone countries to natural hazards. These programs address the need for important changes in policies and priorities, particularly to limit economic development's contribution to environmental deterioration and ecological crisis. For example, the Bank has funded projects to improve local disaster planning and prevention capabilities (in Rio de Janeiro), to help improve disaster preparedness, mitigate the risk of natural hazards (in China and Nepal), control floods and reduce the impact of landslides (in Bolivia), and increase the ability of forest resources to survive wildfires (in China). Such projects are described in the case studies to be found in this volume.

Strategic issues

Climate hazards, climatic change, and development planning

William E. Riebsame

The increased risk of climate hazards calls for a new approach to development planning. Development planners must develop a strategy that reflects (1) the sensitivity of resource systems to variations in climate, (2) uncertainty about climate change and how that uncertainty can be incorporated into an expanded repertoire of responses, so decisionmakers are not pressured into premature action or paralyzed by uncertainty, and (3) awareness of development's effect (good or bad) on the "greenhouse" problem and on social adaptability to climate problems. The development planners' repertoire should include actions that are easily and cheaply implemented and reversed and adjustments that expand rather than limit future options (such as efforts to conserve crop diversity). Planners should expand on a "tie-in" strategy that links the uncertain threat of climatic change to the certainty that current resource management systems (from power generation to agriculture) contribute to current environmental problems (such as acid rain and erosion). The mitigation of current natural hazards should be linked to concerns about climate warming so that actions taken today have both immediate and long-term benefits, whether the greenhouse effect materializes or not.

Climatic fluctuations pose hazards to agriculture, water, and other resource systems. It can be argued that better management of current fluctuations and extremes would reduce not only some constraints on development but also vulnerability to future climate changes.

Many atmospheric scientists predict that human activity will warm the global climate in the next several decades, but uncertainty about the rate and magnitude of change in specific regions is so great that it is difficult to plan resource development with global warming in mind. Moreover, growing public interest in an international treaty to reduce emissions of greenhouse gases is putting pressure on development planners to mitigate the causes and effects of anthropogenic climatic change. Planners who have assumed that environmental conditions would remain the same and who have sought local sensitivity in development plans must now add *global* considerations to regional development plans, responding to a threat the outlines of which are still fuzzy. The threat of global warming calls for a new approach to regional development planning, one that includes:

- Analysis of the sensitivity of resource systems to climate fluctuations.
- A gradual stepping up of responsiveness as

the threat of global warming becomes more certain.

- Consideration of a wider range of adjustment options.
- New links between multiple development goals (for example, economic and environmental well-being).

The threat of global warming

Many scientists argue that changes in climate attributable to human behavior are likely to emerge from the noise of natural climate variations in the next decade or so — and some analysts believe that record warm temperatures in the 1980s are a signal of global warming (Hansen and others 1988, Hansen and Lebedeff 1988). Average temperatures are likely to increase roughly 3 degrees Celsius in the next century according to several scientific groups (World Meteorological Organization 1985, Carbon Dioxide Assessment Committee 1983, IPCC 1990). Recent debates about the reliability of global warming projections offer no compelling new evidence for or against the threat (Michaels 1989, Lindzen 1990, Schneider 1990), but illustrate the great uncertainty and limited understanding of climate dynamics.

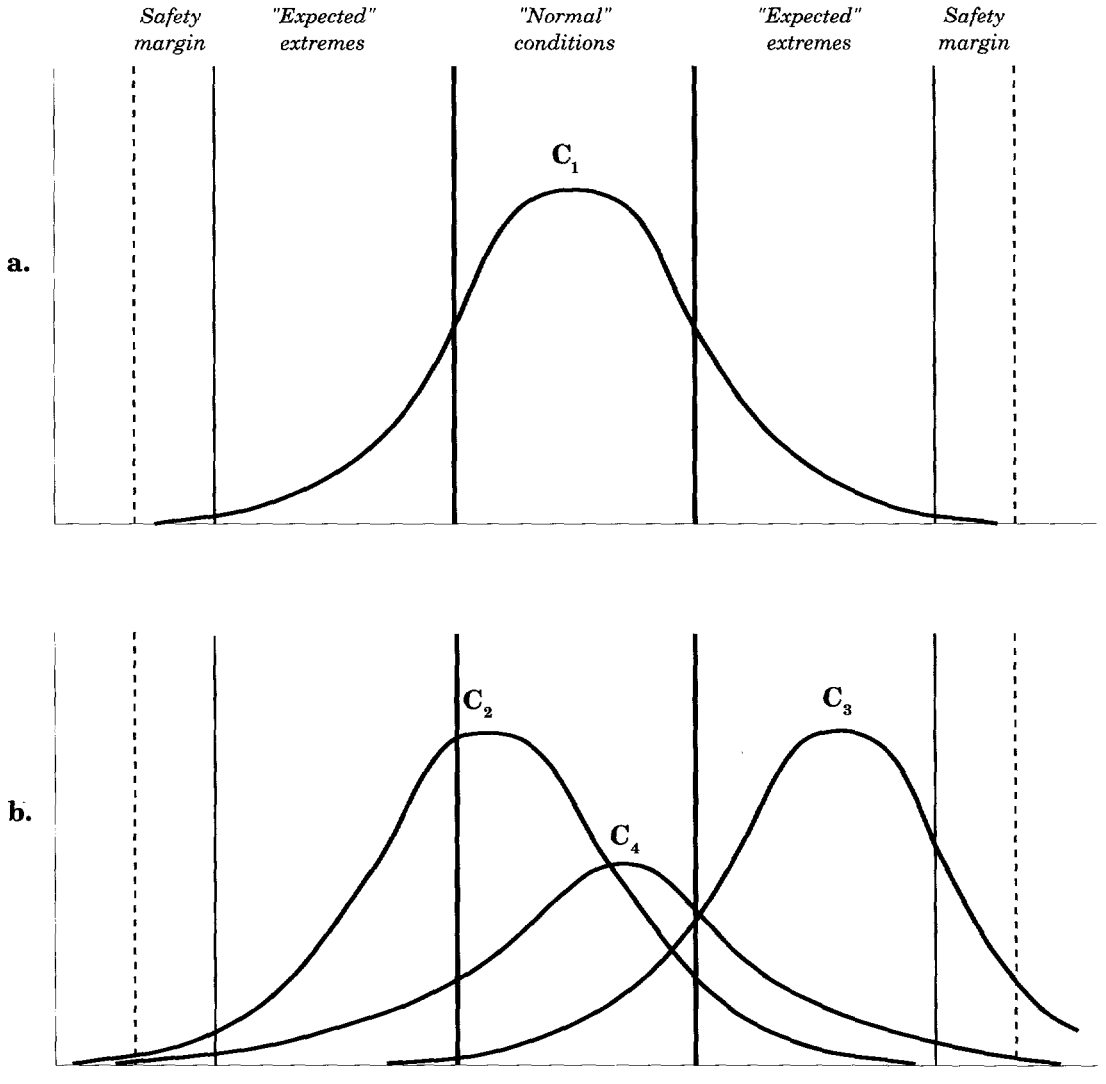
We do know that current extremes of climate regularly disrupt social well-being (National Academy of Sciences 1987, Riebsame and others 1986). Droughts in India or the Sahel, floods in Bangladesh or the Sudan, and frosts in Brazil or Papua New Guinea demonstrate the critical relationship between climate and development (see, for example, Kates 1980). The ability to cope with fluctuations in climate varies among regions: the least developed areas suffer the most from climatic hazards and face the most problems if the climate changes.

Climate is an intellectual construct: the statistical properties of the atmosphere, averaged over time. Fluctuations and extremes of climate are expressions of the tails of the current distribution of temperature, rainfall, storms, and the like. Climatic *change* is a shift in their distribution over time (figure 1). Both can add stress to regional development projects, but while climatic extremes are certain to affect all regions, there is great uncertainty about whether we face significant climatic change per se.

Despite the uncertainty, development planners should examine the potential implications of climate change. The changes predicted by global warming theorists in the next several decades may seem modest, but recent experience indicates that climatic change of this magnitude would severely disrupt ecological and social systems. A broad review of studies of the effect of climate in the last two decades reveals a common, disturbing pattern (see Kates and others 1985, Riebsame 1988c, Parry and others 1988). Existing research indicates that:

- In some localities and natural resource sectors, relatively small changes in climate can be quite disruptive. Modern systems for managing and using water, energy, agriculture, and forests are generally flexible, but in some (for example, semiarid) regions, climatic changes much smaller than one could expect with the doubling of the greenhouse effect threaten to alter resource flows markedly (see, for example, Parry and others 1988, Bolin and others 1986, Riebsame 1988a).
- There are major disparities in our understanding of the effects of climate. We understand fairly well how climatic change affects agricultural, water, and energy systems, but we know much less about how it affects fisheries, grasslands and livestock systems, human health, transportation, urban development, and the general economy (see, for example, Kates and others 1985). Our understanding of how climate and resources interact is especially fuzzy at environmental and social interfaces — the complex interactions between, for example, crops and soil (affected by soil temperature, erosion, and so forth), fisheries and wetlands (perhaps destabilized by rising sea levels), and different resource management institutions.
- The net consequences of global warming remain ill-defined. Productivity could decline catastrophically in some areas as the result of climatic extremes or rapid climatic change. Forests, for example, could produce less because of wildfires; agriculture could suffer from outbreaks of new pests or diseases; water could be scarce or excessive because of extreme events; changes in habitat could affect the viability of species. On the other hand, mitigating factors could produce unexpected gains. Ambient carbon dioxide could enhance biomass; warmer ocean temperatures or coastal inundation could improve fisheries; societies could adapt to changing conditions (a process poorly understood; see Butzer 1980), possibly through the transfer of new technologies and resources from

Figure 1 Schematic relationship between environmental engineering systems and climate variables



a. Normal conditions.
b. Hypothetical new climates with altered frequencies of events approaching or surpassing operating limits.
Source: Riebsame 1990.

"winners" to "losers" as part of the international response to the threat itself. At this time, it is difficult to estimate the balance of positive and negative effects, but most analysts expect global warming to produce a net loss, if for no other reason than that it brings change and increases uncertainty.

• Finally, there is a growing sense that the effects of global climatic change will be socially divisive. Developing countries are widely believed to be especially vulnerable because those countries have fewer options and limited resources with which to adjust to or recover from the effects of climatic damage — as experience with natural hazards and recent fluctuations in climate shows (Jodha 1989, Woods Hole Research Center 1989). Thus, the distribution of the benefits and costs of greenhouse gas emissions is unlikely to be equitable.

Even at the lowest rates projected for the greenhouse effect, it appears that climate change could greatly disrupt activities in certain places and cultures. Thus, despite uncertainty about global warming projections, a consensus is emerging on why and how global warming should

be limited (Mintzer 1987 and 1988, Lashof and Tirpak 1989, Jager 1988). The technical feasibility of markedly reducing greenhouse gases has been demonstrated; the potential for needed social change is less clear. A common approach is to stress the logic of taking actions that pay off — for example, increased energy efficiency — even if the dangers of global warming have been exaggerated. This "tie-in," or no-regret, strategy, links the uncertain threat of climatic change to the certainty that current energy systems waste resources and cause pollution (Schneider 1989).

Proponents of tie-in strategies assume that the threat of global warming sufficiently increases the probability of human damage to the environment to make compelling the need for actions that people have not yet seen fit to take (such as pricing fossil fuels to reflect the full environmental costs of their use). This assumption makes sense, but behavioral studies have identified several factors that limit people's ability to solve resource management problems such as increases in greenhouse gas: their attitudes toward development; their tendency toward temporal discounting; their limited ability to assess risks; and institutional constraints on individual or collective choice. Nor have such actions been supported with full analysis of the risks and benefits of trying to limit, or simply ignoring the possibility of, global warming.

If strategies to limit global warming fail, and if significant climate change occurs, one option is for social systems to adapt. This possibility has received less attention than others. Indeed, one weakness of studies of the effect of changing climates is that they are static — resource systems are often portrayed as having little potential for change. Can our resource systems adjust to the negative effects of climatic change? We do not know with any certainty, nor do we have robust methods for assessing adaptability. Some researchers expect social systems to adapt readily through technological innovation (Wittwer 1980, Waggoner 1983) and economic adjustment (Easterling and others 1989) but the process of adaptation is rarely described explicitly (Riebsame 1988a). On the other hand, concern about global warming is driven mostly by the intuitive belief that the rate of change will outstrip our ability to adapt. The truth probably lies somewhere between these two positions. There is substantial historical evidence that most agricultural systems, water resources, industrial processes, and settlement infrastructure are quite adaptable, but that the less-managed eco-resource systems — such as grassland and grazing systems, forests, and fisheries — often adapt less well to change. Any policy response must address such differences.

The policy response

Global warming is now a high-priority national and international policy issue. Projections of its impact have led to calls for concrete action to alter energy, agricultural, and forestry practices so as to reduce greenhouse gas emissions. Nations are lining up either for (most of the OECD) or against (United States, USSR) quickly reducing greenhouse gas emissions. The issue was the centerpiece of the Second World Climate Conference in October 1990, and will be high on the agenda for the 1992 Conference on Environment and Development.

The potential for ameliorating climatic change by altering energy and industrial systems has been analyzed extensively. Much less attention has been paid to how well systems for managing climate-sensitive resources can cope with rapid climate change (Rosenberg and others 1989). Yet global warming of 1 to 2 degrees celsius could occur in the next few decades even if greenhouse gases are limited — because of accumulated gases and thermal inertia (Jones and others 1987). If projections of global warming are correct, both preventive and adaptive steps will be needed.

A development planning conundrum. Conventional planning assumes that social factors such as population may change dramatically but that basic environmental elements such as climate are stable. The threat of global warming changes undermines this paradigm. Climatic change would affect the ability of resource management plans to meet future social needs and desires. Moreover, because global warming is caused by human behavior, one must also ask how those plans contribute to the problem.

Some policymakers are responding to pressures for quick action to stem the greenhouse effect without waiting for more scientific understanding of the problem (White 1988). But most resource managers have adopted a wait-and-see attitude and are being criticized for failing to

address the issue aggressively (U.S. Senate Agriculture Committee 1989, *New York Times* 1989). The wait-and-see approach is supported chiefly by three arguments:

- That predictions of climatic change are too uncertain, especially regionally, for specific action (White 1988, Katz 1988).
- That current systems can absorb significant climatic change without failing (Hanchey and others 1988).
- That technological change can offset the negative effects of climatic change (Wittwer 1980).

These arguments have merit. Projections are insufficiently detailed regionally for rational alteration of development plans. It is premature to build new reservoirs or plant different tree species because of the greenhouse threat. But current planning approaches fail even to assess the threat in climate-sensitive resource sectors, or to try dealing better with fluctuations in the current climate. Resource managers are also dissuaded by policy from accounting for potential impacts of their actions on such global commons as the atmosphere and climate (Schelling 1983).

The conundrum, then, is how — faced with uncertainty — to respond to pressure for action. Development planners must develop a strategy that reflects (1) the sensitivity of resource systems to climate fluctuation, (2) uncertainty about climatic changes and how that uncertainty can be incorporated into their repertoire of responses, and (3) awareness of the effect of development (good or bad) on the greenhouse problem and on social adaptability to climatic fluctuations. What is needed is a new paradigm for natural resource planning appropriate to the policy environment being shaped by the threat of global warming (Riebsame 1988c).

A new approach to development planning

The threat of global warming calls for a new approach to development planning, one that builds on (rather than replaces) traditional planning approaches that emphasize empirical analysis, economic efficiency, and environmental protection. The new approach should incorporate at least three elements:

- Sensitivity analysis of resource systems that explicitly recognizes the potential for both variability and fundamental environmental change.
- Gradual adjustment that reflects increasing certainty about the effects of global change.
- A wider range of adjustment options that reflect recognition of links between the causes and effects of climatic change generated by human behavior as well as the value of mitigating current climatic hazards to reduce current and future vulnerability.

Sensitivity analysis of resource systems

The management of most renewable resources — and of some stock resources such as fossil fuels — is sensitive to climatic fluctuation (Kates and others 1985). Factors affecting sensitivity and adaptability include:

- The degree to which factors such as temperature and precipitation affect resource yield or the maintenance of desired management criteria.
- The planning horizons for changes in resource systems.
- How often operational criteria are evaluated and updated.
- Whether potential effects may be incidentally accommodated or exacerbated as planners seek other goals such as more efficient use of energy or water.

Sensitivity to climatic change is especially evident in certain areas: agriculture, forestry, floodplains and coastal zones, water and energy resources, and certain aspects of architecture and urban and regional planning.

Unfortunately, the sensitivity of most natural resource and social systems to climatic change has not been analyzed (Warrick and Riebsame 1981). Planners need to assess how different climatic conditions would affect current resource systems and those systems as they might change over time. Analysis of a range of scenarios will provide a more robust evaluation of sensitivity than use of a single projection (Katz 1988, Lamb 1987, Wigley and others 1986).

While interest is high and before climatic change has had a chance to be disruptive, development planners should assess the sensitivity and adaptability of different resource systems and management practices. Many methods for

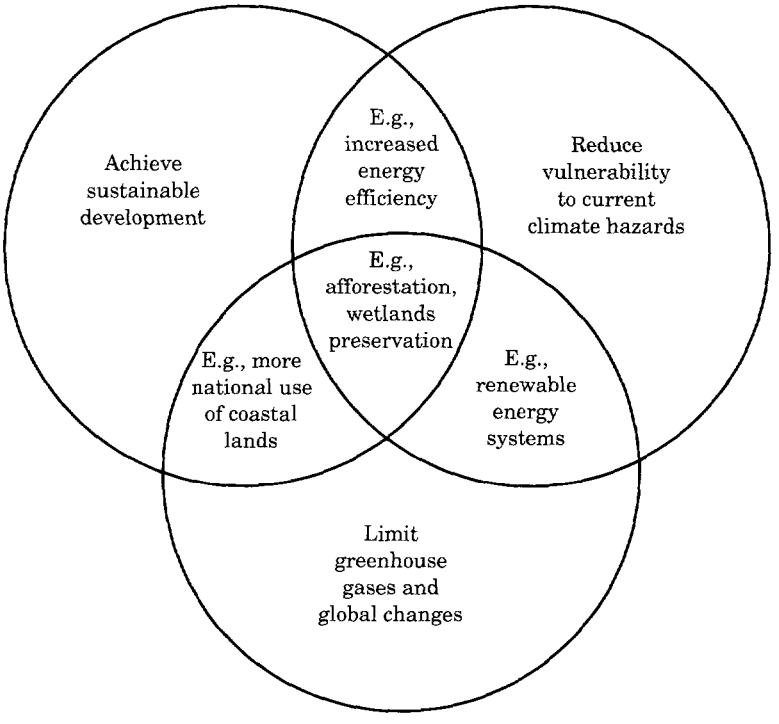


Figure 2 An illustration of the tie-in between efforts to achieve sustainable development, reduce losses from material disasters, and limit global climate change

assessing the effect of climatic change have been developed in the last decade and can be applied to both current variations and broad fundamental changes in climate (for example, Riebsame 1988b). Projections of climatic change are too uncertain to warrant specific action now, but what is needed is a wide range of evaluations of resource systems' capacity to adapt to both variations and broad changes in climate — and resource managers should create contingency plans for such changes.

Gradual adjustment

Heightened concern about global warming has elicited demand for immediate mitigating action. The next several years will see a marked improvement in climate forecasting and possibly conclusive detection of climatic change distinctly attributable to human activity. Development planners should differentiate between steps to be taken immediately and those that should await further refinements of climatic projections or more solid evidence of global warming.

Resource managers cannot be expected to adopt costly or disruptive adjustments aimed at reducing the impact of uncertain changes. Nor are they likely to support drastic changes to limit emissions of greenhouse gases. But neither can they ignore the issue. They should focus first on adjustments that can be justified for other environmental or economic reasons, such as more efficient use of water or more flexible systems (Schneider 1989).

At the same time, they should give serious thought to planning for climatic change per se, especially for resource systems that might fail with modest climate change. Slight warming and drying of northeastern Brazil, the Great Plains of the United States, or the Asian steppes, for example, could disrupt social systems there, requiring enormous changes in land use and resource management (Parry and others 1988). A first step might be to assess how current development paths affect adaptability to a changing climate and to identify trends that limit flexibility. Contingency plans should be made for changes in cropping patterns, resource protection, and rural development. They can be put into effect as the change in climate becomes more certain, and may yield benefits even without climate change.

Expanding the repertoire of responses

To avoid being pressured into action prematurely or paralyzed by uncertainty, development planners must consider a wider repertoire of planning approaches than they have traditionally used. Their responses should include adjustments that are easily and cheaply implemented and reversed as needed (such as more frequent evaluation of operating rules for reservoirs) and adjustments that expand rather than limit future options (such as efforts to conserve crop genetic diversity, and floodplain or coastal land use that places less fixed investment at risk).

Planners should expand on the tie-in strategy proposed by several analysts (Schneider 1989). They should take immediate steps to reduce greenhouse gas emissions, steps that are also justified because they would help resolve current environmental problems such as acid precipitation. They should also take steps to make resource management systems less sensitive to current climatic variations and more adaptable to future climatic change. These strategies coalesce where (1) the needs for sustainable development are met, (2) sensitivity to *current* and future fluctuations in climate are reduced, and (3) emissions of greenhouse gases and other global changes are limited (see figure 2).

Efforts to reduce losses from natural hazards, especially those associated with extremes of climate, will make development less sensitive to climate change, should it occur. At the very least, they will help us sharpen analytical tools for assessing the effects of climatic change and informing governments about regional vulnerabilities to variations in climate.

Regional development in the context of global change

The global nature of the greenhouse problem requires new links between local, national, and international decisionmaking and a better understanding of the role of climate in development. Many resource activities — from power generation to the cultivation of rice — are sensitive to climate *and* produce greenhouse gases. So policy discussions on global warming inevitably embrace links between national resource planning and the global threat. Resource planners at all levels must be prepared to address both how climate change affects their plans and how their activities affect global warming.

How this heightened concern will translate into altered development policy remains uncertain, but the general shape of imminent change can already be discerned. Several principles appear to be emerging from the international dialogue on global warming (World Meteorological Organization 1989, Woods Hole Research Center 1989). First, the greenhouse problem has been caused chiefly by the industrialized nations, which must bear the main burden of its solution. Second, solutions must accommodate Third World needs for economic development. Developing countries cannot be asked to limit greenhouse gas emissions by using less energy, cutting less timber, or cultivating less rice — without equal or better substitutes for the resources those activities yield. Finally, developing countries are most at risk with both current extremes of climate and long-term climate change, so they deserve special attention to help improve their ability to deal with the effects of climate change.

Under these principles, resource planners — even local planners — will be under pressure to change their activities to meet multilateral objectives. Planning principles and global links will be shaped at the highest policy levels, presumably through the international treaty already called for by several political and scientific leaders (World Meteorological Organization 1989: 292-99). Expecting this, development planners at all levels should begin to build a roster of mechanisms that would link planning goals (figure 2) and begin evaluating ways to fit local resource decisions into the emerging global environmental policy framework. Regional forest managers, for example, might begin to account for and alter the carbon balance of their activities in accordance with international agreements (Sedjo 1989) and to measure how reforestation could reduce the impact of climatic change. Links between the use of land and the effects of climate change should be evaluated. National energy ministries could increase research on noncarbon energy systems and on ways to implement them without derailing economic growth. In this way, the threat of global warming adds novel dimensions to traditional planning approaches.

Recommendations

It has been suggested that the best way to prepare the world for climatic change is to

achieve full, sustainable development. The fact that developed countries are better able than developing countries to deal with such natural hazards as droughts and floods has not been lost on those arguing for more equitable development. But development makes sense only if it does not increase a region's vulnerability to climatic impacts. The obvious path for development planning sensitive to the threat of global warming *and* to losses from natural hazards is first to improve our ability to manage current hazards.

Improved planning for drought and more flexible uses of floodplains and coastal zones would begin to reduce vulnerability to climate. Working climate vulnerability analysis into current development programs requires that planners:

- Analyze selected plans for developing regions (such as the Mekong or Indus basins) for sensitivity to climate, analyzing a range of adjustments to climatic extremes. Methods are now available for such analysis.
- Work with regional planners and resource managers to increase understanding of the effects of climate change and the cause of global change, and to expand the range of adjustments they consider in development projects.
- Link mitigation of current natural hazards to concerns about climate warming so that actions taken today have both immediate and long-term benefits.
- Improve institutional ability to assess the effects of, and possible adaptations to, climate change.

This last recommendation addresses a concern expressed especially by scientists and policymakers in developing countries: that the issue of the effects of climatic change — whether natural or from human causes — has been defined by research in developed countries. Strengthening institutions would speed the development of climate policies in developing countries, but this will occur only when climate is recognized as a natural concern and when the developing countries can calculate the risks of climate change through their own analysis of the threat.

Which costs more: prevention or recovery?

Mary B. Anderson

The basic argument for integrating disaster awareness into development planning is that it is wasteful not to do so. The value of property lost to disaster (the absolute value of direct costs) is higher in developed than in developing countries, but losses as a percentage of national wealth are 20 percent higher in developing countries. Disasters particularly hurt developing countries because poverty and disasters are mutually reinforcing, undermine incentives for development, and particularly hurt the nonformal sector. Societies do not choose between disaster prevention or recovery — they usually "buy" some of each. The question is, how much of each to buy. By and large, developed nations choose disaster prevention over recovery. In weighing options, methods of cost-benefit analysis that acknowledge and assess the actual outcomes of different courses of action are preferable to those that "handle" them by mathematical manipulation.

"A stitch in time saves nine," wrote Benjamin Franklin. Policymakers and economists, who consider the opportunity costs, are not so easily persuaded. "What," they ask, "does the present stitch cost us relative to the later costs (discounted to the present) of the nine stitches? Is it better to take only one stitch now, or two? And how do we know if the rip will occur or when?" The choices about where, when, and how much of a nation's resources to use to prevent or ameliorate an uncertain event are complicated.

Which is more cost-effective for a developing country: disaster prevention or disaster recovery? What choices do governments of disaster-prone developing countries face as they adopt programs for economic and social development and try, at the same time, to manage losses and suffering from natural disasters? What are the implications for long-term development of prevention versus recovery? What are the costs and benefits of approaches governments — and donors — must consider as they decide when, where, and how much of their resources to allocate for disaster response?

It is important to understand the links between disaster and development. Disasters often undermine development efforts and waste development resources. All societies can now forecast and prepare for disasters, so their failure to allocate resources to disaster prevention is both inefficient and wasteful.

Frederick Krimgold (1974) defined as a crisis an event that outstrips a society's ability to manage or cope with it, at least for a time. The World Bank identifies a disaster as an extraordinary event of limited duration (such as war or civil disturbance) or a natural disaster (such as an earthquake, flood, or hurricane) that seriously dislocates a country's economy (World Bank 1989b). For the Bank to consider emergency

assistance, the event must be significant enough to "cause the government to modify its economic priorities and programs substantially" — that is, to alter its development strategy, at least for a while (World Bank 1988).

Disasters are different in scope and nature from accidents and everyday emergencies. And disasters are different from catastrophes — in which the effects of disaster are societywide. Not every crisis is a disaster. An earthquake may be severe, but if it occurs in an unpopulated area, or in a populated area where there has been enough preparation so that damage is minimal (as in San Francisco in October 1989), it may not become a disaster. That is, it does not exceed the society's coping ability and does not qualify for World Bank emergency lending. We use the term "disasters" to refer to events that usually have both a "natural" basis (winds, water, land movement) and a negative impact on human life.

The link between disasters and development

It is important to consider the relative cost-effectiveness of disaster prevention and disaster recovery in terms of their potential impacts on the long-term development of developing countries because there is a basic relationship between development and disaster-proneness. (Oddly, disasters are seldom discussed in development literature but development is discussed in disaster literature.) There are three reasons why the disaster "variable" should be integrated into development planning.

(1) Disasters are linked to poverty. Poverty increases vulnerability to disasters. Most disasters occur in poorer countries, and the people who suffer most from disasters — and from environmental degradation — are almost always a society's poor people. One study (UNDRO 1976) estimated that 95 percent of deaths from disaster occur among the 66 percent of the world's population that lives in the poorer countries. In Japan, for example, the average annual death toll from natural disaster is 63; in Peru, with a similar incidence of natural disasters, the annual death toll is 2,900 (Anderson 1985).

Natural events destroy life and property in every country, but the losses, relative to a country's resources, are more of a burden on the poorer countries. Absolute economic losses may be higher in wealthier countries, because more property of higher value is damaged, but the loss of GNP from disasters is about 20 times greater in developing than in developed countries (Funaro-Curtis 1982). Poverty increases the likelihood that a crisis will become a disaster.

(2) Development can increase disaster-proneness. Under some circumstances, development itself can increase the likelihood of disasters. One might assume that a dollar spent decreasing poverty — that is, on development — is a dollar spent on disaster prevention. This is largely true, but the opposite also occurs. The development of industry, for example, increases the possibility of industrial accidents, some of which — including the accident in Bhopal, India — are disasters. Some development projects are planned without recognizing local natural hazards. Human settlements have been built, for example, with no awareness of heavy seismic activity in the area, using no earthquake-resistant building techniques (Kreimer 1989). Development sometimes increases the probability of disaster indirectly. Improved human and animal health and nutrition, for example, have in some regions contributed to overpopulation, overgrazing, and land depletion — to the point of environmental deterioration and ecological crisis. Elsewhere, populations have moved to urban areas for productive employment but, for lack of planning, have inhabited lands susceptible to flooding and mudslides. The environment is often the point of interface between development programming and disaster vulnerability.

Every development program or project in disaster-prone countries either increases or decreases the likelihood of disasters. When development increases a country's ability to cope with (predict, manage, ensure, or shore up against) natural hazards, it contributes to disaster prevention. When development is undertaken in ignorance of disaster-proneness, it may add to the possibility or increase the potential damage.

(3) Development resources are often wasted out of failure to consider disaster-proneness. When development projects are undertaken without regard for potential disaster, scarce development resources are often inefficiently allocated. Investment dollars are wasted when

a project is wiped out by a (predictable) typhoon, earthquake, or mudslide. Disasters shorten the economic life of development investments yet donor-funded development projects have increased the likelihood of disaster or have been built (and destroyed) in disaster-prone areas. (Community-built centers and newly acquired livestock were wiped out by a typhoon in Asia; export crops, requiring a fairly long cultivation period, succumbed to wind and rain damage from tropical storms in Central America; housing projects built on unstable lands were destroyed by earthquake in the Middle East; and irrigation projects that increase soil salinity threaten subsistence agriculture in Africa.) More often, a disaster interrupts ongoing programs and diverts resources from their originally planned use (Jovel 1989). When disaster-proneness is well-known, failure to factor it into planning represents a serious mismanagement of resources.

Between fiscal 1987 and fiscal 1988, the World Bank reallocated about $2 billion of existing loans to reconstruction and rehabilitation efforts after natural disasters. Specific disasters could not have been predicted, but most Bank postdisaster funding goes to countries known to be disaster-prone. More than 80 percent of the Bank's reconstruction and rehabilitation loans between 1947 and 1989 were to countries receiving more than one such loan. Of the 57 countries receiving these loans, 18 — more than one third — received loans for more than one type of disaster and three received assistance for three different types of disaster. Certain types of disaster consistently get proportionately more Bank emergency assistance. Discounting war emergencies — which, since 1947, have received the most emergency loans — floods and drought together account for more than half of the emergency assistance since the early 1970s (Kreimer and Zador 1989).

The point is that even without full-scale probability analysis, a lending institution can predict in which countries economic activity is most likely to be disrupted by natural events, and by which types. Disasters affect the returns on investment for any lending venture, so it is rational to factor the likelihood of such events into economic analysis. (One way to include likely disasters in an analysis of returns on investment would be to use a discount rate that ensures that the returns are realized shortly after the investment before any disaster could wipe them out.) Frequent reallocation of loans is inefficient if for no other reason than that reallocation decisions take time and money.

Donor agencies have a mixed record on acknowledging disaster-proneness in deciding about the economic viability of development projects. Seldom is disaster potential included in economic analyses in project design. In some project papers, the potential impact of a disaster is discussed under "social analysis." One paper, for example, which dealt with the decision to construct a hydroelectric dam in an area of Colombia where seismic activity was common, noted that the project should "pay special attention to the social and environmental effects of a major accident at the hydroelectric site." No mention was made of the potential economic effects of earthquake damage to the dam from seismic activity nor was the probability of an earthquake considered in the analysis of the project's profitability.

The basic argument for integrating disaster awareness into development planning is that it is wasteful not to do so.

Definitions

To identify the relative costs and benefits of disaster prevention and disaster recovery we must first define the two responses. "Disaster prevention" is the activities undertaken *before* crisis to control or mitigate its impact, so that damage is prevented or reduced to a level with which the society can cope. "Recovery" from a disaster involves only those activities undertaken *after* a disaster to restore an economy/society to its predisaster condition — or "get things back to normal." In the real world, activities for prevention and recovery overlap. Most governments maintain permanent disaster recovery institutions to mitigate the negative impacts of disasters through rescue and relief. These operations become active after a disaster, but receive funding and organizational support before and between disasters. In this sense, disaster preparedness is a form of disaster prevention because it focuses on keeping the impact of a crisis within the bounds of society's ability to cope. Similarly, recovery expenditures are seldom intended only to get things back to normal, because "normal" includes those conditions that gave rise to the disaster in the first place. Usually, rebuilding involves improving the capital stock in a way designed to

prevent or mitigate future disasters — for example, replacing earthquake-destroyed housing with earthquake-resistant housing. The World Bank's recovery and rehabilitation projects almost always support improving stock to lessen the damages from future disasters. The overlapping of disaster prevention and recovery activities complicates the analysis of their relative cost-effectiveness.

Moreover, societies do not choose between all prevention or all recovery. They "buy" some prevention and some recovery; the real decision for governments is how much of each to buy. Economically, the amount of disaster mitigation that is warranted is the amount that can be bought for less than the cost of losses that are averted through mitigation efforts (Milliman 1984). To make this marginal decision, governments must be able to assess the benefits and costs of the options available.

Benefit-cost analysis

Benefit-cost analysis involves three basic steps — first, enumerating all of the expected benefits and costs of an activity; second, assigning monetary values to them all; third, discounting all future benefits and costs to present values. One then chooses the option for which the net present value is both positive and greater than that of all available alternative actions (Kramer and Florey).

When natural hazards are known risks, their probability of occurring is essential to the analysis. This presents a few problems. First, not all benefits or costs associated with disaster responses are quantifiable. It is difficult, for example, to "price" social, political, and psychological costs. You can estimate future income lost from injury or death, but not emotional losses. And when a great deal of economic activity occurs in the nonformal economy, loss of "income" is difficult to estimate. It is equally difficult to price the benefits of disaster responses. What, for example, is the value of the sense of security that comes from living in earthquake-resistant housing? Or what is the political benefit to a government of imposing building codes (or the political cost of not doing so)?

Second, how do you calculate the economic value of geological outcomes (such as acres lost to desert or the extinction of a species)? How do you capture the cost of the loss of nonrenewable resources? Do you price them according to lost production? Over infinity? How do you measure the value of acres, ozone, and lost income?

Third, how do you discount future benefits and costs and incorporate the risk of natural hazards into the analysis? Discount rates are the subject of much debate in the literature and there is an inherent problem in some approaches to handling uncertain future outcomes. Some methods — using a cutoff period or adjusting the discount rate to include a "risk premium," for example — incorporate risk into benefit-cost analysis through statistical manipulations that effectively minimize the importance of future disasters to present decisions. The effect of these approaches is to obscure the differences in impacts on long-term development of different courses of action. Game theory and sensitivity analysis, which also incorporate risk into benefit-cost analysis, are more useful at highlighting potential differences in outcomes (Kramer and Florey). In disaster response (as in environmental planning), one is concerned with the measurable economic benefits and costs of different courses of action and with a host of other realities that affect human existence. Even if it were "cheaper" to let disasters happen than to prevent them, it is generally agreed that widespread human suffering should be prevented when possible. So in assessing alternative courses of action to respond to disasters, methodologies that acknowledge and assess the actual outcomes of different courses of action are preferable to those that "handle" them by mathematical manipulation.

Models in the developed world

The wealthier countries, which consider marginal costs and returns in their decisions, by and large choose the course of disaster prevention rather than recovery — as statistics on relative death tolls from disasters in the developing and developed world show. London, for example, undertook a disaster prevention project — construction of the Thames Barrier — to prevent flooding of the Thames River. The project cost £730 million but the potential loss of property — if the "demonstrably mathematically certain" flood were not prevented — was an estimated £3.5 billion. The decision was made despite a very long disaster horizon because, although the generations who paid for the prevention were unlikely to suffer from such a flood, the

losses in case of such a disaster would be enormous.[1]

The San Francisco earthquake of October 1989 did not become a disaster (despite tragic results for some individuals) because major investments in disaster prevention had been undertaken by the region's construction industry. Following building codes that ensured earthquake resistance added an average 4 percent to building costs, a sizable investment in the years before the earthquake.[2] Society judged those costs justified in preventing loss of life and property.

The calculations on which the Thames and San Francisco decisions were made involved marginal economic analysis — and convincing the public to allocate major resources to disaster prevention.[3] But it would have been politically unthinkable for both governments *not* to have undertaken actions to mitigate the consequences of natural disasters experts predicted as certain.

In choosing between prevention and recovery, the richer countries calculate that the sum of the economic, political, and social costs of a disaster justify significant investment in prevention and mitigation. Decisions about how much prevention to "buy" are made keeping in mind both economic and noneconomic considerations. One factor to consider is the state of the art in available technologies for prevention and mitigation. The Thames Barrier could not have been built until certain technologies existed — at a cost and level of reliability that made the decision possible. The state of the art for predicting natural crises also affects decisions about prevention or recovery (Holden and others 1989).

Options for funding preventive action — involving who will pay, under what circumstances, and over what period — also affect the decision about whether or not to undertake it. (The costs of earthquake-resistant construction in San Francisco were spread among all builders or buyers of buildings. The Thames project was funded through the sale of bonds — a decision to increase the public debt.) One must face the issue either of distributing the cost of prevention, or of distributing the costs of not preventing a disaster — that is, distributing the costs of recovery. How severe and extensive would the damage from a disaster be? Volcanic damage would remain fairly localized and would have more or less impact depending on what was built at the foot of the volcano. The impact of a major Thames flood would clearly be widespread. The economic and political perceptions of the "right" choice are influenced by the public's awareness of available technologies (even if expensive) and by people's expectation that they, or someone they know, might be victimized by a disaster that could be prevented. A major Thames flood in 1953, which caused extensive property destruction and the deaths of 300 people, provided the impetus for the decision to build the elaborate Thames Barrier. Often it takes a catastrophic event to arrive at a decision to invest in disaster prevention rather than recovery (Glantz 1989), even though for a disaster such as an earthquake or volcanic eruption the likelihood of a repeat catastrophe is least immediately after the event. Not all benefits from these investments accrue to future generations. Current generations enjoy the "psychic" security of investments in disaster prevention.

Often people in developed countries conclude that sizable investments in disaster prevention are economically and politically justified even if a disastrous event cannot be predicted with certainty. These countries seem to see such investments as sound, as preferable to recovery. Could the same conclusion be assumed to apply to all countries? Or do different circumstances in the developing countries alter the economics or politics of the calculations?

The higher cost of disaster in developing countries

Disasters are costly in all countries, in both immediate losses and long-term consequences. It is difficult to assemble data across countries, but one report (Zupka 1988) indicates that between 1970 and 1985 disasters of only three types (windstorms, floods, and earthquakes) cost an average US$18.8 million a day and, between 1980 and 1985, affected 216.8 million people or almost 5 percent of the world's population. Using Red Cross data, another report (UNDRO 1979a) calculates that between 1900 and 1976 an average 60,000 persons were killed and 3 million injured or left homeless by natural disasters each year. Jovel (1989) reports that in Latin America and the Caribbean, more than 6,000 lives and more than $1.5 billion are lost to disasters each year. Disasters affect developing countries disproportionately.

To assess the costs of a disaster one must consider both the immediate impact on physical assets, employment, and output and the impact

on future economic prospects. Costs are assessed in three categories: direct, indirect, and secondary. Direct costs, including losses of capital stock and inventories, are usually valued as the cost of replacement. Indirect costs — reflected in lost income, employment, or services — are those resulting from lost productive capacity. Secondary costs — those that result from decreased economic growth — include increased national indebtedness, inflation, and balance of trade deficits. Secondary costs also include effects on income or welfare redistribution because of changes in prices or a particular disaster response.[4]

With development resources limited in developing countries, are disaster costs different than they are in developed countries? Do the impacts of different disaster response strategies on long-term development affect the calculation of their relative cost-effectiveness? The value of property lost to disaster is higher in developed than in developing countries. So the absolute value of direct costs is usually higher in richer countries. But the indirect and secondary costs of disasters are significantly higher in developing countries than in wealthier countries. There are four reasons for this (discussed separately below):

- Losses as a percentage of national wealth are higher in developing countries.
- Disasters and poverty are mutually reinforcing.
- Disasters undermine incentives for development.
- Disasters particularly hurt the nonformal sector.

Losses as a percentage of national wealth are higher in developing countries. Although absolute losses from disaster may be higher in developed countries, losses as a percentage of total assets or national wealth are higher in developing countries. And the marginal utility of a unit of currency is presumably lower in richer countries. So the poorer the country, the greater the impact of direct, indirect, and secondary costs. Sometimes all of an asset of national importance is destroyed (as when a cyclone or earthquake destroys a national university). As a percentage of GNP, disaster losses are an estimated 20 percent higher in developing than in developed countries.

The relative impact of a disaster on national wealth depends on a country's size and population density, the type of disaster (how local or general), the relationship between the type of disaster and the national economic base, and the level of national assets. Thus a small island nation, dependent on agricultural exports and susceptible to regular, severe tropical storms that sweep across the whole island, would experience worse losses than a country in which a small group of poor, subsistence farmers lives at the base of a volcano that erupts infrequently. The National Academy of Sciences (1988) reports that a one-meter rise in sea level, which is expected by the end of the next century as a result of global warming, will cover broad areas of Bangladesh, Indonesia, and Southeast Asia. These highly populated areas depend heavily on agriculture (Stevens 1989).

Hurricanes, floods, and drought (which affect agriculture) have stronger indirect and secondary effects on an economy than do earth-

Table 1 Economic losses from natural disasters, Latin America and the Caribbean, 1980-87

(US$ millions, 1987)

Losses / effects	*Earthquakes*	*Eruptions*	*Hurricanes*	*Floods / drought*
Total losses	9,679	224	2,485	3,970
Direct	7,671	154	1,975	1,311
Indirect	2,008	70	510	2,659
Secondary effects				
Public finances	4,286	...	1,132	n.a.
Export/imports	12,567	...	1,076	621

Note: Figures adjusted for inflation through 1987; secondary effects estimated for 1985 through 1987 and projected through 1990.
Source: UN-ECLAC (in Jovel 1989).

quakes and volcanic eruptions, which are regionally more limited (see table 1). Except for volcanic eruptions, indirect and secondary losses are higher than the direct costs of disasters. Where information is available, secondary costs are more than double the direct losses from disasters.

Disasters and poverty are mutually reinforcing. Poverty is exacerbated by repeated disasters. Some of the worst environmental problems in developing countries are often both a cause and effect of poverty (Schramm and Warford 1989). Poverty increases vulnerability to disasters and disasters help perpetuate poverty (often through effects on and from the environment). If the cycle is never broken by preventing or mitigating the effects of disaster, there is little prospect for sustainable development.

This cycle is perpetuated as much or more through indirect and secondary as through direct losses. The Economic Commission for Latin America estimated, for example, that between 1960 and 1974 the damage caused by natural disasters in the five countries of the Central American Common Market reduced their average annual GDP growth rates about 2.3 percent (UNDRO 1979a). Often the cycle is perpetuated by a disaster's impact on a country's debt position — when local products, goods, or infrastructure are destroyed and must be purchased or financed on the international market. As a country's debt service burden increases, it has fewer resources to break out of poverty. The incomplete and scattered data that exist suggest that disasters have significant, long-lasting effects on growth.

Disasters undermine incentives for development. Development requires an environment stable enough to encourage investment and entrepreneurial activity. Repeated losses from natural disasters discourage investment, creativity, and hard work. Were they to occur in wealthier countries they would create similar disincentives and losses in productive investment — except that limiting the impact of disaster also limits the impact on incentives. Repeated disasters limit developing countries' ability to attract domestic and foreign investment and to encourage entrepreneurial activity.

A 1985 business report on Fiji, for example, noted that two hurricanes had left much more than $80 million in damage. They made Fiji virtually uninsurable against hurricanes. After 17 hurricanes in nine years, and three in less than two years with more than $130 million in insurance claims, the international reinsurers and the six companies who provided coverage in Fiji decided that the rewards were too small and the risks too great. The insurance sector had concluded that many of the losses incurred through repeated hurricanes could have been prevented through different building techniques and stricter building codes. They refused to continue to insure unsound buildings (Richardson 1985).

World Bank reports on Bangladesh (1989a), the Philippines (1989c), and the Sudan (1987d) also show how disasters affect the overall business climate. The report on Bangladesh describes how the effects of the floods reverberate throughout the economy, altering the outlook for the future and damaging incentives:

> The floods have necessitated significant revisions in the Government's economic goals and targets for the current year. Before the floods, 6 percent overall economic growth was envisaged, with substantial increases in agricultural production (6 percent) and manufacturing (7 percent). A recovery of crop production from the disruptions created by the 1987 floods, an expansionary public expenditure policy which aimed at stimulating economic activity and raising investment levels (supported by a significant new tax effort), and a revival in demand for manufacturing production as a result of these factors were expected to provide the basis for higher growth.
>
> It is now clear that many of these targets will not be realized. Despite the crop recovery and rehabilitation efforts, agricultural production will be substantially less this year. Income losses associated with this setback and reduction in gainful employment opportunities will have a depressing effect on demand (which is unlikely to be offset by public expenditure policy), and on the manufacturing sector, which has also been directly affected by closure of factories during the floods and damage to equipment and inventories. The stagnation and even decline in the key productive sectors will limit the over-

all growth of the economy to about 1-2 percent in FY89, even though reconstruction and rehabilitation activities in the public and private sectors will help increase activity levels in construction and services sectors.

The dampening effect of disasters on investment and entrepreneurial incentives alone may constrain efforts at development unless disaster prevention strategies can convince investors and entrepreneurs that enough stability exists for productive investment and activity.

Disasters particularly hurt the nonformal sector. The impact of disaster in developing countries is often felt disproportionately by people who live at the margin and subsist in the nonformal economy — activities associated with the production, consumption, and distribution of goods and services not counted in standard systems for quantifying national economic activity. In many countries the nonformal sector represents a significant portion of the economy. Losses in the nonformal sector would include the direct costs of lost equipment, houses (which serve also as business centers), supplies, and the indirect costs of lost employment and income that cannot be made up. These losses are likely to be substantial (UNDRO 1979a).

Hurricane Gilbert affected an estimated 157,000 acres of crops in Jamaica, most of them domestic (Collymore 1988). Even when relief supplies make up the shortfall of crops grown for domestic consumption, this aid may have a sharply negative impact on incentives in the nonformal market. In Bangladesh, imports of relief foods, together with the increases in postflood crops encouraged by government emergency policies, created serious disincentives for small agricultural producers (World Bank 1989a). At the same time, the price increases that result from shortages affect poorer people the most. When these involve inputs, nonformal small enterprises have an especially difficult time.

Nonformal economic activities are invisible to the analyst, so it is difficult to assess the total direct and indirect costs of disasters in countries with a large nonformal market (Peskin 1989). But add the losses in this sector to disaster costs, and costs would rise dramatically both absolutely and as a percentage of national wealth. Preventive actions taken with no regard for their impact on nonformal activities can impose significant costs. The construction of a flood control system, for example, could limit the access of fishing communities to river canals on which they depend for subsistence.

Another secondary cost of disaster, particularly in the nonformal economy, is damage to people's sense of efficacy. When people in a developing society have a sense of their own ability to affect and manage outcomes, they will produce more with a given set of physical resources than when they do not have it. One of the highest costs of disasters in developing countries is the effective undermining of any sense people have of their ability to control and manage their environments or their lives.[5] When disasters are repeated, the effect is compounded.

The costs and benefits of prevention and recovery

If disasters have more serious repercussions in developing than in wealthier countries, how does this affect the benefit-cost ratio of disaster prevention and disaster recovery strategies in disaster-prone developing societies?

Disaster prevention

The direct *benefits* of disaster prevention, in all countries, are equivalent to the savings in losses a disaster would have brought — including lost productive assets in the nonformal and formal sectors. Of special importance in the context of development are such secondary and indirect benefits as maintaining a climate stable enough to promote investment and enterprise and maintaining a sense of efficacy among the people on whom development depends.

In all countries, the costs of disaster prevention include the direct costs of controlling or mitigating the effects of natural crises that could become disasters. These costs may be huge, as in the Thames project, or smaller, as in the construction of fuel-efficient stoves to reduce deforestation and ecological deterioration. The costs of prevention differ significantly with the types of disasters (discussed below) and with available technologies for prevention. Disasters covering large areas that involve heavy environmental degradation are the most difficult — and expensive — to prevent.

Disaster recovery

Disaster recovery involves spending *after* a disaster has occurred. The *costs* of recovery include the direct, indirect, and secondary losses incurred and the costs of supporting rescue and relief operations and recovery management. These costs are significant for developing nations both as a proportion of national wealth and in their long-term effects on development.

Are there any *benefits* to be gained from disasters that would affect our choice — in particular, any benefits for development? Perhaps two. First, a disaster that gains international attention could attract injections of aid in the form of grants (these could have negative and positive effects). But international aid for disasters seldom exceeds an estimated 4 percent of losses (Zupka 1988), so this benefit is negligible. More important, a disaster may attract significant developmental aid focused on long-term programs to reduce disaster vulnerability and increase productive capacity.

A more important benefit of the recovery option may be the secondary, long-term, economic gain of "starting with a clean slate" (Cuny 1983). The recovery of Europe and Japan after World War II is a dramatic example. Obsolete factories and machinery destroyed by the war were replaced by entirely new installations in the recovery period. Countries that have historically produced a crop susceptible to destruction by cyclones may, when the crop is completely destroyed, decide to plant an alternative (possibly newly developed) crop that is less vulnerable to wind, a crop from which greater profits may be realized. Such recovery benefits are highly specific. They depend on special circumstances: the availability of a modern or invulnerable technology, the means to adopt it, and a pricing situation that makes the replacement of old approaches uneconomical, short of destruction. Benefits such as these could be quantified, but because of the special circumstances do not make much difference in analyzing the costs and benefits of the recovery option.

Measured cost-effectiveness of different types of disaster

The assessment of costs and benefits may vary for different types of disaster. For analysis purposes we discuss three types of disaster: predictable and unpredictable sudden-onset disasters and slow-onset environmental disasters.

Predictable sudden-onset disasters. In many disaster-prone countries, the severity of natural crises varies from year to year, but the crises are seasonal and to that extent predictable. In those circumstances, it is difficult to defend a failure to address disaster prevention when technologies are available for doing so. And often such technologies exist. Technologies exist, for example, for wind-resistant housing that prevents most hurricane and typhoon damage. Flood management and control technologies are more expensive, but they exist and are used in many parts of the world. Winds and floods are often seasonal and therefore predictable. When such crises cause frequent, significant damage, it is unreasonable to carry on with development as if they may not occur.

Unpredictable sudden-onset disasters. It is impossible to predict the time and damage potential of an earthquake but we know which areas are subject to seismic activity and can predict where a severe earthquake will eventually occur. A great deal is known about the design and construction of earthquake-resistant buildings using varied local materials. The damage from earthquakes is potentially extensive and expensive so there is a strong argument for damage prevention. It makes particular sense to factor in potential earthquake damage on development projects (such as dam construction) that could become disasters if any earthquake struck.

Slow-onset, environmentally based disasters. Increasingly, major disasters are the result of slow-onset natural events (such as droughts) combined with environmental degradation (such as deforestation) from human activity. When the causes of disasters are far-reaching — say, when environmental degradation changes patterns of land or water use — communities, even nations, are increasingly unable by themselves to effect the changes needed to avert disaster. Bangladesh, for example — as a recipient of floodwaters and silt from other upstream countries — cannot control floods through domestic programs alone. That requires an international effort using international technologies and financing.

When environmental disaster threatens, the costs and benefits of both disaster prevention and recovery change significantly. To the extent that we can predict them, the costs of *not* preventing ecological disaster may include the extinction of species — even of the human race. In the worst case, recovery is impossible.

The benefits of preserving life and productive capacity are assumed to be great, but the costs of prevention are equally high. Preventing or mitigating such disasters may involve a series of special, sometimes costly, actions. They involve creating what might be called the nonstructural apparatus of disaster prevention — activities that create the climate and capability for preventive action. Large-scale prevention requires:

- Data and tools for analysis. The more complicated the data, the higher the costs of collecting and analyzing it (Peskin 1989).
- Systems and institutions for coordinated decisionmaking. To the costs of arranging and holding the meetings at which decisions to create systems are made must be added the costs of setting up and maintaining institutions.
- Public education and political lobbying.

The costs of nonstructural apparatus, which apply in some degree to disaster prevention and recovery, are most significant in preventing massive systemic environmental disasters — because prevention is ineffective without broad collaboration. Prevention of environmental disasters is not too costly to be justified — and there may be opportunities for economies of scale. The same data and communication systems developed to address one large-scale disaster, for example, may be used to prevent other types of disasters. We cannot accurately estimate the economic return on investments in the prevention of large-scale environmental disasters. We do know that the physical and social outcomes of prevention are infinitely preferable to the losses such disasters would entail.

Lessons learned

Disasters occur most often in poor countries and cause the most suffering among poor people. These are precisely the societies for whom development is most urgently needed. Yet by ignoring likely disasters, many development efforts do nothing to decrease the likelihood of disasters, and many actually increase vulnerability to them.

Development planners sometimes call disaster prevention efforts "unaffordable extras" as they design development projects and programs. This attitude is unsound. Development spending and disaster spending are not tradeoffs. In a disaster-prone country every decision made about the allocation of resources to development affects the likelihood of damage from future disasters. And every decision about disaster response strategies — by which we mean actions that acknowledge and respond to the likelihood of disasters — has an impact on a country's potential development.

Anderson and Woodrow (1989) define development as "the process by which a nation's capacities are increased and its vulnerabilities reduced." That definition makes explicit the link between development and disasters. Spending on development and disaster prevention are different investments in the same goal of development, linked and at times identical. Capacities and vulnerabilities involve more than physical assets or a disaster-prone environment; equally important are social, organizational, and motivational factors. A materially underendowed society with a strong, effective political system may be "more developed" in the sense of being able to cope with a natural hazard than one with more wealth but great social barriers. People can energetically engage in enterprise or resign themselves to fate, passively accepting whatever comes. When people have a strong sense of their ability to change and manage their society, they are better able to produce national wealth and cope with natural crises.

Development investment should never increase disaster vulnerability and should include measures that improve the nation's ability to cope with disasters. Physical planning should include an analysis of disaster vulnerability, to avoid increasing the potential for disasters and to reduce environmental and other vulnerabilities. Development planning should also take into account the ways alternative actions may promote, or undermine, society's attitudes about what is possible in terms of growth. All development efforts should provide for disaster prevention. Not to do so is economically irrational and politically unwise.

Even the most efficiently managed disaster

recovery operation leaves a society vulnerable to natural hazards. Prevention not only minimizes damage but promotes a stable environment, incentives for investment and enterprise, and the sense that people can control their own economic destiny. These are crucial for sustainable long-term development.

Endnotes

1. A disastrous flood was a mathematical "certainty" every 2,000 years, according to the mathematician (subsequently knighted) who calculated the benefit-cost ratio for the project. But the environment of the Thames was changing, so by the year 2030 the probability of disastrous flooding would be every 1,000 years.

2. Private conversation with James Polshek (1989), architect and designer of earthquake-resistant buildings.

3. Marginal economic analysis has also been used, of course, as the basis for decisions not to undertake major investments for disaster prevention. See, for example, Holden and others 1989.

4. Jovel 1989, Funaro-Curtis 1982, UNDRO 1979a. Some writers argue that better cost-assessment methods are needed to avoid the double-counting involved in these three categories, which include both "stock" and "flow" concepts. For accounting purposes this is true, but for the purposes of this paper, the distinctions call attention to both the immediate and long-term negative effects of disaster losses (see Milliman 1984).

5. This concept is similar to David McClelland's "achievement motivation" but we do not limit it to entrepreneurs. In the broader population, it is the opposite of a dependancy syndrome or the malaise of victimization. Lamentably, relief assistance often adds to a sense of victimization on the part of those who have experienced a disaster. Too often relief is completely "managed" by outsiders who wrongly assume that disaster victims are no longer competent.

Case study: Rio Flood Reconstruction and Prevention Project

Mohan Munasinghe, Braz Menezes, and Martha Preece

Until the Rio Flood Reconstruction and Prevention Project, disaster-related projects funded by the World Bank focused primarily on reconstruction — especially immediate, short-term recovery. The Rio project was notable as a targeted effort to reduce disaster vulnerability by promoting long-term multisectoral development strategies. It helped confirm that reconstruction projects must address specific disaster vulnerabilities as well as cross-sectoral needs in improving urban environmental management. The project represents a significant step toward developing a strategy for long-term prevention and mitigation of natural disasters and environmental degradation. It is also a good example of an effort to develop support for long-term environmental policies by strengthening indigenous managerial and planning capabilities — something that was not possible previously through short-term recovery projects.

In February 1988, unusually heavy rains fell in the metropolitan region of Rio de Janeiro, Brazil's second most important economic pole and second largest city. In some areas, the equivalent of three months' annual rainfall fell in less than 24 hours. By March 10, the resulting flood and landslides had left about 289 dead, 734 injured, and 18,560 homeless, and had extensively damaged physical infrastructure (roads, bridges, canals, drainage networks, dikes, water and sewerage networks, electric power networks, factories, and commercial establishments). The physical losses severely disrupted Rio's economic activity, particularly in the northern part of the metropolitan region, and left the predominantly low-income population with limited access to schools, health facilities, and basic sanitation. This had been the heaviest recorded rainfall since 1966, the time of the last flood and landslide disaster in the metropolitan region.

The severity of the disaster can be attributed largely to the region's vulnerability to natural hazards. Environmental degradation — resulting from the unplanned expansion of human settlements, faulty construction, congested drainage, and inadequate maintenance — contributed heavily to the event's catastrophic outcome. Poverty was also linked to both the causes and consequences of the disaster. The poor of Rio de Janeiro — who live in such high-risk areas as steeply sloping hillsides, landfills, and floodplains — became both the perpetrators and victims of environmental degradation. Poverty and poor environmental management continue to place the city's population at risk from natural hazards.

In 1989, the population of the metropolitan region was about 10.2 million; roughly one-sixth of the region's families live in poverty (on less

than three minimum salaries a month). Low-income human settlements have spread rapidly in unsafe, environmentally susceptible areas. Unplanned squatter settlements (*favelas*) have developed along the narrow coastal strip and across the coastal mountain range. Located on steep hillsides, they often perch precariously above the city and in lowland areas along riverbanks in the flood-prone Baixada Fluminense region north of the city.

Increasing urban poverty has placed heavy demands on national and local institutions and infrastructure, and basic needs for housing and services have not been met. Local institutions for urban environmental planning are mostly weak and do not coordinate their activities. Planning, programming, and budgeting are inadequate and there are no reliable information systems or trained technical staff. Investment decisions are often politically guided, which has led to inefficient resource allocation and poorly targeted spending.

On much of the city's periphery, especially in *favelas*, the supply of services has been affected by flawed infrastructure planning, inadequate investment in infrastructure, several years of neglect in management, and poor or nonexistent maintenance of facilities. Drainage networks are severely blocked by silt and uncollected solid wastes, and they overflow, depositing garbage and raw sewage on precariously constructed squatter settlements. Inappropriate disposal of solid wastes and uncollected garbage — about 5,400 tons a day in the metropolitan region — became raw material for the landslides of February 1988, burying homes and sweeping away hillside squatter settlements. To compound the problem, most municipal refuse goes to open dumps, which are often occupied by squatters who have no formal access to land. These landfills are hazardous sites for construction because the soil is unstable, so they are susceptible to runoff and erosion. Uncontrolled wastewater ends up in nearby drains or streets, further degrading already unstable land. Landslides and flooding are common because these environmentally sensitive areas are highly susceptible to rain washout.

Poor environmental and disaster planning

The accelerated process of urban growth has been a burden on the natural environment, accelerating the depletion of natural forests and destroying vegetative cover. Steep slopes have also been stripped of vegetation as the result of illegal mineral extraction by the economy's informal sector. Inadequate drainage systems and infrastructure have depleted the bare soil's capacity to absorb water, accelerating runoff and exacerbating landslides.

The degradation of the urban environment — mostly because of institutional inaction and political conflict — coupled with physical damage to health facilities and sanitation networks during the floods, sharply increased the risk of epidemics. Floodwaters contaminated with garbage and human waste led to widespread outbreaks of leptospirosis, hepatitis, typhoid fever, and other gastrointestinal diseases.

Weak policy analysis and program development, inefficient targeting of resources, ineffective implementation, inappropriate and unenforced legislation, and institutional friction have accentuated conflicts among institutions and between government and users. Policymakers have focused on short-term approaches to resource allocation. Projects are largely unsustainable because they must compete for the scarce resources available for operations and maintenance.

Floods and landslides have cost an estimated US$935 million: $400 million in direct costs (physical damage) and $535 million in indirect costs ($435 million in lost production, $50 million in lost revenues from tourism, and $50 million for the cleanup operation immediately after the disaster).

Rescue and salvage equipment were inadequate at the time of the floods and were located far from the emergency sites. Severe gaps in emergency response and preparedness plans compounded the damage from the floods. The emergency response was not carefully planned so people and materials converged on the area, creating great confusion. The chief problem was poor coordination and sharing of information. A great deal of effort was wasted and many urgent tasks were not addressed.

After the disaster, and with some difficulty, the state and municipal governments implemented short-term disaster relief activities, albeit at a snail's pace: roads were reopened, emergency services were restored, and the homeless were temporarily housed in schools and other public buildings. At the same time, the government began considering the longer,

more arduous, and costly tasks of rehabilitating the affected areas and reestablishing economic activity and physical infrastructure. The disaster stimulated local government (encouraged and assisted by the World Bank) to undertake preventive measures to mitigate the effects of minor periodic floods and to improve the region's capacity to cope with the major floods that occur every 20 years or so. On March 30, 1988, the state governor created an Executive Group for Reconstruction and Emergency Works to oversee and coordinate short-term disaster relief and medium- and long-term reconstruction and prevention activities. The municipality of Rio also created a special unit to coordinate activities.

The World Bank's response

The Bank's strategy in response to the disaster was to strengthen the already considerable flow of technical assistance to improve long-run policy development in urban planning and to initiate a US$393.6 million flood reconstruction project, to which the Bank contributed $175 million. The project was designed to:

- Provide a quick response to immediate needs.
- Restore assets and productivity to preflood levels.
- Increase the metropolitan region's resilience when floods occur.

The project's central goal was to strengthen the metropolitan region's institutional and financial ability to manage urban development and environmental planning. It emphasized the need for fundamental reform, giving high priority to:

- Improving institutional capability for responding to emergencies and natural hazards.
- Rebuilding and rehabilitating basic infrastructure.
- Implementing physical and institutional preventive measures to reduce the damage from future floods.
- Helping the governments of the state and municipality of Rio de Janeiro develop flood prevention and mitigation programs.
- Modifying the management policies of the municipality of Rio and in the Baixada Fluminense region to increase the availability of public funds and the ability to mobilize financial resources for routine maintenance and environmental protection.

What has been done

From the early stages of implementation the project confronted a common difficulty: institutional weakness, exacerbated by the complexity of an emergency situation requiring multisectoral and interagency responses. Responsibilities for execution were distributed among so many agencies that coordination became almost impossible. Efforts by Bank staff to clarify and understand the roles of each institution and level of government were a major problem. Political rivalry between the state and municipal governments, and differences with the federal government, greatly increased project risk. Numerous managerial changes in the Caixa Economica Federal (CEF), Brazil's financial intermediary and cofinancier of the project in the two years after the disaster, contributed to an 18-month delay in the project.

But now most structural works — mainly infrastructure in the city of Rio — have been substantially completed. Roads and bridges have been repaired, and the massive dredging of rivers and drainage canals choked with debris and silt deposits has begun. Stabilization of steep hillsides and slopes is almost complete. Repairs of sewerage systems will soon permit improved collection of sewage that currently drains into open waterways. Institutional problems have delayed the preparation and implementation of a metropolitan regional program for improving the collection and disposal of solid waste, but progress is under way.

The project's serviced-sites component provides emergency recovery assistance to families living in high-risk areas. Work has begun on providing families with unrestricted title to the land on 11,000 minimally serviced lots. Housing sites will be provided for about 5,000 families who either lost their homes in the floods and landslides or need to be resettled. Most relocation from housing along the rivers is done under state auspices. Within the city of Rio de Janeiro, about 5,700 refugee families who lost their dwellings have already been moved from high-risk areas in the city.

The state of Rio de Janeiro is being given technical assistance to formulate strategy for disaster mitigation that focuses on developing hazard reduction techniques and reversing en-

vironmental degradation. The strategy is to prepare an integrated system that improves the communication technology, land transportation, and equipment needed for a quick and efficient emergency response. The civil defense plan being prepared for the municipality of Rio covers such natural hazards as floods, landslides, and fires in high-rise buildings and such technological hazards as toxic waste spills.

The municipality of Rio de Janeiro is being given technical assistance to provide educational programs in:

- The proper handling and disposal of solid waste.
- Safe self-help techniques for low-cost housing construction.
- Protecting forests.
- Inspection and control of illegal, informal mineral exploration.
- Strengthening the fiscal administration.

Managing natural disasters

In the short and medium term, the project focuses on key problem areas in disaster preparedness, including housing and environmental sanitation services, landslide control measures, environmental planning and management of spatial development, and urban waste collection and disposal. In the long run, the project seeks to develop the foundations for reform in urban environmental policies through:

- Formulation of an in-depth preparedness plan for the greater metropolitan region.
- Preparation of a medium- and long-term reforestation plan for Rio's metropolitan region.
- A proposal to protect reforested areas.
- An analysis of land-use practices and a proposal for streamlining land tenure issues.
- The preparation and implementation of a program in environmental education.

The Rio Flood Reconstruction and Prevention Project is a remarkable example of an effort to reduce hazard-related losses. Addressing environmental degradation in the city called for integrating environmental policies into the normal activities of public institutions. But the project's most significant feature may be its focus on preventive measures, based on a comprehensive technical assistance program that emphasizes environmental rehabilitation and increasing the region's resilience in future catastrophes.

Case study: La Paz Municipal Development Project

Alcira Kreimer and Martha Preece

Located high above sea level, in a deep valley surrounded by steeply sloping mountains, La Paz, Bolivia, is heavily subject to landslides and mudflows. Their incidence and severity are exacerbated by the squatter settlements on precarious land that have proliferated with rapid population growth. Reducing the city's vulnerability to disaster called for strengthening the city's institutional capabilities and expanding its investment potential, two goals of the La Paz Municipal Development Project that are unlikely to be achieved until there is a continuous municipal administration. Prevention and mitigation efforts often take longer than a policymaker's term of office, and projects that address risk prevention do not always produce short-term political or economic gains. They must compete with and often lose out to more visible or politically rewarding projects. Given the difficulty of designing and enforcing land-use plans through "regular" channels, it probably makes more sense in a city such as La Paz to decentralize disaster mitigation and to emphasize community participation — to promote awareness of the need for such activities and to design disincentives that steer settlements away from high-risk areas and incentives for using disaster-resistant construction techniques.

Controlling natural risks is particularly important in urban areas. In developing countries in particular, many poor urban settlers, unable to afford properly serviced homesites, are forced to live in high-risk areas. Squatters are a serious threat to the urban environment, as they tend to dwell on precarious sites highly vulnerable to natural disasters.

The Bank has been involved in recovery from and prevention of disasters in several cities in developing countries. In recent years it has emphasized strengthening municipal ability to deal with environmental degradation. In seeking ways to help institutions integrate preventive measures into urban and municipal development efforts, the Bank — together with partner governments — has emphasized: (1) assessing urban vulnerability to natural hazards, (2) strengthening capabilities for managing disaster, and (3) developing efficient disaster prevention programs.

Bolivia's vulnerability to disaster

About 44 percent of Bolivia's population (6.9 million in 1988) lives in urban centers. The country's recent pattern of urbanization is a function of economic factors and the unusually difficult climatic and geographic conditions of the Altiplano and Valles regions, where nearly 80 percent of Bolivians live. Migration to the once flourishing mining centers has given way

to increasing flows of people from rural areas and from such mining towns as Oruro and Potosi to larger cities such as La Paz, Cochabamba, and Santa Cruz.

About 1.2 million people live in La Paz, Bolivia's capital, which is located between 3,500 and 4,000 meters above sea level in a deep valley surrounded by steeply sloping mountains. The city's vulnerability stems from its location in a narrow valley of unstable soil, broken relief, and torrential erosion that creates often devastating mudflows and landslides. Plessis-Fraissard (1989) describes La Paz as a city experiencing a continuous earthquake. About half of La Paz is unsuitable for development, and the city lacks administrative capability to enforce any land-use plan that restricts settlement in hazardous areas. La Paz has grown tenfold in the past 50 years, and has roughly doubled in size in the last decade. With no planning, low-income neighborhoods have spread up onto the slopes surrounding the city, further destabilizing the landslide-prone mountainside, where surface materials are generally unstable and rocks are liable to fall. Moreover, urbanization has brought deforestation, which further destabilizes the erodible soil. These problems are compounded by a dearth of basic infrastructure and by the common use of urban rivers for garbage disposal. The result is severe, recurrent floods and landslides. Each rainy season (November to March) is a constant threat to life and economic resources. As unstable terrain becomes saturated, houses are washed away. Development should not be allowed or should be controlled on about half of the valley slopes, but the municipal administration and institutions are too weak to design and enforce sound land-use regulations.

The cost of natural disasters. In the last few decades, rapid urban population growth, caused mainly by rural-to-urban migration, has exacerbated the frequency and severity of natural disasters. The damages produced by catastrophic events represent the equivalent of 1.5 percent of the city's GNP (Masure 1986). Economic analysis suggests that the La Paz Municipal Development Project's disaster management component would generate an economic rate of return between 24 percent (for landslide control) to 44 percent (for solid waste management and community education). The cost of disaster control would be about US$2.5 million, or $2.50 per capita, but annual losses from property damage alone are about $8 per capita. In other words, annual losses far exceed the cost of risk reduction.

The Bank's involvement

When a Bank team began to prepare the Municipal Development Project, disaster mitigation in La Paz seemed a pipe dream. Social, political, and economic constraints — and the extent to which large sections of the La Paz region were at risk — seemed formidable. And the site presented serious physical and managerial problems. The main problems were: (1) deficient infrastructure and services, which have contributed to rapid erosion and chronic landslides, (2) a weak municipal administration, particularly in personnel policy and management, and (3) too little policy attention to education and awareness programs that encourage local involvement in prevention activities.

The Bank's involvement in the La Paz Municipal Development Project was geared to support the government's strategy of strengthening municipal management of urban development programs through rational land-use planning, suitable building codes, and the provision of basic services. The Bank's strategy emphasized management and control of natural risks through planning, information, and community organization, taking into account the limits imposed by the area's natural risks.

The La Paz Urban Development Plan was of great help in formulating the Bank's disaster management program. The plan was produced by a team of ecogeologists and urban planners, with technical assistance from the French government. Commissioned by the mayor of La Paz in the late 1970s, the plan aimed to strike a balance between the city's siting restrictions and its future development needs. Relying on a series of environmental and socioeconomic studies, the technical team produced detailed maps identifying areas where natural risk was high and where construction was suitable. According to their studies, only 19 percent of the urban area was suitable for development, rehabilitating another 35 percent of the region was economically viable, and the rest of the land was unfit for urban settlement. Special conservation and preservation measures were recommended, such as the creation of recreational parks and the promotion of agricultural activities and afforestation. The technical report

found the potential for urban expansion in the *cuenca* of La Paz to be extremely limited. Most of its land is unstable and geotechnically unsuited to building and some of the marginal land would require high-cost development for rehabilitation.

Of particular significance were the criteria and methods used to determine the types of prevention and mitigation measures to be implemented. The Bank team tabulated a ten-year inventory of disaster occurrences and property damage in 10 zones in La Paz. The premise of the analysis was that risk and property damage were foreseeable and quantifiable and so, therefore, were strategies to reduce the probability of disaster. Priority for allocating financial resources and for determining the types of mitigation activities to be implemented was then defined by two criteria: the probability of a hazard's occurrence (imminent, probable, or possible) and its probable gravity (very severe, severe, or slight). Finally, recommended actions and their priorities were synthesized in a time table that included the construction of civil works, land-use planning, and procedures to prevent uncontrolled "irregular settlements."

The Project

The La Paz Municipal Development Project was designed to help the municipality strengthen its administrative and fiscal capabilities and redress critical shortcomings in hazard control and the city's infrastructure. About 35 percent of the project was devoted to natural disaster mitigation, mostly of landslides and floods. Risk management was addressed in a comprehensive way, integrating environmental, institutional, and social considerations. The urban development and infrastructure component addressed disaster management and control by:

- Providing basic services to selected neighborhoods, including water, drainage, and pedestrian walkways.
- Providing flood and erosion control along drainage basins (landslide prevention works and land-use regulations and procedures to prevent irregular settlement).
- Designing and implementing a garbage collection and disposal system and a street cleaning system and developing a laboratory of bromatology and sanitation control.
- Providing community education about urban services, civic duties and responsibilities, and local participation in hazard reduction and emergency recovery activities.

The component to improve local administrative and institutional capabilities focused on:

- Consolidating planning and control.
- Strengthening tax collection, budgeting, and financial and investment planning.
- Increasing revenues from property taxes and improving development planning and the management of urban services.
- Strengthening community relations and promoting local participation.

The urban transport component addressed the low-cost rehabilitation of major access roads, basic improvement of the street network, and the rehabilitation of municipal vehicles and equipment.

The project also aimed to institutionalize disaster management and emergency readiness in La Paz's municipal agencies. Agencies responsible for different aspects of disaster prevention, mitigation, relief, and recovery were to be coordinated within an efficient organizational framework; contingency plans to facilitate communication after a disaster were to be prepared; and an early warning system, including emergency assistance procedures for disaster victims, was to be established. Municipal employees were to receive training on various disaster-related topics, such as communications, urban planning, flood and landslide control, and infrastructure needs assessment.

Constraints on developing institutional capability

Reducing risk called for strengthening the city's institutional capabilities and expanding its investment potential. It was estimated that the municipality could invest US$18.0 million per year, or $18 per capita. This would provide the funds needed for maintenance and erosion control works. Little progress has been made so far for several reasons, among them the frequent changes in administration. The project's long-term objectives of institutional strengthening are unlikely to be achieved without political as well as institutional consensus on long-term

goals and priorities. Reorganizing the cadastre to improve public revenues, which is central to project sustainability, has been delayed by protracted technical discussions. A conservative estimate of revenues lost to delays is US$10 million a year.

This is typical of the barriers to achieving realistic disaster mitigation and prevention when an administration lacks continuity. As Persaud (1989) points out, even when cost-benefit analysis indicates the logic of investing in disaster prevention and mitigation activities, politicians and policymakers do not necessarily concur on the priorities. Prevention and mitigation efforts usually have a longer time horizon than the policymakers' term of office and priorities must survive many competing demands. Projects that address long-term risk prevention do not always produce short-term political or economic gain, so day-to-day planning and more visible or politically rewarding projects often take precedence. The La Paz Municipal Development Project illustrates the financial and administrative difficulties that may be encountered in trying to reduce disaster vulnerability.

The need to create incentives

Despite considerable administrative efforts to control the unplanned expansion of human settlements, population pressures remain and destructive land use continues. Ironically, steps taken to stabilize slopes have encouraged illegal settlements and overpopulation in high-risk zones, undermining efforts at disaster prevention. Aware of the need to control risks, the administration has intensified efforts to encourage sound building practices and to establish the framework needed to promote community participation and to educate citizens about hazard control. Reversing La Paz's land-use pattern will take political leadership and appropriate policy changes to support community initiatives. To achieve a sustained commitment to disaster prevention and mitigation, the administration should create incentives for local participation and get communities involved meaningfully in construction programs and land-use planning.

As Christian Delvoie (1990) points out, people will not participate in land-use and construction programs they do not perceive to be in their best interests. Local participants in a project must be assured of reaping the benefits of their involvement. La Paz should explore such alternatives to a regulatory approach as providing services, construction materials, and technical assistance to encourage safer building systems. An understanding of social, cultural, and ecological conditions and of people's perceptions and attitudes must be incorporated in project design. Public education through mass media will help keep future developments from falling victim to natural disasters and must become a priority.

This project achieved four things. First, the civil works, especially the flood and erosion control components, were completed as the result of the municipality's dynamic entrepreneurial approach. Second, the project paved the way for environmental programs sponsored by the Interamerican Development Bank (IDB), the European Community (EC), and the German Technical Assistance Agency (GTZ), among other aid agencies. Third, the project has helped build up the municipality's investment capabilities, which were negligible before the project. This has increased the level of funding and resources available to finance new actions. Finally, the Bank's main contribution to this project has been the promotion of risk management as an integrated process.

This project illustrates the need for a flexible approach to helping governments in hazard prevention and mitigation efforts. Planning and control of land use require incentives and the full participation and support of local communities. Given the administrative and institutional difficulties of designing and enforcing land-use plans through "regular" channels, emphasis should be placed on developing in the people a strong sense of control in coping with natural disasters. Emphasizing the social nature of natural disasters calls for a proactive rather than a reactive stance. Developing disincentives for steering settlement away from high-risk areas and incentives for using disaster-resistant construction techniques is probably the best approach to setting realistic mitigation and prevention goals for a city such as La Paz.

The International Decade for Natural Disaster Reduction

Neelam S. Merani

The International Decade for Natural Disaster Reduction was launched formally on 22 December 1989 by resolution 44/236 of the United Nations General Assembly. Its objective is to prevent or mitigate — in a way the same object — natural disasters and the loss of life, property damage, and social and economic disruption they produce worldwide. Only individual countries themselves can achieve this objective, but the Decade should inspire them to and should help them acquire or reinforce the means to do so. The Decade should be both an umbrella and a sparkplug for international cooperation and activity.

The key is to mobilize strong, coherent, effective national committees that can coordinate the work of different departments, different levels of government, and different parts of the community — including the scientific, professional, business, and industrial communities. If economic and social development efforts are not to be lost to disasters, it is essential that these national committees share experiences and learn from each other how reducing losses from disasters will benefit their national economies. It is important that they create or strengthen regional and global networks to monitor natural phenomena and human behavior, exchange data and assessments, and bring the latest scientific and technological advances to bear on disaster management, including the early, adequate, credible generation of disaster warnings. Achieving the objectives of the Decade will require a concerted international effort involving the most modern and dynamic sectors of society: science, telecommunications, banking, insurance, local authorities, voluntary organizations (in particular, the Red Cross), the media — each and every one of us.

Economic losses and human suffering from natural disasters have increased in the past two decades, endangering social and economic development, particularly in developing countries. Tackling this problem requires a sound evaluation of disaster mitigation policies. Two things must be determined. First, which investments to protect society and reduce its vulnerability to disaster are cost-effective? And second, when we invest billions of dollars each year on infrastructure and long-term capital development, what measures should we take to reduce those investments' vulnerability to disaster? Our evaluators must remember that disasters are statistically certain to happen, although our scientific knowledge does not yet allow us to predict them with even the certainty with which we predict the afternoon weather.

We must measure the direct costs of restoring or attempting to restore housing, infrastructure, and the economy to predisaster conditions,

particularly in the most exposed developing countries. And we must not forget to measure the loss of human lives, the true basis for — and beneficiaries of — development.

To preserve the delicate balance and two-way relationship between the earth and humankind, it is important that we develop a broad-based historical database on disasters. For reliable results, we must combine the knowledge and know-how of the world's major investment banks (including the World Bank), regional banks, private sources of financing, insurance companies, universities, and economic research centers.

In mobilizing various actors internationally — different international, intergovernment, and nongovernment bodies, scientific and professional communities, and the private sector — the Decade and its secretariat must see itself as catalytic. Its role must be partly to generate resources to support the efforts of others within a framework of commonly supported approaches.

Countries differ in their vulnerability to different natural disasters or combinations of disaster, and in addressing the causes and consequences of disasters must not focus only on those that are easy to address, thus meeting the needs of some countries but not others. We must also attack the causes of the problems, not just the symptoms. In marshalling our knowledge of disasters we must be careful not just to advance the state of knowledge but to find cost-effective, practical solutions.

And we must seek an integrated approach to disaster mitigation. Natural disasters and environmental catastrophes are two sides of the same issue: the two-way relationship between mankind and its environment. Human activities affect the planet earth and our planet affects mankind, sometimes catastrophically. Human beings can adapt only in a limited way to environmental variations, particularly if forces unleashed in the atmosphere or inside the earth's crust evolve into cataclysms. And mankind's vulnerability has been increased by development, because human assets — of population, physical infrastructure, and economic resources — are combined in an increasingly complex and valuable system. The effects of natural disasters have been compounded in terms of loss of life, physical damage, and detrimental effects on the economic development of vulnerable countries.

Environmental degradation, by attacking the earth's resource base, limits the human capacity for long-term development, narrows options, and destroys the heritage of future generations. Environmental degradation has been characterized as a creeping disaster, but hazardous waste is not — nor was Chernobyl. Climate change has been seen as advancing at a slow pace, but our solutions should begin to move beyond a brisk walk. We must see depletion of the ozone layer as an urgent problem. Time is running out.

Natural disasters, on the other hand, are seen as fast-moving events. But activities to prevent or mitigate disasters cannot be conducted in an instant. In many ways they depend in advances in scientific thinking — about plate tectonics and other natural forces that affect our environment, about the interface between biological, geological, and physical forces.

Just as we must integrate our knowledge about the earth, the oceans, and the atmosphere, so we must integrate our approaches to different types of disaster. Although the bell ringers may be different, warnings and preparedness for natural and industrial disasters have much in common. The need to conserve and manage watersheds is the same whether the ultimate concern is flooding or environmental degradation. The UN General Assembly sees drought and desertification as natural disasters in one resolution and as environmental problems in another. What is important is to address them effectively as problems to be resolved.

Nor can a line be drawn in terms of those affected. Environmental degradation, like natural disasters, affects the natural resource base and thus ultimately the human economy. Possibly that is why the last UN General Assembly adopted a resolution, 44/224, on international cooperation in the monitoring, assessment, and anticipation of environmental threats and assistance in environmental emergencies. Resolution 44/224 refers to potential environmental disasters, whether natural, accidental, or caused by human beings — just as the resolution on the Decade recognized the importance of environmental protection for the prevention and mitigation of natural disasters.

It is difficult to foresee putting into place effective measures for preventing climate change; the question may be how much we can moderate it. But sooner than many think, we may need to address the potential for natural disaster that global warming may generate, translate it into regional and country specifics,

Global change and reducing natural disasters

Stephen Rattien

The International Decade for Natural Disaster Reduction (IDNDR) must consciously address two countervailing forces: (1) our ability to mitigate natural disasters through warning, planning, and preparedness and (2) human activity that has contributed to the depletion of stratospheric ozone, the threat of global warming, deforestation, acid rain, the extinction of species, and other negative changes of which we are not yet aware.

Advances in science and technology allow us to mitigate their damage. But the same advances have also made possible the very breakthroughs in medicine, industry, and agriculture that have led to extraordinary population and economic growth — at the price of possibly globe-threatening effects on the environment. To be sure, we have reduced some of the worst environmental effects of early industrialization, but the sheer magnitude of human endeavors has inevitably damaged our planet. Confronting both natural disasters and global change will require a judicious blend of science and technology, public policy and education, help from the industrialized to the developing world, and a partnership between industries, individuals, and governments — within nations and throughout the world.

Certain disaster mitigation activities cost little or nothing; others require changes in practice and investments. Unless governments, industries, and individuals see these activities as being in their self-interest, they will resist them. The same applies to activities to confront global change. Stopping the use of CFCs in aerosol cans is essentially a zero-cost action. But reducing the loss of habitat from the destruction of tropical forests will be far more difficult to accomplish, as it will require assistance that crosses national boundaries.

The challenge of the Decade is to build on already-known science and technology; to replicate successful programs and activities; to find new ways to effectively transfer and implement three decades of disaster research; and, most important, to develop new, flexible, innovative hazard reduction programs that are compatible with, and support, the goals of our communities.

Not surprisingly, confronting the challenge of global change will require a similar approach — on a larger scale and over more time. Cumulatively, individual actions could overwhelm our planet's assimilative capabilities. It is important to understand what is occurring and to take action. *The Cairo Compact*, which resulted from the World Conference on Preparing for Climate Change held in Cairo in December 1988, noted: "All nations, and the vulnerable segments of various populations, will be hit by climate change; by rises in sea level that jeopardize coastal areas, by changing weather patterns, by decreased availability of fresh water, by induced heat stress, by increased ultraviolet radiation, and by the spread of pests and disease. All this will devastate food and agricultural production and adversely affect human health, welfare and cultural heritage."

We generally think of such changes as ozone depletion and the buildup of carbon dioxide as affecting climate — but global change is far more than climate change alone. Ecological diversity is being reduced at an alarming rate, particularly through the destruction of tropical forests; the pollution and overuse of groundwater is reducing its availability for agriculture, while the world's population is swelling; acid rain is destroying forests and lakes; and even great seas such as the Mediterranean are losing their productivity — indeed, their ability to sustain aquatic life.

Global change is often viewed as the impact of man on his environment and disaster as the im-

and prepare for it — hoping to prevent or mitigate its worst consequences. If the consequences will be more tropical storms, for example, we must take appropriate measures in terms of forecasting, warning, and preparedness. Clearly, those in charge of managing natural disasters and those in charge of managing environmental change must work together. The public may not understand if such cooperation fails to materialize. Disaster mitigation policies are essential to the strategy for protecting human survival and life on earth. The International Decade for Natural Disaster Reduction provides us with the framework for an active global approach to protecting that life and earth. Every country must be able to benefit from the scientific and technological knowledge available in some countries that can be used to understand the causes and effects of natural disasters and possible ways to reduce their impact.

pact of nature on man, but man can affect the prevalence and locale of natural hazards, and natural phenomena have historically shaped global change. The effects of many natural hazards are exacerbated by global change. Bangladesh, for example, is essentially a river delta that is flooded when river waters rise or when there is a storm surge. Were the mean sea level to rise through global warming, the frequency and severity of flooding would increase. This is true not only in Bangladesh. New Orleans, much of which is below sea level and protected by dikes, is already vulnerable to hurricanes, as are many low-lying coastal cities around the world. Flooding has been exacerbated by forest-clearing and by certain agricultural practices that promote erosion and reduce the ability of upland soils to retain moisture and of the land to hold back the water.

Similarly, natural hazards can and do affect global change. Historically, global change — rapid, radical global change — was the result of natural forces: meteorites, volcanic eruptions, and firestorms. Relatively recent examples on the paleontological record are the volcanic eruption of Krakatoa and the burning of the North American forests. Now human systems vulnerable to natural hazards can, because of their scale and the materials involved, have a global impact. Oil spills can be the result of a pipeline ruptured by an earthquake or of a tanker or oil platform accident in an ocean storm. Similarly, water pollution is often the result of wastewater systems overwhelmed by stormwater or the runoff during storms of chemical pesticides from farming operations.

Thus, the objectives of mitigating disaster and confronting global change must be intertwined. As Dr. Robert White, President of the U.S. National Academy of Engineering, has stated, "our understanding of the dynamics of the planet and our ability to predict its future state require[s] that all elements of the earth system — the oceans, the atmosphere, the biosphere, and the solid earth — need to be considered as parts of a single interacting and continuously changing earth system. The phenomena of concern [are] interlinked not only by common physical, biological, and chemical forces, but also by common forces of economic and social development."

Disasters are normally relatively rapid-onset events, but it often takes years, decades — even centuries — to set in place the elements that turn a naturally occurring hazardous event into a disaster. Decisions about where to locate, how to build, and what degree of preparedness is appropriate all have long-term consequences, and we are coming to recognize what we need to know and how we must apply this knowledge to reduce future disasters.

Global change is viewed as a relatively long-term phenomenon but it too is the cumulative effect of many smaller decisions about industrial development, land-use patterns, and environmental protection. Efforts to mitigate the effect of natural disasters will almost invariably reduce the threat of unwanted and unanticipated global change, and efforts to understand and confront human-induced global change will almost surely make the world safer.

Science and technology are the skills needed to address both issues. Gro Harlem Bruntland noted (1989) that as the challenging dynamics of global change gradually become clearer, the role of the men and women of science in shaping our common future becomes more central. The interplay between the scientific process and the making of public policy is not a new phenomenon. Indeed, it has been a characteristic of most of the great turning points in human history. It may be more important now than ever before in history for scientists to keep the doors of their laboratories open to political, economic, social, and ideological currents. The role of the scientist as an isolated explorer of the uncharted world of tomorrow must be reconciled with his role as a committed, responsible citizen of the unsettled world of the present. Bruntland's comments apply equally to the challenge of disaster reduction. The choice is not between managing global change or mitigating natural disasters. In critical ways, they share common elements — and both require international cooperation in the application of scientific and technological knowledge. Reducing the toll from natural disasters will bode well for our ability to come to terms with the challenge of global change.

Minimizing the greenhouse effect

Erik Arrhenius and Thomas Waltz

The issue of climate change is by its nature potentially divisive, so caution may be in everyone's long-term interest. International collaboration is essential as no single nation or region is likely to want to bear all costs of mitigation and adjustment. The political obstacles to global collaboration are substantial, however, as different nations and regions have conflicting interests. Creating an effective international system for rationing and curtailing greenhouse gas emissions will take time. In the meantime, other opportunities for collaboration exist. The development community should outline a policy and research program for sustainable economic development that addresses the implications of the greenhouse effect. Clearly the energy sector should get strong attention, but such sectors as agriculture and urban systems are also of importance as emitters of various greenhouse gases — and agriculture could be a sink for carbon.

What we know

We have known since late in the last century that the earth's climate system could warm because of atmospheric emissions and the radiant properties of industrial and agricultural "greenhouse gases." The theory of the "greenhouse effect," conceived more than a century ago by the French mathematician, J-B. Fourier (1827), was given support by Tyndall's studies (1861) on the absorption of heat by gases. The Swedish physical chemist Svante Arrhenius (1896) first calculated that a global warming of 3.2 to 4.0 degrees Celsius (C.) would result from a doubling of the earth's atmospheric concentration of carbon dioxide, a level that could be attained sometime in the next century. The theory of the greenhouse effect has passed from conception to hypothesis to the consensus view that it is both real *and* probably the driving force behind global climate change in our day (Jaeger 1988a).

The greenhouse effect is both normal and essential to life on earth. Without it, the earth would be more than 30 degrees C. (60 degrees Fahrenheit) cooler, and life as we know it would not exist. It is the additional greenhouse effect — the legacy of industrial revolution — that poses a threat to society. The extent and character of future changes will reflect human choices — about the use of fossil fuels, among other things.

The emission of greenhouse gases is expected to increase the global mean temperature more and faster than ever before in mankind's history. Current models predict a warming of 1.5 degrees to 4.5 degrees C. within the next century. The earth's temperature rose only 0.5 to 0.7 degrees C. in the last century, and probably has not varied more than 1 to 2 degrees C. in the last

10,000 years, or 6 to 7 degrees C. in the last million years. During the development of human infrastructure in the last 7,000 years, the average global climate has not been 1 degree warmer or colder than today's climate (Revelle and Waggoner 1983a).

Climate is a statistical description of the mean state of the atmosphere and the variability of the atmosphere, ocean, ice, and land surfaces over time. Climate is conventionally described in terms of historic means, variances, and probabilities (Rosenberg 1987). Climates have been accurately measured instrumentally in some locations for more than a century.

Climatic events that occurred before routine instrumental measurement became established (100 years ago) — and their relation to biogeochemical changes — are by no means unknown. Data from specific climate-related patterns in biological and mineral materials — recovered at time-related positions in sediments and ice cores — have been the main tools for measuring long-term climate change. These data — like "fingerprints" of different climate-influenced ecosystems — provide the basis for reasonably accurate descriptions of prehistoric variations in climate.

The global climate warms largely because certain long-lived industrially and agriculturally generated atmospheric trace gases — mainly carbon dioxide (CO_2), chlorofluorocarbons (CFCs), halons, methane (CH_4), tropospheric (ground-level) ozone (O_3), and nitrous oxide (N_2O) — trap some of the radiant heat that the earth emits after receiving solar energy from the sun, in some ways as glass enclosures trap heat (hence the "greenhouse effect").

We have solid physical evidence of anthropogenic (man-made) emissions of long-lived actively radiating trace gases that contribute to the greenhouse effect. We do not have solid scientific consensus on how these gases will affect the earth's climate. It is still not possible to say definitively, for example, that the global warming of 0.5 to 0.7 degrees C. that has been observed over land masses in the past century is the result of the greenhouse effect. Air temperature data indicate that five of the warmest years on record occurred in the 1980s, and some scientists have claimed statistical proof of the impact of the greenhouse effect (Hansen 1988), but others question whether we will ever be able to answer the question, Is this the year the greenhouse effect began to bite? Recent events do, however, illustrate what might be expected if the greenhouse effect were now under way.

Industrial greenhouse emissions

Greenhouse gases are accumulating rapidly and changing the chemical composition of the earth's atmosphere. Human activities are increasing greenhouse gas concentrations worldwide, intensifying the greenhouse effect. The gas that contributes most to the greenhouse effect is carbon dioxide; burning fossil fuels (coal, oil, and natural gas) releases to the atmosphere carbon that had been buried in the earth for 100 million years.

The next most important greenhouse gases are methane, chlorofluorocarbons, and nitrous oxide. Much methane is produced by the anaerobic (in the absence of oxygen) decay of organic matter such as agricultural (rice paddy and livestock) emissions and urban wastes. Methane also leaks during the extraction and transport of fossil fuels, a fact that should be considered when evaluating the relative greenhouse contribution of different fossil fuels (Abrahamson 1989). The level and lifespan of methane in the atmosphere are increased by the emissions of carbon monoxide that result from incomplete combustion of carbon-based fuels in industry, households, and transport — and from the burning of savannahs and forests in land-clearing and slash-and-burn agriculture. Although not a greenhouse gas itself, carbon monoxide interferes with the atmosphere's self-cleansing capacity by destroying chemical scavengers such as OH radicals, which are present in the atmosphere and would otherwise attack and break down air-borne methane. Thus it extends methane's atmospheric lifetime and its ultimate greenhouse warming effect. Chlorofluorocarbons — inert gases used as refrigerants, aerosols, foaming agents, and solvents — do not occur naturally but are industrially produced. The sources of nitrous oxide have not been fully characterized, but almost half of the emissions are probably from such natural biosystems as tropical forests and estuaries. Most of the nitrous oxides emitted as a result of human activity are released by soil processes, accentuated by various agricultural practices, land clearing, and tropical deforestation. Other sources of nitrous oxide, such as fuelwood burning, fluidized bed combustion, and the combustion of automobile exhausts, are the result of

Table 1 Net enhancements of the greenhouse effect

Compound	(1) Atmospheric concentration (parts per million)	(2) Annual increase (1985) (percent)	(3) Atmospheric lifespan (approx. years)	(4) Relative greenhouse efficiency (CO_2=1)	(5) Cumulative greenhouse contribution (1985) (percent)	(6) Present marginal greenhouse contribution (1985) (percent)
Carbon dioxide (CO_2)	346[a]	0.4	100[b]	1	50	46
Chlorofluorocarbons (CFCs)	0.001	5.0	100[c]	15,000[c]	17	24[c]
Methane (CH_4)	1.7	1.0	10[d]	32[d]	19	18[d]
Tropospheric ozone (O^3)	0.02	0.5	0.1	2,000	8	7
Nitrous oxide (N_2O)	0.3	0.3	150	150	4	5

a. Preindustrial concentration: 260 parts per million.
b. The estimated lifetime of atmospheric carbon dioxide assumes a dynamic equilibrium between the ocean and atmosphere unlike the lifetimes of other greenhouse gases, which are determined largely by chemical breakdown (Bach 1988). The statistical lifespan (calculated as the average atmospheric lifetime) of a single carbon dioxide molecule as a result of physical removal processes is four years (Laut and Fenger 1989).
c. For chlorofluorocarbons presently in use. These estimates may vary, with compensating shifts in the percentage breakdown in column 6.
d. These estimates may vary, with compensating shifts in the percentage breakdown in column 6.
Source: Columns 1-5, Bach 1988; Laut and others 1989. Column 6, World Bank estimate, highlights the relative priorities for possible mitigation of trace emissions as a function of their greenhouse contributions at the margin of increasing atmospheric loading. Footnotes, World Bank.

combustion at low temperatures.

Carbon dioxide is the least efficient of the greenhouse gases in its capacity to absorb infrared radiation. The other gases, because of their higher absorptive capacities, contribute substantially more to the greenhouse effect than the same amount of carbon dioxide (see table 1). Column 4 shows that greenhouse gases vary in their efficiency at absorbing infrared radiation.

For example, using CO_2 as the baseline unit (equalling one) for absorptive capacity, a molecule of methane has 32 times the greenhouse effect of CO_2, and the CFCs average 15,000 times the effect of CO_2. Column 5 presents the current cumulative level of past greenhouse contributions, by compound; column 6 shows what each of the greenhouse gases contributes at the margin. What they will contribute to increases in the greenhouse effect will be a function of their relative atmospheric concentrations, rates of annual increase, and radiative absorptive capacities. These figures indicate where the opportunities for reducing greenhouse emissions lie and are useful for evaluating the most cost-effective measures to be taken by the development community.

Breakdowns of carbon dioxide emissions by economic sector are not available for the world but a breakdown for the United States in 1985 is shown in table 2. Here sectors are treated as independent in their greenhouse effects, but they may be interdependent. Some industrial, transport, and residential building users generate all or part of their own electric power, for example, so these percentage distributions are only first-order estimates.

Table 2 U.S. CO_2 emissions by sector, 1985
(percent)

	Percent of total
Electric utilities	32.5
Transportation	31.0
Industry	24.7
Residential buildings	11.8
	100.0

Source: Personal communication, G. Marland, Oak Ridge National Laboratory, U.S. Department of Energy.

How much more methane contributes to the net greenhouse effect than carbon dioxide does depends on the period of time — or decision horizon — for which their relative effects are compared. Once methane is released to the atmosphere it is vulnerable to the attack of such chemical scavengers as OH radicals. Thus, al-

though methane's greenhouse warming effect is initially 32 times as great as that of carbon dioxide on a molecule per molecule basis, its present expected lifetime in the atmosphere is only 10 years — so its net cumulative effect declines from 32 to only four or five over carbon dioxide's longer lifespan. The contribution of methane and its byproducts to the warming effect will be given more weight for shorter decision horizons and less weight as the decision horizon is longer because methane's lifespan is shorter than that of carbon dioxide. Moreover, the breakdown of methane may involve a complex array of additional greenhouse gases. Thus, in 10 to 20 years the gross warming effect induced by methane emissions and byproducts could be substantially higher than these figures suggest.

And the various greenhouse gas emissions themselves interact synergistically. Methane is more effective per molecule as a greenhouse gas than carbon dioxide, so even small amounts of carbon monoxide (CO) increase the greenhouse effect significantly by increasing methane's lifespan. CO is produced by inefficient combustion in automobiles and industrial and household furnaces. It is worth considering ways to reduce CO emissions, such as introducing appropriate energy efficiency and process control technologies. And since CO is a combustible waste, finding more efficient ways to burn it would also provide more energy.

Recent onsite measurements and remote sensing observations confirm that substantial carbon monoxide is being released not only from fossil fuel combustion in industrialized urban areas but also from extensive tropical and savannah burning to clear land for agriculture in South American and African developing countries (Newell and others 1989). So the OH radicals, which give the atmosphere a natural self-cleansing capacity, are much more at risk than had originally been thought.

Although most CFCs are produced and used mainly in the industrialized world (see table 3), developing countries could become important producers and users of CFCs. But, if they had easy access to affordable replacements or substitutes for CFCs, their harmful effects on the environment would be attenuated. Some of the most promising near-term CFC substitutes, such as HCFC-22, break down relatively rapidly within the troposphere, but also have comparatively short atmospheric lifetimes — 15 to 25 years — more like that of methane than of contemporary CFCs, which have lifetimes of 100 years or more. As with methane, however, estimates of the relative greenhouse warming effect of such "new" CFCs will vary with the length of the decision period.

Table 3 World production and use of CFCs, 1985
(percent)

	CFC production[a]	*CFC use*[b]
United States	31	29
W. Europe, Japan, Canada, Australia, New Zealand, E. Europe, Soviet Union	59	55
Developing countries	<3	16
		100

Sources:
a. Chemical Manufacturers Association.
b. U.S. Environmental Protection Agency.

In short, the relative greenhouse effect of different emissions over time is the combined result of their radiative forcings (changes) per molecule, interactions with other gases and sinks, resulting atmospheric lifespans, and the length of the decision period used for the estimate.

Patterns of change in climatic risk

All current long-term projections of climate scenarios are conjectural, not literal. At the present time, scientists generally do not agree on a paradigm for anticipating climate change. Some climate scientists believe that the climate system tends to shift suddenly in equilibrium as boundary conditions change. Others contend that the climate system is linear, more deterministic than probabilistic in nature.

Oceanographer Wallace S. Broecker (1987) is concerned that we may have been "lulled into complacency" by model simulations suggesting a gradual warming over the next century. Broecker argues that the models' fundamental architecture denies the possibility of critical interactions that we know prevail in the real world. Unfortunately, we are aware of the possibility of so-called "flip-flops" in the climate system, but do not yet know how to incorporate them into our models or predictions.

A system's stability is a function of both the size of its domain of stability and its resilience, or its ability to maintain its structure and patterns of behavior in a disturbance (Holling 1986). And disturbances may be the result of positive feedback as well as external shocks. In a climate system, we may not be able to pinpoint thresholds along the boundary of the stability domain, but we do know that by pursuing the right approach to mitigating greenhouse emissions, we might be able to avoid climatic change altogether. Policymakers should not lose sight of this fact.

Long-term paleoclimatic records indicate that the earth does not respond to atmospheric forcing (changes in its chemical composition) either smoothly or gradually. Rather, the climate responds in sharp shifts that may involve large-scale transformation of the earth's climate system. These records also show that changes of 6 degrees C. in air temperature have been typical of the earth's climatic shifts — and have been *positively correlated* with changes in the concentration of carbon dioxide in the atmosphere. But none of these events has occurred in recorded human history.

Other feedback effects may be either positive or negative. For example, the feedback effects of a changing global cloud cover depend upon the type of cloud and may tend to be negative (because of enhanced solar reflectivity) or positive (by behaving as an insulating blanket, reflecting infrared radiation back to the earth's surface). A shift from one type of cloud to another in the process of climate change may thus induce a flip-flop. The ocean also manifests complex feedback interactions within the climate system. Moreover, the ocean is an important sink for CO_2 not only through its direct physical and chemical absorption, but also through its capacity to sustain plankton-based biochemical and photosynthetic transformations of inorganic carbon into deep sea sediments. The processes by which clouds and oceans affect climate are not well understood and require increased attention.

Empirical evidence strongly suggests that the probabilities of certain *extreme weather events* are correlated in a nonlinear way with mean temperatures. Experience has shown that the probability of extreme temperature events critical to the economy (such as consecutive daily temperatures exceeding 95 degrees F) increases as mean temperatures rise. As mean temperatures rise, so does the likelihood of natural disasters — which currently claim more than $40 billion in global resources and at least 250,000 lives annually. Ninety-five percent of these deaths occur in the poorest countries of the world, while 75 percent of economic losses occur in the wealthiest countries (Kates and others 1985).

Some simulations show a nonlinear relationship between *precipitation changes and the amount of runoff* available to supply irrigation within river drainage basins. In one such study, a 10 percent decrease in precipitation decreased runoff 25 to 40 percent, depending upon the size and mean runoff of the watershed (Nemec 1988). In another study, a 10 percent increase in average annual precipitation, combined with a 2 degree C. rise in average temperature, produced an 18 percent decrease in runoff. To completely counteract the effects of the 2 degree C. warming, a 28 percent increase in precipitation would be necessary (Revelle and Waggoner 1983b).

Some computer simulations with climate models suggest that with global warming the earth's hydrological cycle and resulting precipitation will not only become more intense, but that many areas presently dependent upon rain-fed agriculture will become hotter and drier. They suggest in particular that midcontinent, midlatitude areas that now produce substantial grain may experience *drier summer soil* and an increased risk of *drought*. In some scenarios, grain crops could fail simultaneously in all the earth's breadbaskets.

Similarly, some areas that have been dry may get more precipitation in a warmer world. And changes that by agricultural convention are viewed as positive may be undesirable for the successful adjustment of some species and ecosystems.

Recent international scientific assessments have led to the conclusion that should the anticipated greenhouse warming take place, *global sea levels could rise* 20 to 165 centimeters over the next century, mainly because of the thermal expansion of oceans. Such an increase would bring about *flooding* in many coastal areas, induce *saltwater intrusion* into aquifers, and *submerge wetlands*, the vital spawning grounds for commercial fisheries. At least 10 to 15 percent of the arable land, populated areas, and economic productivity of such areas could be lost. These estimates do not include the consid-

erably less probable scenarios of the melting of continental ice sheets in the Antarctic and Greenland, which would substantially increase progressive or sudden rises in sea level.

Another probable result of the anticipated rise in global mean temperatures would be a decrease in the natural thermal gradient on the earth's surface between the poles and the equator. A likely result will be *major shifts in the global patterns of wind and ocean currents.*

Why the development community should be concerned

Confronted by serious risks that may be menacing, cumulative, and irreversible, uncertainty argues strongly in favor of action and against complacency. There is a real choice (Waltz 1987). The world can continue with business as usual or it can reassess policies and resource commitments — in light of the risk of climate change, but with a view to endorsing precisely those actions that make economic, social, and environmental sense on their own merits. This approach can help buy time in which to learn more about the climatic and policy responses that might make sense later and can help us prepare for them if necessary. As Louis Pasteur stated, "In science, chance favors the prepared mind."

Several factors may influence the efforts of individual countries to deal with the greenhouse problem and to reach the international consensus needed:

- Industrialization is indisputably the principal source of trace gas emissions that increase the risk of (and uncertainties about) global climate change.
- The effects of climate change are likely to be widely dispersed.
- Some countries are far more dependent than others on such natural resources and systems as agriculture, forests, fisheries, and monsoon patterns — systems that depend heavily on climate. And these countries often have far fewer resources available for adapting to or mitigating change than other countries do. They are also more vulnerable to such natural disasters as floods, drought, violent storms, and rising sea levels (Gleick 1987).
- Developing countries have a greater need to increase their energy resources, so they also need to focus on policies and measures to mitigate the greenhouse effect.

The stability domain of the present climate system is unknown, so a critical threshold to turbulent change might inadvertently (perhaps avoidably) be crossed. But the climate system, like all systems, also has an inherent resiliency. Doing the right things now may increase our chances of avoiding truly disruptive climate change altogether.

Opportunities in economic development

Delay could mandate more extreme policy measures later, so taking action now seems prudent. Investing in energy efficiency is the best way of "buying" insurance against the hazards of the greenhouse threat, particularly since many options are economically, technically, and politically feasible. Failure to buy this insurance could increase both the risk and the cost of disaster, especially if there is a flip-flop in the climate system. Investing in energy efficiency is not only the quickest and most effective alternative for mitigating the greenhouse problem, it is also the least expensive (Keepin and Kats 1988, Goldemberg and others 1988).

Decisionmakers face the task of determining what specific investments or policies must take the risk of climate change into account (Waltz 1987). If industrial growth and energy demand take off as expected in many countries, without improving energy efficiency or restraining the use of chlorofluorocarbons, the result will be far more greenhouse gas emissions than are technically needed to meet the goals of development.

Agriculture generates less greenhouse gas than industry does. The stock of carbon in existing forests is about equal to the quantity of carbon now in the atmosphere, but the planet's storehouse of known fossil fuels contains at least 15 times more carbon than either forests or the atmosphere. So deforestation or forestation *alone* can play only a minor role decreasing carbon dioxide levels in the atmosphere. The extensive burning of rainforests does emit substantial amounts of methane and methane-enhancing carbon monoxide, so reversing policies that encourage such burning should be a high priority. Other opportunities for mitigating the risk of, or adapting to, climate change are discussed below.

Mitigating climatic risks

The climate system is resilient but this resilience is at growing risk of being overwhelmed if steps are not taken to reduce global accumulations of greenhouse gases. One risk is the possibility of abrupt and turbulent transitions, the final outcomes of which are unpredictable and adaptations to which are seriously constrained. The best strategy would be to reduce the risk of turbulent change by more aggressively pursuing mitigation measures.

Industry and energy

Industrial policy responses can particularly help reduce emissions of carbon dioxide and chlorofluorocarbons (CFCs). And energy efficiency policies, including those for reducing CO emissions, may significantly reduce the atmosphere's methane content (Arrhenius 1986). Methane emissions through leakage are prominent in the transport and mining of fossil fuels and the generation and distribution of natural gas (Abrahamson 1989). Fortunately, most leaks can be remedied by adopting improved leakproof natural gas handling systems and technologies.

The anaerobic breakdown of organic material in urban sewage, landfill, and agricultural waste also emits a great deal of methane. The controlled burning of such methane — preferably in association with energy production — would shift the net mix of greenhouse gases away from more absorptive methane toward less absorptive carbon dioxide, while increasing the total supply of energy.

Economic sensitivity analyses and uncertainty studies with global models confirm that end-use energy efficiency is the single most important technological factor determining future carbon dioxide and carbon monoxide emissions (Keepin and Kats 1988, Goldemberg and others 1988). And considerable emissions reductions are possible outside the energy industry. For example, 17 percent of global carbon emissions are associated with energy production to heat, cool, and light buildings. New houses often require as little as 25 percent or less of the energy of earlier designs, and it costs no more to build energy-efficient office buildings than inefficient ones (Rosenfeld and Hafemeister 1988). Recent advances in industrial process control technologies and drive systems, as well as in consumer appliances, offer dramatic opportunities to reduce energy demand and thus emissions of CO and CO_2.

Reducing carbon dioxide emissions

The main source of carbon dioxide emissions is the energy sector. Industry (including agriculture) accounts for the largest share of energy use in highly industrialized countries — nearly 43 percent of the energy consumed in the OECD in primary energy equivalent terms in 1985 (Farrell 1987), and nearly 60 percent of total commercial energy production in other countries generally.

The four basic industrial policy response options for reducing CO_2 and CO emissions in any economic sector are:

- Energy efficiency and conservation.
- Alternative energy sources.
- Changes in production processes.
- Emission control.

An integrated systems approach to energy policy across all sectors, consistent with sustainable development and the likelihood of climate change, needs to be elaborated. Such an energy strategy must stress increased energy efficiency, synergy among different greenhouse gas emissions (sources and sinks), reduced use of fossil fuels, and the use — where advisable for development — of alternative energy sources such as cogeneration, advanced biomass, and solar, wind, hydroelectric, and possibly nuclear power. Renewable energy technologies such as photovoltaics and hydrogen-based energy, now cost-effective only in limited applications, are rapidly improving in efficiency. Their technical attractiveness in particular applications, such as long-range energy transport and storage, should improve their market potential in industrialized countries, which could stimulate their earlier adaptation by developing countries.

Many developing countries are now beginning a period of rapid expansion in energy- and materials-intensive industries, as they strive to raise their living standards. The industries of many of these countries are far less energy-efficient than those in developed countries. To a certain extent, this energy differential is the result of government subsidies, inappropriate technologies, and poor management skills. Re-

forms in energy pricing can reduce costs by reducing energy use and can also reduce environmental damage.

A recent study demonstrated that a $10 billion investment in cost-efficient improvements in electricity end use could reduce expected demand for new generating capacity by 22 gigawatts. The capital cost for installing 22 GW of additional capacity would be about $40 billion (Keepin and Kats 1988, Geller 1986, Geller and others 1988, Goldemberg and others 1988).

A related study of energy conservation options in Brazil showed that relatively low electricity tariffs — particularly for industrial customers — were a strong disincentive to investments in conservation. Brazil assembled more efficient air conditioners for export than it produced for sale at home. A 300 percent trade tariff on imported rotary compressors used in the air conditioners effectively inhibited their sale and use within Brazil (Geller and others 1988).

Changes in manufacturing industry process control technologies can measurably reduce CO_2 emissions. In the cement industry, for example, where world production has been increasing at an average annual rate of about 6 percent since the 1950s, a variety of cement manufacturing alternatives exist, some of which release more CO_2 than others (Goldemberg and others 1988). Carbon dioxide is emitted in the calcining phase of cement-making, when calcium carbonate ($CaCO_3$) is converted to lime (CaO). For every ton of cement produced, 0.14 tons of carbon are emitted as CO_2 from this reaction. Generally, even more CO_2 is emitted from the fuel used to drive the process.

The energy requirements for cement-making vary from a low of 4 gigajoules per ton in Sweden and Japan to 7 gigajoules per ton in the United States. Energy is used to heat the kiln and grind the raw materials and clinker. Energy requirements vary for dry and wet methods of production. The wet method is more costly as water is added and must be evaporated afterwards, which requires more energy per ton produced. Other technologies — such as suspension preheaters, flash calcining, cold processing, or using less energy-intensive cement than Portland cement — can all reduce the energy costs of cement production 10 to 15 percent (Goldemberg and others 1988).

CO_2 emissions are thought to be largely irreversible. The U.S. Electric Power Research Institute (EPRI) estimates that deep ocean burial of CO_2 emissions would cost about $426 billion — to eliminate only 30-35 percent of U.S. emissions. So it appears doubtful that, even if proven technically feasible, such technologies would be economical.

Other policy options for reducing carbon dioxide include such emission control interventions as carbon fuel taxes and tightening automobile fuel efficiency standards.

Reducing chlorofluorocarbon emissions

The Montreal Protocol for the Protection of the Ozone Layer, which went into effect on January 1, 1989, calls for staged reductions in consumption, production, and trade in CFCs. Its effectiveness will depend upon the level of participation and compliance. Despite any drop in emissions resulting from implementation of the protocol, the greenhouse effects of CFCs may be expected to linger because of CFC survival rates of 65 to 110 years in the lower atmosphere (Bach 1988). Compliance standards for developing countries, based on per capita measures, are more lenient than for other countries. Replacement technologies either exist or can be developed for most CFC applications, albeit at some cost — and it will take some time. In the meantime, countries can agree not to export inefficient and obsolete CFC-leaking technologies to other countries.

The issue of chlorofluorocarbon emissions and ozone depletion is closely related to the greenhouse issue, but is different in important ways. Mechanisms to mitigate ozone depletion include producing CFCs with shorter lifespans, thereby preventing them from ever reaching the ozone layer. The greenhouse effect of these more short-lived CFCs is still substantial, however, and in the short term (10-20 years) is almost equal to that of present CFCs. Thus, the introduction of these short-lived CFCs would resolve the ozone depletion issue, while the greenhouse effect of CFCs would remain the same. Thereby, one of the cheapest instruments for reducing the risk from climate change is lost.

Agriculture and rural development

The proportionate size of the various compartments of the carbon cycle have important implications for greenhouse warming in the agricul-

tural sector. The amount of carbon in the atmosphere is roughly comparable to the amount in the biosphere, and the amount in soils is half again (1.5 times) as much as either. By contrast, 15 times as much carbon as is found in the atmosphere is stored in the ground as fossilized carbon and peat, and an overwhelming 75 times as much carbon is stored in the oceans.

Reversing the trend toward deforestation could be a cost-effective means of reducing net carbon dioxide emissions in many countries. Policy attention should be given to shifting cultivation, the use of fuelwood, and land use property rights. The destruction of tropical rainforests to develop agriculture and livestock releases large amounts of carbon monoxide, carbon dioxide, and methane — thus amplifying the impact of deforestation by enhancing atmospheric concentrations of methane. But most greenhouse gases are produced by the highly industrialized sectors. The practical potential for modifying the greenhouse effect through deforestation or reforestation is ultimately limited and should be kept in proper perspective.

Reforestation attempts, however, must compete against other demands for land use within the biosphere and must allow for the fact that to remain effective over the long term, the carbon must somehow be sequestered and the process renewed as the trees mature. Efforts to reduce emissions and increase sinks for carbon would be improved if agricultural techniques could be developed to exploit soil's inherent capacity to store carbon by gradually increasing its organic components. Such opportunities are likely to be greatest in the developing world, where much of the land has already been seriously degraded. They would not compete with the efficient productive use of land.

Methane emissions from ruminating livestock could be reduced by an estimated 25 to 75 percent (Gibbs and Lewis 1989). Methane production from ruminants is probably caused by inappropriate cattle breeding and feeding and by unsuitable environments in stables in intensive animal husbandry. The potential range for converting carbon intake to methane in animal husbandry is large, because output (milk, carcasses, and manure) represents only 10 to 25 percent of the input (feed) in energy content. The livestock industry has not begun reducing methane emissions from animal husbandry (Arrhenius 1986). It is technically feasible, but livestock produce only 15 percent of all methane and contribute only 3 percent of the greenhouse effect.

Adjusting to climatic risk

Industry and energy

The risks of climatic change are so imprecisely described that it is neither possible nor desirable to invest now in specific local and regional projects anticipating climatic transformation. But the increasing likelihood of climatic changes suggests the prudence of considering the economic and financial feasibility of building more resilience into the planning and design of industrial and energy infrastructure. The least probable scenario is "no climate change." It may pay to scale down or delay large or long-lived projects — buying time with smaller, shorter-lived ones — to observe what actually happens climatically in particular regions and countries.

Infrastructure and urban development

If ocean levels were to rise because of thermal expansion, rising seas would inundate coastal areas and could decimate large areas of coastal wetland. The economic threat to coastal wetlands alone could be hundreds of billions of U. S. dollars.

In the years ahead, the costs of shoreline protection may rise and the relative effectiveness of alternative measures could change. A one-foot rise in sea level would erode most shorelines more than 100 feet, by some estimates. What this means for coastal, especially delta, communities hardly needs elaboration. Proposals for building or expanding ports, coastal cities, housing, or coastal developments or engaging in coastal agricultural activities — any of which could seriously affect economic development because of their multiplier effects on employment and incomes — should be reconsidered. Smaller, more flexibly designed projects with shorter lifetimes are strategically advantageous for planning such projects as dams, irrigation, and ports.

With changes in precipitation, water supplies for irrigation, dams, and sewage systems might all be threatened. With climate change, the

recharging of groundwater reserves could obviously be a serious problem that should be kept in mind in defining the scale of infrastructure projects that involve water resources, such as dams, irrigation, and sewage facilities.

Agricultural and rural development

In agriculture, the uniformity of plant gene pools and the mechanized synchronization of plant growth and development have made crops more vulnerable to large-scale shifts in weather systems (Rosenberg 1987, Rosenberg and others 1989). Climate change itself may threaten the survival of the natural (wild) gene pool, so we must systematically ensure that an adequate gene pool survives and is sustained. Climatic change also makes crops and livestock vulnerable to extreme weather events such as floods, drought, pests, disease, and soil erosion.

In past long-term temperature changes, forest boundaries have shifted as fast as 1 kilometer a year. Computer-simulated projections of greenhouse-related global increases in surface temperature for the next century suggest faster changes than paleoclimatic records indicate as having occurred before the industrial era. These projections imply that suitable growing areas for forests and agricultural products could shift at an unprecedented pace. This would disrupt mainly forests and unmanaged ecosystems. It is not too early to begin thinking about how such processes might affect investments in agriculture and forestry.

Population and human resources

As the risk of hydrological and temperature change increases, so does the potential for worrisome shifts in vector diseases that threaten animal and human populations. Patterns in nutrition, famine, morbidity, mortality, and migration could also change. Investment planning should address such risks.

The key: energy efficiency

The right energy policies in the next few decades could substantially mitigate global warming through greenhouse gas emissions. Energy efficiency, particularly in end uses, appears to be essential for coping with climatic change. And energy conservation makes good economic *and* environmental sense.

Uncertainties prevent us from knowing how a given level of emissions will affect the rate and magnitude of climate change. And uncertainties about the impact of greenhouse gas buildup are pervasive. But the uncertainties are not about whether the greenhouse effect is real or could raise global temperatures, but about the magnitude and timing of warming regionally and the prospects for cooperatively resolving the results globally.

We can guess about when various levels of warming will occur based on choices we might make now and later. Delaying policy moves toward energy efficiency would substantially increase the global potential for future warming. Fortunately, technical options are available that — if necessary and given sufficient political and economic will — could stabilize greenhouse gas emissions.

Most countries could significantly improve their production efficiency in greenhouse-gas-emitting industries. Such steps would be economically worthwhile even if climatic change were not a risk. But atmospheric emissions could escalate in many countries, so it is crucial for all countries to help stabilize the level of greenhouse gases.

The sooner the international community becomes committed to increasing energy efficiency in all sectors of the global economy — especially end-use energy efficiency — the more time we will have to cushion the inevitable adjustments that may ultimately have to be made by the most vulnerable economic sectors and geographic regions of the world.

Development: from vulnerability to resilience

Case study: housing reconstruction in Mexico City

Alcira Kreimer and Edward Echeverria

The earthquake that struck Mexico City in September 1985 took more than 5,000 lives and damaged the housing of about 180,000 families. RHP, the agency that was set up three weeks later to rebuild urban areas damaged by the earthquake, is a textbook example of successful reconstruction. By July 1987, only 14 months later, RHP had rebuilt 45,100 dwellings — an average of 3,220 dwellings a month. Today one of every seven families living in the city's historic center has a new or rehabilitated RHP dwelling. This was one of the largest reconstruction programs since the recovery from World War II. Almost all of the federal and city development and management agencies contributed to reconstruction. More important, the beneficiaries — the earthquake victims — helped daily to expedite decisions and construction. More than 1,200 private companies participated in the program and more than 175,000 jobs were created, but by May 1987 RHP had begun reducing its staff and most personnel had returned to their former agencies. As Manuel Aguilera Gomez, RHP's director general, wrote afterward: "We all learned to conciliate the desirable with the feasible. We learned to listen with care and interest to the sentiments of those affected by reconstruction. Little by little — in stages — the attitudes of the program beneficiaries changed from hostility, uncertainty, incredulity, suspicion, and doubt to hope and confidence."

On September 19, 1985, at 7:19 a.m., Mexico City was struck by an earthquake that measured 8.1 on the Richter scale and lasted more than a minute and a half. The next day there were a number of lesser quakes, the strongest of which measured 7.8 degrees. The maximum horizontal acceleration was nearly 20 percent of gravity on a dominant two-second cycle. This ground movement resonant cycle coincided with the natural vibration period of the five- to 12-story buildings that predominate in the city's dense historic center — making the earthquake one of the most destructive in the hemisphere's history. Poorly built tenements housing low-income families in overcrowded conditions suffered the worst damage. They had already deteriorated from lack of maintenance and repair. Tenement rents had been frozen since World War II so there had been no incentive for rehabilitation. The catastrophe took more than 5,000 lives, caused 16,000 injuries, and damaged or destroyed 12,700 buildings — 65 percent of them residential. The housing of about 180,000 families was damaged and 50,000 people had to be temporarily rehoused. Also affected were 340 office buildings in which 145,000 government workers were employed, plus 1,200 small industrial workshops, 1,700 hotel rooms, 1,200 schools, and 2,000 hospital beds. The loss exceeded US$4 billion as calculated by the Min-

istry of Finance and the Economic Commission for Latin America and the Caribbean (CEPAL).

Housing reconstruction

The government of Mexico asked the World Bank for assistance for the reconstruction of hospitals, schools, and low-income housing and for research into revised building codes, zoning, and regulatory measures to reduce the city's vulnerability to earthquakes. There were four rehousing programs:

- Popular Housing Reconstruction (RHP) — 48,000 dwelling units, benefiting 260,000 people, reconstructed onsite on expropriated sites.
- Phase II — 12,000 dwellings on nonexpropriated sites.
- Casa Propia — 8,000 dwellings rehabilitated for resident owners.
- Housing Foundation (FOVI) — 12,000 units of relocated housing.

What follows is a description only of the first of these, RHP — a success story in emergency construction and a model for community involvement.

Popular Housing Reconstruction

On October 14, 1985 (just three weeks after the disaster), RHP (Popular Housing Reconstruction) was set up by presidential decree as an autonomous agency with a life of two years (see box by Manuel Aguilera). RHP had a mandate to:

- Rebuild and reorganize urban areas damaged by the earthquake, following the principles of urban renewal and social development.
- Define a policy of social development that preserves and protects the physical and social patterns of urban life, guarantees ownership of the dwellings to the beneficiaries, and provides needed urban services.
- Combat land speculation.
- Rationalize the building finance and investment that would be channeled to the program.

The program was to unfold in five stages:

Stage 1. October 1985 - March 1986. Damage assessment, planning and design.

Stage 2. April - December 1986. Intense construction and social organizing.

Stage 3. January - March 1987. Allocation of dwellings, legalization and registration of deeds.

Stage 4. April - September 1987. Completion of program.

Stage 5. October 1987 - April 1988. Diagnostic history, records, and closure.

1. Damage assessment, planning and design

In the first months after the earthquake, RHP updated an initial survey to estimate the number of people affected, their socioeconomic characteristics, and the physical condition of their dwellings. On the basis of this census, the victims were awarded certificates validating their eligibility for housing assistance. Early proposals for reconstruction focused on vacant land in outlying areas, including a site adjacent to the airport. But World Bank financing was contingent on rebuilding onsite with minimal relocation, a policy based on negative experiences the Bank had had with large-scale relocation in other disaster areas. Most families had lived in their neighborhoods for a generation or more and wanted to remain there, so the government adopted a policy of reconstruction onsite.[1]

This decision required expropriation of privately held land and the provision of temporary shelter by families in the immediate vicinity. This called for both political and administrative skill and enormous sensitivity in dealing intimately, day in, day out, with 60,000 families for more than a year and a half.

On October 11, 1985, the Expropriation Decree was published in the Official Gazette. Some greeted it with appreciation for its social justice; others condemned it as populist and demagogic for its violation of property rights. Errors and omissions needed correcting and individual cases were protested in the courts, but the decree itself was successfully administered with a taking of 4,312 lots or 200 hectares (500 acres).

The Expropriation Decree announced that meeting the collective needs of the people whose homes were destroyed by the earthquake was in the public interest; that the city government was to occupy the property immediately, authorize its upgrading and renewal, and sell the new housing to the people who had been living there; and that the city government was to pay compensation to the former owners within 10 years, according to the capacity of the Treasury.

By January 1986, the RHP was reorganized to create two departments, Construction and Administration, at the same level as the Office of the Director General. The most important change was the decentralization of the Construction Department into five zonal offices in charge of supervising and controlling construction and of building temporary shelters. To reinforce the core staff, RHP borrowed senior planners and engineers from the Ministries of Communications and Transport, the Secretariat of Urban Development and Ecology (SEDUE), the Federal Electricity Commission, the Urban Transportation Commission, and many agencies of the Federal District (DF) of Mexico City. The zonal offices were further decentralized into 12 construction and operations modules that managed all construction activities.

In January 1986 social and technical teams started to match socioeconomic survey data to data on the physical condition of each dwelling. In the process they organized the earthquake victims into community groups to review the whole program, site plans, and prototype apartment designs. Based on the census, the government issued *certificates of residency* establishing earthquake victims' eligibility for benefits. These were issued regardless of who legally owned the building. Many families had abandoned their dwellings immediately after the earthquake, however, so it was difficult to track them down to document their rights to new dwellings. Regular meetings were held to maintain the quake victims' social organization, to review and revise program plans, and finally to approve plans and sign documents for the construction of each apartment. For many groups, planning and redesign took as long as eight to nine months, construction only four. Only after agreement was reached were beneficiaries legally formed into a condominium association that agreed to vacate the building so reconstruction could start. Temporary shelters of corrugated aluminum or zinc were generally located within a block of the building site. Wherever possible, they were built on public lands — parks, sport centers, roadway median strips, service roads, and sometimes actually in adjacent streets.

The social teams organized the condominium associations into "renovation councils" for each reconstruction or rehabilitation site. Although they had no legal status they provided forums for people to speak out. The councils were formally installed with elected representatives authorized to negotiate with the RHP about individual needs. They also had to decide on the legal status of their housing association — whether to be a condominium, a cooperative, or a nonprofit organization.

Many people who had no previous experience in community action found themselves as spokespersons for their association. They became outspoken not only to the press but also to the RHP and city officials. The Director General and Director of Social Affairs spent long hours negotiating and responding to their concerns. The beneficiaries' participation made the process far more rewarding for the federal government, the city, the community, and the beneficiaries.

During planning and design, five types of groups worked with the earthquake victims: political parties, university groups, technical support groups, and private voluntary and religious organizations. More than half the sites received support from one or more organizations, starting with the census survey. University groups began by evaluating damages and later acted as technical support. The political parties also played an important role.

By February 1986 the new "Personal Certificate of Rights" was developed to replace the original "Certificate of Residency," to eliminate fraud and clarify other questions of need. RHP experienced great difficulty handling so much data and residents were reluctant to be interviewed again. There were two main problems. First, people were uncertain and mistrustful because, months after the earthquake, reconstruction had not begun. Second, there was discord about the size of dwellings. Many felt that the size of the dwelling should be proportionate to the titleholder's ability to pay. But this was impractical, given the number of beneficiaries and the time constraints. By the end of February the Social Development Office issued a "Handbook of Social Procedures" explaining how disaster victims could get the replacement housing conceded to be their right.

The technical staff of architects, planners, and engineers labored over criteria to distinguish which damages were caused by the earthquake and which by physical deterioration of the dwellings. The detailed building survey showed that the earthquake had damaged or destroyed 59 percent of the buildings beyond repair or rehabilitation. A third had deteriorated because of neglect and some of these

Reducing urban and natural risks in Mexico City

Manuel Aguilera Gomez

The director of Mexico City's incredible housing reconstruction effort after the earthquake of 1985 describes what happens when artificially induced ecological changes heighten a city's natural vulnerability. He calls for a reorientation of urban development — a qualitative long-term change to close the gap between the city's urbanization pattern and degree of vulnerability. He stresses the need for community development over the continuing development of a metropolitan program vast beyond reason.

In this last decade of the twentieth century, Mexico City — located more than 2,000 meters high, on an enormous lakebed — has become one of the largest metropolises in the world. Risk and disaster have always been part of life in the nation's capital. Home to more than 15 million Mexicans (about 19 percent of the country's population) who live in the Federal District and 17 surrounding municipalities, the city is a disjointed assembly of mixed urban habitats.

These habitats — located in the Valley of Mexico, surrounded by volcanos and mountain chains — differ in their subsoil, altitude, and degree of modernization. Their major infrastructure and service systems are not integrated, and a complex network of regulations and overlapping administrative jurisdictions operate in isolation, with no sense of metropolitan unity. The metropolitan area now covers nearly 1,500 square kilometers.

Economic, political, and cultural factors have all played a part in Mexico City's current problems. The period of fastest urban growth in the valley was from about 1955 to 1982, when expansion averaged 3 percent yearly. This period coincided with a general agricultural crisis in Mexico and the adoption of a development model based on a strong concentration of industry and services. At present, nearly 30 million industrial plants are located in the Federal District alone, which covers 55 percent of the metropolitan area. Although rural migration to the city has fallen off in the last five years, it remains high, with about 300,000 new arrivals each year. Improvements in the Federal District's demographic policy have reduced the annual rate to 1.2 percent, but the same is not true of outlying areas in the State of Mexico, such as Chalco, in the Northeast of the metropolitan region, where the population is growing more than 5 percent a year.

The city's size, artificially induced ecological changes, and constant changes in the use and allocation of urban land have clearly heightened the city's vulnerability. When urbanization pushes the rate of expansion beyond a certain point, risk and vulnerability increase and become a constant factor that must be considered in the design and implementation of urban development policies. The city now lives with permanent risks of earthquake, landslides, floods, severe traffic congestion, and interruptions of the water and power supply to certain critical regions.

We live in an urban complex that began to deteriorate ecologically more than 400 years ago, when the Spanish *conquistadors* began the prolonged drainage of Lake Texcoco. This was completed only at the start of this century, but the consequences of this action are still at the root of many of our problems. In our time we have seen a city rapidly modernizing but as a result it is a victim of bold architecture that sometimes defies the swampy and geological nature of the basin of Mexico.

Its residents are aware of overexposure to contingencies of varied nature and magnitude. But not until the 1985 earthquakes did we become fully aware of our profound vulnerability as an urban community. The painful experience of the 1985 earthquakes illustrates the vulnerability we live with daily and the community's ability to organize quickly in response to devastation from natural disasters.

The earthquake on September 9, 1985, reached 8.1 on the Richter scale. In parts of the city with soft and humid subsoils, or because of amplification, the intensity topped 10. The effects of the seismic waves caused the death of more than 5,000 people and damaged buildings more than eight stories high located in the epicenter, the central-eastern part of the city. Similarly, the duration of the earthquake destroyed older neighborhoods, multifamily dwellings, and such strategic service networks as the water supply, drainage, and main roads and avenues — thus delaying rescue operations.

But as a witness and actor in this period in the history of our capital, as head of the Popular Housing Reconstruction program, I can state that the emergency and subsequent reconstruction were times of unforgettable solidarity and human effort. Few countries and cities have gotten back on their feet in so short a time. Reconstruction was overwhelmingly successful. For example, 48,000 dwellings in the hardest hit areas were raised from the rubble — in the poor but well-serviced center of the city — within 18 months. Virtually all of the city's infrastructure and service systems were restored in only three months.

The terrible lesson of the earthquakes has resulted in increased

community awareness of not only the constant risks but also vulnerability caused by so-called overurbanization. The first step in reducing the vulnerability of the Federal District was the redesign and implementation of an integrated civil protection system. The second was a reorientation of the urbanization process and the city's development model.

Modernizing the Federal District's civil protection system

The first task was to identify the most vulnerable zones and regions, especially the nature and scope of risks in the central and northeastern part of the city which, because of its soil and structures, is most likely to be affected by geological phenomena. The belt of gullies, depressions, and ravines that crosses the city from west to southeast has the highest risk of cave-ins and land faults, as well as flooding because of intense annual rainfall and inadequate storm drainage. The basic purpose of the civil protection system in the Federal District is to guarantee an organized, speedy, and efficient government and community response to any emergency and to coordinate joint efforts to restore normalcy in services and the rhythm of daily life.

The project to modernize civil protection has five strategic guidelines:

- Fostering solidarity.
- Local, decentralized responses to emergencies.
- Adequate training for each population group by zone and type of activity.
- Coordination of the public agencies and the community to give the rescue effort a sense of unity and balance.
- An international exchange of experiences to introduce Mexico City to advanced technologies for the prevention of, and response to, disasters.

The spirit behind these strategies is solidarity and grassroots participation. All of our equipment and trained personnel are useless in a catastrophe if we cannot incorporate the solidarity, civic-mindedness, and the responsibility demonstrated by the millions of anonymous citizens who saved Mexico City in 1985. Specialized teams of volunteers must work with groups in the community, contributing their resources and personnel to promote more collective security. By the end of 1989, neighborhood organizing efforts in the Federal District had attracted 16,000 volunteers to the civil protection system. The second phase will tap the imagination and talent of these volunteers for tasks of such magnitude and importance that we must all join in.

Reorienting urban development

Mexico City has reached a stage in its development that requires medium- and long-term qualitative changes to close the gap between the city's urbanization pattern and degree of vulnerability. We cannot say that Mexico City will stop growing or that its vast problems of pollution and vulnerability will cease to exist or continue to increase if we reduce urban growth. But the urbanization pattern must be reoriented to stabilize the pollution and vulnerability indices, so that we can gradually make overall improvement and restore environmental quality.

For many years, urban growth meant that most investments went to expand such major infrastructure systems as the water supply, storm drainage, and the subway. Improvements were virtually the exclusive preserve of the modern microregions of the city, to the detriment of the poorer, deteriorated areas. True, many of the major infrastructure systems must continue to provide a centralized service that serves the urban whole. But most government action — whether to reduce pollution, improve the urban space, or diminish the uncertainty of foreseeable risks — should be a local, decentralized response to the priority demands of specific, localized social entities.

In the future, most investments in Mexico City must be made in mixed urban habitats. If they are to be integrated in a just and fair manner, community development must be stressed over the continuing growth of vast metropolitan programs. Aggregate demand must yield to priority demand — which should be met primarily by use of local resources.

Through group representation, communities must participate directly in managing everything that bears on their daily lives. This is the true meaning of democracy and the only real way for social justice to prevail in one of the largest cities in the world.

would have to be rebuilt. Rehousing on the expropriated sites was initially set at 46,700 dwellings, of which 23,200 (half) were to be rebuilt, 14,900 (32 percent) rehabilitated, and 8,600 (18 percent) improved by minor repairs. Exposing the structural elements revealed that many buildings slated for rehabilitation had to be replaced. So the number of reconstructed dwellings increased to 35,900.

The technical staff, together with architectural consulting firms, selected three prototype designs for reconstruction. RHP had to take a pragmatic approach to unit size, rebuilding for an average family of 4.6 persons. Each dwelling unit has a minimum net area of 40 square meters, a kitchen/living/dining room with hot water, two bedrooms, a complete bathroom with shower, and a small laundry patio or balcony. The structures are all earthquake-resistant.

The architects and planners were ingenious in providing a diversity of building shapes and heights with a striking use of color and texture. Most buildings are three stories high, with grade beams of 20 x 40 centimeters, load-bearing walls, and reinforced concrete slabs. The structural beams on each floor are tied to the columns to

provide a rigid structural frame. The common walls serve as shear walls to provide added rigidity. Many of the sites had such poor (highly compressible, saturated) soil conditions that as much as 1.2 meters had to be excavated and replaced with compacted crushed stone.

2. Intense construction and social organizing

The bureaucratic procedures for plan approvals, construction, modification, and completion of each building were streamlined between RHP, the Low-Income Housing Fund (FONHAPO), the office of the Federal District (DDF), and the National Bank of Works and Public Services (BANOBRAS). Plans and construction contracts for more than 3,000 sites had to be approved, so it was imperative to reduce approval time to days instead of months. Close daily supervision by zonal offices, community groups, and future condominium owners kept the construction on schedule. A technical team from FONHAPO helped RHP administer the loans. The average cost of the dwellings on the first group of sites was US$4,030, so repayment was based on a down payment of 10 percent and the rest, US$3,630, was amortized over 5.5 to 8.5 years, depending on the purchaser's ability to pay. Monthly payments were set at 20 percent to 30 percent of one minimum wage indexed to inflation. The payments were adjusted once a year using a computerized formula. A special municipal trust was activated to receive the monthly payments and maintain the loan portfolios. As construction expanded to hundreds of sites, construction management teams had to streamline their daily accounting and budgeting systems, which quickly reached a peak expenditure of US$1 million a day. Auditors from the National Chamber of Deputies periodically reviewed the financial accounts. Their reports were published for public commentary — which was continually favorable.

Procurement

Under the emergency act to expedite procedures, in July 1986 RHP called for tenders on delivery of 12,000 toilets and 32,000 wash basins, kitchen sinks, and water heaters. The government and World Bank procurement guidelines on local and international competitive bidding were fully respected but early approval of documents and down payments ensured on-time delivery. Savings of about US$1.5 million were achieved by the bulk purchase, despite the difficulty of storing such quantities of goods.

By mid-1986, RHP had been asked to rehabilitate or restore more than 100 buildings considered to be of historic value, providing residential living space, security, and adequate sanitation within the program's budget. Project designers from the National Institute of Anthropology of History helped identify buildings that were candidates for restoration and conversion to residential use. In many of these old "mesones," densities before the earthquake were one family per room, so many families had to be relocated. The decision of *whom* to move was left to the group. Residents on the alternative site had accepted the move of those who were relocated. On acceptance, final sales prices and plans — including the date construction was to start, the date people were to move to temporary shelters, and the agreement to receive monthly rent during reconstruction — had to be ratified by all partners.

Help from social and community groups and universities was essential. Interdisciplinary groups of students of medicine, psychology, sociology, architecture, and engineering — coordinated by RHP social services — provided the much-needed social services in the temporary shelters, while RHP paid for utilities and provided security, fumigation, and maintenance and repairs to the sanitary installations. As a rule, the beneficiaries were willing to accept the rules of the reconstruction program.

Demand for temporary shelters increased and it was difficult to build more of them in the streets, so in May 1986 SEDUE acquired 28 hectares next to the airport on which to build 1,200 prefabricated dwellings. These were occupied initially by one family per room. When reconstruction was complete, they were modified back to one family per four rooms of about 48 square meters and sold to the beneficiaries. A total of 20,000 temporary dwellings were built. As a complementary measure, rent assistance was increased to significantly reduce the demand for temporary shelters.

By mid-December RHP technical and administrative teams were so immersed in construction management, with many sites operating around the clock, that they chose to work through their normal Christmas holiday to advance the program. In the first eight months of construc-

tion, RHP's construction management team maintained its output at the rate of more than 2,600 dwellings a month — a remarkable achievement. By the end of December 1986 (the end of Stage 2), 21,200 dwellings had been completed and 10,437 of them were already occupied. Dwellings were finished and assigned so quickly that it was necessary to speed up removal of the temporary camps — first those on the streets, then those on expropriated lots.

3. Allocation of dwellings, registration of deeds

In January 1987, RHP began to restore the streets and parks that had been occupied by the temporary shelters. Sidewalks were repaired and the area was cleaned up, gardened, and repaved. On February 6th the International Union of Architects announced that RHP had won an international architectural award, the Sir Robert Matthew Gold Medal award. The reconstruction program was considered by the Architect's Union "the best piece of work on human settlements carried out internationally in the previous three years."

During this period, the Legal Department was verifying the massive data the notaries needed to legalize the transfer of deeds to the new owners and to register them in the Public Registry of Properties. This involved deeds for permanent housing on 2,870 lots constituted as condominiums, along with 46,720 individual deeds for each dwelling or commercial outlet. In addition, the 1,200 prefabricated dwellings near the airport were divided into 11 lots for deed registration. The Social Development Department undertook the problem of verifying the technical and social historical data on each lot. Each site development lot required a complete technical-social file. There were external problems as well. Many of the lots were unregistered and the Cadastral Office of Deeds had incomplete or no data. The Public Register of Properties was not equipped to handle this enormous load, so RHP had to send its personnel and computer data equipment to help check out the background information of the register in the Treasury, the Legal Department of the City Government, and the Tribunals. By the end of March 1987, they had distributed 1,807 deeds for individual dwellings and 188 condominium deeds. Construction was virtually complete, but on March 31 the President of the Republic authorized that "closure" activities continue until the end of September 1987, that the Low Income Housing Loan Trust Fund (FIDERE) would recover the loans, and that the City Government would take over all of RHP's rights and obligations on RHP's demise.

4. Completion of program

By July 1987 the reconstruction of 45,100 dwellings was completed. It had taken 14 months, with an average 3,220 dwellings a month. During the peak period of February-April 1987, RHP was completing more than 120 dwellings a day. To process final payments to the more than 700 construction contractors, on the more than 10,000 contracts of supplies and services, RHP developed a computer program that indexed construction costs to inflation and completion schedules. Final estimates were reviewed by building control personnel who sent them to finance personnel for verification. Contractors who owed money to RHP completed payment by certified check. If payments were due the contractor, a final balance sheet was sent to the financial department for final payment. RHP would return bond security on the advanced payment, leaving the bond covering construction warranties.

By the end of September, the rent payment assistance program was closed. It had benefited 19,900 families with an average of 364,704 pesos (US$750) a family. Rent assistance, which lasted an average eight months per family, included payments for moving furniture and personal possessions twice. The loan portfolio for recovering the loans for 42,000 dwellings and commercial outlets and 2,745 lots (or 94 percent of the total) — together with the hardware and software used to administer the system — was handed over to the financial trust, FIDERE. By September 1987, the gross repayment (monthly payments, advance payments, and insurance) had reached about US$10 million.

5. Diagnostic history

With the help of personnel from the General Archives of the Nation, RHP began analyzing the documentation for the whole program. The structure and content of the General Archives were designed so data could be retrieved for research. A building was rehabilitated to store:

Decentralizing Mexico's health care facilities

Edward Echeverria

The earthquake of 1985 caused disproportionately heavy damage to Mexico's health care facilities because they were concentrated in the capital city center. The Ministry of Health's Centro Medico (3,000 beds) and the Central Hospitals of the Social Security Institute (IMSS, 2,600 beds) — which included important Mexico City hospitals — were virtually destroyed. Immediately after the quake, plans to rebuild these health care facilities followed the national strategy of decentralizing federal government functions to other states.

Health care reconstruction

The Government of Mexico (GOM) took an integrated approach to decentralization. Financing and investments were coordinated at the federal level, planning and programs at state and municipal levels. The World Bank had supported a policy of decentralization since 1985, helping the GOM in projects aimed at achieving spatial decentralization by developing alternative growth poles outside of Mexico City. The earthquake and reconstruction provided an opportunity to execute this policy.

IMSS, the second most important health care provider in Mexico, serves 40 percent of the population: workers covered by health insurance. In the last 20 years, IMSS has gained extensive experience in the design, construction, and operation of health care facilities throughout the country. IMSS's technical design office, which had a deconcentration plan, organized and managed the replacement of 2,000 beds destroyed by the earthquake. It proposed to provide about 1,200 beds in six "second-level" zonal hospitals to serve an estimated 1.2 million people on the periphery of Metropolitan Mexico City. Each hospital would provide ambulatory and hospital services, including gynecology, obstetrics, pediatrics, general surgery, internal medicine, orthopedics, trauma, ENT (ear, nose and throat), and ophthalmology. These zonal hospitals would take care of 95 percent of the cases locally, eliminating the need to travel to the Centro Medico — which henceforth would provide specialized "third-level" services, with only 300 beds. Before the earthquake, about 40 percent of IMSS hospital beds were in the city center, more than two hours from most of the 7 to 10 million IMSS beneficiaries living in the metropolitan area.

The remaining 800 beds were to be built in five regional hospitals distributed countrywide according to need. Some were new nursing units and health care facilities added to existing hospitals so that the five regions — Ciudad Obregon, Vera Cruz, Leon, Puebla, and Merida — could become fully autonomous in providing all types of health care. This would reduce further the need to transfer second- and third-level-care patients for treatment in Mexico City. These actions would improve the level of health services and make them more accessible, at lower unit costs. Costs would continue to be recovered through user and employer fees in accordance with established practices.

Cost and schedules

Four of the hospitals on the periphery of Metropolitan Mexico were built on schedule and operating in 1989. Problems in site acquisition delayed the other two. They had to be relocated, which meant revising site and building plans. Their completion was scheduled for September 1990. The five regional hospitals were completed, equipped, and operating in 1989.

Procuring medical equipment (especially the CAT scan) required a long lead time. Bids for more than US$44 million worth of equipment were finally opened in December 1987. Despite large price increases the project had to absorb, costs remained within the projected range of US$50,000 to $55,000 per bed for equipment and $50,000 per bed for construction.

(1) construction contracts, bidding documents, licenses, and papers for temporary housing; (2) social-legal documents and certificates of rights; (3) accounts, budgets, and data on sources of finance; and (4) information on communications with the media. Security measures were set up so that, by law, the documents would be available for seven years for audits, revisions, and research.

By May 1987, RHP had begun reducing its staff. Most personnel returned to their former agencies. Borrowed equipment and furniture were returned and prefabricated offices and warehouses dismantled. RHP donated much of its office equipment and many computers and vehicles to the city government, the Phase II housing program, and other housing organizations.

From suspicion to hope

RHP finished 45,100 dwellings and 3,600 commercial workshops. It was one of the largest reconstruction programs since the recovery from World War II. Today one of every seven families living in the historic center has a new or rehabilitated RHP dwelling. Clearly, Mexico City could renovate a major portion of the city when both the human and financial resources were mobilized. Almost all of the federal and city development and management agencies contributed to reconstruction. More important, the beneficiaries — the earthquake victims — helped daily to expedite decisions and construction.

A total of 1,240 private companies participated in the program — 738 building contractors, 64 professional firms of supervisors, 184 suppliers, and 258 firms preparing studies and projects. From October 1985 to December 1987, more than 175,000 jobs were created — including 1,200 for the RHP agency itself and many more in construction and services.

Toward the end of reconstruction, Manuel Aguilera Gomez, RHP's director general, wrote, "The earthquake revealed the nakedness of part of the city center. The solution was not to hide the poor in the suburbs, but rather to provide them with appropriate housing. To achieve this aim we all learned to conciliate the desirable with the feasible. We learned to listen with care and interest to the sentiments of those affected by reconstruction. Little by little — in stages — the attitudes of the program beneficiaries changed from hostility, uncertainty, incredulity, suspicion, and doubt to hope and confidence."

Endnote

1. Data revealed that 65 percent of the families had lived in the neighborhood for more than 20 years, 18 percent for 10-19 years, and 15 percent for nine years or less. More than 97 percent of them rented their dwelling and 70 percent of the dwellings occupied less than 40 square meters. Moreover, 80 percent of the heads of household — 87 percent of the men and 69 percent of the women — said they were working. These data were consistent with data on the main economic activities of the city center.

Living with floods: alternatives for riverine flood mitigation

Frederick C. Cuny

Most efforts designed to reduce the effects of floods have focused on such structural measures as the construction of dams or embankments (polders, levees, and the like). Many of these large-scale, capital-intensive projects have been questioned on both technical and environmental grounds. Many development experts question whether large-scale flood control projects are economically suitable for the least-developed countries, since they increase the country's debt significantly for little economic return. And some flood control projects may be counterproductive. Embankments may foster unrealistic expectations that all flooding can be prevented and stimulate movement onto floodplains, thereby increasing total risk. In recent years, there has been increased interest in alternative strategies for protecting the floodplains, especially in rural areas. A key strategy has been to encourage people living in rural areas and in some small communities to adapt to floods and to capture their benefits for economic development. Traditional rural societies have developed many ways to adapt to floods and their consequences. These strategies can often be adopted or modified into a national "living with floods" strategy. Where this strategy has been applied, it has been cost-effective, easy to implement, and compatible with the environment. These measures can be applied before and after floods. More important, they can be incorporated in long-term development programs at little extra cost.

Flooding along the low-lying plains near rivers is the most widespread hazard in the world. Historically, people have avoided living in flood-prone areas but as populations grow and land becomes scarce, more and more people are forced to use these areas for activities that floods can harm. Many societies have developed a portfolio of counterflood actions designed to control flooding, prevent disaster, and, where possible, to harness the floods for such uses as irrigation, navigation, and aquaculture.

The technology to control floods exists, but in recent years concern has grown about the environmental consequences of flood control measures undertaken over large areas. Some experts have challenged the cost-benefit claims of flood control proponents, arguing that the benefits are slow to accrue and cannot always be accurately accounted for. Many have questioned whether sophisticated flood control works are appropriate for developing countries, given their high costs and the countries' added debt burdens.

As nations threatened by widespread flooding plan their development strategies, they must understand that there are options — ways to live with floods and harness their benefits with

limited flood control efforts. Many of these approaches are cost-effective and can be carried out by local communities with help from government and development agencies. They capitalize on people's self-reliance and in the long term reduce costs and speed up protection. Countries that adopt them can adopt capital-intensive programs and to a large extent eliminate costly, never-ending maintenance operations.

The importance of indigenous responses cannot be overemphasized. In remote rural areas where government assistance may be delayed or virtually impossible to provide, these responses may determine how quickly and effectively a family recovers. It is important not only to understand them but to ensure that outside responses do not inhibit or discourage people from applying them.

Preventing floods is not a universal solution. In many cases flood control is not only feasible but more practical because urban areas, vital infrastructure, and critical communication and transportation networks must be protected. But encouraging communities to adapt to floods can be considered as an alternative or complement to capital-intensive structural flood control measures (such as embankments, dams, diversions, and river draining works). Knowing the difference between types of floods is essential for choosing the appropriate strategy.

Types of floods

There are four basic types of floods: flash floods, standing floods, sea surges, and riverine floods.

Flash floods occur as a result of the rapid accumulation of runoff waters from a rainstorm in a mountainous or hilly area. The water usually collects in relatively confined areas — such as gullies, wadis, or arroyos — then cascades until it reaches another stream or a wider, less restrictive area where the water spreads out and its velocity is reduced. The speed of the flood and the debris it carries are what make flash floods dangerous. (Flood velocity is determined by the steepness of the grade of the confined area.) Historically, people have avoided living in constricted areas, although some economic activities (such as sand or gravel extraction) have been carried out there. With rapid, unchecked urbanization, this has changed. Many poor people are forced to live in these areas — so the threat to human life is growing annually. For the most part, the best strategy in arroyos is still prevention. Downstream structural measures, such as diversions and check dams, provide some protection.

Standing floods occur when accumulated rainwater can neither drain off the surface rapidly nor be absorbed quickly into the soils or the water table. Standing floods usually cover relatively small areas. Many are caused by poorly designed transportation networks, such as roads and railways, that cut across natural drains and cause the water to back up behind roadbeds. Little can be done to prevent standing floods except engineering works to collect the water, in canals, and transport it to natural drainage zones or pump it into passing streams or onto lands on which it will do no damage. If the cause of the floods is a man-made restriction, bridges or culverts can often reduce the floods to an acceptable level.

Coastal flooding can occur as a result of storm surges (wind-blown masses of water caused by tropical cyclones — also known as hurricanes or typhoons — or storm-related high tides). Residents of coastal areas have adopted a variety of measures to reduce the impact of these floods. They have built communities on raised platforms, for example, or houses on stilts, and seawalls and other structures to absorb the force of storm surges. They have adopted such escape strategies as evacuation and community shelters as a response to both high winds and floods.

Riverine floods occur when a river overflows its normal streambed because of heavy rains anywhere in the river's watershed. Normally, the area of flooding can be predicted, usually on the basis of topography and past flood history. The overflow area — the floodplain — may be a few hundred meters or dozens of kilometers wide. As a river gets closer to the sea, it usually passes through an area of alluvial buildup. This area, known as the river's delta or fan, is normally fairly flat — and rivers tend to meander in wide lazy Ss as they slow down and empty into the ocean. In these deltas, flooding can be widespread; the extent of the flood and the height of the waters can be affected by rains far up the watershed and by ocean tides, which can slow the discharge of the river and raise water levels at high tide.

Of all floods, riverine floods are the most difficult to control and the ones for which a "living with floods" strategy is most feasible. To understand why, let us examine the ecology of

riverine areas and the benefits of riverine flooding.

Riverine ecology

Riverine areas are important ecological zones. The world's great rivers carry minerals and nutrients to the seas and form delicate, highly complex delta ecosystems that are crucial in maintaining the balance of nature. Most important, the marshlands and swamps provide a bridge between salt- and freshwater environments. Next, the tidal and saltflats provide a way to keep excessive salt penetration from moving inland. Then, on the coastal plains, landforms build up and human habitation becomes feasible and productive. As the rivers slow down, they deposit sediment which gradually creates sandbars in the streambeds. The sandbars divide and redirect the waters, eroding some areas and building others up. The sediment buildup offshore eventually extends the land mass outward into the ocean.

The alluvium the rivers deposit is the key to the deltas' richness. This sediment is a mixture of all the topsoils the rivers pass through. The heavier, rocky materials settle out farther upstream. The suspended solids that reach the fan are fine and light and usually rich in nutrients and humus. In these rich soils, agriculture flourishes; the deltas of the world are also the world's breadbaskets. Rich soil and plentiful water ensures that farmers can grow crops annually, if not semiannually. Even a small amount of land can produce enough crops for societies to prosper — and it is not unusual for these areas to be densely populated. Agriculture is not all that flourishes in this environment. In waters rich in nutrients, fish abound — in both the rivers and the discharge zone.

A riverine environment shapes the daily life of societies along its banks. Agriculture and aquaculture dominate the economy. The people's basic diet depends on abundant sources of water and the flora and fauna within.

A riverine environment promises perennial floods. Usually, not a year will go by without some part of the delta flooding to some degree. To an outsider it might appear that floods are something to which riverbank societies must adapt to survive but most often the disaster would be if floods did *not* occur periodically. The benefits of floods far outweigh their negative effects. Many rural societies welcome flooding. In Bangladesh, the *Barsha* festivals celebrate the flood season and, when waters cover some areas, people take to their boats and venture out of their villages to trade and renew commercial and familial links.

The benefits of flooding

After a severe flood, it is often hard to remember that floods also have a positive side. What are some of the benefits?

- Floods deposit rich silts and replenish topsoil with nutrients vital to agriculture. After widespread flooding, there is almost always a bumper crop the next harvest season that partially makes up for the losses from flooding.
- Floodwaters carry nutrients that stimulate fish development and increase the number of fish. Floods may restock fish in isolated ponds, lakes, or streams that do not flow year round.
- Some ecologists suggest that floods improve the natural varieties of food grains, destroying the weaker strains over time and permitting the stronger strains to thrive.
- Water left standing in fields may help recharge shallow aquifers. Floodwaters may replenish water supplies in lakes and ponds.
- Floodwaters purge the rural (and sometimes urban) environment. This can have a major impact on public health. Some observers have noted that diarrheal diseases usually decline after widespread floods.
- Floods deposit sandbars that can be seeded to form barrier islands. These can be used to expand land area and as barriers against tropical storm surges.
- Floods deposit silts that can be "mined." At a minimum, sand can be collected for construction. More important, the mud can be used for topsoil, construction, and landfill. Possibly they can be mined for important — often valuable — minerals.

In addition to the known benefits, there are many untapped benefits. Floods could be used as a source of energy, for example.

When is a flood disastrous?

Sometimes riverine floods are so big that their harm outweighs their benefits. The negative effects of flooding include death, property loss, a cumulative increase in personal and national

debt, the increased incidence of certain diseases, soil erosion, sandcasting, the penetration of saltwater into soils and aquifers, the siltation of rivers and irrigation canals, and damage to and the destruction of public infrastructure, roads, railway beds, and other transportation.

If flooding usually occurs annually, what separates the normal, uneventful flood from a disastrous flood? Usually the magnitude of the flood. That magnitude can be measured as the number of people killed, the extent of the damages (physical and economic), the incidence of increased disease, and other factors. Usually floods classified as disastrous are defined by a combination of these criteria. But these criteria are subjective, representing mostly the views of urban or industrial observers. When do people who live in riverine areas call a flood disastrous?

In many societies, people distinguish between an inundation and a flood. In 1978, Unnayan, a Bengali rural development agency, worked with flood victims after massive floods in West Bengal, India. Cultivators they interviewed indicated that a flood has occurred when water remains in the field long enough to waterlog, when water strands or drowns livestock, when water currents scour the land, when floods deposit sand that cannot be economically removed, when floodwaters increase the salinity of fields, when water rises above the housing plains, when successive floods prevent immediate recovery, or when fish ponds are inundated and fry and fingerlings are swept away. For landless agricultural laborers, a destructive flood is one that reduces their job prospects or prevents them from going elsewhere in search of work. For nonfarm villagers, a flood is defined as water penetrating and damaging commercial buildings, water penetrating and damaging housing, or water preventing the transport of goods. Most rural people said that a flood was "when waters rose faster than one could take preventive measures," a response which indicates that if more warning could be given, floods might not be so destructive. This response implies a degree of indigenous local flood preparedness (Sen 1978a).

Urban people could define floods similarly to nonfarm villagers, adding that when floods occur normal business is disrupted, schools are closed for excessively long periods, food and fuel are hard to get, and basic services (such as water supplies, electricity, and communications) do not function for long periods.

Governments usually classify floods according to the level of government infrastructure that has been damaged or destroyed, and the number of houses and communities affected. Infrastructure that could be damaged include roads, lifelines and critical facilities, public buildings, schools, and health facilities. Rural people may not need or expect extensive flood control measures. In urban areas, the public is likely to demand structural measures to prevent floodwaters penetrating the community.

As traditional rural society becomes more modern and urbanized, there will be substantially more nonfarm-, nonfishing-, and nonriver-based labor and a corresponding expansion of costly infrastructure that is not inherently flood-resistant. Even in rural areas, the number of villagers not directly involved in agriculture, who do not benefit from flooding, is likely to increase rapidly. So there is a steadily growing constituency for flood control. This constituency — because it is predominantly urban and influential and represents a substantial proportion of heavy investment in the country — is often more effective at advocating flood control than its opponents are at advocating the living-with-floods strategy.

Many governments have a problem weighing the net benefits of floods against the relative cost and benefits of trying to prevent or control them. The negative effects of flood control measures — especially environmental or ecological changes they may cause — are often hard to predict so they should not be taken lightly or rushed into immediately after a particularly damaging flood. Flood control works require intensive study, and proposals must be accepted by all sectors of society before they are implemented.

Adapting to floods

Over the centuries, many societies have developed complex adjustments to floods. These adjustments and their role in riverine ecology should be the starting point for understanding alternatives to costly flood control works.

Adaptations to floods are most visible in the built environment, especially in housing and buildings. Common adaptations include: building houses on stilts so floodwaters can pass underneath, building houses on plinths or platforms so they are raised above flood levels, and building escape areas under roofs.

Siting is important in flood avoidance. Some societies have taboos against building certain forms of structures in known floodplains. In India, for example, the ancient Hindu building code, the *Vastu Shastra*, mandates that structures in coastal areas should be circular with conical roofs — a good design to resist floods and high winds. Traditional architecture usually adapts to flooding in the selection of timber, the design of the house's base or foundation, and the building's orientation to the flow of floodwaters. Human settlements are often collective expressions of these adaptations — for example, villages built on artificial platforms or areas raised above flood level, canal villages, artificial islands, floating villages or settlements, and settlements built on flood control embankments. Even cities adapt to floods; the most famous is Venice, Italy. More commonly, sections of cities adapt to floods by building floating settlements or stilt housing in flood-prone areas.

That regions can come to grips with floods without massive flood control works is evident in some of Thailand's lower delta. Houses there are raised on stilts, roads generally run parallel to the rivers, and, where they cross the watershed, massive culverts permit the water to flow through without backing up. Floods occur every year, but are only rarely damaging. The region has adapted to the environment.

Economic adjustments to flooding

Riverine economies must adapt to floods in every facet of the economy from agriculture to industry, from the selection of crops to the selection of tools, transport, and conveyances.

Most riverine economies are agriculture-based. The crops selected, such as rice, usually depend on large quantities of water. Integrated cropping of grains and such long-stem water perennials as jut or reeds provides additional income and serves as insurance against flood losses.

Some crop varieties show a natural resistance to floods. The longer-grain natural varieties of rice fared much better in the 1988 floods in Bangladesh than the hybrid high-yielding varieties (HYVs). Farmers whose paddy stems were knocked over and waterlogged in the floods simply broke the stems at the internodes and watched them regenerate in time to produce a crop only slightly less abundant than normal. HYVs had to be plowed under and replanted.

Cultivators in deltas have become familiar with backup strategies to counter flood losses: selecting flood-resistant varieties, most often, and planting alternative postflood crops. In Viet Nam's Mekong delta, farmers keep a reserve stock of potato seeds to plant quickly after a flood, using the water hyacinth tailings that floodwaters usually deposit on their fields as a mulch for the seedlings. Rural economies often adjust naturally to a flood. After the 1988 floods in Bangladesh, farmers whose standing paddies were affected by the floods could still collect the stunted stems and sell them as fodder for livestock. So much fodder was lost that prices for the salvaged stalks were almost equal to prices for harvested paddies (UNDP 1989b).

Fishing is always important in riverine economies. Casual fishing in local streams gives families an additional source of protein and an alternative or supplemental income. More important for the general economy, many people in riverine economies normally engage in professional fishing or fishing-related enterprises. Lakes or ponds used for fishing rely on floods to periodically replenish natural stocks of fingerlings.

The most important forms of transport in riverine areas are boats, barges, and rafts — craft that are inherently flood-resistant. In floods, other types of transport usually come to a halt, but river people usually have enough boats to remain mobile. In the Philippines, people often use the floods to float bamboo and forest products, such as logs, downstream to markets that otherwise could not be reached economically. In Bangladesh, people who live some distance from the rivers put goods they have prepared during the year on rafts and take advantage of the floods to transport them to the principal streams for collection and sale in large markets.

People also use floods to replenish drinking and irrigation water supplies. Researchers working in India in 1982 noted that villagers often view flood warning as a signal to intercept and impound floodwater for use on crops, holding back as much water as possible to raise a dry season crop — particularly in areas where short floods are common (Schware 1982a).

Indigenous flood preparedness strategies

Most riverine societies have not only developed ways to live with and use floods, but have developed responses for avoiding the unusually

large events. It is important to identify these measures as they are a clue to where to begin developing a national flood preparedness strategy. As a flood season nears, most riverine people instinctively take certain precautions: moving valuables to higher places in their shelters, moving animals to higher grazing areas or farther from the river, repairing boats, building rafts, and replacing the parts of their houses that have weathered and deteriorated.

Traditional warning systems

Many riverine societies have developed warning systems to give people enough notice to evacuate their homes and find shelter from floods. These systems may appear to be loosely organized, but in practice have been effective for disseminating basic warnings over wide areas. Often a variety of long-established message networks function at the same time, providing mutually supporting messages that condition people's responses. At one level, people observe such natural cues as old flood markers inscribed on trees or ants moving their eggs to higher ground. At another level, they set up a network of voluntary river watchmen and embankment patrols.

Important research on traditional warning systems has been carried out in Bengal, India. In 1980-82, the National Center for Atmospheric Research (in Boulder, Colorado), in a series of studies on flood warning messages, identified socioeconomic constraints on the effectiveness of the official warning system and compared it to the traditional "folk" system. The researchers concluded that the official machinery for disseminating warning messages in the Damodar Valley was jeopardized by mechanical shortcomings and a communication network that was not ideal for communicating to many people widely dispersed in remote villages. They saw grounds for reappraising the official approach to flood warnings. They found that some problems could be met by applying appropriate technologies; others required better coordination of information, to prevent unnecessary time lags; still others called for more awareness of the needs of people who might use the information system (Schware 1982a).

Folk systems adapt to modern times. In India, for example, villagers near police stations that are linked to national police radio networks often make a point of sending someone to the police station several times a day to get the latest radio reports of upstream news on flooding. If there are reports of flooding, the person returns and warns the village. Warnings can be disseminated in many ways. In Indochina, fireworks are often used to alert people that flood notices have been posted. Flags are used in some Philippine and Indonesian communities, among others. In Latin America the ringing of church bells is a common flood warning.

The installation of embankments sometimes undermines these "folk" systems. People believe that the embankments prevent floods, so that there is no reason to maintain the traditional system. Where embankments provide only limited protection from flooding or where they are routinely breached or cut, the abandonment of folk warning systems has left communities with no suitable warning system.[1]

Human responses to flood warnings

How people perceive and respond to flood warnings depends on available options in terms of a particular site, their economic needs, their health, and available information (Schware 1982). Sometimes people can only move to the nearest higher ground — for example, to rooftops, embankments, roads, railway lines, or even trees. Economic factors also come into play. Villagers tend to leave their homes only as a last resort if they believe that thieves in boats will steal their belongings. They cannot afford to leave behind their few tools and household possessions. Often they build rafts of bamboo or banana stems, tie them to a nearby tree, and stay on the rafts until floodwaters subside. Moving to roads or embankments is the next most common evacuation measure. Generally people avoid community shelters. Few can accommodate many people with adequate food and sanitation. Studies of flood shelters in India found that villagers overwhelmingly shun this option unless absolutely necessary.

Knowing about these typical responses is important for two reasons. First, it is doubtful that the longer lead times made possible by high-tech warning systems (radar, remote sensing, and the like) will significantly affect evacuation behavior in the near term. Second, the costly construction of dedicated flood shelters will not significantly reduce deaths and may be a waste of resources.

Traditional recovery strategies

Recovery begins with people's efforts to salvage what remains of crops, tools, and personal belongings. If the family has livestock, a first task is to acquire fodder. Approaches to flood recovery depend on the type of crop, season, and so forth. For example, if it is the growing season, certain varieties of wheat can be cut where they have been bent by floodwaters and they will regenerate. Hybrid grains may not regenerate if waterlogged, but will often continue to grow and can be used for hay.

Flooding in riverine environments often *increases* crop production, especially when natural varieties are grown. After the massive 1988 floods in Bangladesh, the forecast was losses of 40 percent of the normal harvest — but the country actually produced 10 percent more rice than normal. Other staples also showed higher yields (USAID 1989).

Some strategies for economic recovery place a hardship on families — especially migration to find alternative sources of work. Traditionally, workers went to nearby communities to find seasonal work until they could accumulate enough resources to restart their own enterprises. But recent population increases may have saturated the postflood job market, forcing more people to go to large urban areas for wages.

Traditional mitigation measures

Living with the constant threat of floods forces people to take measures to mitigate losses should a damaging flood occur. Typical measures include:

- Adjusting planting and harvesting cycles. The most common method of flood mitigation is to adjust the crop cycle so that crops are already harvested by the time damaging floods are most likely. There are traditional guides for this practice and more recently farmers' almanacs have been used to suggest planting dates (Brammer 1975).
- Seed banking. Farmers routinely hold back some seeds for replanting in case a flood early in the season destroys emerging crops.
- Famine crops. Many subsistence farmers set aside part of their land to grow flood-resistant crops that can be used for food if floods destroy the normal harvest (Campbell 1984).
- Mixing crops. Many farmers mix crop varieties (for example, HYVs with natural long-stem varieties) to reduce potential losses.
- Multiple fields. In some areas, farmers trade land to get fields at various elevations — with the objective of having at least one field that is less vulnerable to flooding. In Indonesia and the Philippines, village elders on some islands reapportion land annually to help farmers spread their risk.
- Alternative on-farm production. Many cultivators reduce their vulnerability by investing in other income-producing enterprises — most often, livestock, poultry (especially ducks), fishing, and the rental of draft animals. This is a much-favored mitigation strategy because the assets are movable.
- Informal "insurance," cash pools, and the like. In Peru and elsewhere, farmers contribute cash to a common fund, or pool, as insurance against flood losses. If a cultivator loses his crop, he may borrow from the pool.
- Cooperatives (especially thrifts). Formal savings and loan coops, a recent innovation, provide cash to farmers in the event of a loss. Development agencies working with coops often encourage members to take collective mitigation measures.

Adapting traditional responses

The beginning point for any flood mitigation program should be to identify such traditional local responses to floods and incorporate them into the national strategy. The most important policy issue to be addressed in developing a national flood strategy is the tradeoff between structural and nonstructural measures. It may be technically feasible to control floods, but is the economic and ecological effect worth it? Do structural measures attract more people or economic activities onto floodplains where they should not locate? Does that produce long-term environmental problems? Will water tables or soils be affected?

Second, a government must decide whether it favors a centralized or decentralized planning and implementation model. Take Bangladesh, for example, where the area of potential flooding is staggering. As much as two-thirds of the land surface was covered by water in recent floods and as many as half of the people were said to be affected. With so much vulnerability, it is impossible for the government to meet all needs, so flood preparedness and mitigation measures

must be selective and must rely on self-help and local initiative. What makes sense in Bangladesh is a community-based approach heavily oriented toward the adaptation of traditional responses.

To adapt traditional responses to official strategy means reorienting the planning process, to plan flood mitigation measures from the perspective of the communities most likely to be affected, and to involve villagers in local plans. Planning should be initiated at the village level and priority should be given to activities that stimulate self-reliance, promote cooperation and community involvement, and contribute to community development. Community development groups can play a major role in planning. Efforts should be made to involve local community development agencies and NGOs in the planning process, to improve coordination between these agencies and the government.

Conflicts and competing agendas

Flood mitigation proposals bring conflicting agendas into focus. Some cultivators may want their fields to be flooded and will take measures to ensure that they are. Not everyone appreciates flood control embankments. Breaches are often intentionally cut in levees — sometimes by people living between the levee and the river, in a desperate effort to lower the water on their side of the embankment; sometimes by cultivators who want to bring water, soil, or nutrients to their fields. People who benefit from floods — such as fishermen, brickmakers, and sand vendors — are also likely to oppose flood control.

Opposition also arises when land is expropriated for embankments. The average holding in many riverine areas is less than one hectare. An embankment could cover much of a plot and, in the process, thousands of small cultivators could be displaced or their land holdings reduced so much they are no longer profitable. In a country where demand for land is high, the political costs of embankments must be weighed carefully. In densely populated riverine areas, the best policy may be to limit embankments, permit controlled flooding, and emphasize community-based emergency preparedness and mitigation measures.

In any flood mitigation program, there are likely to be strong advocates of flood control and equally strong voices for "living with floods." The voices for flood control are likely to be stronger. The constituency for flood control is primarily those who will be harmed the most by flooding or those who will benefit from flood control works. That includes threatened community groups, such as farmers living in low-lying, poorly-drained areas, nonfarm workers in villages, urban dwellers, and people whose livelihoods or income are affected. It also includes such members of the technical community as engineers, construction firms, builders and operators of infrastructure, and government ministries (such as agriculture, power, roads, and railways) whose projects or facilities are threatened. Other members of the constituency for flood control works include large landowners who will benefit from increased land area or irrigation and donors with investments in infrastructure, critical facilities, and projects in flood-prone areas.

Advocates for the "living with floods" approach are less powerful. They include groups with little representation in government, such as small subsistence cultivators, fishermen, and small craftsmen. Their support is normally from environmentalists, ecologists, and development workers — groups that traditionally lack political clout. It is this constituency that must ultimately be mobilized to support any nonstructural mitigation or preparedness efforts.

Flood mitigation efforts compete with other development projects for scarce resources. In any country — no matter what level of development — it is difficult to get disaster mitigation on the national agenda. It can only be justified if mitigation benefits long-term economic and community development. Thus disaster mitigation policy should be part of and should support general economic and social development.

Organizational issues

One of the most important decisions to be made is where to place national responsibility for flood strategy. Designation of the responsible agency often determines how the program will be carried out. If an irrigation ministry is given the task, for example, there is likely to be more emphasis on structural flood control measures, such as embankments or engineering works. If the task is given to a high-level committee, the approach chosen may well reside with the committee's technical staff. If responsibility is assigned to a relief authority, the focus will

usually be only on immediate response and short-term disaster relief measures.

The lead agency should thus be carefully considered. Agencies with experience on this issue (such as UNDRO and USAID) in most cases recommend that a single agency be given responsibility for all pre- and postdisaster functions. If this is the course chosen, responsibility should be vested in a line ministry strong in operational capabilities (communications, equipment, and transport).

An alternative is to split responsibilities between ministries. The usual manner is to delegate responsibility for prevention and mitigation to a ministry with full-time responsibility for planning, construction, and maintenance of flood prevention and mitigation projects; then to delegate the relief and response function to a specialized relief or social service agency. The two then develop preparedness plans jointly and policy and coordination are handled by a high-level, interministerial committee chaired by a top government official.

This approach has some strengths. Comprehensive emergency management requires calling on specialties found in many different types of agencies. It is rare, and probably not even desirable, for all functions to be in one agency; the costs would be enormous. Recognizing the contributions each agency can make and developing the ability to coordinate and draw resources from them in an emergency is generally the most effective way to approach the matter.

Whatever agency is chosen, it is important that flood preparedness and mitigation efforts not be carried out in a vacuum. In most countries multiple hazards exist for which there are other disaster preparedness efforts. Many riverine areas are also subject to cyclones, for example. Efforts should therefore build upon any work already done for cyclone preparedness and mitigation; favor activities that support both cyclone and flood preparedness; and favor measures that build awareness of, and stimulate more effective response to, all major hazards.

Priority activities

In developing a national program, planners should keep in mind the types of local responses that can be improved with outside assistance. These include:

- Issuing warnings at the village level.
- Organizing working parties to repair embankments quickly and preempt breaches. This requires stockpiling materials locally in predetermined locations and developing ways to summon and mobilize the required number of workers on short notice.
- Organizing working parties to sandbag critical facilities. This also requires stockpiling supplies and mobilizing workers.
- Stockpiling and prepositioning tools and equipment to facilitate the relief and support of those who have been evacuated.
- Making transport arrangements so evacuation and relief can be speedy.
- Supporting agricultural recovery strategies, stockpiling information about practices to be followed, and prepositioning essential inputs that cannot be supplied by normal or postflood sources.
- Developing plans to provide emergency supplies of food and clean drinking water.

Issues for donors

It is important that donors coordinate their support. A donors' aid group can be formed for this purpose. The group should meet formally at least every two years to propose new projects and review progress. When any project is developed, the aid group as a whole can act as a project review committee, or at least a group of its members can serve on such a committee. An aid group serves two purposes. It shows that the donors treat the matter seriously and jointly support activities, and it serves as a bridge between old and new focuses when they change. Collectively, the group has more clout when it comes to taking corrective measures. The aid group could be made up of major donors, such as bilateral organizations, the UNDP, or the World Bank. But other interested groups — such as World Food Programme, UNICEF, World Health Organization, and the League of Red Cross and Red Crescent Societies — could also participate. To coordinate the donors' inputs, a full-time disaster preparedness project officer should be appointed and supported with appropriate technical advice, as needed.

Several principles should guide project funding and planning. First, wherever possible, the donors should jointly finance projects. This signals — and ensures — that donor interest

remains high. Second, priority should be given to projects that involve two or more ministries or departments. Ultimately, disaster response requires interministerial cooperation and coordination so it should begin in the preparedness phase. Finally, funding should involve local counterpart funds, where possible.

Program planning

Measures to prepare communities to minimize flood dangers involve flood mitigation and preparedness activities. Mitigation efforts aim to reduce a flood's impact and prevent it from becoming a disaster. Some mitigation measures are *structural*, such as building platforms for villages or local embankments to control or diminish flooding. Most structural measures are individual actions such as reinforcing houses to make them more disaster-resistant or building houses on raised plinths above expected flood levels. *Nonstructural* measures, such as changing agricultural cropping patterns to reduce losses, involve changes in institutions, regulations, behavior, knowledge, and attitudes. For the most part, small-scale, self-help, and community-based measures are the main thrust of mitigation strategies.

Disaster preparedness

The assumption underlying disaster preparedness is that a flood will strike a community and that the community — the people and institutions — should be prepared to deal with it. The focus is on saving lives, reducing property loss, and structuring the emergency response to be timely and to lay the groundwork for rapid recovery. Disaster preparedness for floods involve three kinds of activity: warning, evacuation, and flood-fighting.

Warning

Floods are one of the few forecastable natural hazards for which adequate warning can be given. The objective is to issue warnings as early as possible so people can protect their homes, belongings, and livelihoods, and then, if necessary, evacuate to a safe area. The essential elements of warning systems are *vulnerability mapping, communications systems* that reach the appropriate authorities in threatened communities, and methods of *message dissemination* that stimulate people to take effective safety measures.

Warning systems are crucial to "living with flood" strategies because people must have time to take action. National warnings systems often fail because of:

- Problems disseminating warnings locally, below the district level.
- Unclear "messages."
- No viable response options by the time the message reaches the target communities.

In recent years, exceptional strides have been made in improving warning and evacuation systems, based on behavioral studies and analyses of interpersonal communications. In rural areas, a national warning system is only as effective as the extent to which it builds on the traditional warning system and extends communications to the villages. Warnings based on public radio broadcasts have not been effective in rural areas. National systems are usually more effective at warning urban communities, government institutions, public utilities, large industrial and commercial facilities, and emergency authorities. The centerpiece of rural systems should be local people who observe, interpret, and issue alerts — not the meteorological office. Emphasis should be given to:

- Improving locally generated warnings.
- Getting credible, respected local leaders to issue clear instructions about where to go.
- Arranging for the protection of livestock and movable assets.
- Providing or expanding nearby evacuation sites that meet rural people's need for shelter, food, and the storage of livestock and personal effects.
- Using village-level evacuation transport appropriate to the environment.

Evacuation

Evacuation measures may include providing the transport needed to leave a threatened area quickly; rescuing stranded people; providing temporary shelter, food, water, and basic comforts; and then, when the emergency is over, helping people return to their homes. A successful evacuation, especially in riverine areas, re-

quires detailed planning, identifying escape routes and shelter sites, training shelter managers, organizing rescue and transport teams, and prepositioning food and temporary relief items.

Flood-fighting

Flood-fighting involves measures taken during a flood to prevent or reduce damage to communities, public infrastructure, or critical facilities that might be caused by the overtopping or breaching of embankments, water rising too high, or water threatening areas because of changes in the course of streams, downstream blockage; and so forth. Flood-fighting usually involves building temporary embankments or small-scale plodders — principally by sandbagging — and making speedy repairs to flood control works. Flood-fighting requires stockpiling and prepositioning tools, materials, and equipment, and planning how to mobilize and support large work forces on short notice.

The most important — and most overlooked — function of preparedness is to structure the overall emergency response. This is usually carried out by means of an *emergency action plan*, standing orders for key ministries, or standard operating procedures (SOPs). Ideally, a preparedness plan is a series of subplans, including a warning plan, an evacuation plan, a search-and-rescue plan, an assessment plan, and an emergency response plan.

The whole premise of preparedness planning is that an emergency is not the time to be deciding what to do. During an emergency, information is incomplete, conflicting, and rarely accurate. The best time to make decisions is when they can be addressed rationally, without the pressures of time and urgency that force premature or incorrect decisions. The objective of disaster preparedness is to move decisionmaking forward — out of the emergency — and to predetermine as many of the decisions and responses as possible. Once the decisions are made, detailed plans can follow.

Onsite resources

Many resources are essential to rapid recovery from floods. It is important to identify them and to increase people's access to them in normal development projects. If planners can identify the usual postflood agricultural strategies that farmers use to mitigate their losses, for example, the government can be encouraged to provide the tools or inputs that will be needed locally to build up onsite reserves that could be tapped in an emergency to accelerate recovery and reduce costs. If alternative varieties of crops are grown, the seeds, fertilizers, and pesticides that increase yields can be provided in outlets near floodplains — and reserves can be kept on hand in case they are needed. Similarly, if certain implements are needed to salvage waterlogged crops, it may be possible to provide them through cooperatives, and to promote the practice of holding some in reserve at the coops for postflood use.

Distribution of relief supplies is more effective when people rely as little as possible on external mechanized transport and when local transport is emphasized — especially (in the riverine environment) local, or country, boats.

Concepts about what is needed and important in emergencies should be reevaluated, especially for shelter. It is almost as costly to deliver tents and plastic sheeting, for example, as to deliver galvanized iron roof sheets — a commodity of far more value to local people as it can be used first as a shelter and later in the replacement house.

Outline for developing a national program

A national program incorporating the recommendations suggested in this chapter should begin on two fronts simultaneously: at the community level, working from the bottom up, and at the national level, working from the top down.

Village activities

Plans for community actions should originate at the grassroots level. District and national plans can be developed later to support the array of community plans.

(1) Identify traditional mitigation and preparedness measures. Begin by identifying the full range of local practices, evaluating their effectiveness, and determining ways they can be incorporated or expanded in national programs. Remember that people's responses to floods are shaped by their perception of risks balanced by their perception of benefits. To

motivate people to take action, proposals must address these perceptions. A starting point is thus to:

- *Study perceptions of risk* among different income and occupational groups in different areas, both rural and urban.
- *Determine who is at risk.* Not all communities are equally vulnerable to a flood. It is not possible or desirable to evacuate everyone or to extend protection to those who do not really need it, so *vulnerability and risk mapping* should be carried out. In the long term, detailed maps can be developed, using geographic information systems (GISs). In the short term, gross approximations can be made by examining recent flood experiences.
- *Study the range of local responses*, evaluating their effectiveness and determining ways they could be improved through government interventions. For example, yields of some alternative crops could be increased by timely provision of fertilizers, which could be stockpiled in strategic locations.

(2) Initiate village-level activities. Many activities and practices can be introduced and encouraged at the village level, including:

- Village-based warning and evacuation systems.
- Small-scale protective structures (such as village plinths and evacuation platforms).
- Protective measures for housing (such as water-resistant mud construction and treatment of structural timbers).
- Specific flood season agricultural practices.
- Planting bamboos or fast-growing trees that can be used for disaster-related purposes (such as rafts and components for temporary shelters).

(3) Promote economic development strategies that reduce vulnerability. This is one of the least-explored options. Measures that can be combined with other activities have a better chance of acceptance and implementation. For example, agricultural adjustments or innovations have a better chance of succeeding if they produce greater yields or profits than if they simply reduce a family's exposure to risk — a risk that may not materialize in a given period. An inventory should be made of development programs and strategies that could have implications for disaster mitigation or preparedness.

National activities

While actions are being initiated at the community level, the following national and district-level program should also be under way:

- Evaluation of national and district-level emergency responses to past floods, and identification of lessons and areas where improvements are needed.
- Vulnerability and risk mapping.
- Development of warning systems.
- Development of evacuation and sheltering systems.
- Improvement of communications systems.
- Development of model plans that can be adapted to community needs and can serve as a basis for initiating mitigation and preparedness activities at the village level.

Endnote

1. People intentionally cut embankments for many reasons. A UNDP study of the 1988 Bangladesh floods found that squatters who live between an embankment and the river cut the embankment when floods come hoping to lower the flood level. Some farmers behind an embankment cut it to flood their fields, water their crops, or bring nutrients to their fields. Some people want to flood ponds to recharge them and replenish fish stock.

Case study: creating job and income opportunities for refugees in Pakistan

Alcira Kreimer and Martha Preece

This simple, well-targeted project benefited about 30 percent of the Afghan refugee families by increasing job and income opportunities and providing specialized training in forestry and environmental protection to thousand of immigrants. The project succeeded in developing sound economic and environmental prevention measures to address the problem of degradation of natural resources. It demonstrates the importance of developing simple, down-to-earth solutions to environmental problems, and shows that sound development activities can alleviate the physical and economic damage caused by the massive influx of refugees. By involving the migrants in environmental protection and prevention efforts, the project has helped the region break out of the cycle of poverty, environmental degradation, and disaster vulnerability.

In the last ten years the number of people fleeing from wars, persecution, and natural disasters has escalated. Fifteen million people have been uprooted, and the number of people forced out of their own countries grew more than 13 percent between 1988 and 1989 (McCallin 1990). About 90 percent of those migrants were rural people moving into rural areas in countries already hard-pressed to meet their own people's needs. These massive population movements have placed an extraordinary burden on developing countries' physical and economic assets, ultimately damaging supplies of such natural resources as fuelwood, pastureland, and water. Without sound environmental policies, rapid migration and population growth may significantly deplete forests and ecologically sensitive rangelands, threatening the sustainability of development.

The uncontrolled alteration of environmental systems may increase vulnerability to extreme events. Deforestation and poor land management have already accelerated soil erosion and water runoff in many areas, increasing the threat of landslides, floods, and drought. Environmental mismanagement coupled with massive migration has made large areas more disaster-prone and has spread the impact of natural hazards to both man-made and natural environments.

The problem in Pakistan

The Islamic Republic of Pakistan covers about 197 million acres in four provinces: Baluchistan, the Northwest Frontier Province (NWFP), Punjab, and Sind. In the past 20 years, the country's population (about 106 million) has increased about 3.1 percent a year. More than 72 percent of Pakistan's inhabitants live in

rural areas, and an estimated 65 million or more people live below the poverty line (US$188 per capita in 1986 prices).

Since 1979 as many as 3 million Afghans have arrived in Pakistan. The government has settled most of these people in 325 villages — more than 60 percent in NWFP and Baluchistan. It is said that one of every seven inhabitants of NWFP, and one of every four inhabitants of Baluchistan, is an Afghan immigrant (World Bank 1983). The extraordinary burden of these unplanned population movements hampers these areas' ability to provide basic services and administer assistance.

The massive influx of immigrants has increased the demand for food, fuelwood, and shelter, accelerating environmental degradation and compounding the problems that have resulted from centuries of overexploiting pasturelands and uncontrolled deforestation. Degradation of the natural environment has exacerbated problems of soil erosion and water runoff, increasing vulnerability to floods. In the last 20 years, Afghans and their livestock have put added pressure on rangeland vegetation and their demand for fuelwood has accelerated the rate of deforestation (World Bank 1985).

The Baluchistan region. In the last few years, extensive environmental degradation in watershed regions has threatened fragile ecological balances, drying springs and reducing levels of groundwater. This has especially been true in the low-rainfall areas of Baluchistan, where soil erosion, deforestation, and depletion of the rangeland threaten irreversible degradation. In northern Baluchistan, near the Afghan border, accelerated population growth severely strains the ecological balance of the few relatively fertile valleys that get runoff water from the eroded mountain ranges. Here Afghan immigrants live in 16 major camps and smaller temporary settlements. Their presence and their livestock herds have contributed to deforestation and put added pressure on land and water resources. Compounding the problem, extensive sand dunes have developed because of wind erosion of the largely denuded mountains, imposing severe hardship on the local population and the region's economy. Infrastructure and villages are in continual danger of being buried under sand. Since the mid-1950s, about 35 villages, 50 irrigation channels, many fields, and other residential and agricultural installations have been ruined and subsequently abandoned.

Rapid deforestation has also taken its toll on the eroded hills and the depleted juniper forest. Unregulated felling of trees has virtually eliminated the natural forest and severely eroded the mountain slopes, leading to sedimentation of reservoirs and irrigation systems. The destruction of vegetative cover and erosion of the hillsides have increased the number and power of runoff torrents that cannot be controlled by traditional irrigation structures. The needs of Afghan immigrants exacerbate these problems and threaten further irreversible degradation.

The Northwest Frontier Province. This region's environmental problems are aggravated by the massive influx of immigrants that have settled in the plains, where available land can no longer support the rapidly growing population. The mismanagement of forests and intensive cultivation of hillsides with traditional techniques have increased the area's susceptibility to landslides and flash floods. The depletion of forests and the degradation of rangeland is a particular problem in the Hazara region, where a large proportion of the total population is Afghan immigrants. The enormous need for fuelwood has caused widespread deforestation and thus soil erosion, desertification, and the siltation of watercourses and reservoirs. Trees are felled at an alarming rate with virtually no replanting, so hillsides are almost devoid of vegetative cover. As a result the ability of the soil to permit infiltration and retain moisture has been reduced, accentuating problems of erosion and exacerbating the danger of flooding and landslides. Hillside stabilization is a major concern in the Kagan Valley, where the Forestry Department has been trying to prevent avalanches.

The Punjab region. Here soil erosion is the heaviest. Deforestation, particularly at higher elevations, is so dramatic that the damage is often irreversible. Landslides commonly destroy houses and infrastructure. In the rainy season, destructive flash floods and hillslides severely threaten the survival of some towns. The effects of population pressure and the mismanagement of natural resources are compounded by traditional rights to land and resources — particularly

in tribal areas, where tradition conflicts with sound resource management practices. (Each adult male is allowed to fell three primary-category trees a year — and one more for each funeral. These hereditary privileges have multiplied with the growth of the local population.) Efforts by the Forestry Department to preserve the ecosystem and protect investments have been largely unsuccessful. They have failed to create incentives to influence local communities' willingness to implement soil conservation treatments on their land.

The Income Generating Project for refugee areas

Since 1983, the Bank has been working closely with the UN High Commission for Refugees to identify, prepare, appraise, and supervise the Income Generating Project for Refugee Areas in Pakistan. Financed by donor grants, the project was administered by the Bank.

The Income Generating Project addressed some of the problems created by the protracted residence in Pakistan of some 3 million Afghan refugees. Its objectives were to create job and income opportunities for refugees and local residents, to improve the rural environment and repair the environmental damage caused partly by the influx of immigrants and their livestock, and to create viable economic resources in these areas. In the long term the project aims to restore the disturbed ecological balance and ease the pressure of population and cattle on natural resources.

The project consisted of many small-scale, labor-intensive subprojects in three sectors: forestry and watershed management; irrigation and flood control; and road construction, upgrading, and rehabilitation. In Phase I, 52 subprojects were undertaken in NWFP and Baluchistan between 1984 and 1987. The second phase (162 small subprojects) began in 1987 in NWFP and Baluchistan and one district in Punjab.

Afforestation and watershed management subprojects. Forests cover only 3.7 percent of the land in Pakistan, and only 1.2 percent of total forests are commercially productive. The forestry subprojects aimed to rehabilitate forests and watersheds that had deteriorated as a result of the added demand by immigrants for fuelwood supplies and livestock grazing areas. All subprojects focused on preventing soil loss by surface or gully erosion, and reducing rainfall runoff in seriously denuded watersheds to prevent and mitigate flood damage. Efforts were also made to protect the remaining forests from illicit use and afforestation, especially in the NWFP. There the focus was on restoring ground and tree cover; reducing soil erosion from overgrazing, cutting, and burning; and preventing surface runoff — to produce stabler stream flows. This subproject emphasized community participation in rural tree planting programs and natural forest management. The watershed management subprojects (mainly in Baluchistan) aimed to promote soil conservation practices, improve fuelwood production, and increase groundwater infiltration.

Irrigation and flood protection subprojects. These 106 subprojects (24 in Phase I, and 82 in Phase II) were to build spurs, bunds, and walls to protect disaster-prone areas from floods in NWFP, Baluchistan, and Punjab. In addition to minimizing flood hazards in villages and refugee camps, the projects are expected to improve agricultural output by protecting arable lands from excesive surface runoff and erosion.

Technical assistance was provided to help the pilot extension program in forestry and watershed management, to monitor the work of Afghans and locals, and to advise technical staff. Immigrants were trained in afforestation and environmental management and protection techniques, including tree planting, flood protection, drainage, and soil conservation. Pilot schemes were developed to reduce fuelwood consumption at the household level.

Sustainable environmental management

This project has been an excellent vehicle for involving the refugee community itself in alleviating some of the damage refugees have done to Pakistan's environment and infrastructure. It illustrates how to integrate strategic work on conservation of natural resources, disaster prevention and mitigation, and the generation of jobs and income.

Managing drought and locust invasions in Africa

Thomas R. Odhiambo

The two most critical African natural disasters — drought and locust outbreaks — are least understood in terms of the four activities considered essential to long-term disaster reduction: hazard prediction, risk assessment, disaster preparedness, and disaster management. In finding a solution to the drought and desertification that plague Africa's Sudano-Sahelian belt, planners would do well to study indigenous adaptations to the unpredictable Sahelian ecosystem. They should study them, translate them into scientific terms, validate them, and try to implement them to stabilize the Sahelian and other drought-prone ecosystems. The key to solving the problem of locust swarms may lie in the work being done by the International Centre of Insect Physiology and Ecology. ICIPE hopes by studying the behavior of locusts to find a way to dampen the locusts' swarming cycle and intensify their solitary cycle so that locust populations can maintain a relatively sedentary, grasshopper-like lifestyle. ICIPE hopes that solitary locusts can continue to exist as natural herbivores in Africa's semiarid breeding grounds, continuing their participation in the dynamics of the savannah ecosystem without periodically breaking into locust plagues.

A.J.W. Taylor (1978) described disasters as "catastrophic events that (a) interfere with everyday life, disrupt communities, and often cause extensive loss of life and property, (b) overtax local resources, and (c) create problems that continue for longer than those that arise from the normal vicissitudes of life." In this sense, disasters need not be sudden, unexpected, or devastating. Otherwise, disasters such as drought, famine, and epidemics would be excluded. All disasters — industrial or natural — vary in the degree of vulnerability to which victims are subjected and the special attention they require. But disasters caused by the forces of nature are perhaps "the most readily accepted, even if with despair and resignation. They represent the unleashed fury of the natural world against which mankind is quite helpless" (Taylor 1978). This feeling of helplessness has given new impetus to a search for long-range solutions to the management of two pervasive natural disasters in Africa: drought and locusts.

"The true dimensions of poverty are existential rather than economic," wrote Albert Tevoedjre (1978). To Walter Weisskopf (1989), misery reflected impotence:

> The medieval world outlook believes in a supernatural, but comprehensible order. The Newtonian model believed in an order routed in nature and comprehensible through reason. Having abandoned a be-

> lief in providence, grace and other worldly rewards for religion's virtue as well as the deterministic belief in nature and reason, the Heisenbergian paradigm seems to deprive us of all protection against the threat of the unknowable future and of the unknowable reality. (Quoted in Giarini and Stahel 1989.)

The point about such impotence is that people's traditional, communal ability to cope with recurring setbacks can no longer provide a safety net for victims. They have become more vulnerable, and natural disasters have become an ultimate crisis of destitution. Consequently, more than any other community, Africa's scientific community today has the responsibility of creating a new perception of natural disasters.

Developing long-range solutions to the two most difficult natural disasters in Africa — drought and locust outbreaks — requires an information-intensive, management-aware strategy. In 1988, the UN Secretary-General appointed an international ad hoc group of experts to recommend a scientific framework for launching the International Decade for Natural Disaster Reduction (IDNDR) for the 1990s. That group considered four kinds of activity essential to a solution-oriented long-range program:

- *Hazard prediction* through monitoring, early warning systems, and the like.
- *Risk assessment* — for example, by mapping hazard levels.
- *Disaster preparedness*, especially by training key personnel, educating the general public, and appropriately controlling land use and construction.
- *Disaster management*, by developing schemes for local evacuation, establishing lines of emergency supply, and mobilizing civil defense groups.

Drought and locust outbreaks are poorly understood in terms of these four activities. As the group of experts stated in its report:

> Drought is a complex environmental phenomenon, including long-term climatological changes and wide-scale ocean/atmosphere interactions as well as ecological deterioration of human origin. The management of drought as a natural disaster has many factors in common with management of disasters of more sudden onset. Drought predisposes the environment to several rapid-onset natural hazards, including locust infestations and, in many instances, flash floods. Drought alone causes large agro-ecological damage and seriously disrupts socioeconomic life. Over this century, droughts have tended to intensify as a result of accelerating deforestation and large-scale soil erosion, especially in Africa; their management globally has become a matter of urgent action.

These catastrophic phenomena now demand a thoroughgoing scientific explanation, leading to solution-oriented technologies that may well incorporate elements of social invention. What Africa needs is to master science and technology, not merely identify with it. This requires that problem-solving become the principal aim of our scientific endeavor focused on drought and locusts. We must become dissatisfied with the existing state of knowledge about these natural processes and events, mistrusting the obvious and searching for the underlying order in natural processes (Sindermann 1985).

Drought in Africa

The Food and Agriculture Organization (FAO) of the United Nations predicts that unless Africa takes corrective action, rainfed croplands on the continent will become 30 percent less productive by the end of the 1990s, mostly because of soil depletion and erosion (World Resources Institute 1989). Part of Africa's unrealizable potential for agricultural productivity is the 40 percent of the continent that is either extremely arid or subject to cyclical drought.

The Sahara, the largest desert in the world, receives less than 100 millimeters of precipitation a year (Conservation for Development Centre of IUCN 1986). Other arid areas, such as the Kalahari Desert in the south, also suffer chronic low precipitation, usually with high temperatures. Drought, on the other hand, is a temporary feature, experienced only when rainfall deviates appreciably from normal levels (of about 200 millimeters a year). Drought can occur in virtually any rainfall or temperature regime (Lockwood 1988). The Sahel — the zone across the continent south of the Sahara Desert, with annual rainfall of 200 millimeters — has experienced a north-south migration in its

600,000 years of human occupation. The Sahel has now stabilized between 13 degrees north and 19 degrees north, but the research of A.M. Lezine and her colleagues shows that the zone has shifted substantially in the past 20,000 years, a period that has been studied in some detail. Rock paintings show a succession of scenes from game-rich savannah to cattle-herding pastoralists to desert panoramas. Geomorphological and palaeontological evidence in the guise of fossil river systems and drainage networks (for instance, the Wadi Howar system in the Sudan) contains fossil remains of crocodiles, hippos, and river bivalves — in a region that now receives merely 25 millimeters of precipitation a year. Pollen analyses indicate that fossil lakes in the Sahel (for example, the Selima Oasis) once sustained savannah grasslands in areas now hyperarid. These studies conjure an image, some 18,000 years ago, of savannah grassland with scattered acacia trees that extended only as far north as 10 degrees north, which is further south than its current geographical limit. In 8500 before the present (BP), moisture-demanding types of vegetation extended northward rapidly, eventually reaching 400-500 kilometers north of their current agroecological limit. Reversal of this northward shift began in about 6100 BP and intensified in about 4500 BP; Sahelian vegetation as we know it today became established in its present zonal limits (13 degrees north and 19 degrees north) about 2,000 years ago.

Despite this volume of evidence, and the more recent episodes of drought in the Sahel during this century — including the great drought of 1984 that caused about 100,000 deaths — we cannot yet predict drought (Conservation for Development Centre of IUCN 1986). We believe that arid lands are rapidly spreading in Africa, often aided by the long cyclical drought periods, based on observations on the fringes of the Sahel and similar semiarid and arid areas such as the Kalahari and Namib Deserts, Somalia, and North Eastern Kenya (UNEP 1985). This aridification, and the rapid deforestation of much of Africa, is leading to three critical phenomena:

- *Desertification* of the Sahel, through bushfires, overgrazing, increased harvesting of fuelwood, and the spread of cultivation to marginal lands.
- *Sahelization* of the savannah grasslands.
- *Savannahization* of the forests.

Desertification has now reached 88 percent in Sudano-Sahelian Africa, 80 percent in southern Africa, and 83 percent in Mediterranean Africa. We cannot yet accurately quantify in time and space the changes associated with desertification, sahelization, and savannahization. Nor are we certain about the factors that determine the onset of drought, although some associations are becoming apparent.

Past studies suggest that drought in Africa south of the Sahara is correlated with (1) drought in the Central America-Caribbean Atlantic region and (2) warm sea-surface temperatures and rainfall on the Pacific coast of Latin America (associated with the so-called El Niño effect) — in other words, associating African drought with interactions between the ocean and the atmosphere (Rind and others 1989). Similarly, rainfall in the western Sahel is affected by anomalies in sea-surface temperatures in both the Pacific and Indian oceans. Not that these examples reflect a direct causal relationship. Rather, the droughts over much of the Sahel and North Africa are associated with the reduced (but not delayed) northward extension of the Inter-Tropical Convergence Zone (ITCZ), the band of wet weather that circles the world at the point where the trade winds blowing from the Northern and Southern Hemispheres meet (Rind and others 1989).

For all our ignorance of what causes cyclical drought in Africa, its impact on the human population is profound. The two-decade drought from 1966-67 to 1987 was the worst for 150 years but others almost as bad have occurred every 20 to 25 years or so. Under these circumstances, it is meaningless to speak of protecting the environment. Rather, a way should be found to fit human activities into the reality of the natural systems.

Of the world's 40 million nomadic pastoralists — whose livestock-based economies survive on deserts or semiarid savannahs — 25 million live in Africa, most now relegated to marginal lands (Bass 1990). Anthropological studies reveal that traditional pastoralists' knowledge of the environment in which they live and work is highly complex and organized — their plant and animal breeding and husbandry the result of experiential fact-finding that cannot be ignored by modern scientists. According to a Dutch study, quoted by the Independent Commission on International Humanitarian Issues (1985), "traditional herders produce as much protein

per hectare as do ranches in areas of equal rainfall in the United States and Australia; the Sahelian herders, however, accomplish this with infinitely less mechanical energy inputs, relying for the most part on manpower." This husbandry, based on traditional knowledge, requires that the Sahelian herder not stay in one place — lest overgrazing and desertification set in. Settling herders in semiarid areas is therefore often unwise:

> Sedentarizing nomads ignores the fact that they employ their marginal resources better than anyone else could. Nomads have lower birthrates than their settled neighbors. Their family herds support more people on the land than do commercial ranches. Nomads make few demands on the state, and they practice the kind of self-sufficiency that any enlightened government should want to encourage (Bass 1990).

Indigenous Sahelian social systems were intimately linked to their agro-ecosystems, until externally imposed changes in recent times led to environmentally destructive change, such as the charcoal production associated with trans-Saharan trade and the expansion of transportation networks (Gritzner 1988). Indigenous adaptations to the unpredictable Sahelian ecosystem — including integrated agro-sylvo-pastoral practices — are not only highly sophisticated but have inherent scientific validity (Gritzner 1988). We would do well to understand them, translate them into scientific terms, validate them, and then try to implement them to stabilize the Sahelian (and other drought-prone) ecosystems.

Desert locust swarms

The Sahel is full of other surprises. One recurrent problem is occasional massive outbreaks of locust swarms. In October 1988, desert locusts (*Schistocerca gregaria*) bred on an unprecedented scale along much of the Sahel, so that in early October several swarms of them reached the Atlantic coast of West Africa — from Guinea-Bissau in the south to Mauritania in the north — then invaded the Cape Verde Islands on October 5-6 and 12. Soon thereafter, the locusts were sighted over the Atlantic Ocean and began reaching the eastern West Indies from October 14, stretching from St. Croix in the north to the coastal areas of Guyana and Suriname in the south. They made this intrepid landfall 4,500 kilometers from the West African mainland with the assistance of the tropical storm Joan (Rainey 1989).

There are at least five important locust species (and their ecogeographical subspecies) in Africa: the desert locust, the tropical migratory locust (*Locusta migratoria migratorioides*) found everywhere in Africa and beyond, the red locust (*Nomadacris septemfasciata*) found in Eastern-Central Africa, the brown locust (*Locustana pardalina*) found in Southern-Central Africa, and the Senegalese grasshopper (*Oedaleus senegalensis*) in West Africa and the Atlantic Ocean islands. Undoubtedly, the desert locust is the most intractable, widespread, and perennially destructive of all these pestiferous locusts. There are at least 200 other grasshopper species resident in the Sahel that live normally as herbivores in this savannah ecosystem without swarming as marauding migrants.

In normal years — during the frequent drier periods when the desert locust goes into recession — the species is widely distributed over a wide belt of arid and semiarid lands (including the African Sahel), covering some 16 million square kilometers. Under this recession, the desert locusts live as inconspicuous, solitary grassland herbivores in these semiarid areas. Major locust swarms develop as a result of a rapid increase in locust numbers among the erstwhile recession population when widespread, heavy, prolonged rains occur after a long stretch of drought, in several scattered breeding areas. These wet periods permit two or three generations of the locust to develop in each breeding area, multiplying rapidly — sometimes by a factor of 10^5. These aggregate, match as hoppers, then swarm as adults, becoming highly mobile and traveling up to 1,000 kilometers a week, assisted by winds. Such gregarious locust swarms arise only after favorable rains, occurring over several seasons, succeed a long stretch of drought years (COPR 1982). The locusts may well invade a much larger area, covering some 29 million square kilometers, taking in all of the Sahel, North Africa, the Mediterranean region, the Middle East, and West Asia.

The old hypothesis that locusts migrate from areas that have become untenable is not correct. The flying locust swarms tend to be carried toward areas where rain has fallen, following

the Inter-Tropical Convergence Zone (COPR 1982). The late Reginald Rainey (1989), who made a life-long study of locust migration, concluded, after 40 years studying locust swarming phenomena, that migration is intrinsically adaptive — that locusts use migration as a mechanism to exploit seasonal changes in the spatial distribution of environmental resources. The desert locust simply exploits the necessary environmental resources by becoming airborne, and latching onto the geographically patterned global and local wind systems, which eventually take them to their convergence zones and their rains. The locusts then exploit the ephemeral vegetation, which develops quickly after unusually good rains over an area normally occupied by arid thornbush. This larger invasion area is often even more fragile than the locust's usual recession breeding area, so the locust invasion wreaks devastation.

The change from inconspicuous, solitary, grasshopper-like individuals (in the drought years) to highly mobile, gregarious, marauding locust swarms (early in the wet years) is associated with a major change in locust behavior, and fairly accurate forecasting systems exist for the appearance of matching hopper bands and locust swarms. The onset of recession — the petering out of locust plagues — is not so simple to predict. We have few clues as to what causes this behavioral change. In 1965-66, desert locust infestations worldwide were at their lowest level in 27 years, and an equally significant 18 years of locust silence followed. Rainey thought that the decline of desert locust infestations in the mid-1960s was associated with "a marked change in the global wind circulation, which had reverted sharply to a type of regime which had prevailed before the 1890s" when desert locust swarms had also been rare. The hypothesis is that these prolonged locust recessions are associated with a shift of the desert zones toward the equator, with equatorial rains (and the ITCZ) more concentrated than before close to the equator (Rainey 1989). It is recognized that these changes do not necessarily entail a direct causal relationship.

The challenge of managing locust invasions

It is a major challenge for the world scientific community — particularly Africans, who have lived with periodic marauding locust swarms for at least 600,000 years, since humans first settled in the Sahel — to begin to manage this natural disaster effectively. It is the belief of the International Centre of Insect Physiology and Ecology (ICIPE) that long-range desert locust management technologies will arise only when scientists know the behavior of locusts *intimately* and can interrupt mechanisms that regulate such behavior.

Attempts to change the physiology and behavior of the locust between the solitary and gregarious phases are at the heart of ICIPE's innovative attempts to ground the locust — to make it remain *sedentary*, behaving as a solitary, *grasshopper-like* population — and to keep it permanently nonswarming, nonmigratory, and nonmarauding. These efforts, never before tried, are one approach to sustainable management of the desert locust. Other approaches include use of the locust's natural enemies (including parasitoids and pathogens), the selective use of chemical locusticides, and a more refined locust forecasting and monitoring system. It is ICIPE's conviction that interrupting the gregarization, the sexual maturation, and the oviposition pheromone systems (which together bring about the rapid and synchronized development of coherent, highly dense locust swarms), together with promoting the solitarization and sexual maturation-inhibition pheromone system (which intensify solitarization), should help locust populations maintain a relatively steady sedentary, grasshopper-like lifestyle. By accomplishing this goal, ICIPE hopes it will help the pheromone-maintained solitary locusts continue to exist as natural herbivores in Africa's semiarid breeding grounds, continuing their important role as a participant in the dynamics of the savannah ecosystems, without periodically breaking out into locust plagues.

Disasters and development in East Africa

Daniel D.C. Don Nanjira

Despite countless disasters in East Africa, no data are available about their frequency, complexity, or magnitude. The Intergovernmental Authority on Drought and Development (IGADD) was formed in 1986 to strengthen the disaster preparedness capabilities of six East African states (Djibouti, Ethiopia, Kenya, Somalia, the Sudan, and Uganda). But IGADD should be strengthened and its mandate expanded to include other nations in the region and other issues besides drought and desertification. Millions have already suffered from disasters in East Africa and things will get worse unless policies change and corrective measures are taken by the East African states and the international community to strengthen disaster preparedness and to make the area self-reliant. The countries of East Africa must coordinate regional research efforts and implement regional strategies to conserve the soil and the environment and to develop agricultural self-sufficiency.

The Sudano-Sahelian belt

In 1986, Djibouti, Ethiopia, Kenya, Somalia, Sudan, and Uganda (part of the Sudan subregion) formed an Intergovernmental Authority on Drought and Desertification, better known as IGADD. IGADD was based at Djibouti. This paper is about that group of IGADD countries — plus Burundi, Mozambique, Rwanda, Tanzania. These countries are part of the Sudano-Sahelian region, which the UN's 1977 Conference on Desertification defined as "the belt extending across Africa South of the Sahara and North of the Equator from the Atlantic Ocean on the West to the Indian Ocean on the East." The Sudano-Sahelian belt is a zone of arid and semiarid land bordering the southern edges of the great Sahara Desert. The belt extends from the Atlantic coast almost 2,600 miles across Africa between the latitudes of 10 and 20 degrees north. Broadly speaking, it stretches 3,500 miles, from Mauritania to Somalia, and includes Djibouti. These 2 million square miles are one of the least developed regions in the world. All life in the region depends heavily on sparse and variable rainfall.

IGADD was an attempt to strengthen national and East African disaster preparedness capabilities to deal systematically with the common problems of drought and desertification, and to improve disaster prevention, long overdue in East Africa. These governments wanted to pool resources, coordinate their recovery and development efforts, implement a common strategy to combat drought and desertification, and develop and promote the funding and implementation of cooperative subregional projects.

The IGADD projects have so far concentrated

on a food security and early warning system, the development of interregional communications, animal health, and agricultural research and related manpower development. IGADD is basically a subregional development organization with a total land surface of 5.2 million square kilometers — 23 percent of Sub-Saharan Africa. The subregion's arid and semiarid lowlands receive less than 400 millimeters of rainfall a year. Farmlands cover more than 36 million hectares, or 7 percent of the IGADD's total surface. Forests occupy 94 million hectares (about 19 percent) of the land surface, and permanent pastures cover 139 million hectares, or about 28 percent. The rest of the land — 41 percent — is unproductive. IGADD's inland water surfaces cover 31 million hectares, but woodlands and grasslands are the backbone of the subregion.

IGADD countries have a population of about 100 million, about 26 percent of Sub-Saharan Africa's entire population. Population growth in East Africa is among the world's highest — 3 percent by World Bank estimates. Between 1972 and 1987, the population grew from 63.4 million to 103.1 million. Kenya, recently said to have the world's highest population growth rate at 4.1 percent, is now said to have a growth rate of 3.5 percent a year. If this rate is maintained, IGADD's population will jump from 100 million in 1987 to 168 million in 2000. This is an alarming trend. About 76 percent of the IGADD countries' population is believed to inhabit rural areas, including 65 million sedentary farmers and about 11 million nomads and seminomads. About 40 percent of IGADD's 25 million town-dwellers live in cities, the largest of which by 1987 estimates were Addis Ababa (1.6 million), Nairobi (1.5 million), and Khartoum (1.1 million).

Most of the IGADD countries' economies are agricultural, except Djibouti, whose economy is based on nomadic pastoral and related services. Agriculture contributes most to the gross national product (GNP) in Ethiopia and Somalia (48 percent). Services prevail in the Sudan (51 percent) and Kenya (48 percent). In Uganda and Djibouti, small-scale agricultural farming predominates. All told, there are about 12 million farming families — but no IGADD nation is self-sufficient in cereal.

Livestock in IGADD nations is dominated by smallholder production. About 2.3 million pastoral families have about 96 million tropical livestock units. Foreign exchange shortages are serious and health conditions are generally poor. Life expectancy ranges from 44 years in Somalia to 52 in Kenya — by far the lowest of any region in the world. Djibouti and Uganda fall below dietary standards set by WHO.

The East African disaster belt

The so-called Third World countries seem to suffer more from disasters than the developed nations. Why this is so is not clear. It may be because of political turmoil and economic exploitation in developing areas. It may be because their location subjects them to the geological and climatic forces of nature that occur mostly in the tropics. It may be because of the unholy alliance between disasters and development; because of the poverty syndrome; because Third World countries lack the resources to respond to disasters, which often destroy the infrastructure crucial to their socioeconomic development; because poverty, inadequate health care, and chronic food shortages make them susceptible to epidemics.

To the natural disasters so common in Africa have been added those of humans living collectively. Population growth has outpaced agricultural production. Arable land is scarce and expensive so low-income families that cannot afford land and decent housing are forced to move to shanties or other vulnerable housing in marginal areas such as the slopes of steep hills, along riverbanks and in flood-prone areas, in artificially reclaimed areas, active volcanic zones, and unsafe houses not designed to withstand extreme events.

East African economies are vulnerable to perilous events and East Africa has been prone to disasters from time immemorial. But the past 30 years have brought catastrophe of unprecedented proportions. East Africa's natural hazard belt is characterized by heavy rains, floods, landslides, drought, and desertification. East Africa's economic vulnerability to these disasters is aggravated by armed conflicts that swell the ranks of displaced persons and refugees. The gravest toll from natural disasters is the result of drought, desertification, and to some extent of pest infestation.

The East African economies are small economies, mainly agricultural in nature, situated in a natural hazard zone. These economies are highly specialized. Each country normally ex-

ports one or two primary commodities. So the economies are highly vulnerable to the vagaries of international trade, inflation, fluctuating prices for oil and other commodities, and other external shocks the countries cannot control. These countries face severe balance of payments and foreign exchange problems.

The East African economies are among the least developed in the world by any measure: by per capita GDP; proportion of the labor force outside the agricultural sector; and per capita social facilities, energy use, and road mileage. The East African peoples are among the world's most dependent upon imported manpower for jobs requiring specialized training and skill; imports of fuel for energy and basic food for consumption; capital imports for economic modernization; and external determinants for economic growth. They also depend for their livelihood on the weather and a healthy ecological balance — and both let them down.

East Africa is part of Sub-Saharan Africa, the only region in the world where per capita food production has declined. Famine, hunger, and malnutrition are the result not only of drought, disease, and flooding, but of the ever-widening gap between the rate of agricultural (especially food) production and the rapid population growth rate, especially in the last 30 years. Hunger and famine accelerate the exodus of rural people fleeing drought in search of water and food for themselves and their livestock. They also increase the need for food imports. Imports of food aid to meet emergency needs divert resources from longer-term planning. Regular supplies of emergency food retard development.

Africa south of the Sahara has the highest population growth in the developing world. It also has the most developing countries in the world, some of which — Burundi, Ethiopia, Rwanda, and Somalia — are also among the poorest. Africa's soils are high in iron and aluminum (laterite) and are mostly infertile. The iron and aluminum compounds become hard on exposure to the sun and air. Sand and laterite erode easily and hold little water. This, plus erratic, deficient rainfall, results in severe shortages of water and animal feed. The resulting devastation of crops and livestock has fed rural migration, rapid urbanization, rapid urban population growth, and the bottlenecks that accompany it. Meeting Africa's unmet needs requires systematic water control (irrigation) and research and development into how to improve seeds and produce higher yielding crops.

African agriculture has been heavily shaped by policies designed to integrate colonies into metropolitan trading networks, often to protect populations of settlers. Government policymakers have paid too much attention to urban issues at the expense of rural economies, have focused too much on armaments and too little on investment, too much on centralization and too little on decentralization and popular participation in government activities. There are no clear policies or government machinery for disaster management or for creating public awareness of what needs to be done in case of disaster.

The lack of national mechanisms for disaster prevention and mitigation increases East Africa's susceptibility to disaster. It is difficult to analyze the economic effects of disasters on the subregion because there is so little data on the nature, extent, and effect of disasters and emergencies, especially in the past. Although drought and desertification take the heaviest economic toll, about 90 percent of human deaths and property damage from disasters are attributed to water and wind. There is a close relationship between disasters, development, and environmental degradation and the resulting economic retardation and poverty. Official and public complacency and ignorance about disasters increases the region's vulnerability to them.

Disasters, development, and the environment

Desertification worldwide is spreading at the alarming rate of 6 million hectares a year, and erosion is damaging Africa's soil 26 times faster than it was 30 years ago. The Sahara Desert is said to be advancing southward at an alarming rate — an estimated 125 miles a year. There is a real danger that Africa may become permanently plagued by drought and desertification. The spread of the Sahara over an area 40 times the size of Switzerland has involved the destruction of at least 300,000 hectares of arable Sahelian land and forests. The reforestation rate in Africa is only 1:30, which means that 1.3 million hectares of dense forest and 2.3 million hectares of open forest are destroyed annually in Africa, and only 93,000 hectares a year are replanted. The grim realities of hunger, malnutrition, starvation, and death hit

small farmers, the rural landless, the urban unemployed, and other marginal groups the hardest.

Bad weather accelerates the loss of topsoil, nutrients, and humus and the dryness that results from water running off a compacted ground surface. The sectors most damaged by drought are agriculture, forestry, fisheries, livestock, meteorology and hydrology, food and nutrition (different food crops), industry, resources, transport, education, and health. Deforestation contributes to soil erosion and flood damage in East Africa. Floods have caused heavy casualties and economic losses in Kenya, Tanzania, Uganda, and the Sudan. Deforestation and soil erosion are the subregion's most pressing environmental problems, and subsistence agriculture and heavy use of fuelwood are largely to blame. In drier areas, deforestation leads to desertification, which, once started, is irreversibly catastrophic. The tragedy of the Sahel illustrates the grave environmental and economic consequences of desertification and drought. Reduced agricultural production causes food crises that ruin human health, divert foreign exchange earnings from development to food imports, and create a dependence on food donations that are often used as political weapons. Prolonged food shortages accentuate social inequities, lower morale, and cause political and social instability. The grave effects of disasters and environmental degradation are felt most in the following sectors of the East African economy:

- Agriculture, East Africa's main economic sector, foreign exchange earner, and source of employment.
- Tourism, a leading foreign exchange earner for Kenya and some other East African countries (for which conservation of nature and wildlife is essential).
- Industry, which is developing and needs more investment.
- Water supplies and management (needed for irrigation, sanitation, and nutrition).
- The environment, land use, forestry, and fisheries development.
- Livestock.
- Infrastructure (transport and communications, storage facilities, logistics, warehousing, and distribution).
- Energy, especially alternative renewable energies.

Changing the priorities of policymakers

To be effective, policies designed to deal with disasters in East Africa must also address problems of development and the environment, as the three are intertwined. Food and agricultural policies are most important, not just to East Africa but to the whole continent. For 30 years, agricultural production has deteriorated as urbanization and the population have grown, so per capita food consumption has declined. Post-harvest losses have also increased, as has Africa's dependence on food imports. The resulting drain on foreign exchange earnings has retarded development in all African economies. Africa has a food problem largely because agriculture is not given the priority it deserves by policymakers. Enough resources should be allocated to promote agricultural and food productivity, which would improve welfare, especially in rural areas where most Africans live. Policies must:

- Give incentives to rural development and rural small-scale farmers and cooperatives.
- Involve rural women and youth in agricultural development.
- Improve the living conditions and real incomes of farmers and ordinary people.
- Encourage self-sufficiency in livestock and fish production.
- Reduce food waste.
- Diversify agricultural development.
- Strengthen food security.

Food security and early warning systems go together. To increase food production it is essential to develop improved seeds and aim at incentive producer prices. As part of early warning systems, it is essential to help national governments monitor crop conditions and food supplies and be alert to adverse trends.

To control drought and desertification, policies should protect vegetation, trees, and shrubs to prevent erosion, provide water catchment, maintain biological diversity, and produce fuelwood and fodder. About 95 percent of wood consumed in Africa is for fuelwood — Africa's main energy source. To sustain this energy source, it is essential to launch reforestation programs, improve stoves, teach people more efficient ways to produce charcoal, conserve and rehabilitate rangelands, reduce and control overgrazing, make livestock production more

efficient, and provide animal health centers, public information and education programs, and training facilities for farmers and pastoralists.

Water resources should be developed and better managed. These resources should be regulated, improved, and distributed evenly. The East African nations should provide research and training, should organize an integrated approach to lake and river basin development, should promote irrigation schemes, and design water points, boreholes, wells, and small reservoirs that resist pollution by barring inappropriate animal and human access.

Improving interregional cooperation will require improving transport and road access to drought-stricken areas so strategic food reserves and aid can be mobilized in emergencies; opening up land-locked areas by linking them to harbors; and improving telecommunication and power transmission between states.

There should be research and training to improve land use, soil conservation, and crop yields. Institutes of applied agricultural, livestock, and forest research should give priority to containing ecological (environmental) degradation, developing energy resources (especially new and renewable energies), developing environmental manpower, and improving communications between researchers, planners, and implementers.

Policymakers must address the problems of refugees and displaced persons (of which there are at least 2 million in East Africa alone), population growth, family planning, and land tenure. But most of all they must promote:

- Sustainable agricultural production that does not deplete the natural environment.
- Protection of crops and strategic food reserves, especially through pest control and improved storage and processing (drying and preserving) facilities to minimize post-harvest food losses.
- Intensified rural production to conserve natural resources and attain food self-sufficiency.
- Redevelopment of exhausted farmland, especially the rehabilitation of run-down irrigation systems.
- Improvement of village water management, including small-scale irrigation and water harvesting.
- Pastoral development.
- Disaster insurance, especially for tourism and wildlife.
- Afforestation.
- Development of drought-resistant livestock, trees, and crops.
- Increased productivity on arid and semiarid land.
- The formulation and implementation of national plans, programs, and projects for rehabilitation, recovery, and long-term development.

Emergency measures to relieve disaster victims should be short-term (last only three months), and rehabilitation and recovery programs medium-term (only three to 18 months). Their end should mark the beginning of the long-term development period (18 months and beyond) during which the focus is (East) Africa's environmentally balanced socioeconomic development. All disaster-related projects should be either national or subregional. Subregional development policies endorsed by the national governments of cooperating states should be implemented as national projects coordinated to attain common strategic objectives. Subregional projects should harmonize national efforts toward the common objectives of subregional policies and national schemes.

Many policies are wrong-headed and should be changed. Food aid, for example, should become a tool for development. Food aid must be accepted in emergencies but policy should be to promote development, not to depend on relief or emergency food aid. Development strategies are wrong that stress the production of cash crops for export at the expense of food production for domestic consumption. Because of inappropriate pricing policies for crops, it has been difficult to supply enough food to urban populations and to create adequate food reserves. Other government policies produce inequalities in income distribution; neglect rural areas in overcentralized development efforts; neglect environmental concerns and ignore disaster mitigation in planning national development; fail to promote growth with equity (public investment that eliminates growth distortions and supports the poor); and fail to promote crop diversification, to reduce the economic losses from disaster.

Effective disaster management in East Africa should aim to:

- Provide for financing disaster preparedness, prevention, and mitigation.
- Strengthen national strategies and mecha-

nisms for disaster management.

- Involve local people in national development and disaster management activities.
- Provide public information and education programs for the public, schools, and workplaces.
- Develop a coordinated approach to resolving East Africa's environmental, development, and disaster problems.

Ill-conceived policies and programs aggravate rather than mitigate disasters. It is also important to coordinate action and support from the international community.

Action plans

Any action plan for dealing with disasters should:

- Look to the year 2000 and beyond.
- Develop strategies (measures) for all levels, from local to global.
- Establish a network of national disaster relief coordinators.
- Provide for community and regional training.
- Provide a regional plan for a network of regional training and information systems that cover medical surveillance, water stocking, drought surveillance, the provision of adequate storage facilities and grain stocks, and the like.
- Establish within the regional network a joint stocking facility, joint training facilities, joint transport of goods and services, joint health services, a regional program of feeder roads (currently vulnerable), and such emergency services as a joint flying doctor service.
- Jointly solicit international and bilateral technical, financial, and other support.
- Reactivate IGADD, which is too weak as it is. The IGADD ambassadors in Rome and elsewhere should be mobilized and asked to formulate practical proposals on ways to combat disasters. Research should be done on improving rural infrastructure, including road transport; an early warning system for food crops, locusts, climate, and natural hazards; environmental hazards; and public information and education programs.

How donors can help

The primary responsibility for development and for dealing with disasters and environmental hazards rests with the East African governments themselves. But these nations' needs are too enormous to be satisfied without external financial and technical assistance. Financing institutions such as the World Bank could provide technical and financial assistance for long-term development projects, human resources development, and insurance coverage for disasters. FAO, IFAD, the OPEC Fund, UNIDO, WFP, WHO, and other agencies could provide assistance to help poor farmers; develop infrastructure; increase agricultural productivity; carry out research and development to strengthen disaster management capabilities; tackle disaster insurance problems; develop industrialization, support the recovery and rehabilitation of water resources, renewable energy resources, and food production, processing, and storage facilities; support relief supplies and food aid for development projects; develop information and early warning systems for crops and food security; and facilitate access to remote sensing of meteorological conditions.

HABITAT, UNDP, UNDRO, UNEP, UNHCR, UNICEF, and WHO can help with the preparation of national development plans and disaster preparedness activities; training, research, and other disaster management activities; technical assistance for developing national emergency policies and promoting public awareness for disasters and emergencies. Other antidisaster institutions such as the International Decade for Natural Disaster Reduction could help provide disaster management skills for East Africa. Workshops and seminars on disaster problems should be encouraged, and promoted on a larger, more systematic, scale.

Annex 1

Table 1 East Africa's disaster-proneness and economic vulnerability

Country	Area (square miles)	Climate	Population (1987)	Population density per square kilometer (1987)	Date of independence	Year of UN membership
Burundi	10,747	Tropical volcanic soils, irregular rains	5,001,000	179.7	01/07/62	1962
Djibouti	8,958	Arid volcanic rocks, torrid, high tropical monsoons	483,000	—	27/07/77	1977
Ethiopia	483,123	Tropical plateau, semidesert	46,184,000	36.9	Ancient times	1945
Kenya	224,960	Equatorial tropical forests	21,163,000 (1986)	36.5 (1986)	12/02/63	1964
Mozambique	308,641	Tropical forests, dry and hot	15,127,000 (1988)	18.9	25/06/75	1975
Rwanda	10,169	Tropical, wet and dry, marshy, volcanos	5,700,000	218.6	01/07/62	1962
Somalia	246,201	Savannah plains, semideserts	6,860,000	10.8	01/07/60	1960
Sudan	967,500	Flat tropical plains, semideserts	18,681,000 (1983)	8.2	01/01/56	1956
Tanzania	364,900	Tropical rainforests, woodlands	23,217,000	23.8	26/04/64	Tangganyka 1961 Zanzibar 1963 Union 1969
Uganda	93,104	Equatorial tropical forests, plateau	12,630,076	52.4	09/10/62	1962

Table 1 East Africa's disaster-proneness and economic vulnerability (cont.)

Country	*Economy / main agricultural commodities*	*Per capita GNP (US$)**	*Type of disaster*	*Cost of disaster as percentage of GNP (1980)*
Burundi	Subsistence agriculture/ coffee, beans, groundnuts, sweet potatoes	240	Drought, famine, refugees, civil strife, displaced persons, floods, pests, epidemics	8.50
Djibouti	Trade services/ livestock, vegetables, sheep, goats, asses, cattle, camels, fishing	460	Drought, pests, epidemics, civil strife, floods, refugees	1.60
Ethiopia	Agriculture/ tobacco, barley, maize, potatoes, beans, sugarcane, groundnuts, coffee, cotton, livestock products	130	Drought, desertification, famine, pests, civil strife, epidemics, earthquakes, floods, refugees, displaced persons	40.80
Kenya	Fruits, sugarcane, cotton, cotton seeds, forestry, sisal, maize, millet, sorghum, cashew nuts, coffee, pineapples, tea, coconuts, pyrethrum, tobacco	390	Drought, desertification, refugees, floods, pests, earthquakes, epidemics	69.30
Mozambique	Cassava, cotton seed, cashew nuts, groundnuts, maize, fruits, livestock products	270	Floods, civil strife, cyclones, epidemics, famine	32.62
Rwanda	Agriculture/ cassava, beans, tea, coffee, peas, livestock, maize, sorghum	220	Drought, civil strife, famine	11.50
Somalia	Pastoral/ agriculture (irrigated and plantations), maize	260	Drought, desertification, pests, epidemics, oil spills, refugees, displaced persons, civil strife	11.10
Sudan	Agriculture/ sugarcane, forests, cotton seed, groundnuts, millet, sesame seeds	360	Desertification, famine, floods, epidemics, pests	67.40
Tanzania	Agriculture/ rice, sisal, sesame, cotton seed, maize, millet	270	Desertification, famine, drought, epidemics, floods	48.90
Uganda	Agriculture/ coffee, maize, bananas, beans, groundnuts, millet, sweet potatoes	200	Epidemics, drought, floods, famine, civil strife, refugees, displaced persons, desertification	24.90

*Nine nations are less-developed countries; Kenya is low-income.

The link between reconstruction and development

Jelena Pantelic

Reconstruction after an earthquake should improve the residents' standard of living. Local social and cultural values and resources should be incorporated into reconstruction and development efforts.

It is a fallacy that disasters do not choose their victims, but strike all people alike. Quite the opposite seems to be true. Disasters often particularly affect the most vulnerable segments of the population, people who can afford to occupy only the dangerous flood-prone valleys or the edges of ravines and landslide areas, or who live in substandard homes or work in unsafe buildings. Poverty lies at the root of disaster vulnerability just as it lies at the root of most problems developing societies face today. So efforts to reduce disaster vulnerability are inseparable from general development efforts — especially after a disaster, when reconstruction becomes a primary medium of development policy.

This view of the link between reconstruction and development has been gaining ground, replacing the old notion of competition for resources — in which recovery was seen as diverting funds from development efforts. Reconstruction after disaster is viewed today as a process that can effectively unify development and recovery goals — by improving the disaster resistance of physical structures, improving the standard of living, generating new jobs and creating new skills, and integrating them with the community's social and cultural values and resources.

Rebuilding physical structures

To rebuild damaged or destroyed physical structures has always been the main goal of communities affected by earthquakes. Rather than simply restore buildings to pre-earthquake conditions that may have contributed to their vulnerability in the first place, reconstruction should improve a structure's quality, especially its earthquake-resistance. Reconstruction of physical structures after earthquakes should both reduce seismic hazards and upgrade the standard of living.

Improving safety

To allow development to continue after future disasters, the first step is to improve structural performance during an earthquake. This usually begins with regulation — adopting new or revising existing building codes. Mexico City's Emergency Building Code, for example, was in place just five weeks after Mexico's 1985 earthquake (Esteva, forthcoming). But rigorous regulations on design and practice mean little without proper enforcement, which is one of the weak links in improving earthquake-resistance in physical structures. Inadequate implemen-

tation of the building codes, rather than their absence, was one of the principal causes of deadly building failures in the 1988 earthquake in Armenia.

Throughout history reconstruction after earthquakes has inspired new construction technologies. The famous wooden frame called *gaiola* became a standard component of masonry construction in Lisbon after the catastrophic earthquake of 1755 (Tobriner 1980). More recently, reconstruction programs in Guatemala successfully promoted the use of *lamina* (lightweight aluminum sheeting) as roofing material instead of the traditional heavy ceramic tiles that had proved lethal in the 1976 earthquake (Bates 1979).

Construction techniques and materials are important but so is the location of a building and the quality of soil on which a structure is built. Land-use planning should regulate development in vulnerable sites. Relocating entire settlements to safer sites is one of the oldest, most radical land-use measures, but in the long term it rarely succeeds. The residents of Antigua, Guatemala, for example, reluctantly abandoned their city after Spanish authorities officially relocated it in 1779 — only to return several years later (Tobriner 1980). Similarly, the town of Gediz in Turkey, which was ruined in the 1970 earthquake and rebuilt on another site, exists 12 years later in two thriving neighboring locations, Old and New Gediz (Aysan and Oliver 1987). Yugoslav authorities seriously considered relocating Skopje after a 1963 earthquake, but opted instead for a restrictive land-use strategy by rezoning the seismically hazardous Vardar valley as open space (Davis 1978).

Introducing new building regulations and technologies requires a well-organized education and training program if earthquake mitigation measures are to be effective. Training technical personnel and the population at large in earthquake-resistant construction has become more common in the past 20 years. In Guatemala after the 1976 earthquake, for example, some programs trained residents how to distinguish between safe and vulnerable locations for their homes and how to improve the traditional building process, rather than providing them with complete houses (Davis 1978, Cuny 1983). Similarly, in Nepal, which is now recovering from the effects of the 1988 earthquake, several dozen demonstration houses have been built in strategic locations to show safe building practices to people from remote areas (Fujiwara and others 1989, Kreimer 1989). In the last decade, earthquake education courses for professional architects, engineers, and planners have proliferated in the United States — and the public at large has not been neglected. Specialized earthquake preparedness projects in California disseminate information about the threat of earthquakes and provide guidelines for self-help improvement of the earthquake performance of homes (BAREPP 1990).

Upgrading structures

Substandard physical structures, especially in low-income residential areas, are common in developing countries. Dwellings often lack kitchens, bathrooms, and water, as well as access to sewers, electric power, paved roads, and health and education facilities. More often than not these residential quarters are overcrowded and poorly maintained and are rarely owner-occupied. This makes them particularly susceptible to earthquake damage, as was shown in earthquakes in Mexico City in 1985, the Italian countryside in 1980, and the medieval cities on the southern coast of Yugoslavia in 1979. So physically upgrading structures after earthquakes to improve the occupants' standard of living has become an important goal of reconstruction. In Mexico City, for example — in a remarkably successful large-scale attempt to reconstruct residential buildings — both the buildings' earthquake-resistance and the occupants' standard of living were improved. Before the earthquake, the average size of an apartment was 22.25 square meters, shared by an average 4.37 occupants, with 63 percent of households sharing bathrooms and 30 percent sharing kitchens with other families. The rebuilt dwellings were an average 40 square meters and contained two bedrooms, a living and dining area, a bathroom, kitchenette, and washing area (Puertos 1987, Stolarski 1987, RHP 1987).

Increasing the size and quality of dwelling units alone will not improve the occupants' standard of living, if that is done at the expense of more vital necessities. Kreimer (1980), for example, shows that access to jobs and services is more important to the low-income population in developing countries than the quality of the structure they occupy. In Managua, after the 1972 earthquake, long journeys to work reduced the attractiveness of the low-income residents'

new, well-equipped housing units built on the city's outskirts (Bolton 1988). By contrast, residential neighborhoods in Mexico City were rebuilt on the same site near the city center — a vibrant focus of the formal and informal economy —which enabled people to maintain their position in the life of the community.

Social aspects of reconstruction

Local social and cultural values must be considered in development and reconstruction programs. According to Weitz (1986) — who calls for "massive representation" of local communities in development projects — a "major reason for the recurrent failures of past development efforts is the neglect to involve value systems in development planning and implementation." Similarly, Goulet (1978) asserts that the values of the society itself must calibrate the terms of its development. Analysts of recovery programs after earthquakes and other disasters link the failure of many reconstruction programs to a lack of respect for the social and cultural values of the affected communities (Aysan and Oliver 1987). Two objectives of reconstruction should be to strengthen the local community by using its resources and to incorporate the cultural values of the community into the reconstruction process.

Strengthening the local community

Many people participate in planning and implementation of reconstruction after an earthquake, but the victims are often left out of the process. In the short term, reconstruction is thus deprived of local skills, experience, manpower, institutions, and sometimes significant funds for rebuilding. In the long run, the community is robbed of the invigorating experience of rebuilding and runs the risk that its lifestyle may be changed beyond recognition. Outside decisionmakers often bring ready-made solutions, foreign technologies, and inappropriate lifestyles to communities whose residents are excluded from meaningful participation in reconstruction. Turkish authorities, for example, provided prefabricated housing with modern amenities to the victims of the Gediz 1970 and Lice 1975 earthquakes, housing that proved to be sorely inappropriate for the traditional rural and nomadic culture and religious beliefs of the affected population (Aysan and Oliver 1987, Cavanagh and Johnson 1976).

Involving the local community and resources in reconstruction planning and implementation can materially strengthen a community hit by an earthquake. For example, in Renovacion Habitacional Popular (RHP) — the groundbreaking housing reconstruction program that provided almost 50,000 housing units in Mexico City — decisionmaking involved representatives of all concerned groups from the local communities in which reconstruction was taking place, including neighborhood associations, tenement groups, and church organizations. The result of negotiations, a formally signed social agreement, became a blueprint for implementing reconstruction, in which the local community continued to participate actively (RHP 1987, SEDUE 1987).

Assistance from outside the community — although often welcome and sometimes necessary as a "catalyst" for successful reconstruction — must not take on a leading role. Foreign aid can expedite development but "cannot in and of itself develop a poor nation" (Weitz 1986). The same applies to reconstruction. Local participation brings in the special knowledge, work experience, and technical and organizational skills needed for successful recovery. Local involvement in reconstruction provides a framework for social and economic community development. In Mexico City, for instance, many funds were funneled back into the communities affected by the earthquake. Renovacion Habitacional Popular created about 115,000 new jobs in the construction industry, which were filled almost exclusively by locally recruited workers (RHP 1987). And the community's economic base was strengthened in the long term by providing production shops and commercial spaces for local businesses.

Two objectives in Mexico City were to strengthen the alliance between the public and the private sector and to reinforce existing institutions rather than establish new institutions. RHP was organized as a task force, combining experts from the public and private sector. Members of this group were on "loan" from their parent organizations as long as reconstruction lasted. Then RHP was dissolved, preventing the institutionalization and bureaucratization of the reconstruction program. The public sector provided institutional support, a timely flow of information and funds, and shortcuts in bureaucratic procedures, while the private sector

Urban growth and natural hazards

Michael Cohen

There is a great need for research and development on the urban environment, particularly on the relationship between global and urban environmental problems. If global warming does occur and sea levels really do increase, think what the implications are for cities such as Bombay, Lagos, Rio, Dacca, Manila, Shanghai, and New York. What will happen to the quality of the aquifer? If the water supply for such huge populations is ruined, what will happen to economic activity? If half of the GDP is generated in the cities, how will that affect economic growth? What are a country's economic prospects without its major urban centers? Or look at it the other way: How do cities affect global environmental problems? Cities pollute — and eat up scarce environmental resources. We don't know as much as we need to know but one thing is clear. We must define urban policy and take action in urban areas. Four aspects of urban growth demand special attention in discussions of natural hazards: demographic growth, constraints on urban productivity, spatial growth, and weak local institutional capabilities.

Demographic growth. In 1960, only one city — Shanghai — had a population of 10 million; in the year 2000, 17 cities are expected to have populations above 10 million. And secondary cities in most developing countries are growing faster than many larger cities. The urban population, which was about 1.3 billion people in 1988, will expand by about 600 million people by the year 2000. Urban growth continues, the numbers are huge, and no effort to restrain urban growth — such as limiting migration — has worked. It is impossible to keep people in rural areas and in any case growth often occurs in the cities themselves, from natural increase. Cities impose tremendous pressures on environmental resources, especially air and water. What is the carrying capacity of large cities? We do not know, as cities are growing to unprecedented levels.

Constraints on urban productivity. Cities are crucial to economic productivity. Almost half of the gross domestic product (GDP) in most of the Bank's member countries is generated in urban areas. This is less true in rural African countries, but certainly applies in such countries as Argentina, Brazil, and Mexico. About 80 percent of future growth is expected to come from the urban economy.

But in most developing countries, cities are not as productive as they could be. There are serious constraints on productivity, the most obvious being deficiencies of infrastructure, such as traffic problems in places like Cairo and Mexico City and shortages of water in Karachi and Bombay. Economic policies make daily economic activity far too complicated and complex regulatory frameworks hinder rather than regulate growth. But worst of all constraints on productivity are the weak institutional frameworks for managing cities. The result is extensive urban poverty. By World Bank estimates, about one quarter of city dwellers — roughly 330 million people — live below the urban poverty line. And a substantial portion of the 600 million to be added to the urban population will be urban poor.

Spatial growth. Cities are expanding rapidly into peripheral areas. Areas that once were agricultural land are now inhabited by increasingly dense populations. Employment tends to decentralize; areas that were once residential, and before that agricultural, are now becoming employment centers. Areas that are now residential were once zoned for industry and still may be industrial to some extent. Land used for mixed purposes creates hazards, introducing industrial pollution and hazardous waste to residential neighborhoods, for example.

With spatial growth in some areas comes densification and centralization in others, which increase rather than decrease the risks associated with natural disasters. Pollution is heavy, air quality is deteriorating, marginal lines are being settled, and environmental risks in cities are increasing rapidly. But among data on the developing countries, you will find surprisingly little information on the urban environment.

Weakened local institutional capabilities. In most countries local governments are weaker now than they were 20 years ago — particularly in infrastructure. Administrative pressures to centralize government have starved local governments of revenues, autonomy, and technical capabilities. Urban infrastructure in most parts of the world is in a crisis, with poor maintenance undermining the value of development investments. Institutional capabilities are especially poor in zoning and the enforcement of environmental regulations. Even data on air and water pollution in Mexico City and most African and Asian cities are not available.

Our phenomenal ignorance of the escalating economic, social, and political stakes of urban growth makes risk assessment exceedingly difficult. The likelihood of environmental disasters is probably increasing, and the prospects of their affecting cities is certainly increasing — because human activity is becoming densified and residential, and industrial activities coexist in the same neighborhoods in interactions about which regulations and policy are not clear. We must work together to identify ways to reduce these risks, but there is much to be done.

contributed practical experience in finance, design, construction, and management.

Safeguarding the community's cultural values

Physical structures identify neighborhoods, embody a way of life, and express the cultural values of the community. One important measure of a reconstruction program's success is the extent to which a community can preserve its cultural identity and lifestyle. Urban ambiance, the historical heritage, and traditional architectural values are frequently destroyed by an earthquake, but often reconstruction programs sacrifice these values, too, damaging the social fabric of the community. Before the 1963 earthquake, for example, Skopje was a closely knit city with a strong medieval Ottoman heritage. Reconstruction converted it to a low-density, thin, linear city, 24 kilometers long — changing forever the lifestyle of its citizens (Davis 1975).

More efforts were made to maintain the cultural identity of communities recovering from earthquakes and other disasters in the 1970s. The cultural values of the victims in Guatemala, for example, were integrated into its reconstruction programs (Thompson and Thompson 1977). Of course, some strategies to preserve a place's cultural identity may cause hardships for its residents. Venzone, for example — a historical town damaged in the 1976 Fruiuli earthquakes — embarked on a slow process of rehabilitating its historical buildings and preserving its unique ambiance at the expense of its residents, who were displaced to prefabricated dwellings outside of town (Hogg 1980). Mexico City's local residents, however, were not displaced but camped near the reconstruction sites, observing and helping in the rebuilding of their new homes. The concept of the traditional neighborhood and the spirit of the "vecindad" were skillfully translated into the design for new condominiums, and the historical "vecindades" — the subjects of special architectural conservation projects — received their original residents as soon as they were rebuilt.

Risk management

Disaster response: generic or agent-specific?

E. L. Quarantelli

This paper addresses three questions about possible differences between disasters and their implications for planning. First, for planning purposes, are disasters best approached generically or in agent-specific terms? (The answer, based mostly on research, is that the generic approach is more valid. This does not mean there are no meaningful differences between disasters.) Second, along what lines might disasters be usefully differentiated? (Eight dimensions significant for emergency responses are discussed.) Third, what distinctions are made, and do they apply equally in all phases of the disaster planning cycle: mitigation or prevention, emergency preparedness, emergency response, and recovery? (It appears that the generic approach is most applicable in the emergency phases and somewhat less so in the mitigation phase. Recovery falls somewhere in between.) Answering these questions is a useful way to discuss the institutional and organizational behavior appropriate for disaster planning in different situations.

Disasters as generic phenomena

Most but not all disaster planning is agent-specific. People tend to organize planning around specific disaster agents. Thus, there are often separate plans for disasters resulting from hazardous chemicals, hurricanes, emergencies in nuclear plants, floods, and so on. Usually different organizations prepare for and respond to threats or events viewed as different from each other.

This agent-specific orientation might seem logical. Are not chemical threats different from earthquakes? Are not floods different from huge fires in high-rise buildings? The answer, of course, is yes — but in an important sense it is the wrong question. Thus, in the last decade there has been an increasing shift by disaster researchers — especially in developed countries — to a more generic, all-hazards approach.

Disaster researchers at one time approached the field in the same way many disaster planners still do. Four decades ago, in the earliest days of social science disaster studies, most researchers in disaster planning accepted the everyday distinctions between different kinds of disaster agents (such as floods, explosions, hurricanes, and fires). Soon these distinctions tended to be collapsed into two general categories: natural disasters ("acts of God") and technological ones (those supposedly brought about by human actions). Recently, these surface or manifest distinctions are increasingly questioned and the focus is more on whether to take a generic or an agent-specific approach to disasters (Quarantelli 1982).

The agent-specific approach assumes that each type of disaster agent (such as a volcanic eruption or nuclear fallout) or each class of agents (whether natural or technological) has certain

distinctive characteristics that affect what occurs (Baum, Fleming, and Davidson 1983). The generic approach assumes that there are more individual and organizational behavioral similarities than differences for all disaster occasions (Quarantelli 1987b). Most social scientists in disaster research now take a generic approach rather than study different agents or classes of physical agents separately.

There are two main reasons for this shift to a generic approach. One is theoretical, the other (more important) empirical. Theoretically, there has been a shift away from a physical focus toward a more social conception of disasters. This is partly the result of recognizing that an event such as an earthquake or a chemical explosion does not automatically result in a "disaster." That is, a natural land movement of a certain kind is an earthquake, and the transformation of an inert liquid into an expansive gas is a chemical explosion. But unless there are significant social negative consequences of some kind, these happenings remain only a geophysical event or a chemical process (for example, an earthquake in uninhabited land or a safely contained chemical explosion). From this perspective, a disaster can be identified *only* in terms of a social occasion, by the characteristics of individuals and groups reacting to a situation. The socially oriented conception of disaster shifts the focus to the common or similar properties of the social happening and away from the physical features of natural and technological agents and their effects.

More important, social science studies reveal that most sociobehavioral features of disasters are not agent- or class-agent-specific, but are generally similar for different types of natural and technological agents (Drabek 1986). For many of the human and organizational problems that come up in preparing for and managing a response to disasters, it does not matter what specific kind of disaster agent is involved. Whatever the agent, the same general activities have to be undertaken, whether the task be warning, evacuation, sheltering, feeding, search and rescue, disposition of the dead, mobilization of resources, communication flow, interorganizational coordination, or public information, and whether the tasks involve individuals or groups.

The same kind of warning system is needed, for example, to get people to evacuate, no matter what agent is involved. It does not matter if the agent is a tornado, an oil spill, a tsunami, or a major fire at a hazardous waste site. What motivates people to heed warning messages, what kind of warning message is effective, what limits the acceptance of a warning, and so on, is the same in all cases (see, for example, Perry and Mushkatel 1984, Perry 1985). The human aspects of disaster behavior do not depend on the type of disaster agent.

Similarly, if there is a need for organized search and rescue or large-scale emergency medical services after a disaster, the specific disaster agent is irrelevant to important organizational issues that must be dealt with. Research consistently shows, for example, that the less seriously injured are likely to be treated first, that one or a few hospitals will take a disproportionate number of the injured victims, and that there will be no overall coordination of the medical-health response (Quarantelli 1983, Auf der Heide 1989). Similarly, studies show that ordinary local citizens quickly undertake most of the initial search and rescue, that the handling of dead bodies is psychologically disturbing, and that formal search-and-rescue teams tend to operate in an uncoordinated way (Mileti and others 1975, Drabek and others 1981). The type of agent involved affects the execution of such emergency tasks very little.

The same is true for different classes or categories of agents. A disaster preparedness primer, for example, notes certain differences between community planning for natural and chemical hazards. But it then observes that:

> These differences do not necessarily rule out the application of principles of natural disaster planning to problems of chemical hazards. In fact ... studies on natural disaster planning and response can be of value for persons connected with chemical disaster preparedness.

It then states:

> Regardless of the characteristics of a particular disaster agent and the specific demands generated by it, the same kinds of community response-related tasks are necessary in both kinds of disaster and for all disaster phases. In any community, for example, the assessment of hazards and

> the aggregation of disaster-relevant resources are necessary, regardless of the specific hazards and resources in question. Similarly, post-impact communication and decisionmaking procedures must be planned for and activated in *any* community crisis.

Then it notes:

> To draw an analogy, a battle on land is fought with different weapons, materiel, personnel and support systems than those used in sea battles, but, nevertheless, the general overall battle requirements are the same for both. In both cases, intelligence about enemy strength and movements must be gathered, resources must be collected, trained personnel must be led effectively, and so on. The same is true for disaster planning: although disaster agents and the human and material resources needed to respond to them may vary, the same generic kinds of activities must be performed in the predisaster, preimpact, response, and recovery periods, regardless of the specific threat (Tierney 1980: 18-19).

Questioning of the distinction between technological and natural disasters has accelerated in the last decade. Researchers such as Bolton (1986), for example, note many similarities between natural hazards and industrial crises in developed countries. And operational personnel, such as Wijkman and Timberlake (1984) indicate in the very title of their volume, *Acts of God or Acts of Man?*, that the distinction is not meaningful in developing societies. Others looking at particular behaviors such as evacuation have noted similarities in volcanic eruptions, floods, and nuclear power plant accidents (Perry 1983).

Even when social behavior seems somewhat agent-specific, closer examination often indicates a link of a broader nature. The concept of "disaster subcultures," for example, was initially linked to a specific agent. The terms "flood subculture" and "hurricane subculture" (Moore 1964, Osborn 1970) refer to individual and organizational adjustment mechanisms developed as the result of repeated exposures to the same kind of disaster. There is now reason to believe that experiential and other situational factors are more important in the development of adjustment subcultures than the characteristics of the agent (Drabek 1986: 339-40). Some even argue that activities such as earthquake prediction are not fully agent-specific. Turner (1980) implies that much of what researchers know about how people respond to threats and warnings for other dangers applies equally to prediction scenarios for earthquakes.

Finally, researchers who argue for a generic approach question whether concrete agents can be identified for all disasters and whether agents can always be easily classified. What is the agent in a famine or drought, for example? Are the sources of forest and brush fires, or of avalanches and landslides, to be found in human actions or natural phenomena? What about physical fatigue in bridges or pipelines that results in structural collapse? What about nondeliberately contaminated food or medical products? What is the source of disaster? Plane crashes and many other transportation accidents can be generated by both natural and technological agents.

Not only social science disaster researchers favor the generic approach. When the U.S. Congress was considering the implementation plan required by the Earthquake Hazards Reduction Act of 1977, the Office of Technology Assessment was asked to develop "Criteria for Evaluating the Earthquake Mitigation Implementation Plan." On the issue of an "earthquake versus an all-natural-hazards strategy," the OTA report concluded that:

> While it may be convenient for researchers and the large Federal agencies to handle hazards categorically, the practicalities of State and local government organization and function increasingly required integrated planning and operations for all hazards. Similarly, Federal construction and housing programs also could be responsive to all hazards, not just to one or a few selected hazards (quoted in *The Hazard Monthly* 1980; see also Coates and others 1979).

Some say the distinction between approaches is operational, not academic — that field personnel dealing with an emergency need agent-specific knowledge such as how far people must be evacuated to avoid toxicity or flying debris if a chlorine tanker threatens to explode. Others

say academic researchers can afford to deal with the more generic questions such as what general factors motivate people to evacuate.

This distinction between operational and academic concern is really a confusion of *tactical* matters (such as the distance to evacuate), which would vary whether disaster agents are similar or dissimilar, with *strategic* matters (such as general principles of motivation applicable in all situations). There are strategies for dealing with disasters that cut across disasters. Tactics tend to be more situation-specific, but even the military (from which the concepts of strategy and tactics are drawn) seems to feel that soldiers can be taught tactical principles that apply in most combat situations.

Even so practical a field as medicine proceeds as if disaster planning and response need not be agent-specific. Rarely do disaster medical personnel train and prepare for only one kind of medical treatment. The World Health Organization defines a disaster as "a situation which implies unforeseen, serious and immediate threats to public health" (Lechat 1980: 18). Disaster medicine emphasizes general principles, focusing on such nondisaster-specific aspects of organization as personnel alerting systems, triage, and the allocation of patients to hospitals (Butman 1982).

The generic approach to disasters, by combining dissimilar agents and factors, may appear to violate common sense. In a way, this is correct but not necessarily significant, as this analogy may illustrate: biologists have long classified bats, whales, and human beings as mammals. Despite manifest differences in size, structure, and function among these three creatures, for biological purposes these obvious commonsense differences are far less significant than less overt structural and functional similarities, such as the fact that all mammals are warm-blooded and bear live young. For purposes of studying and applying biological principles, the fact that a whale is bigger than a bat, or that a whale needs a water environment and human beings basically need a land environment, is unimportant. The same principle applies in combining manifestly different physical agents or elements of disaster planning. In fact, disaster researchers have been advised to follow the lead of biologists and distinguish between phenotypes and genotypes, focusing less on manifest surface (phenotypical) features and more on similar underlying (genotypical) characteristics (Quarantelli 1987b: 27).

The generic or all-hazards approach has not always been easy to accept, for several reasons. For one thing, much early work on disasters focused on the physical agent involved, so this became a habitual way of approaching the problem to some — for example, flood control or hurricane prediction specialists. More recently, researchers and operational people in fire research and nuclear risk have shown a similar reluctance to move away from an agent-specific orientation. They have long struggled with questions about those physical agents and their agent-specific characteristics, and they have trouble seeing that sociobehavioral studies of other disaster situations can apply directly to their own areas. They illustrate Kenneth Burke's statement that "a way of seeing is also a way of not seeing" (quoted in Lindesmith and Strauss 1949: 101).

The possibility of recognizing that the agent-specific perspective may be less valid than another may be limited for people working on disaster problems because many of them live in relatively different professional and intellectual research worlds, between which communication is limited. Some people specialize in one kind of agent (such as fires, earthquakes, nuclear hazards, or landslides); others specialize in topics and questions that cut across disasters (such as systems for warning, search and rescue, medical treatment, and handling of the dead). In a sense, some divide the disaster world horizontally, others vertically. This does not facilitate communication between one axis and another. And it is probably more difficult for a vertical communicator (an agent-specific specialist such as a seismologist) to understand a horizontal communicator (a general disaster specialist such as a sociologist) than vice versa. The seismologist is likely to have a narrower perspective than the sociologist.

Different dimensions of disaster

The generic approach does not deny that there are important differences between disaster occasions — only that they are not linked to specific agents. In some cases, for example, warning is possible and in others it is impossible or difficult. In some cases a disaster's impact is diffuse and in others it is focused and local. The

physical difference between an explosion and an earthquake is less important than the fact that neither usually allows time for warning. Similarly, "a flash flood resulting from a broken dam might have more similarity to a sudden tornado than to a slowly rising Mississippi River flood (Stoddard 1968: 12); and "a flood in Cincinnati for which there may be two weeks' warnings, is simply not a comparable event to a flood in Denver with six hours' warning, or to one in Rapid City where warnings were received as flood waters entered dwellings" (Mileti and others 1975: 5). "The differences between damaging events due to the same natural or man-made agent may be larger than between events initiated by a different agent" (Hewitt and Burton 1971: 124). Some approaches cut across agents and look at different dimensions of the social setting in which disasters occur.

Disaster typologies based on combinations of meaningful dimensions of social occasions would help us understand common social behavior for different agents and different social behavior for the same agent. Such typologies should combine such generic social dimensions as a disaster's predictability, relative loss impact, recurrence, unfamiliarity, and rapidity of onset; the social centrality of the affected population; the proportion of the population involved; and how long they are involved (Quarantelli 1985: 58). All of these dimensions can be seen as characteristics of the social occasion rather than of the physical disaster agent.

These dimensions cut across not only different disaster agents (both natural and technological) but also the same disaster agent (such as a flood or chemical explosion). For instance, a chemical explosion may be a familiar threat near chemical complexes but unfamiliar in other communities. The local people's familiarity with chemical complexes will affect their responses to warnings, their probability of evacuating, and their expectations about emergency organization and behavior. Here I suggest that disaster researchers follow the lead provided by biologists who distinguish between phenotypes and genotypes. We should develop typologies of disaster occasions.

Unfortunately no such typologies exist — or none has found wide acceptance in the disaster research community. (For one proposed even before social science disaster research had any vitality, see Carr 1932; for more recent proposed typologies, see Barton 1970 and May 1989.) In the last decade, eight dimensions of a population's response to disaster have increasingly been singled out as important for a typology within the generic approach:

- The relative proportion of the population involved.
- The social centrality of the affected population.
- The length of time the affected population is involved.
- The rapidity of involvement by the population.
- The predictability of involvement.
- The unfamiliarity of the crisis.
- The depth of the population's involvement.
- The recurrence of involvement.

These eight characteristics of a population's response to disasters emphasize characteristics of the social occasion rather than of the physical agent (even if there is one and sometimes, as with a famine, there is not).

1. The *relative proportion* of the population involved

The proportion of the population involved relative to some base is far more important for planning purposes than absolute numbers (Britton 1987: 35-36). This is true whether the focus is on concrete losses or psychological involvement. For example, 500 dead in a metropolitan area of 5 million involves proportionately far less of the community than does 100 dead in a town of only 1,000 inhabitants. Similarly, in terms of property damage or destruction, the same absolute numbers might mean a catastrophe in some communities but only a bigger-than-usual emergency in others. Generally this disaster characteristic has less to do with the scope of geographic or physical impact than with the social impact of the disaster. The degree of community involvement has to be measured relative to the total social resource base.

Organizationally, this dimension has several important implications. For one, the greater the relative social involvement, the more the occasion is a disaster rather than an emergency. It has increasingly been argued that a disaster is both quantitatively and qualitatively differ-

ent from an emergency and necessitates different kinds of planning. A Bhopal gas poisoning incident is not merely at one end of a scale on which a gas leak in a house is at the other end (see Shrivastava 1987a).

Along another line, the huge urban complexes that are coming into being in many developing societies are — contrary to widespread belief — far more likely to accelerate the rate of everyday emergencies than the rate of disasters. But when an urban disaster occurs, it is more likely to be catastrophic. The tip of a disaster is much higher when viewed relatively than in absolute numbers. Handling 250 deaths a day may be a normal statistic in a metropolitan area. Institutional disaster planning must take this into account.

2. The *social centrality* of the affected population

Also important for planning purposes is whether the affected population is central or peripheral to the larger social community. That is, the victims may be from the area or they may not be (see Quarantelli 1985: 60). The identical disaster agent would have a different effect on different population mixes in the same community. If a tornado were to hit a crowded airport terminal, for example, its effect would be different than if it hit a large, local social event. In one case the victims would include many transients; in the other, many closely linked, longtime neighbors would be the victims.

Organizationally, the more mixed the population of victims, the more likely there will be problems. Everything else being equal, homogeneous populations present fewer planning problems. In developing societies, for example, some areas are populated at certain times of the year by many temporary migrant workers, and some are populated mostly by a stable native population. Disaster planning, to be effective, should be different for the two situations, even if the disaster occasion is the same.

3. The *length of time* the affected population is involved

The length of time of involvement refers to the crisis response of the population, not to the duration of the threat, which is a dimension of the physical agent. Sometimes the duration of the primary disaster agent is short but the length of crisis involvement is longer because of perceived secondary threats. For example, an accident involving a train carrying chemicals may be over in a few minutes, but the threat or actual slow release of toxic chemicals from the wrecked train may generate a crisis that lasts days — as happened in Mississauga, Canada (see Scanlon and Padgham 1980). Or, as a number of disaster researchers have noted, on an occasion like the 1979 nuclear hazard accident at Three Mile Island, the duration of the accident was relatively short but psychologically the crisis for certain segments of the population continues to this day. The volcanic eruption at Mount St. Helens has had the same effect on some nearby residents.

This dimension of disaster is primarily a matter of perception and the so-called experts and the general population may perceive the risks very differently. Thus, in developed societies some potential nuclear and chemical threats are often viewed differently by interested parties. Citizens generally use different criteria for risk assessment than do workers or specialists in these fields (Slovic, Fischhoff, and Lichtenstein 1980, Covello 1983, Slovic 1987). The differences are less the result of a technology being involved and more a reflection of different perceptions. Those most intimately involved with a technological threat downplay it with something like the "fatalism" with which native populations in developing countries view such natural threats as volcanic eruptions or floods. Such major perceptual differences can present major planning difficulties for disaster planners, who must get people to agree on definitions of what is or is not safe, must get people to evacuate, and so on. Generally, the longer the perceived involvement, the more criticism disaster response organizations can anticipate.

4. The *rapidity* of involvement by the population

Sometimes a population becomes slowly involved in a crisis, sometimes its involvement is rapid. Populations were quickly involved in the flash flood in Rapid City, many dangerous chemical emergencies resulting from transportation accidents, the false story of a dam collapse at Port Jervis, New York, and the collapse of a hotel walkway in Kansas City (see, for example, Mileti 1974, Danzig, Thayer, and Gallanter 1958,

Quarantelli 1984b). Rapidity of involvement is sometimes related to predictability but is independent of it. Predictability has to do with expectedness, rapidity with speed. The two can vary independently. And rapidity of involvement is a characteristic of the disaster occasion, not to be equated with the speed of onset, which is a feature of some physical disaster agents.

The rapidity of the response pattern is viewed from the perspective of those involved. It may or may not correspond with the actual time available for action. This can obviously create planning difficulties. Generally populations and organizations adjust best when they are involved slowly. In some cases there may not even be much of a crisis. Adjustment is much more difficult when involvement is rapid. Problems are often compounded in developing countries where conceptions of social time differ between more Western-oriented emergency groups and the local population.

5. The *predictability* of involvement

Sometimes populations can predict their possible involvement in disasters; other times, the crises are unexpected. Such evidence as exists indicates that the unexpected is much more psychologically disturbing than the expected. If one can predict involvement in a dangerous situation, one is more likely to attribute culpability for the involvement to self. If predictability is low — as seemed to be the case at Mount St. Helens and Three Mile Island — others are more likely to be held culpable. Also, if predictability is high — as when populations live near chemical complexes or on floodplains — there is greater sensitivity to danger cues, more willingness to act upon them, and less trauma in evacuation (Quarantelli 1984a). Finally, if predictability is low, we speculate there would be a tendency toward more affect being expressed in the reaction.

The common thread in all of this is the element of the unexpected, as a result of which people are unable to bring their normal routines and coping mechanisms to bear on a crisis. Most people behave relatively well in an immediate crisis, but there is undoubtedly considerable stress and strain that may have negative psychological consequences. By definition, there are problems predicting the unexpected — and the less a situation is expected, the less likely relevant organizations are to have prepared and trained for the occasion.

6. The *unfamiliarity* of the crisis

Unfamiliarity with a disaster occasion also seems to be psychologically and organizationally disturbing, for many reasons. For one thing, people see different kinds of threats differently. They are clearly most concerned about and afraid of those that are most unfamiliar, such as threats associated with chemicals and nuclear power plants. The actual knowledge populations have of many natural disaster threats may be little better than their knowledge of other threats, but some threats are perceived as more unfamiliar and therefore more worrisome to most people.

Unfamiliarity can be associated with the "statistically unusual." For example, few people have experience in search and rescue activities. Too, in many disasters many different tasks must be undertaken in very short periods of time. What in normal times is familiar and spread out over time often occurs almost simultaneously on the occasion of a disaster. Often, although not always, there is a strong perception of being unable to control the event to which one is subject. All of these factors affect the reactions of disaster victims.

These are examples from the behavior of individuals, but groups are little better at coping with the unfamiliar. Organizations do have an advantage over individuals in that good disaster planning can often forecast well what problems might arise should disaster strike. Disaster agencies, whether in developed or developing societies, are not totally vulnerable to the unfamiliar.

7. The *depth* of the population's involvement

One can take certain kinds of losses (such as deaths of family members, the loss of homes, forced moves) as an indication of a disaster's impact. But the relative nature of the loss may be more important than the absolute loss. It is not so much what one has lost in absolute terms, but what one has lost relative to others. In one of the first disaster studies, Prince (1920) noted that victims of the Halifax ship harbor explosion felt less personal loss because they viewed their own losses in the context of about 2,000 dead and enormous property damage. Of course, the perception of deprivation can be relative to other people or relative to one's own standard of liv-

ing. The same kind of disasters may seem different because of the victims' different depths of involvement.

This is a particular problem for organizational disaster planning. It is generally not a matter for which too many realistic prior scenarios can be projected. But sensitivity to the possibility that the issue could arise can somewhat lessen its impact when it happens.

8. The *recurrence* of involvement

For some populations, involvement in disasters is a recurrent, not a new, experience. There may even be differences among subpopulations. In a number of communities, some groups living on floodplains can almost count on some flooding every year, just as people living near major chemical complexes can expect emergencies. But the fact of prior experience, even of many experiences, appears to be far less important than whether those experiences have been incorporated into attitudes and behaviors. Sometimes the development of a disaster subculture is unrelated to the frequency with which events occur. Disaster subcultures essentially make a quasiroutine of disaster occasions, which makes them much less psychologically disruptive and disturbing. If recurrent experiences do not become a quasiroutine, they can become a source of stress. Whether recurrent disasters harm mental health depends on whether a disaster subculture developed to protect people can also help or handicap organizational involvement in recurrent disasters. Everything else being equal, most organizations plan and respond better the more experiences they have with a type of disaster. But experience with disasters is not automatically good. Some groups learn little and, worse, a few learn the wrong lessons. There is also a strong tendency to take the last disaster, and the needs and problems it creates, as the prototype of future disasters. This can be very important. The next disaster may be drastically different and may create very different demands for the organizations involved. See Forrest (1979) for a study of a community that usually expected a hurricane but instead got a flood.

Other possible dimensions

Are these eight dimensions all that should be considered in a disaster typology? Almost certainly not. Another is resource availability: what would be usable for disaster planning. Some societies and communities are simply more resource-rich than others. The distinction is not so much between industrial/urban and agricultural/rural societies, as much as between developed and developing countries (labels and distinctions that leave much to be desired). Everything else being equal, organizations, communities, and societies that have more resources can better prepare for and respond to disasters.

Similarly, there are differences in both degree and kind of disaster preparedness. (There is some correlation between preparedness and development but it is far from a high correlation.) Adding resource availability and degree of preparedness as dimensions for disaster typologies seems both logically and empirically justified — they have been used in an attempt to develop a societal typology for disaster emergency medical service (Quarantelli 1989) — but until typologies based on a generic approach to disasters are systematically generated, used, and evaluated, this is only a suggestion, not a recommendation.

Different phases of disaster planning

The examples given for the eight dimensions relevant to all disasters apply almost exclusively (and equally) to the two middle phases or stages of the disaster planning cycle: emergency preparedness and response. The generic or all-hazard approach is most useful for those two parts of the planning cycle.

The generic approach is also somewhat valid for certain disaster mitigation and recovery issues. Issues about pre-impact individual disaster insurance coverage (Kunreuther 1978) and the longer run demographic consequences of disasters (Rossi and others 1983) seem more or less the same whatever the specific disaster agent. Research has shown a widespread reluctance to purchase disaster insurance and relatively few important changes in the demographic structures of disaster-stricken communities and societies. Further studies may reveal significant cross-societal differences in these matters but they would still be a function of the social situation, not the specific agent.

Disaster mitigation behavior might be somewhat more agent-specific than other disaster planning activities, for two reasons. Some mea-

sures that can be taken to prevent disaster or weaken its impact are agent- or agent-class-specific — for example, seeding clouds to prevent the formation of hurricanes or encasing nuclear power plants in building structures to mitigate radiation leaks. And the knowledge bases and specialists needed for such planning are different from those needed for other kinds of preventive or mitigation planning.

Not all aspects of disaster mitigation planning are agent-specific. For example, the general bureaucratic arguments advanced for a physical solution to potential disaster problems, the sources of government and private sector support for and resistance to such measures, popular views of the legitimacy and acceptability of suggested plans, and the willingness to put preventive measures on a political agenda: these tend to be similar whatever the disaster agent. The nontechnical problems of implementing earthquake mitigation measures (Drabek, Mushkatel, and Kilijanek 1983) are not so different from the problems implementing preventive measures for chemical disasters (Tierney 1980). In short, human, group, organizational, community, and social aspects of disaster mitigation planning tend to be generic rather than agent-specific.

This is even true of planning for disaster recovery. To be sure, some technical factors will be agent-specific. How to clean up the pollution of agricultural land from saltwater flooding or nuclear radiation are different technical recovery activities. But the social aspects of recovery planning are more generic than agent-specific.

The implications for planning seems clear. Organizations involved in any aspects of disaster management should give priority to the generic approach to planning — especially institutional planning for emergency preparedness and response. More technical aspects of mitigation and, to a lesser extent, recovery activities require some attention to more agent-specific factors.

Apart from theoretical, logical, or experience-based reasons for taking the generic or all-hazards approach to disaster planning, there are practical reasons for doing so. The generic approach is (a) cost-efficient in terms of time, effort, money, and other resources; (b) politically better because it mobilizes a wider range of groups, thereby creating a more powerful constituency for the process; (c) a good way to prevent duplication, conflict, overlaps, and gaps in preparedness and response efforts; and (d) a way to increase the efficiency and effectiveness of organized efforts to cope with disaster occasions (Quarantelli 1982).

Integrated planning for natural and technological disasters

Parviz Towfighi

Preparing simultaneously for natural and technological disasters is complex but planning models exist now that make integrated planning easier. Integrated planning involves a shift in emphasis from postdisaster relief to predisaster preparedness; a public education program that gets usable information to the people who should be prepared for disaster and that helps change their attitude from one of indifference or fatalism to one of preparedness; the establishment of early warning systems useful for all disasters; the integration of disaster planning into the mainstream of government decisionmaking; stronger organizations and better coordination of the links between them; better training at all levels; and the increased transfer of technology and knowledge to those at risk. Local media appropriate for disaster communications (especially radio) should be bolstered and local emergency response mechanisms strengthened. Regulation of land use (including the siting and transportation of hazardous materials) should be rationalized internationally as well as locally.

In 1989 a distinguished group of experts appointed by the UN Secretary-General under the chairmanship of Dr. Frank Press was asked to prepare a program of activities for the International Decade for Natural Disaster Reduction. This group recognized the validity of an integrated approach to disaster preparedness. The agenda it prepared for the Decade included the following priorities:

- A shift in emphasis from postdisaster relief to predisaster preparedness and planning.
- A public education program to shift the public attitude from fatalism to awareness.
- Acceptance of an integrated approach to disaster mitigation.
- The establishment of early warning systems.
- The development of reliable historical databases.
- A reorientation of government thinking to integrate disaster planning into the mainstream of government decisionmaking.
- Improved organizational strength and the training of specialists.
- Increased transfer of technology and knowledge to those at risk, particularly in developing nations (Ad Hoc Group of Experts, UN IDNDR 1989).

The ad hoc group of experts laid the foundation for a system of disaster mitigation that will be developed globally, regionally, and nationally in the 1990s.

"Integrated planning" — which considers technical, technological, physical, economic, social, psychological, organizational, and institutional factors — differs substantially from traditional predisaster planning (which stresses

regulatory measures) and disaster management (which is concerned solely with emergency preparedness and management). Does it make sense to combine planning for natural and technological disasters? After all, there are major differences between them. They differ most in predictability, the type of health hazard they entail, and the degree of specialized response they call for. A word, first, about those differences.

Predictability. Most natural disasters, except earthquakes, can be predicted with a reasonable degree of accuracy. Predicting the occurrence of natural phenomena relies heavily on technological systems. Predicting the probability of occurrence of technological disasters is more difficult because machines cannot factor in human error, a significant factor in technological disasters.

Health hazards. Natural disasters can cause casualties, property damage, and certain epidemics, which can be brought under control in a reasonable amount of time. The harmful effects on health of technological disasters tend to last longer and be harder to cope with.

Specialized response. Technological disasters require specialized emergency responses. The community, pulling together, can usually cope with the effects of such natural disasters as earthquakes and floods. A nuclear mishap is different. Dumping 5,000 tons of boron, lead, and other material on the reactor core at Chernobyl required specialized help and absolutely no community participation.

But both types of disaster require certain similar measures for preparedness, emergency response, and postdisaster periods. Early warning systems can be used for both natural and technological disasters, for example. And both require institutional response capabilities, logistical preparedness, community education and training, vulnerability and risk assessment, site evaluations, communications networks, and plans, procedures, and hazard control mechanisms.

Integrated planning

Preparing for natural and technological disaster is complex. Doubts about the feasibility of integrated planning in the 1960s and 1970s stemmed from the inability of existing planning models to relate many variables — especially qualitative and quantitative variables — to each other. The development of complicated models is less of a problem now than it was then. And certain steps are important to planning for both types of disaster. These are described below.

Managing technology

Industries have a great responsibility in preventing disasters. References to industries and disaster usually evoke images of the chemical and nuclear industries — and the preventive role of these industries cannot be overemphasized. But the focus of media and active antinuclear groups on technological disasters has obscured the importance of other industries, especially the construction industry, which can greatly reduce loss of life and property when appropriately regulated. Regulatory measures are more strictly observed for chemical industries than for construction.

Chemical industries, especially multinationals in developing countries, ordinarily deal with the central government. As a result, local authorities have little, if any, control over the siting and inspection of facilities or the policing of adherence to safety regulations and standards.

Siting decisions about nuclear power plants in developing countries rest with the central government. Decentralization of decisionmaking is impractical because local authorities lack the expertise needed for planning and control, local communities are unaware of the potential dangers of nuclear power plants, and local media are too weak to make an issue of such developments or to awaken the community about potential problems. As part of integrated planning, a process should be put in motion that will overcome such difficulties at the local level and preparations should be made for partial delegation of decisionmaking to local communities and governments.

Despite much debate about the transfer of technology, appropriate technology, and the adoption of technological safeguards, important technological issues remain unresolved, as they have to do with developing countries' wishes for technological advancement and their ability to pay for transfer of the most advanced technologies, should barriers to such transfer be removed. A major goal of the International

Decade for Natural Disaster Reduction is to ease the transfer to developing countries of advanced technologies that can be used to prevent or mitigate disasters.

Technological disasters that result from the transfer of technology may occur because of the types of technology transferred or because of the recipients' inability to use them, control them, or make them safe. Human errors play a large part in many technological disasters but so do economics, because budgets affect which technologies are used.

Strengthening local media

Western telecommunications are so advanced and the developed countries are so used to instant news on world events that telecommunications has assumed an exaggerated importance in disaster planning and management. Certainly speedy transmission of news of a disaster is valuable in disaster management. Equally important are community awareness and preparatory programs, local education and training programs, and simple guidelines and manuals that reflect awareness of local social and economic conditions.

Local predisaster planning should be a joint effort of local authorities and the communities they serve, whose active participation in planning will strengthen their ability to implement emergency measures. Local media must also be strengthened — and must be appropriate for the situation. If most of the population is illiterate, newspapers, manuals, and guidelines are not the best way to reach or educate the public — and radio may make more sense. But many local communities, especially in rural areas, do not have local radio stations, and regional or national stations do not have preparedness programs for natural or technological disasters that threaten a specific community. The IDNDR is drafting a strategy for bolstering local media.

Providing control mechanisms

In any manual or guideline for predisaster planning and preparedness one finds recommendations about land-use control, legislation, and regulations, as well as strict criteria for the siting of hazardous industries and the inspection of facilities. But rules and regulations, while necessary, are not enough to prevent disasters. Control of land use, for example, is as difficult to enforce in developed countries (which suffer from highly decentralized decisionmaking) as in developing countries (which suffer from centralized decisionmaking). Everywhere the economics of land use often overrides other considerations. Integrated planning must find practical ways to deal with this problem. Otherwise, the rules remain on the books and the manuals on the shelves while residential quarters continue to be built near airports and chemical facilities on unsuitable land threatened by floods and landslides.

Sometimes governments violate safety standards rather than protect and safeguard them. The transboundary movement of toxic wastes is a case in point — a prime reason for having international laws and conventions to control the movement and dumping of such wastes. IDNDR could sort through the hierarchy and recommend which decisions should be made by local, regional, national, or international authorities.

Providing local response mechanisms

In a first step toward preparing communities to be ready for impending disaster, IDNDR has already put a reasonable amount of emphasis on the development and deployment of global and regional early warning systems. A second and perhaps the more daunting task is to develop or improve local response mechanisms. What is needed is a partnership between global early warning systems and initiatives to develop national and local response mechanisms. International agencies should address this issue. Developing countries need financial and technical assistance to build such capabilities.

Providing preventive education

Natural and technological disasters are the domain of scientists and experts whose studies are more often concerned with technical and scientific issues than with their social, psychological, and economic ramifications. But technically oriented educational programs and information systems have only marginal value to the people who might be affected by such disasters. Industries, civil defense organizations, and the scientific community are most active in

preparing the information and educational programs, and most of those that are available focus on the emergency and postdisaster period. There is little on how to prevent certain disasters or mitigate their impact. Roles must be defined for predisaster planning.

It is important not only to create and share technological and scientific databases, but to develop information systems for the people who are vulnerable to specific natural and technological disasters and to find the right mechanisms for getting that information to them. But making people in disaster-prone areas aware of a potential danger is not much help to them if the price of prevention or protection is beyond their means or that of the community. Whatever their form, information packages should indicate practical actions that communities should and could take in cooperation with other actors.

Changing attitudes

To some extent, disasters cause death and property damage because of value systems, superstition, unawareness, indifference, curiosity, fatalism, and sentimental attachment. In a raging blaze, people sometimes risk their lives to rescue household effects of sentimental value. Spectators gather near a chemical explosion to watch. In disasters for which people should stay indoors, curiosity leads some to venture out. People tend to rebuild their houses on sites destroyed by earthquake. Authorities tend to ignore scientists' and technicians' warnings. Instead of making preparations to mitigate disasters, public officials often try to minimize the extent of risk. Institutions established to control land use and enforce building codes become lax in carrying out their duties. Short-term economic gains take precedence over public safety. Relocation efforts encounter resistance because people do not believe they are in immediate danger. Distrust of authorities, fatalism, and sheer ignorance often increase the number of casualties.

To change attitudes that reflect cultural values is not easy. Predisaster planning is alien to many communities, the need for it not readily felt or understood. The first step is to increase awareness. Changing attitudes takes longer. Programs such as APELL (Awareness and Preparedness for Emergencies at Local Level) should be improved and translated into local languages and dialects. Issues should be discussed in the context of local cultures. Guidelines and manuals should be made more useful for the educated public and government institutions. There is little that authorities can do if the support, understanding, and participation of local communities are not forthcoming.

The economics of disaster prevention and mitigation

Preparedness and mitigation measures, it is often argued, cost much less than losses in life and property that would otherwise occur as the result of a disaster. This argument is morally sound but can be carried to an extreme. One could recommend, for example, scrapping plans for all future nuclear power plants and dismantling the existing ones; relocating people who live in coastal areas threatened by hurricanes or tsunamis or installing protective facilities; relocating settlements on major faults; preventing the poor from building on land subject to landslides and floods and giving them land in safer zones; building all chemical plants far from population centers; relocating most international airports, and so on. Few take these recommendations seriously, but this does not prevent people with good intentions from suggesting them.

At the other extreme — not often recognized as such — preparation for disasters is a cost-effective response to risk, based on an assessment of vulnerability and the probability that a certain disaster will occur. How valid are these assignments of probability? No one can tell. The probability given for a meltdown in a nuclear plant was one in 10,000 years but a meltdown did happen. An event with a zero probability of occurrence does not have a zero *possibility* of occurrence. Risk assessment techniques are developed primarily for insurance purposes, so they are not a suitable basis for formulating policies and measures for preventing and mitigating disasters. Bhopal and Chernobyl are good arguments for changing the bases of risk assessment and economic rationales for disaster preparedness.

Developing countries cannot afford to undertake disaster mitigation measures without outside help. Protecting them from such effects of

global warming as recurrent floods, hurricanes, and rising sea levels will require bold measures and international cooperation. Industrialized countries have already discussed helping Bangladesh contain its devastating floods. IDNDR should seriously consider establishing an international fund for predisaster preparedness and prevention projects. This might prove to be a better service to the developing countries than funds for reconstruction and development.

Economic incentives and disaster mitigation

Andrew S. Natsios

Policymakers can probably change social behavior more effectively through market incentives than by threatening punishment for failure to comply with rules. Lower insurance premiums and lower taxes for those observing building codes could be the best way to encourage disaster-resistant construction. Loan qualifications could be determined partly on the basis of risk assessment. Farm families could be given incentives to plant and care for trees, as part of reforestation projects. Consumers could be taught to ask for and expect disaster-resistant construction. The state, instead of policing such cooperation, could direct its funds and energies toward such necessarily public services as providing effective early warning systems for disaster.

In 1976 Charles Schultze, chairman of the Council of Economic Advisors under President Carter and now professor of economics at Harvard University, gave the Godkin Lecture at Harvard, perhaps the most celebrated lecture series in the United States. His remarks were later published by the Brookings Institution in the 1977 book *The Public Use of Private Interest*. I would like to apply the model of analysis described in that book to disaster prevention, mitigation, and preparedness. The results may offend some scientists and practitioners as it suggests that some of their work has not been productive. But the disaster mitigation strategies we now pursue need to be reviewed critically and, I believe, need to take some new directions.

Schultze argued that domestic public policy in the United States had failed to provide much of what it had promised both in public services and regulatory reform. He wrote:

> There is a growing body of objective evidence that government is not performing its new tasks effectively. The counterproductivity of governmental regulation of transportation is well documented. Efforts to improve the environment, while far from a failure, are unnecessarily expensive and increasingly bogged down in Rube Goldberg regulations, legal snarls, and games between regulators and industry as enforcement deadlines draw near. While Medicare and Medicaid have improved access to health care for the poor and the aged, government attempts to deal with rapidly escalating health costs have produced only burgeoning volumes of regulations and no results. Professional evaluations of manpower training, work experience, and related federal job programs usually find that their payoffs are low. Although the compilation of absurdities perpetrated in the name of industrial safety often emanates from suspect sources — the industries being regulated — even the sympathetic observer finds it hard to recognize many of

> the regulations as anything but absurdities. The current debate over long-term energy policy shows how very difficult it is for government to deal with complicated price and resource-allocation problems.

A growing body of research has been done primarily by economists comparing the measurable consequences of government programs and regulatory schemes with the specific objectives those policy interventions sought to achieve. This research has shown a wide gap between promise and reality. Public policy in the United States has frequently had general consequences few anticipated, some of which were quite pernicious, others of which were irrelevant and unrelated to the explicit goals of the interventions, and most of which cost either government or particularly the private sector a good deal of money that could have been much more productively used elsewhere.

One example will suffice to indicate the flavor of much of this research (though this particular example is taken from a study done after Schultze's book). Richard Zeckhauser, an economist at the Kennedy School of Government at Harvard University, studied OSHA regulations (the Occupational Safety and Health Administration), a regulatory invention of the late 1960s to reduce accidents and health risks in the workplace. He found that while OSHA itself estimated just one of its regulations would cost American industry $10.5 billion to implement, "it seems reasonably certain ... that the gains have not been major" in improving safety or health in the workplace. Zeckhauser explained this discontinuity between objective and result by suggesting that what appeared dangerous to regulators caused few accidents and that OSHA does not have the staff to police American industry. He suggested instead raising the cost of accidents to industry by taxing them at a rate sufficiently high that managers would, without any regulation, find out how to reduce the accident rate in their workplace. The moral of the case study is that appearances in public policy are usually deceiving: those conditions on the workplace that appeared to cause accidents did not. We did much damage to the competitiveness of American industry but accomplished little for the American worker by imposing this regulatory scheme (Nicholas and Zeckhauser 1977).

Schultze and Zeckhauser suggest that social and economic forces are much more complex and mysterious than any scholar could understand. As the complexity of these forces increases, our ability to regulate their operation declines. People find ways to take financial advantage of programs and to evade regulations that frustrate the most brilliant policy and program analyst. Human behavior is not as simple or as controllable as some policymakers think.

In many respects the disaster preparedness discipline faces the same discontinuities that domestic policymakers now confront in the United States. Our early warning systems for droughts, hurricanes, volcanos, and floods sometimes include no system for evacuating the vulnerable population from the affected area. Sometimes even when evacuation plans are prepared they are not implemented or, worse still, the vulnerable population ignores the warnings. We had ample evidence of the latter phenomenon in the Bangladesh flood of 1988. Building codes with earthquake engineering standards in many, if not most, developing countries are as a rule, I suspect, ignored. Building codes are often ignored in developed countries. Why expect more regulatory rigor from developing countries? So much for earthquake engineering. Little research has been done on whom we train in our preparedness instruction, what they learn, how effective the training is, and how long those we train remain in relevant positions of authority. More distressing, we train people to respond to disasters after the event occurs — when the damage has already been done (except for evacuation procedures). Too many carefully done vulnerability assessments and statistical probability analyses have been carefully filed away and forgotten rather than used to affect public policy decisions before a disaster occurred. Western donors and multilateral institutions have spent money and used their technical advice on institution-building in developing countries with little to show for it. The institutions collapse without western assistance or when they continue are often dysfunctional or poorly managed — they are ineffective for the same reasons Schultze attributes to western institutions.

Schultze's central thesis was that public policy objectives are best carried out by altering the structure of the marketplace rather than issu-

ing regulations in the fashion of a command and control economy. Put differently, policymakers can change social behavior much more effectively by changing the incentives of the marketplace — the public use of private interest — than by threatening punishment for failure to comply with voluminous rules. Positive incentives work better than negative incentives. Indicating a policy's desired outcome and leaving how to achieve that outcome to the economic actors will yield the best solution to public problems. The marketplace will direct economic resources to their most efficient use. This approach to policymaking allows the use of technological and managerial innovation for a single policy objective.

This model has useful applications for disaster management. The goal of disaster prevention, mitigation, and preparedness is to save lives and protect economic resources. One application of the Schultze model would be to build into the casualty insurance industry — for the few developing country investments covered by insurance — a strong premium differential for earthquake- and hurricane-resistant construction. We have been doing risk vulnerability studies for some time; the data should now be put to good economic use. I suspect many insurance companies in the developing world do not include disaster vulnerability data in their premium structure or in some cases simply exclude from coverage damage done to a building by a natural disaster. Much higher premiums for poorly engineered buildings and lower premiums for earthquake- and hurricane-resistant construction will act as an economic stimulus to protect a country from the effects of these sorts of disasters. Different insurance premiums would also create an incentive for retrofitting existing structures to protect them from disasters. I suspect the financing of building construction by whatever means in developing countries seldom includes risk assessment data for loan qualification. It should. Both of these approaches would require little if any regulatory intervention by the state. Both would be private market rather than command and control solutions.

These market solutions might well not provide enough of an incentive to cause actors in the marketplace to factor disaster mitigation into their planning, investment, and construction processes. Probably more economic incentives must be added to the cost of dealing with disasters before economic actors will actually change their behavior — which is what incentives are designed to do. One economic intervention developing countries might consider is a property or excise tax on new construction located in chronic flood-prone areas or near active volcanos, and on buildings that are not earthquake- or storm-resistant. The proceeds from the tax could be put into a fund to pay for retrofitting vulnerable buildings to make them more disaster-resistant.

Too many development projects seeking to mitigate environmental damage do not deal with the cause of the problem. Reforestation projects try to repair the damage done by villagers cutting trees for firewood — a practice that increases the frequency and severity of flooding, landslides, and desertification. Replanting forests is a waste of money without creating incentives to protect seedlings from further cutting or providing a fuel substitute for firewood.

The U.S. Agency for International Development initiated an agroforestry project in Haiti predicated on the assumption that for reforestation programs to succeed farm families must have economic incentives to plant and care for trees. Since benefits from planting trees are not realized for at least 18 months, the Haiti program initially provided a small subsidy to farmers to plant and care for the trees they owned and planted on their land. After a two-year period there was no longer a need for the subsidies because the farmers began benefiting from various products. Fruits, charcoal, animal feed, pesticides, and woodproducts (lumber for construction and tools) were either sold or used for domestic consumption. The net effect was that farmers saw that it was in their interest to protect and care for the trees that would otherwise have suffered the same fate as the original forests. This program made a significant impact on slowing down the deforestation of Haiti's dwindling forest resources, and is a fine example of a marketlike disaster intervention to protect a damaged environment.

Even these reforms in our strategic approach to disasters will not reach deeply enough into the social and economic structure of a developing country to change people's behavior. Our office is now reviewing another approach to hazard mitigation: training small contractors

in simple, relatively inexpensive construction techniques to protect against earthquakes and storms. This strategy would reach what Hernando de Soto, the Peruvian businessman and economist, calls the informal sector or what economists term the black market, underground economy. De Soto's research in Peru (1989) indicates that these contractors produced as much as 69 percent of the housing in Lima in 1985. Because of the extralegal nature of their work they are likely to be outside the financial and casualty insurance system. Training these contractors on how to increase the value of what they build without increasing their cost would increase mitigation in this structurally unintegrated portion of developing country economies. These informal contractors might begin advertising the resistance of their work to common natural disasters consumers have come to fear. Making technical information available to consumers can create a market for a product, including disaster protection. The resulting competition might well persuade unenthusiastic contractors to adopt the same building standards.

This use of marketlike incentives to encourage more energetic hazard mitigation will not work for all types of risk. I suspect that this approach must be reserved for protecting economic assets, because it will do little to protect human life. Unless some creative economist can think up a unique marketlike intervention, I do not see how early warning and evacuation systems for storms, volcanos, floods, and tsunamis can be built into the marketplace. These systems must be managed by the state as a public service. In that case we should examine early warning systems to ensure they work properly — that the technology provides timely warning of an impending disaster, that the information is quickly disseminated to the general public, that a tested evacuation plan is in place, that personnel can execute the plan, and that people respond to the evacuation order by leaving their houses. Any disconnect in any step will render the entire system inoperable. Every hypothesis used in an early warning system must be tested to see if it works. Too many lives are at risk to leave this to chance.

The International Monetary Fund and the World Bank must often assess the economic effects of disasters and environmental degradation. Developing countries whose economies are highly vulnerable to disasters would benefit from serious mitigation measures. The World Bank should seriously consider introducing market-based disaster mitigation conditionalities into its programs with these countries.

Many of us in the disaster response business hope the International Decade for Natural Disaster Reduction will help make disaster preparedness an integral part of development. This will require integrating disaster preparedness into the economic structure of developing countries. So long as this is a highly specialized, arcane discipline separate from the work of business managers, financiers, insurance actuaries, and construction superintendents it will be ineffective, misunderstood, or, worse, irrelevant.

Coastal zone management

John R. Clark

Bangladesh, St. Lucia, the Philippines, and dozens of other countries are vulnerable to serious storms and flooding. The damage from these and other hazards could be reduced through programs that control the type, density, and location of coastal settlements. It is particularly important that such programs preserve natural landforms that take the brunt of storms and thus protect lives and community structures.

Many coastlines are at high risk of damage from natural disasters — particularly death and property loss from the winds and waters of hurricanes or cyclones. These violent storms born at sea strike the coast with winds up to 200 miles per hour (mph). Tsunamis and certain types of soil liquefaction, land sinkage, and landslides are also peculiar to coastal zones. Environmental characteristics such as daily tides, mangrove forests, coral reefs, tidal flats, and barrier islands are found only at the coast. In coastal zones, critical habitats have been carelessly destroyed, ecosystem processes disrupted, and waters heavily polluted — often as a result of donor-supported coastal development.

Strategies to reduce coastal hazards should take advantage of environmental planning initiatives. Many critical ecosystems and habitats — such as coral reefs, mangroves, and sandy beaches — are also key defenses against storm damage. The United States and other countries, in efforts to build sustainable coastal societies, have begun to experiment with combining natural disaster prevention and environmental management for coastal zones in a single comprehensive, multisectoral program called "coastal area management and planning" (CAMP) or "coastal zone management" (CZM). (For details, see case studies on Sri Lanka and Mexico.)

In many densely populated nations, population growth and development projects are increasing the risk of natural disasters to inhabitants of the coastal lowlands. Coastal people become more susceptible to natural hazards such as floods, typhoons, or tsunamis when land reclamation projects encourage settlement in dangerously low-lying areas, or when land clearing and construction remove protective vegetation, reefs, or sand dunes. A particularly disastrous example is Bangladesh, where more than 300,000 people were lost in major sea storms and floods in the recent past (Wijkman and Timberlake 1984).

Reducing losses from hazards begins with preservation of coastal landforms that provide natural resistance to wave attack, flooding, and erosion from hurricanes and storms. These landforms differ significantly around the world. Human activities that remove or degrade protective landforms — for instance, by removing beach sand, weakening coral reefs, bulldozing dunes, or destroying mangrove swamps — diminish the coast's natural protection (Clark and others 1980). Removing dunes to mine sand or

to improve ocean views, for example, increases the risk to coastal development behind the former dunes. Similarly, mangroves serve to dissipate wave energy and to protect the land behind them from the erosive forces of storms. The value of these natural resources in hazard prevention reinforces the need to identify them as critical areas and give them strong protection. They also serve a unique role in coastal ecosystems.

Measures to conserve ecological resources are often the same as measures to preserve the natural landforms that serve as barriers to storms and flooding. Consequently, many communities have found that combining hazards and resource management simplifies coastal management and leads to more predictable decisions about what constitutes sustainable development.

The same setback requirement that protects beachfront settlements from erosion and storm waves, for example, could also preserve turtle nesting sites. Similarly, a zoning restriction on development of mangrove swamps would both conserve an economically valuable resource and help maintain a defense against storm waves. In a final example, a seashore or coral reef park can protect these natural landforms as both natural resources and hazard protection (Salm and Clark 1984). Well-developed CAMP programs are authorized in most U.S. coastal states by the U.S. Coastal Zone Management Act of 1972 (P.L. 92-583). There has also been progress toward truly integrated programs in many other countries (Sorensen and others 1984).

Because large-scale development can increase coastal hazards beyond natural levels (Hausner and Sorensen 1984), it is the responsibility of governments and the development community to see that these additional risks are controlled and cost-effectively minimized, whether from cyclonic storm (hurricane) attacks, tsunamis, shore erosion, coastal river flooding, land and mudslides, or soil liquefaction. The main risk in the coastal zone is tropical cyclones, which can equal earthquakes in potential for property damage and deaths. With rapid population growth, more people inhabit coasts, increasing the risk of damage, disturbance, and death.

Hazards and natural defenses

The short-lived but intensive winds of hurricanes and cyclones exert enormous pressure on natural and constructed systems. They drive before them rising water, known as storm surges, which can sometimes elevate water levels to 20 feet or more. A moderately intense storm (such as Hurricane Alicia, which struck Galveston, Texas, in 1983 with maximum winds of about 110 mph) can raise water levels six to 12 feet above normal.

The winds build waves on top of the storm surge. As they strike the coastline, waves can increase flood elevations as much as 55 percent over the surge level. In an open ocean, waves 40 to 60 feet high and higher have been observed by seamen and operators of offshore oil rigs. But these wave heights depend on great depths of water beneath them. (A three-foot wave needs at least four feet of water beneath it to be sustained; a six-foot wave needs eight or nine feet, and so on.) As the wave enters shallow water the sea bottom slows the submerged portion of the wave and reduces the sustainable wave height, so the wave finally breaks.

The wave's energy is quickly dissipated as the wave strikes the coastline, beaches, dunes, vegetation, and structures built in the wave zone that absorb this energy. At the boundary of land and sea, beaches and low-lying dunes may be scoured by waves and the scoured sand washed overland hundreds of feet or deposited seaward, where shallower water acts to trip the waves. By yielding to waves, beaches are efficient dissipators of wave energy. If the sand is deposited seaward, the water depth will be decreased, causing storm waves to break farther from shore. Thus, dunes are important suppliers of sand.

When dunes are removed by sand mining or to improve ocean views, the risk to coastal developments behind the former dunes is greatly increased. Similarly, mangroves dissipate wave energy and protect the land behind them from the erosive forces of storms. Reefs, beaches, dunes, and mangroves are important natural defenses against the ravages of wave action.

Reefs also act to trip waves. The reach between the reef and the shore is often too short and shallow to permit waves to build to the heights they reached before striking the reef. So important are reefs that many countries have special reef conservation programs. Sri Lanka, for example, organized a nationwide management program to protect reefs and save its southwest shoreline (see case study).

Development management

Two guidelines that are particularly important in coastal management and planning are:

- Conserve protective features — protect as much as possible all the natural elements that protect the coast from storm surge and waves in hazardous areas. For example, prohibit sand removal, avoid mangrove clearing, and protect coral reefs. (Conservation of these protective features is administered in the same way as conservation of natural habitats.)
- Establish a coastal construction setback line. Delineate a "high hazard zone" for the coast and keep all coastal construction inland of it.

The "high-hazard zone" is that part of the coast that is periodically subject to flooding (rising still water) from storm surges and to the effects of fierce storm waves (including erosion and property damage). The periodicity of storm and flood events is calculated as the chance that a hazard event will strike in any one year. The result, often called the "recurrence rate" or "return probability," is given as the percentage chance that an event will occur in any one-year period. Thus, a recurrence rate of 0.10 at a particular site means there is a 10 percent chance that a damaging storm will occur there in any one year.

With that information, the CZM authority can place the coastal setback at a particular risk point far enough back from the high water line that all structures behind it have only a 0.04 (4 percent) probability of being hit by a flood or storm waves. The 4 percent probability level is sometimes called a 25-year event because four chances in 100 equals one chance in 25. In placing the setback line, the CZM authority could pick the 20-, 50-, or 100-year event (0.05, 0.02, or 0.01 probability) as the controlling risk factor, and establish a corresponding distance inward from the high water line. The degree of precision needed to delineate and map the line depends on the program. The setback line is only for storm hazards. If there are also boundaries and buffer areas for essential habitat types, the two should be combined in a single setback line.

The most troublesome erosion of beaches occurs in developed areas where buildings and roadways have been placed too close to the water's edge and are being undermined or threatened by storm-induced erosion. In such cases, the beach is often "armored" — that is, seawalls or groins are built to protect threatened properties or jetties are built to keep inlets open. But these structures are expensive and may even worsen the general erosion.

Planning approaches should reduce the damage from future disasters. Virtually any development project in a coastal area will be affected by, and will have an effect on, the risk of hazards. Roads are expensive to build but easily washed away in a flood. Roads in coastal areas should be designed not just to be safe from flood damage, but to be adequate to evacuate local populations when a severe storm is anticipated. Similarly, housing built in hazard-prone areas should be built on sites and to standards that assure personal safety.

Coastal development projects attract more people to and around a project site, increasing the number of lives and the amount of personal property in jeopardy. For many reasons, the principal city in most tropical nations is a port, and people migrate to such cities for economic potential that cannot be found upland. Development in coastal areas around the Bay of Bengal, for example, continues to stimulate enormous population growth despite recurrent cataclysmic cyclones and floods in the area.

Poorly controlled development often has destructive effects on coastal natural resources. Demands for waterfront land have been intense in many countries. Developers have encouraged and satisfied these demands and, in so doing, have frequently imposed high capital and service costs on coastal communities. Moreover, poorly planned development can be destroyed quickly and at great cost in floods, severe storms, and hurricanes (Clark and others 1980).

Using CZM

Fully comprehensive CZM programs aim both to prevent or mitigate natural hazards and to conserve coastal resources (Sorensen and others 1984). These two purposes are both compatible and mutually supportive. They both do the following:

- Require integrated approaches to influence where development occurs and what types of structure are built, at what density.
- Should involve all levels of government, national to local, and international cooperation when appropriate.

Case study: Sri Lanka

John R. Clark

The use of coastal zone management (CZM) for hazard prevention in Sri Lanka was motivated by persistent coastal erosion and storm damage caused by the mining of coral reefs along the southwest coast. Sri Lanka's Coast Conservation Department recently completed four years of intensive work on a plan to prevent erosion and the loss and degradation of coastal natural habitats and to protect scenic areas and cultural and religious sites. The plan, developed in coordination with other Sri Lankan agencies responsible for coastal resources, represents the best reaction to the nation's coastal problems. It provides a policy framework and a practical strategy for dealing with the problems (Olsen 1987).

For each important issue, the plan presents management strategies, which include regulation, research programs, better intergovernmental coordination, and public education. The erosion management strategy, for example, establishes a setback line to ensure that structures are not placed so close to the shoreline that they contribute to or are affected by erosion. Regulatory measures prohibit the construction of shoreline protection works in some locations and establish review procedures for building such structures along the rest of the coast. Coral and sand mining are also regulated because they accelerate coastal erosion. Other elements of the erosion management strategy are a public education campaign to make coral and sand miners aware of the impact of their activities, a program to identify alternative employment for displaced coral miners, and research to identify alternative sources of lime for the building industry. Complementing these management efforts is a public investment program to build shoreline protection works where appropriate.

- Stress preservation of the natural elements — such as mangrove forests, dunefields, and coral reefs — that protect coastal populations from cyclonic winds and storm surges.

Agencies responsible for the prevention and mitigation of natural hazards and agencies responsible for resource conservation and environmental protection should both be interested in advancing CZM programs.

The dual goals of CZM — conserving coastal resources and maintaining nature's hazard protection systems — can save money, lives, and property. As growth along the coast accelerates through development, the publicly assumed liability for storm damage increases in many countries. Reversing this trend means preventing increased exposure to hazards and reducing the public assumption of liability. Prevention of natural hazards should be part of CZM planning. If no other government agency is dealing with the maintenance of natural storm defenses, CZM should be. Officials who are responsible for coastal hazards may concern themselves mostly with emergency response and postdisaster relief, ignoring the condition of coastal protective resources. That is why it is often essential for CZM to play a primary role in prevention.

Because of the link between development and disasters, an important aim of CZM is to integrate knowledge of coastal hazards and risks into planning for development. Guidelines for estimating how a project or program affects risk of coastal hazards should be applied to every development proposal. Many actions can be taken to assure that any project does not increase risk and, further, that the project can be implemented in a way that even reduces existing hazards and that is cost-effective. An example worth studying is the massive runoff from rainstorms associated with a major "El Niño" event in 1983 that caused heavy property damage on Ecuador's coast and disabled much of the aquaculture industry. Hazard assessment can be accomplished through CZM mechanisms for project review and environmental impact assessment (Hausner and Sorensen 1984).

Case study: Hurricane Gilbert in Yucatan, Mexico

John R. Clark

Hurricane Gilbert of 1988 was the record cyclonic storm of the Western Atlantic, with the lowest internal barometric pressure (885 mb) ever measured in the Western hemisphere. Wind speeds of more than 200 mph were recorded by National Oceanic and Atmospheric Administration (NOAA) aircraft flying at 10,000 feet east of the Yucatan peninsula, when the eye was eight to 10 miles in diameter. Because of a ridge of high pressure to the north, Hurricane Gilbert held to an unusual, almost straight-line, west-northwest track, rather than curving north through the straits between Yucatan and Cuba.

Gilbert reached hurricane status on September 10 and struck the Yucatan coast on the morning of September 14, with its center near Cozumel. The cyclone had broadened and wind speed had diminished so that, on arrival, the wind speed at ground level was 115-150 mph. Hurricane Gilbert then moved west-northwest across the peninsula, exiting in the vicinity of Progreso on the northwest Yucatan coast. Hurricane-force winds covered a swath of about 100 miles, rotating around an eye about 25 miles in diameter. Ocean surge heights averaged an estimated eight to 10 feet and wave heights 10 to 15 feet. Damage was extensive in the resort areas of Quintana Roo (for example, Cancun) and in rural and coastal Yucatan.

There were north winds on the front edge of Hurricane Gilbert, a prolonged calm in the eye, and southeast winds on the back edge. Damage was caused by both wind components but the north winds caused more wind, wave, and surge damage. Return flow damage across barrier islands from north coast lagoons was greater on the southeast component. Flooding occurred up to 12 miles inland in Yucatan.

Only 27 persons died (20 more were listed as missing) but 35,000 people suffered property damage — 13,000 homes in 63 towns. And losses in natural resources, habitats, and species were high. For example, as many as 3,000 to 8,000 adult flamingos were dead or missing out of a pre-Gilbert population of 20,000 to 25,000 — and 150 fledglings died. (A week after Gilbert struck we counted 16,000 survivors in an aerial survey.) An estimated 15,000 hatchling sea turtles (greens, hawksbills) were lost and three turtle hatching pens were destroyed. But the most serious effects on the north Yucatan coastal ecosystem were from 21 cuts through the barrier island strand into the estuaries — including cuts in Rio Lagartos. The Rio Lagartos cuts have serious implications because that hypersaline river provides the only nesting environment and a favored feeding area for the Yucatan population of flamingos.

After Hurricane Gilbert passed, leaving Rio Lagartos open to the sea's entry, salinity dropped dramatically. The Industria Salinera salt works — Los Colorados' main industry on Rio Lagartos — was put out of commission for nearly two years because of the drop in salinity, nearly total destruction of the *charcos* (salt pans), the destruction of infrastructure and roads, and the demolition of mills, warehouses, and pumps.

High winds destroyed the important lumber industry in Colonia Yucatan, leaving many jobless. Losses to the fishing industry varied. Because of a well-organized predisaster program — all persons were evacuated from the coast and most small boats were hauled ashore or put in safe harbor — small-scale fisheries sustained little damage and within seven days 90 percent of the boats were ready to operate. But the port of Progreso/Yucalpeten, with larger craft, sustained serious losses: 200 boats were damaged altogether, and 85 boats driven aground in the harbor required major salvage operations (about $10,000 each).

Agriculture also suffered. Half of the area's 3 million chickens were killed, and 100,000 beehives were destroyed, for a loss of 3,500 tons of honey valued at about US$3 million. The corn crop loss was estimated at about 95 percent of the total planting of 150,000 hectares. There were also extensive losses in fruit, sorghum, rice, and beans.

Perhaps the worst economic effect was a midterm loss in tourism revenues in areas such as Cancun and Cozumel. Almost all tourist reservations at Cancun were canceled — most with refunds. It took two to 20 months to rebuild the hotels and resorts. The power and telephone systems were heavily damaged. The beaches at Cancun lost an average two meters deep of sand, with no practical way to restore them other than to wait for natural processes to act. Sixty percent of corals were detached from reef strongholds. Ninety percent of mangroves were destroyed. It may take several more years to restore operations and regain tourist confidence.

Disaster insurance in New Zealand

L.B. Falck

New Zealand, recognizing that its economy could not absorb the heavy financial losses from a major disaster, reviewed its national system for insuring the public against disaster. Its national insurance commission has sought the maximum reinsurance protection the world market could provide and has considered ways to minimize the government's contingent liability. New Zealand is not alone in understanding the need for a government-backed fund for disaster relief. As reinsurance pools shrink, international financial institutions such as the World Bank may be called upon to provide an underwriting facility that offers reinsurance at either a discount or an "average" cost.

New Zealand, which lies on the "Pacific Rim of Fire," faces seismic hazards similar to those in Japan and California. But New Zealand, a small country with a small population, does not have the economic resources to withstand severe natural disasters. New Zealanders are fortunate that river floods tend to be localized events and that severe windstorms (tropical cyclones) have generally exhausted their energy before moving past New Zealand.

Earthquake is the most severe hazard the population faces. Each year about 800 are registered and between 150 and 200 felt. Typically one or two are of magnitudes above 6 on the Richter scale, 10 to 20 of magnitudes between 5 and 6, and the rest smaller (*Seismological Observatory Bulletin* 1983). A glance at any map of seismic events in New Zealand shows that no region is really safe from earthquakes. The need for mitigation measures is a concern to both government and the private disaster insurance industry.

The New Zealand Earthquake and War Damage Commission was established by statute in 1944 as a government agency with responsibility for the financial mitigation of losses from earthquake-related events. Speaking to the New Zealand Parliament, the then Minister of Finance Walter Nash (New Zealand National Society for Earthquake Engineering 1984) said that the endeavour had been to "work out a principle under which the whole loss is deemed to be a national loss, and under which those people who might be affected will subscribe towards a fund to meet losses which may come to any of them." He added that "if the common fund is insufficient to meet the lawful claims thereon, the Minister of Finance shall, without further appropriation than this Act, pay such sums out of the Consolidated Fund as may be necessary to meet the deficiency. . . . this in effect is the guarantee behind this fund." This act put into effect a nationwide insurance scheme that has provided for such losses since 1944.

Under that legislation, rates were determined by the government under delegated regulatory powers. (The initial rate of 5 cents per $100 indemnity-insured value continues to this day.) Private insurers, as agents of the commission, would collect premiums. Under these arrangements the commission was unable to identify its insured until a particular company lodged a claim and declaration of insurance. Property was insured for material damage to indemnity (current market) value only. (Insurance companies were permitted to provide "top up" replacement policies.) The New Zealand Government would indemnify the commission through *loans* for any deficiency in meeting its lawful claims. Any insurance policy with fire coverage immediately attracted earthquake and war damage coverage.

Since its inception the commission has built up a reserve of nearly $2 billion (New Zealand dollars). Revenues from annual premiums were $91 million at the end of fiscal 1989. In addition, the commission has reinsurance of $1 billion for a catastrophic earthquake (New Zealand Earthquake and War Damage Commission 1989a).

The effect of heavy losses

In 1987 a shallow earthquake of 6.3 on the Richter scale struck the area known as the Bay of Plenty, causing severe damage to domestic and commercial property. Losses for the commission, insurance companies, and government agencies were initially estimated as follows (in New Zealand dollars):

	$ million
Earthquake and War Damage Commission	130
Private insurance companies (including losses from interrupted business)	300
Government	400
Unsecured losses (both domestic and commercial)	50
Total estimated losses	880

These losses were a shock, coming as they did in an area of low population density and poorly maintained housing stock. And domestic policy losses were disproportionate. Five thousand domestic claims cost the commission $20 million, and 10 commercial claims resulted in a payout of about $120 million. Over the many years the scheme had been working, inequities and inflation had distorted the basic purpose of the earthquake scheme.

Such heavy losses also caused concern about what would happen if a major loss occurred in one of New Zealand's major population centers. Wellington, the capital city, lies astride the main active fault line. The last major earthquake there (in 1855) is estimated to have exceeded 8 on the Richter scale. Auckland, the main population center and New Zealand's commercial capital, is situated on and near more than 60 dormant volcanos — the last of which erupted in the seventeenth century. New Zealand's largest lake (Taupo) is also a dormant volcano which has the unfortunate habit of erupting explosively and ejecting the contents of the lake and the surrounding district 20 kilometers (12.5 miles) into the atmosphere.

If disasters were to happen in these areas, the New Zealand economy would be sorely pressed to cope with the financial repercussions. Confidential government studies showed that the current and future tax base would be unlikely to generate enough revenue to meet loan demands for needed reconstruction and rehabilitation, and the commission and private sector insurers would probably go bankrupt. So the New Zealand Government launched a review of how the commission and the disaster insurance industry function.

The review found that New Zealand's economy could not absorb large financial losses as easily as the United States could. The California earthquake strained U.S. resources, but California and the federal government could cope with the situation without seriously jeopardizing the economic well-being of the rest of the country. New Zealand is not so resilient. The review identified the following problems in the current arrangements:

- The Commission, as a public service department, had not developed management and reporting structures that ensure efficient operations. For one thing, it had inadequate financial and accounting procedures. It has paid little attention to advances in information and telecommunications technologies in disaster and claims management. It has put little

effort into promoting a corporate role for the commission.

- The composition of the Board was inappropriate, so the commission was too easily influenced by the government of the day. Clear rules had not been established for communication between the commission board and government ministers.
- The investment policies conducted by the New Zealand Treasury on the commission's behalf were inadequate and took little account of the commission's risk status.
- In the event of catastrophe, the current indemnification arrangements between the commission and the government were likely to place a debt burden on the commission that would cripple its operations and saddle it with debt far into the future. And the lack of reinsurance arrangements meant that the commission's capital assets were totally exposed in the event of a disaster.
- The commission had not promoted and funded earthquake-related research. Among other things, there was an urgent need to review the position of other insurers in the market and their ability to meet large claims. And research was needed to determine agreed-upon estimated maximum loss figures for the government, the commission, and private insurers.
- The government had not reviewed its policy and management options for contingent liabilities in the event of a major disaster. Little attention had been paid to ensuring that there were effective economic contingency plans for dealing with such an emergency. And war coverage was inappropriate (New Zealand National Society for Earthquake Engineering 1984).

Agenda for reform

The board and government had a big agenda for reform and restructuring. The government decided it was appropriate to address these issues in two distinct phases: first, the complete restructuring and refocusing of the commission's operation; second, comprehensive examination of the regulatory environment and industry operations as a whole. After consultation with the commission board and private sector interests, the government introduced permissive restructuring legislation that provided a new management structure for the commission (New Zealand House of Representatives 1988).

The government instituted the following changes by statute:

(1) The commission was reconstituted as an independent statutory corporation with the Crown of New Zealand as the sole shareholder. The minister of finance was invested with the rights of shareholder on behalf of the Crown. The commission now had the powers and opportunities available to corporations.

(2) The board was restructured, the minister of finance was no longer chairman, and the number of board members was increased to nine. This removed the last vestiges of political influence over the commission's affairs.

(3) The commission's financial assets were firmly vested in the commission and removed from Treasury control. Treasury now acted solely as agent for the board's investments.

(4) The guarantee provisions of the 1944 legislation were revoked and the government assumed the role of "underwriter of last resort," whereby in exchange for an agreed-upon premium the government undertook to grant to the commission such sums as it needed to meet its claims liabilities. This premium was loaded to encourage the commission board to seek reinsurance in the private world market.

(5) The government required the commission to adhere to the management, accountability, and reporting rules set out in the State Owned Enterprises Act (New Zealand House of Representatives 1986). These rules placed the commission's management on the same basis as private companies (see appendix 1). To assure a level playing field, the commission was required to pay the same dividend and tax as other insurers.

Meanwhile, as a transitional provision, the government retained the right to set premium levels and to direct commission policy — requiring that when the minister directed the commission, such directives were to be in writing and published in the commission's annual report. Since October 1988 the board has received only one such directive, about management of the commission's financial assets (New Zealand Earthquake and War Damage Commission 1989b).

Once these amendments were enacted the commission considered its internal operations. The board rapidly refocused the management

structure to give it a commercial ethos, balance sheet operation, and comprehensive claims management procedures. The board's main concern was the lack of reinsurance. Under the previous statute, successive governments had resisted reinsurance because some people in government believed reinsurance would distort New Zealand's foreign exchange market. This problem disappeared when the government floated the New Zealand dollar and gave the commission independent control of its financial resources.

New emphasis on reinsurance

The board moved with alacrity to establish a reinsurance program. With the help of three specialist reinsurance brokers it sought the maximum protection the world market could provide. After intensive negotiations the commission purchased a heavy layer of catastrophe protection: $1 billion in excess of $1 billion — the largest program of this kind in the world.[1] (Purchasing reinsurance of this magnitude allowed the commissioner to negotiate a lower market premium for such reinsurance than is usually available to private insurance companies.) This purchase of capital protection radically altered the commission's ability to withstand losses, providing a guaranteed influx of funds should a disaster occur. The effects of such an influx of offshore currency funding is currently being carefully modeled by the Reserve Bank (New Zealand's central bank), to ensure that when the inevitable occurs the Bank has suitable contingency plans to prevent rapid hyperinflation and associated effects.

The second phase of restructuring has been to examine New Zealand's natural disaster underwriting industry and to consider ways to minimize the government's contingent liability. Several proposals are being introduced or considered. They include:

- Making earthquake insurance compulsory for all domestic householders (whether or not their property is insured for fire) and not requiring that commercial property be insured.
- Deregulating the market. This would permit private companies to compete with the commission in all market sectors, thus ending the commission's monopoly, facilitating the introduction of further capacity, and diversifying industry risk. Deregulation would also inevitably reduce the government liability, currently focused through the commission.
- Reducing Crown indemnity by requiring government departments, corporations, and agencies (such as schools and hospitals) to obtain suitable private insurance, financed through their operating budgets.
- Reducing assistance to local and municipal authorities by requiring them to take out adequate protection against disaster.
- Discouraging charity and government aid packages that provide more than immediate postdisaster relief assistance. In previous disasters uninsured property owners have had a comparative advantage over the insured, who had prudently paid premiums over the years. The uninsured have inevitably been helped in rehabilitation by the mayor's, government's, or private relief aid packages (New Zealand Government 1988).

Related policies will permit the commission to determine its premium rates on the basis of the risk profile (without government concurrence) and to devise an investment strategy that ensures that existing financial assets are placed offshore in a portfolio that ensures maximum growth yet provides access to extensive foreign currency reserves in time of need. The commission will also try to establish relationships with international banking agencies so it can eventually establish lines of credit and access to standby foreign currency borrowing facilities.

Worldwide implications

New Zealand is not alone in understanding the need for a government-backed fund for disaster relief. It is important to compare the New Zealand disaster insurance model with other similar disaster mitigation schemes operating elsewhere in the world. France, for example — where the major potential disasters are flooding and windstorms — passed a law in 1982 guaranteeing that all French citizens (including those in obviously risky areas) could obtain catastrophe coverage. Citizens pay an additional premium to insurance companies who then reinsure with the state-owned reinsurance company, CCR. Storms in October 1987 highlighted the value of this coverage. Up to half of the claims fell under the law's auspices. Iceland, a nation whose seismic hazards are similar to those New Zealand faces and whose economic infrastructure

is equally fragile, recently established a scheme for disaster underwriting modeled on New Zealand's current scheme. The Japanese Government, jointly with all Japanese non-life-insurance companies, is setting up a fund and layers of reinsurance to ensure that funds are available to cover homeowners for earthquake insurance. All homeowner earthquake coverage provided by domestic and foreign insurers is wholly reinsured with the Japanese Earthquake Reinsurance Co. Ltd. (JER).

In the United States, there is currently no such government-backed disaster fund. But the U.S. insurance industry is pressing the federal government to take on up to $50-$60 billion (U.S. dollars) of earthquake risk in return for premiums that would build up the fund (the Earthquake Project). The total net worth of the U.S. insurance industry is about $134 billion. The industry would face irreparable damage if it had to make a $60 billion payment in the event of a major earthquake in Los Angeles. The Earthquake Project is basically a reinsurance program for which the federal government would assume most of the risk until a fund has been built up from premiums. This proposal is likely to go ahead, after the federal government completes its own research into the industry and calculates probable maximum losses. The government will probably require that a damage mitigation program be put in place as there would otherwise be no incentive to reduce risk (Price Waterhouse of New Zealand 1990).

The common purpose of all these schemes is to guarantee that insured domestic property owners are protected in the event of a severe natural disaster. Naturally they differ in philosophy, application, and underwriting risks but all propose a relationship between the government and the commercial insurance sector aimed at maximum mitigation of economic loss to citizens. All schemes also accept the basic tenet that such arrangements will not work without the government's active and willing participation.

There would be nothing to prevent a group of small nations from jointly establishing a disaster underwriting agency and introducing — through an agreed-upon, uniformly compulsory regime — a scheme to provide basic disaster insurance for homeowners. Such a scheme is being considered by a group of small South Pacific island nations. In the past few years these nations have suffered severe economic dislocation from tropical cyclones — the latest example being the cyclone that devastated both Western and Eastern Samoa in 1989. The suggestion is that each participating nation take out a share (proportionate to its population) in the underwriting agency and commence building up reserves and reinsurance to protect against future losses. To effectively manage the loss, the agency would be given an initial "no-liability" period in which to build up a reserve fund and obtain reinsurance. In addition, it has been suggested that in future part of disaster aid could be financial help in meeting underwriting losses. It is important that the scheme make insurance of domestic dwellings compulsory and that some form of statutory authority be available to enforce this requirement. A similar scheme could provide some relief to the economies of the Caribbean nations that face the devastating effects of the hurricanes that pass regularly through the Caribbean.

All these schemes are predicated on the willing participation of commercial reinsurers. Their capacity to underwrite huge losses obviously depends on the extent of their asset bases and their own success in obtaining reinsurance.[2] Potential customers of the reinsurers must always be aware that market capacity depends upon the current loss ratio the market faces collectively. In March 1990 the loss ratio London underwriters faced was about 550 percent after the British and European windstorms. As a result of these losses, together with all the other major losses reinsurers have faced in the last two years — Piper Alpha, Hurricane Hugo, San Francisco, Newcastle, and so on — the market is hardening and, more alarming, capacity is being withdrawn from the world pool. Premiums are rapidly increasing as reinsurers seek to generate revenue to offset what for many of them is currently a negative cash position.

Major international financial institutions could help underdeveloped countries by providing an underwriting facility that offers reinsurance at either a discount or an "average" cost. This would enable developing nations to establish disaster underwriting mechanisms that would not only alleviate distress but also mitigate the large injections of financial aid that are generally needed when these events occur. Through such arrangements the aid organizations could better provide planned assistance.

Governments can manage the economic effects of natural catastrophes or disasters effectively

if institutions exist that have both the capability and the financial independence to manage the aftermath of these inevitable events.

Endnotes

1. One billion New Zealand dollars was the equivalent of US$620 million. Participation in the commission's program has been as follows:

Lloyd's Underwriters	29%
London companies	20
European companies	21
Australian companies	14
U.S. companies	11
Others	4
Asian companies	1

The New Zealand Earthquake and War Damage Commission provides only for catastrophic disaster. It does not cover such gradual events as New Zealand's possible inundation (if the southern icecap melts) or the medical effects associated with the thinning of the ozone layer. According to New Zealand scientists, if a slab of ice the size of France broke off, sea level worldwide would rise one meter. If the entire ice cap slides off, sea level would rise 40 meters.

2. Reinsurance of reinsurers is facilitated through underwriters commonly known as retrocessionaires. Usually several layers of such reinsurance underwrite any primary reinsurers; the subsequent payment of claims is called the "Lloyd's Spiral."

Appendix 1
Extract from New Zealand's State Owned Enterprises Act
Accountability provisions

PART III

ACCOUNTABILITY

14. Statement of Corporate Intent - (1) The board of every State enterprise shall deliver to the Shareholding Minister a draft statement of corporate intent not later than 1 month after the commencement of each financial year of the State enterprise.

(2) Each statement of corporate intent shall specify for the group comprising the State enterprise and its subsidiaries (if any), and in respect of the financial year in which it is delivered and each of the immediately following 2 financial years, the following information:

(a) The objectives of the group;
(b) The nature and scope of the activities to be undertaken;
(c) The ratio of consolidated shareholders' funds to total assets, and definition of those terms;
(d) The accounting policies;
(e) The performance targets and other measures by which the performance of the group may be judged in relation to its objectives;
(f) An estimate of the amount or proportion of accumulated profits and capital reserves that is intended to be distributed to the Crown;
(g) The kind of information to be provided to the shareholding Minister by the State enterprise during the course of those financial years, including the information to be included in each half yearly report;
(h) The procedures to be followed before any member of the group subscribes for, purchases, or otherwise acquires shares in any company or other organisation;
(i) Any activities for which the board seeks compensation from the Crown (whether or not the Crown has agreed to provide such compensation);
(j) The board's estimate of the commercial value of the Crown's investment in the Group and the manner in which, and the times at which, this value is to be reassessed;
(k) Any other matters as are agreed by the shareholding Minister and the board.

Case study: reconstruction after North China's earthquake

Alcira Kreimer, Edward Echeverria, and Martha Preece

The North China Earthquake Reconstruction Project emphasized community participation, cultural traditions, and government commitment. Damaged dwellings were replaced by improved housing based on local architectural styles, layout, and construction methods. Project leaders worked closely with community leaders in planning and implementation, thus paving the way for sustainable improvement. By strengthening the ability of institutions in disaster-prone areas to deal with risk reduction, mitigation, and rehabilitation, the project is reducing the vulnerability to disaster of human settlements and capital investments. A strength of the program is the central and local governments' commitment to allocating resources to prevention and mitigation efforts that are seen as essential to national development goals.

In 1989, 30 quakes with a magnitude of 5.0 or above hit the Chinese mainland in Datong-Yanggao. On October 18 that year, five earthquakes registering more than 5.0 on the Richter scale swayed part of Northern China, the peak shock measuring 6.1. Strong aftershocks followed on October 23. Housing, hospitals, schools, and small-scale industry were damaged extensively, as were telecommunications, water supplies, and electric power. This was one of the worst earthquake catastrophes to hit the region since 1976, when a quake registering 7.8 killed more than 400,000 people and destroyed the city of Tangshan in Hebei province. The heaviest damage of the 1989 earthquake in Datong-Yanggao occurred in the impoverished rural Bu Cun Village located on a windswept, eroded plain about 1,300 meters above sea level; it was almost totally destroyed. Casualties were slight (20 dead and fewer than 200 seriously injured) because of earlier, less severe warning quakes and prompt evacuation action by local officials. No major urban areas were significantly affected, partly because of their distance from the epicenter and partly because of the greater resilience of urban buildings. But rural areas are vulnerable to natural hazards, mostly because of inappropriate building techniques and materials. Poorly built houses — made mostly of mud-brick and stone and certainly not designed to be earthquake-resistant — offer no resistance to the devastating effects of the shock waves. Even the public buildings and factories, made of better quality materials at higher standards, succumbed to the Datong-Yanggao earthquake.

The region's main economic activities are coal mining and agriculture (mainly subsistence crops). The destruction of many economic and social facilities has wrecked the fragile local economy. The heaviest damage was to physical

infrastructure and buildings: some 25,000 houses and more than 3,000 rooms in schools, clinics, and community facilities were destroyed, and 46 local industries were devastated. Direct losses were estimated to be more than US$150 million, and about US$15 million in indirect production losses — mainly in industry and commerce — were expected the first year. About 150,000 people were rendered homeless, their barns and stables destroyed and their stored winter food and animal feed lost. Nearly 1,500 workers lost their jobs. By early December 1989, 32,000 families (about 15 percent of the region's population) were in temporary shelter, improvised in either the same damaged, structurally impaired homes with some minor repairs, or in small, excavated mud rooms. National and local agencies had difficulty accommodating overwhelming demands on institutions, particularly for the fast, efficient restoration of basic infrastructure and housing and production facilities. Post-earthquake needs required enormous financial resources. Funds from national and local budgets were needed for reconstruction and for irrigation and water supply works. Countries made financing for construction of schools, clinics, and other community facilities available as grants. More funding came from private donations, insurance refunds, and local revenues.

China is disaster-prone. Sixty percent of its land area is in seismic zones vulnerable to earthquakes registering more than 6.0, and 70 percent of metropolitan areas with populations of more than 1 million are in seismic zones vulnerable to quakes registering over 7.0 on the Richter scale. China has experienced some of the most severe recorded earthquakes in the world. Since 1900, it has had 662 earthquakes registering more than 6.0 on the Richter scale, 106 of them registering more than 7.0 (about 30 percent of the world's earthquakes are above that intensity). The death toll from earthquakes in China in the twentieth century alone exceeds 600,000 (50 percent of the world total). And seismic risk analysis in China indicates that after a decade of relative calm, the country is entering a period of heavy seismic activity that is expected to last 12 to 15 years. (For details on disaster reduction in China see box by Chen Hong.)

Disaster preparedness and emergency response. China has a long history of research in forecasting earthquakes. Since 1966, Chinese scientists have made detailed observations of the activities that precede earthquakes. Observations and analysis have been used to develop a methodology for predicting earthquakes far in advance (10 to 20 years) or imminent (in two to 12 days). The research and analysis procedures were formalized with the establishment of the Center for Analysis of Prediction (CAP) under the State Seismological Bureau. The center's ultimate goal is to reduce loss of life and property from earthquakes through disaster preparedness and mitigation. But now the seismological monitoring network provides only partial coverage of China's vast territory because of limited data.

The authorities responded rapidly to emergency needs after the October 18 earthquake. Immediate investigation of earthquake damage was organized by the various departments of the Ministry of Construction. The prefecture had a plan to speed up emergency assistance for the affected villages, including the temporary restoration of homes, stored foodcrops, and production capabilities until housing and agricultural storage could be permanently restored. Relief efforts were coordinated by prefectural and county civil affairs offices and supported by nongovernment groups and modest international aid. The recovery activities involved detailed planning for the reconstruction and repair of villages and affected assets, including the restoration of electricity in most village centers.

Reconstruction as prevention and mitigation

The disruption of the local economy and its effects on development prompted the government to ask the World Bank for assistance in normalizing economic activity through reconstruction operations in Yanbei Prefecture of Shanxi province and Yangyuan County in Hebei province. Reconstruction planning was undertaken with the support of a provincial task force from the architectural, engineering, and town planning institutes, advised by experts from the Ministry of Construction and the State Seismological Bureau.

The International Development Association's (IDA's) involvement in this project is in line with its primary mission in emergency recovery assistance: restoring productivity and promoting

Case study: disaster reduction in China

Chen Hong

The Chinese people have a long history of struggling against natural disasters. A vast territory with a complex climate and geography, China is beset every year with drought, floods, windstorms, earthquakes, mudflows, plant diseases, and infestations of insect pests. Since the founding of the People's Republic of China in 1949, China has averaged 7.7 droughts, 5.8 floods, and 7 typhoons a year. Drought, floods, and earthquakes are the most destructive. Since the turn of the century, China has experienced over 2,600 destructive earthquakes, more than 500 of them registering above 6 and nine of them above 8 on the Richter scale. These earthquakes have killed 270,000 people and injured 220,000. Mudflows and landslides threaten hundreds of small and medium-sized cities and China's 1,800-kilometer coastline will be highly susceptible to rising sea levels, should the threatened greenhouse effect materialize. In addition, soil erosion, degradation of the land, and environmental pollution are increasingly severe.

In an ordinary year, natural disasters damage roughly 20 million hectares of agricultural land, causing the loss of 20 billion kilograms of grain. This — together with the collapse of 3 million rooms and losses in other sectors — causes direct annual economic losses of about 50 billion yuan RMB (US$10 billion). Each year, natural disasters kill thousands and affect more than 200 million people.

China's countermeasures against disaster

China's government has focused heavily on reducing natural disasters, holding as its first priority disaster prevention combined with relief operations. Its achievements include the following:

- Bringing big rivers under control. In the past 40 years, the government has invested about 80 billion yuan in large-scale engineering works to control and exploit rivers by building and consolidating dikes and dams, building flood storage and discharge areas and reservoirs, and dredging waterways to the sea. The Yellow River — known as "China's suffering" in the past — hasn't burst or changed its course in more than 40 years. The main cities on the Huai, Hiehe, and Liao rivers are able to control the major floods that occur once in 100 years and have been able to prevent the big floods that tend to occur every 20 to 50 years.
- Strengthening construction against damage from typhoons, floods, and earthquakes. Embankments have been built and housing elevated to prevent flood damage in low-lying, flood-prone areas. Earth and straw houses have been replaced with brick constructions in southeastern coastal areas subject to storms and typhoons. New buildings must be earthquake-resistant. Flood-diversion and storage areas have been built along the banks of great rivers, and manpower from all walks of life is mobilized to control floods and to move people and property to safety when floods come. After floods and typhoons recede, engineers rush to repair such lifelines as highways, railways, and communication lines.
- Building irrigation works. In drought areas, wells and ditches have been dug to increase irrigation. In flood areas, dikes and dams have been built to drain waterways, and salted low-lying areas have been reformed.
- Planting trees to prevent soil erosion and sandstorms. It is national policy to cover the country with trees; March 12 is national tree planting day. After nearly 40 years' efforts, forests now cover 12 percent of China, up from 6 percent in 1949. Two long shelter belts have been formed: one, 7,000 kilometers long, protects 12 provinces and autonomous regions in north China; the other provides windbreaks against typhoons in coastal areas.

disaster prevention, mitigation, and preparedness. The emergency recovery project was designed to prevent similar disasters from occurring in the future. It includes: (a) a component for rebuilding rural infrastructure, housing, education, health, and industry in about 150 villages, and (b) a national component for institutional development and technical assistance that gives maximum support to existing institutions' efforts at earthquake prediction and disaster preparedness in China.

The reconstruction plan was based on rehabilitation options that varied based on degree of damage and prospects for cost recovery. Repair and reinforcement will take priority wherever possible, but reconstruction will be carried out where damage and needs are extreme and where reconstruction is affordable. Existing buildings, even those with little damage, are to be reinforced so they are more seismic-resilient. All new structures must conform to the seismic requirements of state building codes and to affordability criteria and will be built using traditional and modern materials and construction methods. Financing has been provided for the rehabilitation and reconstruction of schools, health posts, community offices, stores, and small-scale agricultural processing facilities.

• Improving disaster prediction and warning capabilities. China has set up 2,700 meteorological stations, applying advanced science and technology to improve the accuracy of weather forecasts. An earthquake monitoring system — a network of professionals and nonprofessionals — has been established in the main seismic areas. China has also established a National Forecasting Station for plant diseases and pests, drawing on the work of 2,000 scattered substations.

• Formulating and promulgating appropriate laws and regulations. Laws have been passed to improve forestry, wildfire control, environmental protection, urban planning, the control of forestry diseases and insect pests, and the use of land, water, and grasslands.

Recovery and rehabilitation

Every year the government helps about 3 million victims of disaster recover their ability to earn a living, restore production, and rebuild their homeland, encouraging a spirit of self-reliance and mutual support in times of difficulty. China encourages victims to help themselves through individual efforts to maintain productive sidelines; through collective management of enterprises (roughly 45,000 enterprises provide jobs to victims of disaster); and through relief work, without which victims receive no relief assistance.

Since 1985, China has been trying to launch disaster relief insurance, which it considers an effective tool for disaster relief in a poor economy. China also encourages mutual assistance — through voluntary aid and donations between families, villages, and prefectures. In savings associations and grain associations, village farmers who contribute savings or grain may borrow grain from the association in times of need. This practice is particularly important in inaccessible mountain regions. There are about 200,000 savings and grain associations in China.

China has also encouraged international cooperation on disaster mitigation projects and the mutual exchange of information and experience. China has received disaster relief assistance from foreign governments and international organizations, which have helped both in rehabilitation and in providing ways to make a living.

Disaster management

China's central government is responsible for decisionmaking and command, and handles prevention activities and relief. Headquarters for flood and drought control and forest fire prevention are subordinate to the central government. Local governments are in charge of organizing and directing disaster work within their administrative division. Manpower, tools, machinery, and materials needed for disaster prevention, fighting, and relief are strictly allocated within the region, as is support from higher levels or other regions.

The People's Liberation Army is the main force against disaster. The People's army contributes significantly to project construction, flood control, resettling victims, providing medical services, repairing lifeline projects, and helping victims restore production and rebuild their homeland.

China's disaster reduction strategy

In response to the UN proposal for the International Decade for Natural Disaster Reduction, China has developed a strategy for disaster reduction that emphasizes:

• Conducting scientific research on relevant problems, with a view to harnessing the destructive force of natural disasters and converting it to energy that benefits mankind.

• Developing practical applications for scientific knowledge. (Generally speaking, China's level of scientific research about disasters is low, with some exceptions.)

• Establishing a national system for predicting and issuing warnings of disaster.

• Building major disaster-reducing engineering works, as the national economy develops.

• Using mass media to improve national awareness of ways to reduce natural disasters and to provide training in basic disaster reduction skills.

• Improving international cooperation and the exchange of information and ideas to combat humanity's common enemies.

An enterprise rehabilitation component financed building repairs to restore a limited number of rural enterprises to their original capacity. The project also provides for the rehabilitation of such basic infrastructure as roads and paths, drains, water supplies, and sanitary facilities. All reconstruction of major buildings is being carried out to national design standards and codes.

The project emphasized community participation by consulting with village communities to determine the scope of reconstruction possible given applicable cost ceilings and using local labor equivalent to about 25 to 30 percent of building costs. Government project teams visited each community to work out with villagers and their leaders the community's highest-priority investments in light of the available budget and schedule for reconstruction and repair, and to help organize the community's labor input. These teams also helped supervise the reconstruction process and helped villages invite bids for the rehabilitation of public buildings and infrastructure.

The national component included provisions geared to reducing vulnerability through earthquake prediction and emergency preparedness. This component emphasized institutional sup-

port to improve the State Seismological Bureau's (SSB's) network of earthquake monitoring stations in areas identified as being high in seismic risk (Sichuan, the capital region, and Yunnan) and to reinforce satellite communication and computer equipment at SSB's Beijing headquarters. Shanxi province also drew up an emergency preparedness plan for Yanbei Prefecture for earthquakes and other natural disasters and emergencies — such as large chemical spills, the disruption of urban water supplies, and collapsing buildings — a pilot effort at the prefecture level to be replicated elsewhere in the country. The project agreement also called for immediate, on-the-spot investigation of earthquake damage.

Human and social factors

The North China Earthquake Reconstruction Project emphasized three key elements of reconstruction: community participation, cultural traditions, and government commitment. Project design gave special attention to human and social factors. It provides opportunities for local participation and preserves local traditions by maintaining village identity and avoiding unnecessary relocation. Destroyed or damaged dwellings are replaced by improved housing based on local architectural styles and village layout and construction methods. By selecting simple, cost-effective building techniques and structures that use local building materials, the project ensures the rapid rehabilitation of permanent dwellings at the same time that it strengthens local capabilities for housing reconstruction. And by working closely with community leaders in planning and implementation it paves the way for a successful action program.

Because of China's vulnerability to natural hazards, central and local governments are strongly committed to preventing and mitigating losses from natural disasters. The Ministry of Construction has drawn up a program of studies and research into earthquake damage mitigation for its Earthquake Resistance Bureau. It includes:

- Techniques for strengthening the earthquake-resistance of existing buildings and lifeline structures (traditional rural housing, high-rise apartment buildings, and hospitals).
- Earthquake vulnerability assessments for key cities.
- Case studies of earthquake reconstruction experience.
- Staff training in modern design and construction techniques.

Strategies and policies have been formulated to bring natural disaster reduction programs into the strategic plans for national economic and social development. By strengthening the ability of institutions in disaster-prone areas to deal with risk reduction, mitigation, and rehabilitation, the project is reducing the vulnerability of human settlements and capital investment to seismic events.

Case study: Nepal Municipal Development and Earthquake Reconstruction Project

Alcira Kreimer and Martha Preece

The Nepal Municipal Development and Earthquake Reconstruction Project emphasized the disaster-resistant reconstruction of housing and schools, the adoption of improved building techniques, and the development of building codes. It also stressed the need for vulnerability analysis through hazard mapping and the establishment of a centralized data bank. Community participation was central to Nepal's strategy for disaster prevention and mitigation. Self-help housing reconstruction moved along quickly because there were few land tenure problems and most homes were owner-occupied. The reconstruction experience is expected to demonstrate the feasibility of low-cost housing solutions so banks will be encouraged to embark on a full home financing system.

The effects of disasters can in large part be traced to poor planning, inappropriate design, faulty construction, lack of maintenance, and the effects of poverty. Direct and indirect losses and institutional demands are often the result of inappropriate or no preventive measures, compounded by years of neglected maintenance and reduced public and private investment. Prevention and mitigation policies and programs can reduce social vulnerability. Earthquakes exert enormous pressures on public finances, reducing public revenues on the one hand and increasing public spending on the other. After a calamity, a rapid response is required not only for relief activities but also to reduce the vulnerability of human settlements and capital investment to seismic events.

Background

Nepal is among the world's poorest countries. Life expectancy at birth is 54 years for males and 51 for females. The infant mortality rate is 111 per 1,000. More than 40 percent of the population (18 million people) live below the poverty line. More than 90 percent of the Nepalese live in small towns or in the remote countryside.

National economic policy in Nepal emphasizes development of the rural sector, but urban areas are growing rapidly. New and improved roads, together with limited farm employment opportunities, have encouraged rural migration to urban areas. The number of urban settlers is expected to grow at least 4 percent a year. Towns play a key role in Nepal's economic growth. They not only absorb much of the surplus rural labor, but also provide essential services for the rural economy. Managing rather than constraining urban growth will be a major challenge. More than 90 percent of homes are said to be owner-occupied but pressure on the housing stock because of rural-to-urban migration is upsetting home-ownership ratios. There has been no planning and control for the growth of cities. Many landless people have become

squatters on marginal, disaster-prone lands. Services and basic infrastructure are constrained by limited institutional and managerial capabilities and scarce financial resources, both central and local.

Nepal's vulnerability to earthquakes

Sixty-eight percent of Nepal's land area is mountainous and exposed to heavy seismic activity. Earthquakes that register 5 to 8 on the Richter scale are experienced throughout the country; 279 earthquakes with epicenters in Nepal and magnitudes above 3.9 were recorded between 1963 and 1986 (Asian Institute of Technology 1990).

After an earthquake measuring 6.7 on the Richter scale struck parts of central and eastern Nepal on August 21, 1988, it was difficult to assess damages and assist victims. Although the tremor lasted only 30 seconds, more than 720 people died, over 6,000 were injured, and housing, schools, hospitals, public buildings, roads, and bridges were extensively damaged. In the months after the earthquake, helicopter surveys identified about 66,000 damaged or destroyed homesites; an estimated 460,000 persons were without shelter. More than 2,000 schools (about 17 percent of all educational facilities) were ruined beyond repair and more than 300 required extensive rehabilitation. Other public buildings were also ruined. The total direct cost of destruction was US$172 million. The greatest losses were to housing (US$78 million), roads and bridges (US$62.4 million), and schools (US$32 million).

Despite the earthquake's relatively low intensity, there was widespread devastation because of the region's vulnerability. Nepal lies in a tectonically active zone, but does not enforce earthquake-resistant construction measures and has no seismic maps. Before 1988, there was no building code for low-cost and nonengineered building construction, and no appropriate zoning and land-use policies and regulations. Not even basic construction techniques, much less earthquake-resistant features, were always part of building practices. Most construction was done in the informal sector, so no training programs on seismic-resistant construction were available. Rural families commonly build their own dwellings with the help of unskilled artisans.

Most collapsing houses were two- to three-story mudbrick constructions. Faulty construction, especially lack of framing, was identified as the principal cause of structural failure but housing units of better quality — built of stone or with cement mortar — were also badly cracked. Only houses with framed construction or reinforced concrete escaped damage. Infrastructure was also vulnerable to disaster. Many of the hill roads had been built without engineering surveys and were prone to flash floods and landslides. Nor were there national awareness campaigns to mitigate disaster.

Reconstruction

Immediately after the earthquake, the central government, with the help of the local and the international donor community, mounted a relief operation. Two thousand NRs (Nepalese rupees) (US$82) were provided to a family in which someone was killed and 1,000 rupees (US$41) to families that lost a house. Some families were provided with a temporary shelter as part of disaster relief. At the same time, the government embarked on a program of reconstruction, recovery, and disaster mitigation and management. In December 1988, the government asked for help to rehabilitate about 2,350 schools damaged in the earthquake and provide temporary accommodations for schools not included in the first year's construction plan (Patrick McCarthy 1989). The international community supported the relief and rehabilitation operations.

On September 22, 1988, the government launched a comprehensive reconstruction and rehabilitation program that cost US$54.8 million for housing and US$30.2 million for schools. With the help of a Bank credit, the Nepalese government designed a scheme to grant concessional loans to all homeless families under a system of interest rebates. Annual lending rates for reconstruction loans vary between 1 percent and 15 percent. The government pays the banks the difference between those interest rates and the standard annual lending rate — at the time, 19 percent. All families who received early assistance through the initial payments for loss were eligible for these loans. So many low-income victims were affected that few had the resources or savings to rebuild independently. Most loans of US$400 covered only

housing repairs, mostly in rural areas. About 5 percent of housing loans for about US$2,000 were provided to finance starter homes in urban areas. Any family with a certificate of need (eligibility) could qualify for a loan, which was unusual in Nepal, where housing loans are not generally available. The reconstruction experience is expected to demonstrate the feasibility of low-cost housing solutions so banks will be encouraged to embark on a full home financing system.

The Bank agreed to help the government with long-term housing reconstruction geared to reduce vulnerability and mitigate the effects of natural disasters. The idea of the reconstruction program was (1) to provide technical assistance and training for both rural and urban housing, (2) to help nongovernment organizations (NGOs), (3) to improve construction standards, and (4) to address the environmental problem of the building industry's overuse of wood.

One of two project investment streams was for municipal development; the other, for emergency housing reconstruction, aimed to provide immediate and longer-term assistance to householders hurt by the earthquake. The housing component focused on (1) improving building techniques and earthquake-resistance, (2) supporting NGOs in the provision of such resources as low-cost sanitation, water, improved stoves in rural areas, and innovative building materials, (3) helping entrepreneurs and community groups manufacture such building products as cement blocks and steel doors, and (4) encouraging the use of alternative building materials that would reduce the use of timber. In addition, the longer-term technical assistance and training program would help with (5) disaster management, (6) preparation of a national building code that encourages earthquake-resistant construction, and (7) implementation of epicentric and seismic mapping for Nepal.

Twenty-five percent of the funds for housing reconstruction were disbursed in the first five months of project implementation. Each member of a reconstruction team directed the activities of two "panchayats" or municipalities. Each team was guided by ten "overseers," or technical officers — local contractors and engineering students especially trained in earthquake-resistant construction. To ensure that more hazardproof building methods were used in rehabilitation, overseers reviewed designs and construction onsite. Moreover, the use of earthquake-resistant techniques was a condition of the loan. Building inspections were not always possible because many damaged homes were inaccessible. To give loan recipients the opportunity to make adequate choices about disaster-resistant construction, they were required to walk through demonstration houses built near the lending banks. The models emphasized simple, cost-effective, earthquake-resistant features such as bonding at the corners, securing gable walls, and providing lintels over openings and secure roof structures. In district headquarters and urban areas it was mandatory to incorporate such features. The Housing Ministry took advantage of the reconstruction effort to promote better sanitation and low-energy cooking stoves. Both were included in the demonstration houses and financial incentives for their construction were part of the loan packages.

Immediately after the earthquake, the Bank proposed reallocating savings from an ongoing Primary Education Project to help rehabilitate school buildings. But the government's priorities were on housing reconstruction, so not until December 1988 was a formal request made for Bank assistance in school rehabilitation. IDA agreed to launch a major school rehabilitation project, based on the Bank's emergency assistance procedures — which give prominence to disaster prevention, mitigation, and preparedness.

The idea of the schools project was to build five to 13 classrooms in the shortest possible time in all affected communities. Plans were to provide a basic reinforced, earthquake-resistant school structure with roofs, foundations and floors, sill perimeter walls, and door and window frames. The community was responsible for finishing works, providing building supplies from nearby, and some construction work.

The School Rehabilitation Project's most difficult challenge was to deliver construction supplies and undertake construction at more than 2,000 sites, many of them remote. Strategically located temporary storage and distribution centers made it possible to provide recovery supplies to outlying areas.

In the first of two phases in the emergency recovery project the community helped provide construction materials; in the second phase, the school walls were completed and the schools finished. The project was to be implemented in

three years. By January 1990, 40 pilot schools had been completed, located mostly in easier-to-reach areas.

Both the housing and school rehabilitation projects were coordinated by a central technical unit that made periodic site visits. A central coordinating committee chaired by the Ministry of Housing and Physical Planning coordinated the reconstruction program.

What the project accomplished

Several factors helped in Nepal's reconstruction efforts. Most important, more than 95 percent of homes were owner-occupied, so land tenure was not an issue and families began rebuilding their homes almost immediately after the earthquake. The project promoted public awareness of disaster mitigation by distributing booklets showing earthquake-resistant designs and providing guidelines on the construction and use of materials for disaster-resistant construction. The project relied heavily on self-help construction and emphasized community participation — particularly through the dissemination of information about and the adoption of hazard-resistant technology. The government moved quickly to keep up with the rapid pace of reconstruction.

The project was realistically targeted to reconstruction-specific issues: carrying out short-term rehabilitation, strengthening domestic construction capability to repair earthquake damage, and maximizing disaster prevention and mitigation. The project agreement included measures geared to preventing losses and reducing vulnerability to earthquakes. Efforts focused on allocating resources to restore the economy and to generate income-earning opportunities. The goal of disaster prevention training was to reduce seismic vulnerability and to strengthen the government's ability to cope with catastrophic events. The project focused on broadening policymakers' understanding of natural disaster vulnerability and mechanisms to reduce it.

This project laid the foundation for stronger disaster management practices in Nepal but much remains to be done at the institutional level. Nepal still needs an appropriate legal framework, institutional management, and mechanisms to coordinate and develop a coherent policy that integrates technical disaster prevention into national development programs. The development of such instruments as building codes and land-use regulations must be incorporated in the national strategy for reducing vulnerability to calamities.

Training in the Asian-Pacific region

Brian Ward

Programs need people to implement them and people must be trained. This paper addresses the why, who, what, how, and where of disaster management training. It is based on five years' experience at the Asian Disaster Preparedness Center (ADPC) assessing training needs and implementing training programs in the Asian-Pacific Region. The greatest need for training is in Africa.

Why?

The goals of the International Decade for Natural Disaster Reduction (IDNDR) reflect awareness that disaster management is a national responsibility and that disasters and development are closely related. The importance of strengthening disaster management capabilities in disaster-prone developing countries has been repeatedly emphasized. But most discussions of the Decade have taken place in the developed world. The developed world's identification and support of risk reduction strategies must be matched by an improved capability in the developing world — which already faces awesome developmental difficulties and conflicts of priorities — to implement those strategies nationally. Without human resource development programs in developing countries, the altruism of the developed world may be misunderstood, developing countries may become disillusioned, and the expectations of the Decade may be unrealized.

"At times training becomes a remote and irrelevant activity with little apparent impact on performance and with considerable waste of resources," wrote W.C. Baum and S.M. Tolbert (1985) in an evaluation of World Bank experience. Why is training sometimes ineffective? Are the aims wrongly defined? Is the training badly organized? Are the trainees incorrectly selected? Surely nobody would suggest that training per se is wrong.

What is disaster management and why is it necessary to train for it? Disaster management is the term used to describe all disaster activities from prevention to reconstruction. An effective disaster manager must, first, be a good manager generally; second, understand disasters; and third, be a good crisis manager. In normal circumstances, managers usually have time on their side and can proceed cautiously, using sophisticated planning tools to arrive at considered, economical decisions. But a crisis manager is expected to analyze information (often incomplete and sometimes inaccurate), make decisions, and issue clear, unambiguous instructions under extreme pressure.

The aim of disaster management training is to improve the skills of practicing managers by

- Upgrading their knowledge of the theory and practice of disaster prevention, mitigation, preparedness, response, reconstruction, and

recovery, and their relationship to development.

- Introducing to them the special tools of disaster management, such as risk and vulnerability analysis, counterdisaster planning, and crisis management.

But in a crisis people with good basic management skills will outperform intrinsically weak managers, no matter how much disaster management training they have had.

To be effective, training must be preceded by thorough needs assessment studies so that aims are clearly defined and appropriate programs developed to meet them. There have been several needs assessment studies in recent years. A comprehensive regional assessment was undertaken at the Australian Counter Disaster College, Mt. Macedon, to determine training requirements in the Asian-Pacific region (National Disaster Organization, Australia 1981). Another review conducted in the region by UNDRO/WHO (1985), with funding from UNDP, led to the establishment of the Asian Disaster Preparedness Center (ADPC). UNDP commissioned a global survey and WMO/ESCAP reviewed areas of interest to the Tropical Cyclone Committee. The United Nations Institute for Training and Research (UNITAR 1988) conducted a global survey on behalf of UNDRO. Although heavily oriented toward Africa the survey highlighted the recurrent lack of comprehensive disaster management programs and dependence on external ad hoc assistance for training. It recommended that training methodologies be formulated to stimulate national capabilities and suggested the following avenues for action, which apply equally in the Asian-Pacific region:

- Strengthen cooperation between neighboring countries and the donor relief community through existing regional apparatus, provide a central point for accessing and diffusing disaster information, and improve coordination of relief activities between donor organizations, nongovernment organizations (NGOs), government agencies, and the national government itself.
- Use "trainer training" to build the relief assistance officers' skills in training personnel with other roles and functions.
- Strengthen the link between the means of collecting disaster information and its dissemination to improve decisionmaking about the stocking and distribution of relief supplies, for early warning and forecasting, and for building public awareness.
- Find more innovative ways to interpret the evaluations and translate the experience of relief assistance managers into training activities.
- Improve the disaster management skills of the personnel responsible for managing relief operations, including full-time relief assistance managers and personnel charged with food supply and distribution and early warning systems.
- Define the disaster and environmental threats each country faces and define training needed to meet those threats.
- Identify the latest techniques and skills in disaster management and find ways to adapt them to training programs for disaster authorities.

The UNITAR report stresses the importance of stimulating national capabilities. Sykes (1989) suggests that the answers to the challenges posed by disasters are to be found in the disaster-prone areas themselves — that the first order of business is to learn from traditional practice and response, to strengthen local capabilities, and to seek locally based, low-tech solutions for local disaster reduction. This bottom-up approach — focusing disaster mitigation and response at the community level — has always been a cornerstone of the ADPC's program philosophy. Top-down programs — in which the role of intervening international agencies or the protection of donor investment are seen as paramount — are conceptually flawed. The first priority for the international community should be to help strengthen national capabilities.

Who?

Who needs to be trained? Almost everybody, because disasters can affect the whole community. But not everyone needs to be trained as a disaster manager. Training must be appropriate to the level at which it is conducted. Potential victims need to be shown what they can do to help themselves, relief workers need to be trained to help others, community leaders must be shown how to prepare their communities, and so on. In acquainting themselves with the sort of assis-

tance that is likely to be asked of them and preparing to provide it, donors must recognize that their perception of what is needed may not be the same as the recipients' perception.

For governments, disaster management is an extension of routine administrative responsibilities. The Government of India (1878 and 1913) recognized this long ago, which may account in part for the remarkable success of its recent relief operations after the severe drought in 1987 and the cyclone in Andhra Pradesh in 1990.

The district officer or governor is the person who takes charge of local disaster relief operations, no matter what the cause of the disaster — be it a typhoon or an industrial accident, the effects of which extend beyond the factory fence. That person — as an administrator, not a specialist — has to coordinate the work of different relief agencies: the people themselves, government departments, NGOs, the private sector, and international agencies. So government officials should be high on the priority list for disaster management training.

The ADPC has found that its twice-yearly six-week disaster management courses — which bring together 25 to 30 people from various disciplines and from 12 to 15 countries — provide a stimulating forum for interdisciplinary and international interchange. It is not easy to promote dialogue between different disciplines — engineers and sociologists talk different languages — but if they cannot work together in disaster training, what hope is there that they can work together in the event? The ADPC has also introduced a novel series of courses on "Improving Cyclone Warning Response and Management," for which a team of three experts is selected from each country — a meteorologist who is responsible for preparing and issuing cyclone warnings, a disaster preparedness official responsible for public awareness and response programs, and an engineer or planner responsible for preparedness and mitigation measures. The aim is to create the nucleus of a national interdisciplinary team for a common purpose. Once a small national multidisciplinary cadre of like-minded people — a critical mass — has been established in a country, disaster-related programs begin to expand.

Given the limited availability of training programs it is important that training be put to good use. The ADPC's primary criterion for selecting participants for its training programs is that applicants must hold positions in which they have direct responsibility for some aspect of disaster management. The application form for the ADPC Disaster Management Course asks them to state to what use they will put the knowledge they will acquire in the course. There is inevitably waste as alumni move on to other jobs, but the training is not entirely lost. They may return later in positions of more authority and probably remain disciples of the disaster management philosophy.

What?

The first step in organizing a course is to decide specifically its aim, target group, and content. The ADPC adopts the "need-to-know" principle in designing its course curricula: what does a person need to know about a particular topic to be able to do a job better? The assumption is that applicants are already practicing disaster management professionals, and that the aim of training is to sharpen their skills. Emphasis is on practice rather than on theory and principles. Participants are encouraged to share their knowledge and experience, are introduced to new concepts and skills, and are stimulated to think through course work to commit their experiences and thoughts to paper. Each national group is required to give a presentation on the disaster profile and organization of its country. Individuals are required to present a case study and prepare a briefing paper incorporating the disaster profile (including a 10-year projection), a description of the counterdisaster organizations in their country, a statement of the role of their own organization, an analysis of their organization's performance, and recommendations for improvement.

In addition to individual skills training and sectoral training programs, an essential component of a national disaster management training strategy should be multidisciplinary training programs for managers. The "generalist" training of disaster managers should be matched by technical training for specialists. Academic training is not enough for specialists in disaster mitigation; practicing professionals need updates. In the Philippines, in collaboration with national institutions, the ADPC organized two intensive training courses — Aseismic Design and the Construction of

Structures — to introduce practicing engineers and architects from the Philippines and other ASEAN countries to the latest techniques in seismic hazard mitigation. In the Philippines the ADPC has also helped train local engineers and foremen who are now supervising an immensely successful Core Shelter project in which people in local communities are building their own typhoon-resistant, low-cost housing out of local materials.

How?

The recent rapid expansion of disaster-related training in the Asian-Pacific region has been most encouraging. Bangladesh, Indonesia, Nepal, the Philippines, Sri Lanka, and Viet Nam, for example, have all organized successful programs. Support has come from donors who have been quick to recognize the value of this training: AIDAB, CIDA, SCF (UK), UNDP, UNESCO, ODA/UK, USAID/OFDA, and others. Donor agencies such as WMO/ESCAP and the Australian Overseas Disaster Response Organization have helped with regional training programs. But all national programs have been conducted on an ad hoc basis despite considerable difficulties, handicapped by a shortage of qualified trainers and good teaching materials and no national institutional base. It would be sensible for any future programs to build on these successes. How can these handicaps be overcome?

All supervisors have an obligation to improve the professional skills of their subordinates. On-the-job training and learning by example are important parts of this process — but only parts. There is also a need for professionally conducted training programs. It is unrealistic to expect busy officials to organize high-quality, intensive training programs on top of their routine duties, although they make valuable contributions as resources. It is wrong to assume that someone sent on a disaster management course will return as a trainer able to organize effective training programs. It is one thing to acquire knowledge; it is another to know how to pass it on. Disaster management training courses are best organized by a small cadre of professionals who usually have learned better teaching skills in short courses on teaching methods. There is a need for "trainer training."

National trainers can easily become discouraged by the lack of available teaching materials. There is a pressing need to develop high-quality common-user teaching packages — including audiovisual aids of the style used by the Pan American Health Organization (PAHO) and the Centre for Research on the Epidemiology of Disasters (CRED) — to use, with appropriate modifications for local circumstances, in national training programs.

Management is best taught by creating an environment in which people learn from experience in an interactive process for which lectures or self-instruction are no substitute. On-the-job training — observing good and bad managers at work — works well in normal circumstances but not for teachers of crisis management. The training would come too late. Simulations are an indispensable teaching tool. Simulations were invented by the Germans more than a hundred years ago to give their armies practice at war; they called them war games. Recently business schools discovered them and renamed them simulations; then academia discovered them and called them hypotheticals. Whatever they are called, they try to recreate as realistically as possible in a learning environment a real-life situation and the problems that are likely to occur in it so that the players can develop their individual and group response skills. The ADPC routinely uses the ATLANTIS crisis management simulation exercise developed by the Cranfield Disaster Preparedness Center — jointly with the IBM/(UK) Scientific Center — for its disaster management courses.

Where?

Disaster management training, like any form of continuing education, is an ongoing process. Officials move on to new appointments and those taking their places must be trained. Trainers themselves must be kept up to date, to refresh their knowledge, lest they get out of touch with the realities of disaster and their teaching becomes remote and irrelevant.

Ad hoc programs lack continuity, have no institutional memory, and are denied the security of ongoing budget provisions. An institutional base can be provided in three ways: by creating a separate entity, by assigning the responsibility to a particular government ministry or department, or by assigning the responsibility to a particular agency or institute.

All three options have been tried. Australia established a Counter Disaster College. The United States has the Federal Emergency Management Agency. The Indonesian Disaster Management Center, with interdepartmental responsibilities, is under the day-to-day care of the Department of Social Affairs. The ADPC is part of the Asian Institute of Technology, an autonomous regional institute of higher education. Each option has its advantages and disadvantages. There is no definitive formula; the most appropriate option depends on a country's organizational structure, perceptions of operational responsibilities, research needs, funding, and so forth. Whatever formula is adopted, it should be seen as no more than an institutional base that, while conducting its own training activities, also supports training elsewhere.

Training should be conducted as widely as possible. Schools can teach children basic survival skills; universities should be encouraged to introduce relevant disaster-related courses into their routine curricula. Governments should make greater use of institutes, schools, and colleges through which promising officials pass in midcareer as part of the promotion process — for example, institutes of public administration, schools of management, and service staff colleges. Introducing disaster management training into the routine curricula of such institutes would provide a wonderful opportunity, at minimal cost, of disseminating the concept of disaster management to captive audiences of people at the right level of seniority who might well be key actors in a real event. This concept was put forward by UNDRO (1975) and Ritchie (1976) but has yet to take root.

What is the role of international centers? The UNITAR report (1988) highlighted some of the advantages of a regional multidisciplinary disaster management center or mechanism. It:

- Provides a formal, multidisciplinary approach for training national relief assistant managers and managers from NGOs, especially the national societies of the Red Cross and Red Crescent.
- Gives specialized training for technical disaster experts such as health managers, assessment teams, and engineers specializing in disaster-resistant construction.
- Establishes a permanent forum for disaster management networking, facilitating collaboration among international, bilateral, and nongovernment organizations providing disaster assistance.
- Provides a center for disseminating information on training techniques and practices and disaster-related publications.
- Encourages predisaster activities to stimulate planning in countries that have few resources or weak response capabilities.

The ADPC sees its role as directly analogous to that of its parent organization, the Asian Institute of Technology — which is to provide training in an international forum, usually multidisciplinary, at a level that is not now available nationally. Thus its role is support, not substitution. The formula seems to be working. The ADPC has served as a catalyst in Asian-Pacific countries.

Putting knowledge into practice

Training is a means to an end, not an end in itself — its purpose, to enhance capabilities. At the ADPC, all course participants are told that the success of their training will be measured by what they do when they return home. It is not enough that they are better informed; they must put their knowledge into practice. Each participant is invited to make a list of personal goals for the next 12 months and encouraged to report his achievements. Training strategies should build on past achievements and make use of available opportunities. The disaster training needs of Asian-Pacific countries are for help in creating cadres of trainers, providing them with effective training tools, providing national institutional bases, and providing opportunities to share knowledge and training expertise with neighboring countries.

This paper has concentrated on training in the Asian-Pacific region and claims little knowledge of training in other regions, although it may be similar. According to the UNITAR report (1988) the greatest need for training is in Africa. The Cranfield Disaster Preparedness Centre has trained about 500 African officials. Other organizations — notably the UNDRO/Pan-Caribbean Disaster Preparedness and Prevention Project (PCDPPP), the Disaster Management Center at the University of Wisconsin, and the Oxford Polytechnic (UK) Disaster Management Center — are providing support to

national and donor agency programs elsewhere. The Relief and Development Institute (UK) has developed excellent training materials. The UNITAR report suggests that the ADPC and PCDPPP represent new approaches to disaster management, "models from which applications could be made for the formulation of a training curriculum in the targeted sub-region(s) of Africa," but these two organizations are by no means the only actors. IDNDR offers a golden opportunity to pool worldwide expertise and develop training programs and materials for the benefit of disaster-prone developing countries.

Remote sensing and technology transfer in developing countries

H.M. Hassan and Wayne Luscombe

Natural disasters are more devastating in developing countries than in developed countries as developed countries are better prepared to cope with disasters through well-established surveillance, early warning, and preparedness programs. Information technologies designed to predict, monitor, and assess disasters are generally unavailable and poorly understood in developing countries. Improving disaster information management in developing countries is a technology transfer problem, but issues of intellectual property rights limit disaster information management applications in those countries. The use of remote sensing information in disaster management in developed countries has been limited and mostly exotic. Remote sensing is considered high technology, and there is a widespread belief that it cannot be transferred to developing countries — whether for disaster management or broader uses such as natural resource and environmental management. Developing countries must be helped to have better access to remote sensing technology so they can deal with disasters more effectively.

Disasters can never be eliminated, but modern technologies give us access to detailed information that can be used to minimize damage. Most disasters must be dealt with in a matter of days and sometimes hours. Disasters are by nature unpredictable, uncontrollable, difficult to assess, and disturbing. Decisions must be made in a state of shock and uncertainty, when the information needed for rational judgments is imprecise and often nonexistent. Remote sensing is especially helpful in developing countries in which baseline information is unavailable and communication systems are weak. Remote sensing can play an indispensable role in disaster warning, monitoring, and damage assessment, especially in relation to droughts, floods, storms, earthquakes, volcanic eruptions, forest fires, and locust outbreaks.

Floods. Satellite images made it easy to compare the extent of inundation to normal preflood conditions during the Mississippi River Flood of 1973 (Deutsch and others 1973). The synoptic (three-dimension) coverage of satellite remote sensing provides a bird's-eye view of the whole flood area at uniform scale. The satellite's frequent revisits to flood-prone areas allows a comparison of flood conditions over time at reasonable cost. Remote sensing allows quick delineation of inundated areas, allows rapid calculation of flood damage to agricultural and urban lands (combined with other data), and facilitates planning for flood control and disaster preparedness programs. The flood forecasting and early warning program in Bangladesh was one attempt to use different remote sensing and ground survey data to establish a depend-

able early flood warning system. With significant recent improvements in spatial, spectral, and temporal resolution of satellite remote sensing, flood monitoring and forecasting are now more achievable. State-of-the-art disaster management technologies have been used in a few developing countries, but such applications were situation-specific and implemented mostly by outside agencies. There was little, if any, interaction with local people and no real know-how was transferred.

Earthquakes. Satellite remote sensing is of limited use in the assessment of earthquake damage to buildings, structures, transportation, and communication networks because of the relatively coarse resolution of current commercially available satellite images. However, the synoptic view provided by satellites has been helpful in studying earthquake-prone areas worldwide. It is possible to analyze the surface signatures of deep-seated structures that appear on satellite images as distinctive lineament patterns. Using satellite data, seismologists are able to pinpoint areas of dangerous deformation on the earth's surface—information that is useful in forecasting seismic activity. Active earthquake zones can be roughly located and risk maps produced by reviewing plate tectonic motions and past seismic activity and geologically interpreting remote sensing data. It is also possible to assess landslide-susceptible areas by analyzing spectral patterns on satellite imagery and studying maps of soil and water resources.

Earthquakes are not preventable, but it is possible at least to reduce the damage from them. At least twice in China the prediction of earthquakes saved many people's lives (Gunner and others 1984). Advanced Japanese, Soviet, and U.S. research in earthquake prediction is promising, and applications of satellite images for earthquake damage assessment have been reported (Simonett 1978, Carter and Easton 1973). Time is the most important factor after an earthquake disaster. If less time is spent gathering information on which to base decisions, early search, relief, and restoration measures may save lives and property.

Volcanic eruption. Timely satellite images allow rapid assessment of the damage caused by volcanic eruptions. Areas covered by lava, mudflows, and volcanic ash are easily detectable against satellite images of undisturbed soil. Thermal and infrared channels on satellite and aircraft sensors have been used to study the temperature differential between lava flows and ash and their colder surroundings. Measuring the tilt of a volcano before eruption allows an early warning if coupled with other indicators such as the geochemistry of emitted gases, the heat flow from the volcano, and measures of microseismic activity.

Tropical cyclones. Because of their violent nature, their duration, and the extensive area they can affect, tropical cyclones can be among the most devastating of disasters. They develop over the open sea and may continue to have destructive power for two weeks or more. Cyclone disasters result from violent winds, excessive rainfall, and rising seas. If a tropical cyclone moves inland or along a coastline it can bring death and damage to extensive areas, involving many countries. Scientists understand the nature of tropical cyclones relatively well, thanks partially to radar, weather satellites, and computer modeling. It is not possible to prevent tropical cyclones, but radar, satellites, and radios allow their course to be tracked and warnings to be issued in reasonable time. Cyclone-prone areas can be studied and preparedness programs developed for those areas.

Drought. Drought is a long-term creeping disaster that is usually not limited to one country but crosses national boundaries to cover regional ecosystems. Satellite remote sensing has been extensively used in the prediction, surveillance, and assessment of drought and drought damage. Early warning systems with remote sensing components for drought monitoring have been established in many drought-prone areas worldwide. Low-resolution satellite data from weather satellites have been useful in making rough but quick predictions and assessments of drought in Africa's Sahelian zone (Heilkema and others 1986). High-resolution satellite and aerial data have been used to zoom in on specific areas in a drought zone for detailed study and analysis.

Agriculture and forestry disasters. Many calamities occur because of stress on forests and crops from disease, insect infestations, fires, and the like. Changes in spectral reflection of remotely sensed images of crops, forests, and rangeland indicate irregularities in the degree

of plant vigor. This clearly shows in the microwave and infrared bands. Changes in spectral responses can be detected long before images are visible to the naked eye. Time-lapse images are useful in early warning and damage assessment programs. D.E. Pedgley's early work using satellite images in the surveillance of locust breeding sites in Saudi Arabia was followed by FAO's successful work using NOAA satellite data in the early detection of locust breeding habitats in North Africa (Heilkema and others 1986).

Problems of technology transfer

Some problems hinder the transfer of remote sensing technologies to developing countries for disaster management:

- Remote sensing is considered high technology and because of trade issues involving intellectual property rights often cannot be transferred to developing countries.
- Few developing countries have the technical capabilities to absorb the transfer of such complex technology.
- Policymakers and managers find it difficult if not impossible to devote limited human and financial resources to such high-technology endeavors.
- In many developing countries, long-term planning is practiced only on paper. Soon after long- or medium-term plans are prepared and approved they are ignored and begin gathering dust on shelves. Reactive, piecemeal, short-term programs are the norm, not the exception.
- The "supply-driven" approaches promoted by technologists and technology vendors have been counterproductive in influencing policymakers and planners to accept and promote long-term disaster information management programs, because these high-technology disaster information management programs have not been integrated with indigenous policy planning.
- Remotely sensed data have been only intermittently available in developing countries, because of the high cost of data and security measures imposed by some countries. This makes the use of such information for long-term planning difficult.

There is an inconsistency between the level of technological development that can be used in disaster management, and the level developing countries can and do actually use. Disaster information technologies transferred to developing countries after a disaster are often both unfocused and oversophisticated. Most of the disaster information technologies deployed in developing countries are technologies borrowed from the military. Others are makeshift technologies quickly put together for that particular situation.

What must be done

The 1972 Declaration of the UN Conference on the Human Environment states that "environmental deficiencies generated by the conditions of underdevelopment and natural disasters pose grave problems and can best be remedied by accelerated development through the transfer of financial and technological assistance as a supplement to the domestic efforts of the developing countries" (OAS 1988). Until recently, disaster assistance programs have traditionally provided relief immediately after a disaster. Few disaster assistance efforts have included rehabilitation, and no comprehensive systems of disaster preparedness have been implemented in developing countries.

In the last two decades, with recognition of the repetitive patterns of many natural disasters, increased attention has been paid to predisaster measures, especially early warning systems and preparedness planning. The Organization of American States (OAS 1988) recommends making natural hazard assessment and mitigation an integral part of development planning. Disaster information should be part of ongoing natural resource information management programs in developing countries.

Accurate data and effective communication are basic needs in normal development planning. When and where disaster strikes, they are even more important. Disaster information should be thought of as a layer of natural resource information management with critical time requirements. Although there may be certain specifications for disaster information, developing this information as part of an overall information management program for development planning will guarantee its sustainability and the effectiveness of technology transfer. It will also help establish the long-term baseline information that is crucial in disaster studies. Resources available to national, subregional,

and regional organizations in the fields of remote sensing, geographical information systems (GIS), and natural resource information management should be used to develop such a system. Scientists and technicians in natural resource centers should be the targets for proposed technology transfers. Properly trained, they can work with local personnel to develop sustainable systems for monitoring, forecasting, and managing disasters and issuing early warnings.

Remote sensing technology, geographical information systems, and methods of information dissemination may all need to be transferred. Training should be provided in acquisition and storage of remotely sensed data, in planning and implementing aerial surveys, in processing and analyzing the data visually and digitally, and in disseminating information.

"Do not give me a fish," says the old Chinese proverb, "but teach me how to fish." Simply supplying a country with machinery does not constitute technology transfer. The "mastery of technology cannot be bought; it must be learned" (World Bank 1988c). One does not so much transfer technology as transplant it, and one must recognize the complexity of integrating a technological approach in a new setting.

Case study: Minas Gerais Forestry Development Project

Alcira Kreimer and Martha Preece

The Minas Gerais Forestry Development Project came about at a key point in environmental development and planning. For 20 years, the philosophy behind forest management was that forest fires are essentially healthy for overall growth and that forests should be allowed to burn naturally. The devastating effects of uncontrolled fires have forced a review of this approach and of policies that encourage or are lenient about slashing and burning forests to expand agricultural land. The Minas Gerais forestry project changed the emphasis from emergency response to long-term prevention and mitigation of uncontrolled conflagrations. This project recognized the need for important changes in government policies and priorities, especially those that minimize environmental damage from the expansion of agriculture and the promotion of economic growth. An important step in that direction is the project's emphasis on controlling forest harvesting and forest fire, managing native forests, improving industrial production of wood, and educating the public about conservation.

The environment is deteriorating at a fast pace in Brazil. Its 850 million hectares contain about 350 million hectares of endangered tropical forest (about 30 percent of the world total). The depletion of forest resources is commonly attributed to the expansion of agriculture — particularly the conversion of natural forests to subsistence agriculture, livestock production, and commercial and industrial plantations. Brazil's national deforestation rate is relatively low compared with other developing countries, but in the last five decades much of the forest stock has been removed for sawtimber and pulpwood. In addition, the savannah areas (*cerrados*) have been progressively reduced to provide land for agriculture and as a source of construction materials, fuelwood, and charcoal for the steel industry of Minas Gerais. Dennis Mahar (1989) reports that deforestation in Amazonia has accelerated since the mid-1970s. About 125,000 square kilometers had been cleared as of 1980 and almost 600,000 square kilometers by 1988.

Minas Gerais

Minas Gerais is the fourth largest state in Brazil. Its 586,624.3 square kilometers (7 percent of Brazil's land area) are inhabited by about 14.6 million people, 26.5 percent of whom live in rural areas. A major iron and steel producing region, Minas Gerais produces 85 percent of Brazil's charcoal-smelted pig iron and steel. It also leads in use of charcoal as a cooking fuel. Forestry, including charcoal manufacturing, is the second most important

industry, generating 11 percent of the state's gross domestic product.

Except for a few small state parks, virtually no virgin forests remain. Less than half of 1 percent of the state's surface area is in state or federal parks and reserves. And many important ecosystems, including the *cerrado*, have no reserves at all. About 25.7 million hectares (43 percent of the total) are classified as "forest" lands, including 2.1 million hectares of plantations. But most of them are severely degraded because of mismanagement and uncontrolled timber removal. This has disrupted the natural and human environment, degrading soil and water, making fuelwood scarce, reducing agricultural productivity, and increasing the risk of floods. Further degradation, whether the result of natural hazards or mismanagement, threatens long-term sustainable development by increasing the region's vulnerability to disasters. Uncontrolled fires disturb the soil, diminish its ability to store water, and threaten the forest's ecological balance. Reduced tree cover—because of forest fires or deforestation — magnifies the risk of flooding, water runoff, the sedimentation of riverbeds, and thus disasters.

The growing industrial demand for fuelwood, the repeated uncontrolled burning of pasturelands, and rudimentary, somewhat inefficient charcoal manufacturing methods have exacerbated the rate at which native forests are cut. Domestic demand for fuelwood cannot be sustained by natural regrowth, given the present low productivity of the natural forest. Despite large-scale reforestation and increasing supervision and control of forest cutting by the State Forestry Institute (IEF), more than 80 percent of the fuelwood used for charcoal production still comes from native forests — mostly from the *cerrado* areas. The gathering area for fuelwood continues to expand, threatening the survival of tropical forest ecosystems countrywide.

Regional vulnerability

There are no reliable data on the number and causes of forest fires in Minas Gerais. IEF estimates that up to 30 percent of the state is burned annually, mainly to clear land for pasture or croplands. Many of these deliberately set fires extend into forest areas, risking devastation and heavy economic and environmental losses. The problem is compounded by policies designed to expand the agricultural frontiers, by poorly defined regulations, and by inconsistencies between environmental laws and broad economic policies and incentives. IEF has no appropriate preventive action programs and inadequate staffing and equipment, so forests have become increasingly susceptible to natural disasters. Today, the equilibrium of some areas — particularly the *cerrado* ecosystem — is rapidly changing, possibly endangered by large-scale land clearing for agricultural purposes and to provide charcoal for the iron industry. Soil erosion and progressive degradation of the remaining forests force farmers to shorten fallow periods, eroding the land's productive capacity and precipitating further destruction of the forests. These conditions have diminished the forest's ability to maintain soil fertility, control water runoff, and prevent flooding.

Changes in Brazil's forestry policy

The government's objective of promoting economic development by expanding the agricultural frontier over the past two decades has put increasing pressure on Brazil's forest lands. In the 1980s, there was growing recognition that efficient, sustainable economic development depends on sound use of natural resources. The government has tried to establish a policy and institutional framework to encourage the protection of natural forests. The government has modified important policies and laws that conflicted with the goals of environmental protection and sound management. One policy now prohibits new fiscal incentives for establishing extensive beef cattle schemes in forest areas of the Amazon. Another eliminates legislation that requires clearing land as proof of its occupancy and a precondition for securing the title to the land. This program also included measures in support of sustainable extractive uses of the forest. Forest development and conservation programs remain weak, however, because of strong resistance to land reform and population control, and the lack of consensus among professional, social, and political institutions. Moreover, forestry policies are difficult to implement in Brazil. This has been especially true of laws requiring reforestation in charcoal-producing areas.

The Minas Gerais Project

Environmental issues have become increasingly important in the Bank's program in Brazil. In the last decade, the Bank has supported environmental, forestry, and Amerindian protection programs under many of its projects in Brazil. It has participated in more than 50 agricultural projects in the country, totaling about US$3.5 million.

In April 1982 the Bank appraised a project to finance 40,000 hectares of industrial-scale reforestation in the state of Minas Gerais. Negotiations broke down because the federal government was preparing a national reforestation program that would include most of the components contemplated for the project. Unfortunately, the national program failed to materialize for lack of government financing. Meanwhile the depletion of forest resources in Minas Gerais accelerated. In late 1985, the state government asked the Bank to support a forestry project that would help preserve and conserve the state's native forests. The Bank's involvement in the project is based on its strategy of promoting sustainable economic growth through comprehensive action programs for environmental management and protection of natural resource bases.

The Minas Gerais forestry project focuses on expanding reforestation and increasing the productivity of native forests through better management, protecting forests through conservation and prevention programs, and strengthening the management capabilities of the State Forestry Institute. The credit for reforestation will help finance the expansion and rehabilitation of the state's industrial forest area. At the same time, through the small-scale reforestation program the Bank will continue supporting forestry activities that encourage better land management, the conservation of native species, and extension support for small farmer silviculture. Labor-intensive planting, plantation maintenance, and harvesting activities are expected to generate jobs and income in the rural areas. Meanwhile all of the Bank's rural development projects have targeted the forest sector with land management, soil conservation, small-scale reforestation, and fire prevention and mitigation activities.

Through December 1985, more than 47,000 hectares of small woodlots were established on the land of more than 26,000 participating farmers. An additional 34,000 hectares are expected to be established on more than 14,300 properties. An increasing number of native species are seriously threatened by uncontrolled deforestation, so the project is establishing and managing 7,300 hectares of native species plantations. To encourage community participation, the project expects to subsidize small farmer forestry activities. Seedlings and extension will be provided free to farmers who supply the labor to plant the trees on their land.

The project's forestry conservation component is a key feature of its hazard prevention and mitigation strategy. The fire prevention and control program combines legal controls with environmental education to stop invasive burning. Surveillance and policing will focus on virgin rainforest and other protected areas. The Bank is also financing the staffing and equipping of a State Operational Center (COE) for forest fire prevention and control. Federal and state agencies will coordinate the formation of ad hoc fire-fighting brigades and will provide the information needed to predict or combat fires. The private forest and forest industries sector will also be called upon to form fire-fighting units. Procedures will be updated, particularly the system of permits for controlled burning by landowners. Six fire towers will be built in parks and reserves as part of the comprehensive fire response effort. Public education and awareness campaigns will be aimed at preventing hazards through better land-use management, planting, controlled burning, and fire control techniques. A variety of activities will promote measures to prevent and mitigate environmental degradation and losses from natural hazards. A state forest inventory and vegetation maps will be prepared to monitor, protect, and control forest harvesting and to examine changes in vegetation annually and semiannually. This will allow the Control Department (DC) to identify areas where unauthorized cutting is taking place.

To prevent further degradation of the *cerrado* vegetation that covers 55 percent of the state — providing more than 80 percent of the charcoal for the steel industry — the project may try to increase productivity of *cerrados'* energy production. Because of heavy cutting followed by repeated burning, much of this vegetation has

been devastated. The project may establish eight experimental plots to determine what different management techniques yield in fuelwood and charcoal production.

To reduce the pace of environmental degradation and ultimately protect and improve the quality of life, the project proposes to consolidate state parks and reserves, create public recreation areas, and support ecological research. The project will finance infrastructure, equipment, and staff for existing (legally designated) reserve areas and develop the most comprehensive ecological research program ever carried out in the state.

Case study: Da Xing An Ling Forest Fire Rehabilitation Project

Alcira Kreimer, Martha Preece, and Horst Wagner

By any standard, the Da Xing An Ling Forest Fire Rehabilitation Project was an extraordinary accomplishment. The impressive organization of the Da Xing An Ling Forest Corporation made it possible to salvage 12 million cubic meters of timber from a forest devastated by fire, and generate funds for forest regeneration and reconstruction of local infrastructure, among other things. The program significantly changed local attitudes toward fire prevention, by increasing awareness of the need for preventive activities. The disciplined approach of the fire fighters and their vastly improved fire safety records show the effectiveness of this strategy. Only the important work of forest regeneration has been slow because of the region's difficult climate and a shortage of local expertise. Those efforts must be strengthened, particularly in the crucial areas of seed usage, site preparation, and seed harvesting and handling. But this project is a landmark in efforts to integrate environmental issues into the economic justification for the Bank's involvement in rehabilitation programs.

Forest fires are often viewed as unavoidable quirks of nature and environmental degradation as the result of willful human tampering with natural environments (see box on fire management). Even the Bank distinguishes between natural disasters and environmental degradation as if the two were unrelated. But in recent years more preventive measures are being considered so future development efforts will not fall victim to catastrophe.

The underlying causes of a natural crisis can often be traced — at least in part — to tampering with the natural environment. One natural disaster often leads to another. Fires spreading freely through forests may deplete soil nutrients, rapid runoff from a burned area can contribute to flooding, and the erosion of exposed soil can trigger landslides (National Academy of Sciences 1987). Their origin may be linked to natural causes, as in China, or to human activities. In Brazil, colonization projects put settlers at more of a disadvantage than other producers because credits, agricultural input prices, and major markets were far beyond the reach of small producers. Low agricultural productivity, together with population pressure and poverty, forced farmers to fell and burn forests (Mahar 1989). Moreover, the increasing development and exploitation of natural resources is forcing a shift from extensive to intensive land use. The result is to shorten the fallow period, thus reducing the organic matter

in soil and soil's capacity to hold water. But fire also alters ecosystems and increases the chance of erosion and water runoff, thereby exacerbating a region's vulnerability to further natural hazards. The fact that a disaster occurs "naturally" does not lessen its impact on environmental systems. Nor does it mean that attempts should not be made to assess the effects of disasters and protect the natural habitat from their potential damage.

The risk of wildfires becoming uncontrollable disasters has increased as environmental degradation accelerates, widening the path of disaster-proneness. After the devastating consequences of the Da Xing An Ling forest fire, the government of China is paying close attention to natural disaster reduction initiatives, focusing on activities to protect the natural environment. With Bank support (a $56.9 million loan), the country launched the largest salvage operation in the world and set up a fire protection system to prevent and mitigate wildfires. The Da Xing An Ling project became the Bank's first effort at forest fire rehabilitation.

The vulnerability of China's forests

Only 12 percent of China's 9.5 million square kilometers of land area are under cultivation. Forestry, which employs 2.2 million people, accounts for less than 5 percent of the gross value of agricultural output. An estimated 261 million hectares, or almost 28 percent of China's total land surface, is suitable for forest growth, but forest cover came to only 116 million hectares in 1985. Naturally regenerated forests cover about 110 million hectares; of these, 81 million hectares are timber forests, 10 million protection forests, 11 million farm forests, 3 million bamboo, 4 million fuel forests, and 1 million special-use forests. The other 6 million hectares are man-made forests. In 1984, timber production grew to almost 300 million cubic meters (compared with 95 million cubic meters in Japan and 317 million cubic meters in the United States). Forest products are the principal source of household fuelwood and housing construction materials in China. The country is undertaking a massive afforestation and reforestation effort, but it also faces an unprecedented demand for wood products. This, coupled with an accelerating decline in the supply of roundwood, has forced the government to increase imports of quality timber and to focus on improving forestry management and protection. China's objective is to restore forest coverage to 20 percent of the total land area by the year 2000. Timber and fuelwood use is an estimated 300 million cubic meters a year; only slightly more than 50 million were logged for commercial use.

Historically, the country has regularly lost 40 percent of its annual timber production to fires. Between 1966 and 1986, fire destroyed an average 130,000 hectares of forests annually in the DXAL area, exacerbating the country's wood shortage and intensifying the pressure on remaining forests.

The Da Xing An Ling area, in the far northern portion of Heilongjiang Province and the Inner Mongolia Autonomous Region, is China's most important timber producer. It covers 22.7 million hectares, of which 13.5 million hectares are closed forest stands. The dominant species are larch (70 percent of the standing volume), white birch (20 percent), scotch pine (7 percent), and spruce, poplar, and oak (3 percent).

In May 1987, one of the biggest wildfires on record occurred in China. The Da Xing An Ling fire lasted 28 days, blackened 1,330,000 hectares, and devastated 870,000 hectares of timber forest in the northern part of the country. It killed 193 people, left 56,000 homeless, and destroyed much of the region's infrastructure, including railroad tracks, power lines, offices, and industries. "The city of Xilingji was wiped out in half an hour since gale force winds fanned the flames. The victims were mostly elderly and sick people, unable to escape quickly enough. Although the government concentrated more than 40,000 firefighters in the area, it took a month before the blaze was extinguished, with the help of the first spring rains" (Lindzen 1990). Nearly 40 million cubic meters were affected by the fire. Although the trees died, the wood was still intact and could be salvaged.

Fire has occurred often in the Da Xing An Ling forest region, where recurrent fires are part of the natural growth cycle. The area is dry and windy in the spring, with rainfall of only 200 millimeters in the winter, evaporation of 170 millimeters from March to May, and occasional gale-force winds from mid-April to mid-May. Nearly 100 forest fires a year are triggered by lightning and burn an average total of 150,000 hectares. The forest damage rate is 1.7 percent. Usually forest fires are not detected until they

Some thoughts on fire management

Martha Preece

Environmental degradation may not trigger natural disasters, but it can make an area more hazard-prone. Forest environments are particularly susceptible to wildfires, quick-onset disasters that may be set off by a volcano, lightning, or human carelessness. The risk of a naturally ignited fire turning into catastrophe is increasingly seen as a function of the degradation of the forest habitat. Crises caused by fires are compounded by such long-standing problems as rural poverty, technological constraints, and inefficient tenure patterns and use of land. Mounting pressure on scarce land and forest resources has led to rapid and massive deforestation. Degradation of the environment sets the stage for sedimentation of surrounding riverbeds, major watershed problems, floods, landslides, acute water shortages in dry periods, and the irreversible loss of biological diversity.

Uncontrolled fires have contributed heavily to the depletion and exhaustion of natural forests. Like land clearing, they set in motion events that may result in permanent losses in biodiversity, soil fertility, and sustainable forest-based production. They usually produce large tracts of eroded and weed-infested lands, altering ecosystems and increasing vulnerability to natural hazards. Wildfires destroy timber and forage, disrupt animal habitats, deplete soil nutrients, and diminish an area's tourist (scenic) value. Rapid runoff from a burned-over area can lead to flooding, and erosion of exposed soil can trigger landslides.

In the last 20 years environmentalists have been debating the merits of the controversial "let-it-burn" approach to forest management. The idea behind it is that blazes actually benefit the natural environment by both clearing underbrush that blocks sunlight from seedlings and preventing uncontrolled conflagrations. According to the U.S. Park Service, "the old suppress-all-fires" system caused more problems than it solved. The 1990 blaze at Yosemite spread quickly not only because of drought but also because decades' worth of excess brush had accumulated during the years before controlled burning began (Dorfman and Wyss 1990).

Peters and Neuenschwander (1988) acknowledge the many benefits of slash-and-burn techniques and their near indispensability as a tool for shifting cultivation. But they emphasize how the exploitation of tropical forests has threatened the sustainability of traditional agricultural practices. "Land scarcity, brought about by population pressure and the increasing development and exploitation of natural resources, is forcing a change from extensive to intensive land use," they write. When less land is available for subsistence cultivation, the only economical way to produce the same yields of traditional crops is to reduce the fallow period. The low value of crops usually does not justify the use of fertilizers, so the alternative for small farmers in developing countries is to exploit marginal lands and primary forests. The low cost of the slash-and-burn technique makes it the only economically feasible way for smallholder producers to clear land. But the practice has become an ecological, sociological, and economic concern because its uncontrolled use has caused severe environmental degradation. Accidental or escape fires can become catastrophes with devastating consequences. Unrestricted shifting cultivation and indiscriminate use of fire have become a major threat to forests. Therefore, fire prevention programs must address the issue of agricultural practices, poverty, and landlessness.

have spread over more than 60 hectares, and are not controlled until they reach an average 4,000 hectares. Use of these forests makes it necessary to break the natural cycle of recurrent forest fires. Development of this forest area started 22 years ago, but investments in fire protection in that period were not adequate to reduce average fire loss.

The Da Xing An Ling fire developed from three major fires. Of the 40 million cubic meters destroyed and damaged, 12 million cubic meters were high-quality larch and pine with a railside value of at least US$1 billion. A quick salvage operation was necessary because insects and fungi spread rapidly in areas affected by fire. Only six months after the fire, bark fell off half of the dead trees, and 30 different insects were found in about 12 percent of them. The salvage operation was to be completed within two to three years and, indeed, by April 1990 the DXAL Forest Corporation had salvaged the planned 12 million cubic meters. Not all of the wood could be transported out of the region because of bottlenecks in rail transport; about 4 million cubic meters were stored and preserved to be transported in 1991.

After the devastating DXAL wildfire, the Ministry of Forestry was determined to restore

the productive capacity of the forest industry and prevent any more uncontrolled fires. Besides rebuilding the houses and all the destroyed infrastructure in the area in 1989, the government was committed to developing a comprehensive fire prevention and protection system. Authorities have substantially revamped the fire prevention and control capability and have established an effective ground protection system combined with early warning detection by air surveillance and satellite. They have also built up firefighting capability by combining ground brigades, all-terrain vehicle crews, and helicopter fire-suppression systems.

Bank strategy for DXAL fire protection

In 1988 the Bank approved a credit for $56.9 million, financing 11 percent of a project that cost US$517 million, to "launch the largest salvage operation in the world and set up a space age fire protection system in a forest area the size of Great Britain" (Wagner 1988). The Bank's strategy included:

- Fire prevention — building up a multilevel prevention system that combines ground patrols, fire towers, and early aerial and satellite fire detection systems.
- Fire suppression — by mechanized fire brigades on the ground and aerial fire suppression by helicopters carrying fire retardant chemicals and firefighting brigades.
- An emergency salvage operation — to minimize economic losses by felling, logging, and transporting burnt but usable timber before it decayed or became infested with insects.
- Regeneration of the forest cover mainly through seeding, natural vegetation, and — to a lesser extent — plantation.

The regeneration program still needs improvement. The management, equipment, and proper use of seed harvesting and handling technology must be reviewed to improve seed quality, reduce costs, and accelerate regeneration. The regeneration of larch, scotch pine, and birch has been emphasized. Larch is remarkably adapted to these cataclysmic sites. Its thick bark protects it from severe burning, and its coning and seed distribution patterns are ideally suited to the vagaries of the climate. Scotch pine complements larch, taking over certain ecological niches unsuited to it, and birch has the capacity to sprout from tree stumps, so it establishes a canopy quickly, creating the conditions needed to reestablish larch. Further technical assistance will be needed to speed up the regeneration process. The project has emphasized the development of nurseries to raise stock for hand planting. But the regeneration of indigenous species increases the potential for infestations of pests and disease. Such extensive reforestation calls for adaptation of the methods developed for the natural forest. A scheme to encourage villagers to protect birds should reduce insect infestation, and restocking natural predators should reduce the serious rodent damage experienced in some places.

An extraordinary achievement

In the DXAL fire, a natural crisis became a disaster for lack of a reliable prevention and disaster preparedness program. Implementation of the aerial and satellite fire detection and firefighting measures has significantly reduced the effects of fires. In 1989, the DXAL forest area had the lowest incidence of fires in its history. The loss of forests to fire dropped from an annual average of 130,000 hectares to fewer than 60 hectares. (The appraisal target was 30,000 hectares.) Fire management has been improved by a fire protection system that combines aerial and satellite surveillance with fire tower and ground patrol observation. About 1,500 kilometers of fire breaks were opened up and 135 lookout towers were set up to improve the early discovery and suppression of fire. Firefighting capabilities in both Heilongjiang and Inner Mongolia were improved by establishing a responsibility system, expanding roads to inaccessible areas, and improving the organization, mobilization, training, and equipment of the fire brigades. In the spring of 1990, only 14 fire alarms were reported — eight times fewer than in 1988, which had been the best year in fire prevention. The incidence of fires decreased 37 percent. But the danger of fire remains, as the forest corporations in Heilongjiang and Inner Mongolia have not yet reached their full capability for handling large fires in inaccessible areas.

The Da Xing An Ling Forest Fire Rehabilitation Project is a remarkable achievement in terms of timber salvaging and improving fire

management. It made national and regional political leaders and government decisionmakers focus on the need for a priority salvage operation and rehabilitation program. It mobilized widespread support for tree planting, seedling protection, and the regeneration of highly fire-resistant indigenous species. The program succeeded because of the government's commitment to it, a commitment that made massive mobilization possible. The project strongly emphasized the need for proven regeneration techniques, increasing the rate of industrial plantation, accelerating research on regeneration, harvesting and using timber resources more efficiently, and developing effective fire prevention capabilities.

Coordinating efforts

Case study: Sudan Emergency Flood Reconstruction Program

Jonathan Brown and Mohamed Muhsin

After a disaster, aid is best coordinated by the recipient country itself. But aid coordination by an outside institution such as the World Bank may be warranted when the country lacks administrative capability, when the disaster is so big that government services are fully occupied for a long time with both relief and normal operations, or when issues of concern to the Government and donors cannot be resolved internally. This is not a matter of the Government giving up its sovereignty. Rather, it is similar to hiring consultants or an investment bank for their expertise in a particular or unusual situation. This kind of aid coordination is probably most effective in the preparation of the reconstruction program if it is clear that the program is that of the Government and not that of the lead donor or of the donors as a group. Aid coordination becomes less effective during implementation, largely because most donors insist on their own rules and procedures for procurement and disbursements.

In August and September of 1988, much of Sudan was devastated by heavy rains and flooding. At the Government's request, the World Bank organized a multidonor, multisector mission to help the Government prepare a US$408 million reconstruction program to present to the donor community (see box on flood reconstruction funding). The Bank hosted a donors conference in November 1988 to fund the emergency lending program, then helped the Government and donors monitor program implementation. This is a review of the Bank's experience in that aid coordination effort.

Background

Sudan, with an area of 2.5 million square kilometers, is the largest country in Africa. Its population in 1988 was about 23 million — a heterogenous mix of ethnic groups and religions. Per capita GNP was US$330. Sudan has the natural resources and, more than other African countries, the trained manpower to develop a vibrant economy. But the economy has performed poorly most of the time since independence, and in the past several years has deteriorated at an alarming pace. The main reasons for this state of affairs are mistrust of the private sector and political instability — stemming from a prolonged civil war, poor economic policies, and a weak administration — reinforced periodically by adverse shocks from the weather and the international economy and by the influx of refugees from neighboring countries. By May 1986, when a coalition government assumed power after democratic elec-

tions, GDP had grown only 1 percent a year for a decade and per capita income and consumption had fallen well below the 1970s' levels. In June 1989 the civilian authorities were replaced by a military government.

In August and September 1988, Sudan experienced two separate but related events. First, there were three weeks of unprecedented heavy rainfall, including a 200-millimeter rainstorm August 4-5 in the Khartoum region — more rain in one day than the average rainfall for an entire year. Then there was heavy flooding of the Nile and other rivers, including sheet flooding down wadis that had not seen water in living memory. These events devastated much of the population, particularly in Khartoum and the northern regions, where there was massive damage to agriculture, property, infrastructure, and social services. Some 200,000 homes were extensively damaged or completely destroyed by the floods and rains, which took days to dissipate, in flat areas with impermeable clay soils. About 2 million people were left homeless, more than 80 percent of the schools in the Khartoum area were damaged or destroyed, and farmers along the Nile and in irrigated areas lost substantial productive capacity. Because so much damage was done in so many sectors, and so little reliable data was available, no damage assessment was made, but the general consensus was that it was probably more than US$1 billion equivalent.

Emergency relief efforts began almost immediately after the heavy rains, with the help of the UNDRO/UNDP and the support of the international community and local and international nongovernment organizations (NGOs). Efforts to meet the flood victims' immediate relief needs — for food, medicine, temporary shelter, and emergency medical relief to prevent epidemics — were successful and no widespread diseases were reported.

The multidonor mission

As it turned its attention from immediate relief to longer-term reconstruction, the Government asked the World Bank to lead a multidonor, multisector mission to help it assess reconstruction requirements, establish a reconstruction program, and coordinate donor reconstruction efforts. The Bank, in consultation with the Government, agreed on several steps. First the Bank mission (working with the Government) waited to outline the reconstruction program until emergency relief efforts were under control, to give highest priority to the Sudanese people's immediate needs. Second, from Washington, the mission began to establish the framework for a multidonor effort to produce with the Government an Emergency Flood Reconstruction Program (EFRP). This effort involved a series of actions:

(a) Other donors were invited to join a multidonor mission to prepare the EFRP with the Government. A number of donors accepted, including the African Development Bank, the European Economic Community, France, the Federal Republic of Germany, IFAD, the IMF, Italy, Jordan, the United Kingdom, UNICEF, UNIDO, and WHO. The multidonor mission was also in touch with other international organizations (such as FAO and UNDRO) and with other countries (such as the Netherlands and Japan) which eventually helped fund the EFRP.

(b) Local and international consultants (with the financial support of the UNDP) were recruited to supplement the staff of the Bank and other donors and to provide special expertise to the Government and the mission. The United Kingdom also funded consultants to establish with Sudanese officials the nature of the flood and rain events and the probability of their recurring — to help in future disaster mitigation efforts.

(c) The mission determined that because of Sudan's poor economic performance and weak administrative capabilities, the donors would respond more positively to requests for emergency reconstruction assistance if Sudan's needs were assessed in detail and Sudan's implementation capability thoroughly documented by sector. The mission decided to produce a detailed technical document, including equipment lists, which is not usually a priority in emergencies. The Government established special sectoral task forces to assess damage in the sectors served by their ministries, and the Bank and the Government agreed by telex on the kinds of information the donors would need and on a format for their presentation.

(d) Within the Bank, an ad hoc reconstruction advisory group of experts familiar with emergency projects was convened. The Bank named a division chief to lead the multidonor mission

and Bank technical and program staff began meeting to coordinate their inputs so that the Government and the mission would be able to produce the EFRP document in the field. This meant agreeing on a common approach to report writing — on such things as the format, costing assumptions, and definitions — and ending up with an outline of the report. The mission was staffed with secretaries and portable computers so that with the help of the local UNDP office it would be able to produce its draft and final reports without imposing a burden on the Government. As for the mission's organization, a core group of Bank staff — the mission leader, a lawyer, two consultants experienced in Bank, donor, and Sudanese procedures, and the Bank's senior advisor on emergency lending — would work on the draft EFRP to be discussed with the Government. The core group would review general policy issues with the Government and would handle project implementation issues and disaster mitigation efforts. The Government and mission sector specialists would form sectoral groups to prepare and present their sectoral reconstruction programs to the core group after clearing them with Sudan's sectoral ministers. Sector groups were established for agriculture, education, health, industry/construction, power, telecommunications, transportation, urban, and water supply. This decentralization of responsibility would allow the mission to cover the nine sectors in the EFRP yet maintain common approaches and standards through the work of the core group. The World Bank agreed that the draft EFRP would be produced in the field without being brought back to Washington for review, thereby accelerating the process and ensuring that the EFRP was a product of the mission and the Government rather than of the World Bank.

(e) It was important to get donor commitments to the EFRP quickly, so before the mission left Washington a donors' meeting was scheduled for the end of November at the Bank's Paris office. This put pressure on the Government, the mission, and the donors to produce a detailed document on which prospective donors could make funding decisions. The document would also identify areas in which existing projects with available funds could be reoriented to cover urgent reconstruction requirements — since donors might need some time to make new commitments even in an emergency situation.

Multidonor preparation of the EFRP

A number of sector specialists arrived in Sudan in late September to begin working with the Sudanese, who were already gathering reconstruction data by sector. The main mission — 50 people representing 13 donors — arrived in Sudan October 4. The mission, the donor ambassadors accredited to Sudan, and the Prime Minister and his cabinet met and clearly defined the next steps: preparation of the draft EFRP by the mission and Sudanese ministerial staff, Government review and approval of the EFRP, and submission of the EFRP to the November donors' conference. So large an area was affected by the flood and rains, and data were so unreliable, that the EFRP was to focus on (1) assessing the damage to productive capacity and essential social services (rather than on economic losses, about which there was much debate), and (2) preparing a two-year reconstruction program that could be implemented and disbursed over a three-year period — given Sudan's administrative capabilities. This represented a compromise between the Government, which wanted a larger EFRP for a longer period, and the donors, who thought that Sudan's near-term implementation capability should determine how much funding could be absorbed, even in an emergency.

In the next two weeks, while the subsector groups prepared their parts of the EFRP for submission to the core group, the core group met often with the local donor community to brief them on progress and to solicit their views. Every evening several of the sector subgroups presented reports on their progress to the core group; those meetings were open to all members of the multidonor mission. The core group also undertook several field missions to understand more fully the sector specialists' submissions. Several donors sent a number of sector specialists, while others were represented by only one or two staff members, so the briefings of the donor ambassadors and the nightly sector meetings allowed the donors to be fully informed about all aspects of the EFRP. Allowing for different viewpoints improved the quality and credibility of the draft EFRP and the donors' commitment to it — because it was truly a product of the multidonor mission rather than of the World Bank.

Highways was the first subsector group to finish its work. Highways produced a detailed

Flood reconstruction funding

Jonathan Brown and Mohamed Muhsin

Sectoral funding was allocated as follows:

Sector	Local cost ($ millions)	Foreign cost ($ millions)	Total cost ($ millions)
Agriculture	33.8	63.6	97.4
Rural water	6.6	17.4	24.0
Education	11.9	24.3	36.2
Health	5.9	32.7	38.6
Industry/construction	15.0	35.3	50.3
Power	5.9	29.0	34.9
Telecommunications	3.3	31.1	34.4
Transportation	7.9	25.6	33.5
Urban	31.3	25.0	56.3
Program coordination and flood prevention	0.6	1.4	2.0
Total	122.2	285.4	407.6

Agriculture: $97.4 million to rehabilitate infrastructure, provide credit and essential inputs, reestablish nurseries to stock perennials, and expand locust and pest control programs.

Rural water: $24 million to replace damaged rural water facilities and install new water systems in rural areas in the northern region where inhabitants of traditionally dangerous villages have volunteered to resettle.

Education: $36.2 million to rebuild 100 destroyed primary schools, import materials for self-help reconstruction of damaged schools ($10 million), and assist higher education ($2 million).

Health: $38.6 million to control malaria and diarrheal diseases, restore drug supplies, and rebuild physical facilities and equipment for health units.

Industry/construction: $50.3 million to increase cement production in Sudan's major factory (which did not meet demand before the floods for lack of spares and equipment) and $45 million to import building materials.

Power: $34.9 million for power reconstruction and rehabilitation.

Telecommunications: $34.4 million for reconstruction and rehabilitation of a telecommunications network that was in a deplorable state before the flood — to provide Khartoum, secondary towns, and some rural areas with minimum telecommunications service.

Transportation: $33.5 million for highways, $16.4 million of it for the Khartoum-Port Sudan Road.

Urban: Rehabilitation of infrastructure and services in Khartoum and a strategic plan for the city, in which services were minimal before the flood, and large areas unplanned.

Flood prevention: $500,000 to outline the requirements for setting up better data collection and a flood forecast system for the Nile. The EFRP was presented to the Prime Minister and his cabinet and so were three nonsector-specific issues about which the donors felt strongly: (1) equal treatment for southern refugees in Khartoum who had lost housing; (2) restoring a small amount of infrastructure that had been inadequate before the disaster to a higher standard; and (3) favoring more labor-intensive methods in some civil works, especially in urban areas (to create jobs), over the imports of heavy machinery favored by some Sudanese technicians. The Prime Minister resolved these issues and on October 25, 1988, the Government formally cleared the EFRP for distribution to the donors in preparation for the donors' conference. Soon thereafter the World Bank, in its coordinating role, established contact with the headquarters of several donors to clarify EFRP requirements.

description of the damage to productive capacity and a program for reconstruction in that subsector. The other sector teams followed highways for basic format and standard of quality. The core group concentrated on implementation issues, a major donor concern. It was decided to use existing implementation units in government ministries and agencies, beefed up where necessary. NGOs participated in the relief effort, but the Government was reluctant to channel donor funds for rehabilitation through the NGOs — preferring that their efforts should be freestanding, outside the EFRP framework. The core group agreed with the Government on the following implementation procedures:

(a) The Government would continue its policy oversight of the reconstruction effort through

the High Ministerial Committee for Rehabilitation (HMCR), chaired by the Prime Minister and composed of key ministers.

(b) A National Reconstruction Task Force (NRTF) with representatives from all implementing agencies would be created to ensure coordination of the multisectoral EFRP at the technical/agency level.

(c) A National Reconstruction Implementation Unit (NRIU) with a professional staff of Sudanese and expatriates would be established to service the NRTF and the HMCR and to help sectoral implementation units coordinate their work with donors and other government departments. The NRIU was to have access to the Prime Minister through the Minister of Finance and Economic Planning, to expedite the resolution of problems in implementation. The Government promised to name — and subsequently named — a highly qualified Sudanese (the State Minister of Finance) to head the NRIU before the donors' meeting.

The full draft EFRP was completed on October 17, 1988 — within two weeks thanks to the preparatory work of the Sudanese and the full integration of all mission subsector groups with their Sudanese counterparts. The EFRP represented a two-year time-slice of a reconstruction effort amounting to US$407.5 million with a 70 percent foreign exchange component (US$285.4 million) in the agriculture, rural water, education, health, industry/construction, power, telecommunications, transportation, and urban sectors and in program coordination and flood warning.

The donors' conference

A two-day donors' conference was held at the World Bank's Paris office on November 29, 1988. It was clear from the donors' reaction that the EFRP document had enabled them to see their contributions in a broad national and sectoral framework that, because of its detail, their technical experts could review in the month before the donors' meeting. And having most of the donors represented on the multidonor mission had enormously increased their commitment to seeing the process through — at the very time that the donors were rethinking their normal development programs in Sudan because of the Government's inability to make progress on a macroeconomic adjustment program and on negotiating a settlement of the civil war.

The main challenge of the donors' conference was to make sure that the full EFRP was funded, because the donors had different sectoral interests, types of assistance, procurement arrangements, and time needed to begin disbursements. EFRP components were merged with available donor funds in two ways. First, subsectoral technical groups met so that bilateral donors could indicate their preferences and make commitments to specific program elements, including lists of major equipment and material. Second, the multilaterals — essentially the African Development Bank and the World Bank — agreed to fund those program elements not taken by the bilaterals. In this way, the main elements of the EFRP were funded — although having two or more donors in a sector increased the burden on sectoral implementation units, the NRIU, and the World Bank (which would assist with donor coordination during implementation). At the other donors' request, it was agreed that the World Bank would fund the NRIU and would regularly keep the donor group advised of progress on implementation.

As a result of the Paris meeting, indications of donor financing amounted to about US$300 million — including the reallocation of funds from existing projects but excluding some promises of large private contributions from Middle Eastern countries. By and large, the bilaterals were able to make their funding available quickly. The World Bank's US$75 million IDA credit was approved by its Board of Directors only in June 1989, largely because of the Government's general instability. The African Development Bank's US$32 million was approved in January 1990.

Implementation and lessons learned

The World Bank began helping the Government with implementation after the donors' meeting, largely by exchanging information about donor pledges and procedures. The NRIU was staffed satisfactorily with high-level Sudanese, led by the State Minister of Finance. A 12-person World Bank mission visited Sudan in June 1989 to help with the startup of the Bank's own $75 million credit —which covered part of the funding for the agriculture, education, health, telecommunications, and urban sectors as well as funding for EFRP coordination and an early

warning system for floods. Five World Bank missions, often joined by other donors, visited Sudan between June 1989 and November 1990. Each mission was composed of three of the five members of the original core team plus other sector specialists involved in the first mission. At the beginning, during, and at the end of each supervision mission, meetings were held with the local donor representatives. The missions' aide-memoire and World Bank telexes summarizing the status of all donor funds were shared with all the donor organizations involved in the EFRP.

The Bank and other donors tried to maintain the same staff on the supervision missions. Just as the original mission could not have been staffed without the financial support of other donors, particularly the UNDP, so the supervision effort benefited from UNDP assistance to finance consultants. The stability of donor personnel was particularly important as the change of government at the end of June 1989 meant that key ministers and high-level civil servants, including essential NRIU personnel, were replaced by Sudanese who needed time and guidance to implement the EFRP efficiently because many of them had not been involved in its preparation.

The implementation phase taught several lessons, some of them relevant to aid coordination generally:

(a) The World Bank can help coordinate aid, especially with quarterly missions to summarize progress and pinpoint key issues, but the Government must feel real ownership of the aid coordination process. At times the NRIU initiated visits to donors, but only irregularly. Often the donors have had to take the initiative to contact NRIU.

(b) Having so many donors, each with different procurement and disbursement procedures, inevitably causes frustration and slows down implementation, particularly when the government's administration is weak. The Government rarely sends technical staff, who bear the brunt of procurement and disbursement work, to visit the donors to expedite matters. The NRIU has tried to help in this effort but there is no substitute for frequent, direct contact between donor agencies and the sector implementation units — particularly in Sudan, where telecommunications are unreliable.

(c) When it comes to implementation, each donor has its own procurement and disbursement procedures and reporting requirements, so donors are less likely to follow the technical advice of a lead donor than the donors were in the EFRP preparation mission. As a result, aid coordination becomes less effective in maintaining donor cooperation. But the donors want to be kept regularly informed of the EFRP's progress by both the Government and the World Bank.

(d) The donor efforts that have been most successful in Sudan have been self-contained and have not depended on contributions from more than one or two other donors. Unfortunately this limits the size of a program as most EFRP components are too large for any single donor.

UNDP coordination of disaster and development planning

Seyril R. Siegel and Peter Witham

Many disaster-prone countries are recognizing the need to formulate development policies that are more responsive to the need for disaster prevention and mitigation. Case studies of Bangladesh, Colombia, Ethiopia, and Jamaica illustrate how this is being accomplished. The UN system, especially the UNDP, has a special role helping governments strengthen links between disaster planning and planning for development. It will be upgrading the ability of its field offices to support governments in this area, through an extensive training program.

Rapid telecommunications and media coverage have brought to world attention visual evidence of the increasing number of earthquakes, hurricanes, landslides, floods, volcanic eruptions, and prolonged droughts. Increasingly these natural disasters have added to hardship in the lives of population groups already living in clearly unacceptable conditions. In Latin America, for example, the pace of urbanization and industrialization has exacerbated the devastating effect on cities of recurrent natural disasters. Each time disaster strikes, most of those who must be evacuated, lodged, fed, and cared for in temporary shelters are from the lower-income groups.

The effects of natural disasters are magnified by the chaotic and uncontrolled process of human settlement in urban areas. Until recently, environmental impact assessments, risk analysis, contingency programs, and the lessons learned from past natural disasters were rarely taken into account before new settlements were established, so natural disasters were costly to local and central governments (UNDP 1988).

Recent experience around the world illustrates how the effects of disasters can be mitigated by an effective system of predisaster activity (see boxes on Ethiopia, Jamaica, Bangladesh, and Colombia). Some countries are experiencing the same kinds of disaster more often than in the past, and some emergency situations could have been mitigated or even prevented. Several governments are paying increasing attention to disaster-related issues in their development planning.

UNDP involvement

The United Nations Development Programme (UNDP) has long been involved in disaster-related activities, in four ways: as a funding source; as the field representative of the United Nations Disaster Relief Office (UNDRO), and often as executing agent of disaster management projects, through its Office for Projects Services (OPS); and because the UNDP resident representative is often asked to help coordinate disaster relief.

Between 1971 and 1988, US$34 million was spent on 229 activities related to disaster relief, rehabilitation, preparedness, and prevention. Fifty-nine percent of those projects were con-

Case study: Ethiopia

Seyril R. Siegel and Peter Witham

The disastrous situation in Ethiopia needs little introduction. In 1988 alone, an estimated 7 million people were threatened by drought. The complex nature of the situation — the effects of drought compounded by civil strife — have posed many problems for development and relief agencies.

Disaster preparedness. In December 1988, a successful UNDP-funded seminar in Ethiopia was hosted by the Office of the National Committee for Central Planning (ONCCP), which has overall responsibility for development planning. This was a seminal event, as until this point there had been little attempt to integrate disaster preparedness into development planning. The links between the Relief and Rehabilitation Commission (RRC) and the ONCCP still need to be strengthened, however. One possibility is to strengthen the small disaster preparedness unit in the ONCCP. The functions of such a unit should be (1) to evaluate the preparedness and prevention programs of the line ministries, (2) to develop ways to strengthen the National Preparedness and Prevention Plan, and (3) to find ways to integrate disaster prevention and preparedness into other government initiatives.

Relief. A National Committee for Relief and Rehabilitation, chaired by the head of state, includes in its membership the Deputy Chairman of the Council of Ministers, the Deputy Chairman of the ONCCP, the Commissioner of the Relief and Rehabilitation Committee (RRC), and the heads of relevant ministries. The RRC is the body primarily concerned with the day-to-day coordination of the government's relief efforts. Interministerial committees are chaired by RRC officials at all administrative levels down to the awraja. The RRC's mandate is extensive, but it does not have the authority and resources it needs to implement its mandate effectively.

The UNDP's role

The UN system in general, and the UNDP in particular, places a high priority on focusing its programs on the relief-preparedness-development continuum. In response to the continuing emergency, the structure of the UNDP office was radically changed in late 1985. Before that date, the UN's office for Emergency Operations in Ethiopia (EOE) was separate from the UNDP office. The appointment of Mr. Michael Priestley in 1985 as the Secretary General's Special Representative, the Resident Coordinator, and the UNDP Resident Representative enabled the UN system (with considerable help from bilateral donors) to start building the same

nected with emergency relief. The $5 million in funds released to finance those projects were drawn from the UNDP's Special Programme Resources (SPR). Financial commitment averaged $37,000 per project. The other 41 percent of the projects addressed disaster rehabilitation, prevention, and preparedness. Funding of $29 million was financed from SPR and from country Indicative Planning Figures (IPFs). The SPR component for the financing of rehabilitation and/or reconstruction activities amounted to $14 million for 41 projects — usually direct-support, short-term (two- to three-year) projects to meet specific needs emerging from government programs targeted to populations in devastated areas (UNDP/UNDRO 1989).

It is UNDP policy to encourage the inclusion of disaster prevention and preparedness projects in country programs financed by the IPF. Of 50 projects that have been or are being implemented (at an average cost of $280,000), 31 aim to reinforce governments' ability to plan for disaster.

In 1988, a joint UNDP/UNDRO task force urged the UNDP to include disaster management and disaster mitigation activities more systematically in its program and project cycle. It is UNDP policy to do so, but only recently are governments fully appreciating these links. For the UNDP to help governments conceptually and institutionally link development planning with disaster preparedness, it has commissioned a study on institution-building, to identify lessons learned about how governments are addressing the effects of slow-onset or recurrent natural disasters and to recommend how the UNDP can best cooperate with governments in programs to mitigate the effects of disasters. This study, which is being carried out in three stages (including extensive field studies in three countries), is expected to be completed in January 1991.

The UNDP and UNDRO are about to launch a cooperative effort to train their staffs in disaster reduction, emphasizing the links between disaster reduction and ongoing development. The emphasis will be on training country personnel (UN personnel, NGOs, bilateral donor

type of links between disaster response and preparedness that had been advocated for the government.

In January 1987 a UN Emergency Preparedness and Prevention Group (EPPG) was established in Addis Ababa. Members of the EPPG include FAO, UNDP, UNHCR, UNICEF, WFP, WHO and the World Bank. Backstopping the EPPG is a UNDP coordinating unit many of the staff members for which have been provided from bilateral sources working on UN contracts. The advantages of this arrangement are that the unit benefits from the multilateral and "neutral" image of the UN, yet bilateral donors can help backstop the coordination effort. The unit's staffing can be easily adjusted in response to the changing emergency situation. The professional staff has declined from a high of 22 in 1985 (in the unit that predated the EPPG) to six in 1989. The coordinating unit plays a vital role in monitoring the relief activities not only of the UN but of bilateral donors. (EPPG reports are often quoted to the legislative bodies of donor countries.)

The EPPG and the coordinating unit collaborate with NGOs, primarily because bilateral donors have chosen to channel most of their relief activities through NGOs (in 1988-89 as much as 60-75 percent). EPPG is represented at the meetings of the 50-member Christian Relief and Development Association (CRDA).

Linking disaster response and disaster preparedness

Nationwide efforts in rehabilitation and reconstruction must inevitably await the end of civil conflict. The UNDP is helping the government prepare an emergency famine code. Needs that must be counted in this phase include the resettlement of displaced persons. Development activities should be targeted directly at these groups. Reconstruction efforts must tackle the underlying causes of periodic emergencies. Long-term efforts must be tackled through the country's regular development infrastructure rather than those government agencies responsible for emergency management.

The Conference on Disaster Preparedness and Prevention made recommendations that can only be summarized here. One conference paper, delivered jointly by representatives of the ONCCP and the UNDP, advocated the following measures, among others:

- Use preparedness as a platform for prevention. Food-for-work programs, for example, should be devised with longer-term prevention projects in mind.
- Look for preparedness components within current development programs. Reassess how current development projects can incorporate elements of preparedness.
- Link preparedness and prevention in all future project and program initiatives. The two components should be part of the criteria for virtually all future project and program proposals.

Agreeing about the desirability of such measures may be easy, the paper concluded, but substantial efforts must be made to strengthen institutions, improve communication between them, and provide clear guidelines for implementation. Herein lies the greatest challenge for the government and donors, including the UNDP.

representatives, and representatives of central government planning organizations) to work as a country team on disaster mitigation and response. About 1,800 people in 50 disaster-prone developing countries are expected to receive training of varying length and content in the next three to four years.

Coordinating disaster planning and relief

Within the UN system, there are formal mechanisms for coordinating predisaster planning and disaster relief. UNDRO's mandate is to be "a focal point in the United Nations system for disaster relief matters," but the resident coordinator of the UN system in each host country is responsible for coordinating UN cooperation with that country. In virtually all countries, the UNDP resident representative is also the resident coordinator. In this role, as stipulated in article 8 of General Assembly Resolution A/RES/36/225, "in response to a request for disaster relief from a disaster-stricken state, as necessary, and in particular in disaster-prone countries, the United Nations Resident Coordinator shall, with the full concurrence, consent and participation of the Government, convene meetings of the concerned organs, organizations and bodies of the United Nations system to plan, monitor and take immediate action to provide assistance."

In any case, the UNDP resident representative is UNDRO's ex officio representative at the country level. In this dual capacity, all resident coordinators serving in disaster-prone countries have been instructed to form UN disaster management teams. These teams are made up of country representatives of those UN organizations with a specific mandate in disaster management, such as UNICEF, FAO, and WFP. Each resident coordinator has also been instructed to nominate a senior UNDP national professional officer to serve as the "focal point" for disaster management matters in the UNDP office. As the case studies show, the UN team has played a significant role in coordinating the UN response in each country.

Case study: Jamaica

Seyril R. Siegel and Peter Witham

Jamaica lies squarely astride the path for hurricanes and tropical storms, which have caused widespread catastrophic losses. In the past 109 years, the island has experienced 21 hurricanes — an average of one every 5.1 years, the most recent of which was Hurricane Gilbert in September 1988. Hurricanes and tropical storms have been few and far between in the last three decades, but this is a historical anomaly. There is little reason to believe this pattern will continue.

In the same period, more than 35 tropical storms have either made landfall or passed near the island. Some brought much-needed rain, but others caused substantial, generally local, wind damage and brought floods that were especially damaging to agriculture. Tropical storms occur an average once every 2.5 years.

Hurricanes and tropical storms cause most of Jamaica's catastrophic losses, but the island also has significant earthquake exposure. The earthquake of 1692 submerged the better part of Port Royal and that of 1907 extensively damaged Kingston. Kingston and other urban centers would probably suffer heavy damage should another major earthquake occur.

Recent disasters

On 12 September 1988, Hurricane Gilbert struck the island with wind speeds estimated at more than 140 miles per hour. After the disaster, 810,000 homeless people were accommodated in 1,136 emergency shelters. Forty percent of the island's housing stock was badly damaged; close to 30,000 mainly low-income units were completely destroyed. Losses were an estimated US$1 billion: $300 million in public infrastructure, $260 million in housing, $200 million in manufacturing, $160 million in agriculture, and $80 million in tourism.

Banana, coconut, cocoa, coffee, and yam crops suffered severe damage and the broiler industry was shattered, with most birds and crops lost. Electricity was severely disrupted as both the generation and distribution facilities were damaged. There was also widespread damage to various public buildings such as schools, hospitals, clinics, and offices.

The hurricane came when Jamaica was beginning a steady economic recovery and the effect of a $1 billion loss on an economy with a $3 billion GDP was severe. Losses in tourism were relatively minor — more in cancellations and lack of services than in damage to physical facilities.

Casualties were relatively light — only 45 deaths were reported — mainly because of an efficient preparedness program administered by the Office of Disaster Preparedness (ODP), the Government's permanent professional agency responsible for disaster preparedness and mitigation. The island was fortunate that the expected storm surge, which would have caused extensive flooding, failed to materialize.

To understand the events following reconstruction, it is important to know that Jamaica was about to have a general election when the hurricane struck. The upcoming elections played a crucial role in determining the pace at which rehabilitation and reconstruction work was implemented.

Government arrangements

Disaster preparedness. The country's chief coordinating body for disaster preparedness is the Office of Disaster Preparedness and Emergency Relief Coordination (ODIPERC), established in July 1980. Overall policy is contained in a National Disaster Plan. In the event of a threatening, imminent, or actual disaster, ODIPERC assumes the lead in coordinating and activating the plan. It is supported by a National Disaster Committee, parish committees, and emergency services.

ODIPERC was established to create and maintain contingency plans at national, parish, and local levels; to promote public awareness of disaster threats and appropriate responses thereto; to monitor the effectiveness of hazard mitigation strategies; and to establish an emergency response when major disasters occur. ODIPERC has an ongoing program in public information and provides officials with disaster training. The responsibility of ODIPERC's director is to ensure that contingency plans are developed and activated for national

and major emergencies. He advises the prime minister and the minister of local government on disaster preparedness and maintains contact with government agencies, major donor agencies, and private sector groups.

Disaster response and relief. The roles of government agencies, emergency services, and volunteer agencies are clearly defined in the event of a disaster. The security forces and the fire department play a vital role in emergency and recovery situations. The security forces maintain law and order; search and rescue operations are coordinated by the fire department and emergency services, assisted by the Jamaica Defence Force. Government agencies such as the Ministry of Construction (Works), the Ministry of Social Security, and the Ministry of Local Government oversee repairs, rehabilitation, and coordination in disasters. The Ministry of Local Government supports the Parish Disaster Committees that arrange to procure resources (manpower, materials, equipment) in all 14 parishes and ensure their mobilization in emergencies and disasters.

Voluntary organizations such as the Red Cross, Project Accord, and the Salvation Army work closely with ODIPERC and the Ministry of Social Security. These autonomous bodies act as auxiliaries to the established public institutions. Because of their decentralized operations they are in a position to provide effective administrative links regionally and locally. ODIPERC coordinates the activities of these agencies through the Parish Disaster Committees. It supports the agencies by facilitating access to scarce resources and handles requests for external assistance — money, equipment, or technical assistance — so they can function effectively.

The UNDP's role. Hurricane Gilbert was truly a national disaster. Every one of the island's 14 parishes was affected. The suffering — particularly of the underprivileged — was exacerbated by the loss of most subsistence-income-generating activities through the destruction of cash crops, soil erosion, widespread flooding and water damage, the suspension of power and water supplies, significantly diminished health and sanitation services, and the suspension of schooling, transportation, and telecommunication services. At the same time, successive structural adjustment programs had resulted in diminished public services, layoffs, and cuts in public spending. With institutional capabilities severely depleted, the government asked the UNDP/UNDRO representative to coordinate relief needs with donor and international responses.

Working with the office of the Prime Minister, the UNDP chaired daily meetings between the donors, local and international nongovernment organizations, the UN system, and officials representing the sectors that had suffered damage. The UNDP and the ODP established a computerized system for tracking and monitoring all relief supplies and ensuring the precise specification of needs.

The UNDP helped the World Bank and other bilateral donors by providing the information and services needed to facilitate the damage assessments on which quick-disbursing reconstruction grants and loans would be based. A geographic information system was established based on earlier work by the OAS, and an interactive emergency information network was put in place in 11 government public utilities and departments to facilitate resource management in the reconstruction phase and in preparation for future disasters.

Several UNDP-financed postdisaster studies were carried out to provide information on which decisions could be made to improve national resource management and to reduce disasters' negative effects on the economy. The most important of these was "A Catastrophic Loss Insurance Programme for Agricultural Industries, Low-Income Housing, and Critical Public Services." This study points out that "no one can define with any measure of accuracy precisely which Government installations and services are critical. This would not be so important except for the fact that neither the GOJ [Government of Jamaica] nor the ministries and agencies thereof have an inventory of capital stock and their replacement values. The Government literally does not know what it owns, where it is or what it would cost to replace."

At the request of the government, the UNDP later redirected its country program using as a window of opportunity rehabilitation and reconstruction for structural changes in national resource management. This strategy has met with limited success, but has set a basis for significant improvement as there is now greater national appreciation of how disasters affect the economy.

Case study: Bangladesh

Seyril R. Siegel and Peter Witham

Bangladesh meets most of the conditions guaranteed to increase a country's vulnerability to natural disasters. It is a developing country. It depends heavily on its agricultural sector, but remains a net food importer. Deforestation is a serious problem and Bangladesh is the most densely populated developing country in the world, with an annual population growth rate of at least 2.6 percent. All these factors put enormous pressure on arable land and many people live where they are virtually defenseless against tropical storms and storm surges (such as the "chars" in the Bay of Bengal). Moreover, the topography of the country is such that at least 80 percent of the land area is subject to severe flooding. Worse, the country's major riverine systems originate outside Bangladesh, so the government has little control over the volume of water entering this almost totally deltaic and low-lying country. As a result, the country is subject to both drought and flooding.

Recent disasters

One of the greatest disasters of modern times occurred in Bangladesh (then East Pakistan) in 1970 when a huge cyclone struck the country's southern coastline, killing about 300,000 people. In 1985, another large cyclone hit the southern part of the country and the storm surge killed 10,000. In 1987, the country was hit by the worst floods in 70 years. The immediate death toll was about 1,000, and the IMF estimated that the country's economic growth rate for that year had been halved. In 1988, the country was hit by floods of even greater magnitude than those of 1987, inundating 53 of the country's 64 districts and affecting 45 million people—rendering about 25 million of them homeless. Just as the floods were receding, another cyclone hit the relatively less-populated southwest coast, killing about 6,500.

One can only guess at the economic effect of these disasters but at least 30 percent of the population (more than 30 million people) are landless peasants, totally dependent on sharecropping for income. Obviously, the medium-term consequences to them of sudden huge drops in agricultural production are grave. But there are also other costs. The floods of 1987 and 1988, for example, diverted government energies away from ongoing development work toward dealing with the effects of the floods. Thus damage from the floods is measured not only in GNP lost but in development postponed. "We have no margin for disaster," stated the Secretary of Planning in November 1988. Successive floods undermine investors' confidence in economic growth and inhibit development. On top of this, the cost of repairing or replacing capital stock was an estimated $1.1 billion for the 1988 floods alone.

Government arrangements

Disaster preparedness. The current (third) five-year plan of the Government of Bangladesh (GOB) makes no reference to the need to link disaster preparedness with ongoing economic and social development. Neither do annual development plans or sectoral plans. But so many people (and all development sectors) were affected by these floods that a disaster preparedness strategy for Bangladesh must encompass not only all government-sponsored development but also society as a whole.

Traditionally, the Ministry of Relief and Rehabilitation has been responsible for disaster preparedness and response. Two factors have inhibited this ministry's ability to fulfill its role. First, structurally, it is parallel to the regular "line" ministries, so it has not been in a position to participate in top-level or even sectoral planning. Second, its mandate is in effect directed to postdisaster activities. Current dialogue between donors and the GOB, therefore, focuses largely on the institutional arrangements needed in government so that the following functions can be performed: (1) changing the nation's development strategies and programs to reflect a proactive rather than reactive response to disasters; (2) taking steps to convert disaster forecasts into effective national and local warnings, which may involve revising government standing orders, simplifying bulletins, broadening communication channels, and mapping local vulnerability; and (3) analyzing the increased risk of disaster as part of environmental

impact assessments for proposed projects.

Overall responsibility for macroeconomic planning rests with the Planning Commission; most line ministries have planning cells. The *government-based* cast of actors must include the Bangladesh Water Development Board (BWDB), the Water Master Plan Organization, the Planning Commission, the Ministry of Planning (including probably the External Resources Division and the Implementation Monitoring and Evaluation Division), the Ministry of Relief and Rehabilitation, and the line ministries (including Agriculture and Forests, Fisheries and Livestock, Irrigation, Industry, Health and Education, Local Government, Rural Development, and Cooperatives). Nongovernment organizations (NGOs) such as the Red Crescent, the Grameen Bank, and the Bangladesh Rural Advancement Committee must clearly play an essential role in development and implementation of any national disaster preparedness plan.

Disaster response and relief. The country generally expects that in the event of a major natural disaster the presidential secretariat will coordinate the national response (not least the military and civilian relief efforts). This expectation was fulfilled in the 1985, 1987, and 1988 disasters. The immediate response of government — particularly the military — to recent disasters has earned relatively high marks from many observers, although the 1987 and 1988 floods revealed weaknesses in the response of many district and upazilla (subdistrict) administrations.

Rehabilitation and reconstruction. Four donors (Japan, France, the United States, and the UNDP) commissioned studies to examine the lessons to be learned from the 1987 and 1988 floods and to recommend more effective flood protection measures. These studies focused largely on the first of two types of institutional issues: the clear need to coordinate overall and local planning and implementation of any flood control strategy. The relationships between the "water-oriented" institutions are of particular importance in disaster control strategies.

A second category of institutional issues is even more complex — those concerned with the relationships and compatibility between needed physical measures for flood control (particularly the recommended "compartmentalization" approach) and ongoing development. Recent experience in Bangladesh has demonstrated that people will not hesitate to breach embankments if they perceive them as inhibiting the pursuit of their livelihood. Flood control measures must be planned carefully so they do not harm such activities as community forestry and inland fisheries. The whole issue of land use must be addressed. It features prominently in the terms of reference for the main regional studies coordinated by the Flood Action Plan panel of experts.

The UNDP's role. In the 1985, 1987, and 1988 disasters, both the government and donors asked the UNDP office to help the government coordinate the international response. The local UNDP office chairs and provides secretariat support to the permanent UN Disaster Management Team (DMT), which includes representatives of the Asian Development Bank, FAO, UNICEF, WFO, WHO, and the World Bank, plus technical specialists from such relevant UNDP-assisted projects as flood forecasting and warning and meteorological services. Government officials and NGO representatives attended most of the meetings.

In addition, the UNDP resident representative, with the government's full agreement, convened weekly meetings to which all donors (at the chief of mission level) were invited. Senior government officials also participated in these meetings. Within the UN system, each organization assumed responsibility for aspects of the disaster falling within its technical competence (for example, WFP for food aid and logistics and WHO for health requirements). The team's efforts were greatly assisted by consultants fielded by UNDRO. Some donors (notably the United States) used the UNDP as a mechanism for channeling assistance to the GOB, in both relief and followup phases.

In retrospect, it appears that the efforts of the UN system were appreciated both by the GOB and the donors. UN staff (particularly senior national officers from UNICEF and WFP) were in a strong position to provide up-to-date information on needs in the disaster-affected areas. The DMT collated this information and provided it to UNDRO headquarters, whence it was sent out in the form of telexed situation reports (SITREPs). Information gathered from various points in the country was made available immediately to local donor representatives. These SITREPs also included information on relief supplies and funds pledged and delivered by donors.

Case study: Colombia

Seyril R. Siegel and Peter Witham

Throughout its history, Colombia has suffered disasters and calamities with some regularity. The country is located in the Pacific "fire belt" and much of its territory is crossed by the Andes — exposing it to continuous seismic and volcanic risk. Its topographical, geologic, and climatic conditions cause periodic floods and frequent mudslides.

Recent disasters

The 5,400-meter-high volcano Nevado del Ruiz had been relatively inactive since a major eruption in 1945. Then, on the night of November 13, 1985, tremors and blocks of red-hot pumice melted part of the ice cap that crowns the volcano. A mixture of water, pumice, and soil sped down the mountainside, gaining speeds of 30 miles an hour as it descended along the Azufrado River channel and the Lagunilla River, already swollen by heavy rains. The mudflow arrived with such force that it collapsed a natural dam on the Lagunilla and swept away the town of Armero, located about 45 kilometers from the crater, killing about 22,000 of the 29,000 inhabitants. It caused another river, the Gualí, to overflow, carrying away houses and a bridge on one of the main roads to the Colombian capital, Bogotá. On the western side of the mountain, another mudslide descended upon the Chinchiná coffee-growing area, destroying 400 houses and killing more than 1,000 people. The economic loss to the social and productive infrastructure was estimated at the time to be more than $211.8 million.

This disaster was known worldwide, but Colombia has also been affected by less well-known events such as earthquakes in the Antigua Caldas region (1979) and Popayan (1983) and a seaquake in Tumaco (1979). In September 1987, after several days of heavy rain, a landslide buried 500 people and destroyed 300 houses in Villa Tina, a poor slum in the city of Medellin. And in 1988, winter floods that are common in Colombia's northern plains were made worse by Hurricane Joan.

Government arrangements

The national system for disaster prevention and assistance. Not until after the tragedy of Armero did the government realize the importance of developing an appropriate policy for preventing and managing emergencies, particularly from natural disasters, or realize that such planning and prevention should be part of national development policies. In 1986, the National Office for Disaster Prevention and Assistance (ONAD) was created within the administrative department of the office of the Presidency of the Republic. In November 1988 Congress approved a law creating the National System for Disaster Prevention and Assistance. In May 1989 the National System was regulated and all related norms were codified in Decree 919, which defined the functions and responsibilities of various national and local public, autonomous, and private institutions.

This far-reaching decree calls upon ONAD to develop a full plan for the prevention of and attention to disasters. This plan is to cover all policies and programs related to all economic, financial, social, legal, and institutional aspects of prevention, response, reconstruction, and development, including education, training, community participation, information and communication systems, institutional and sectoral coordination, scientific research, technical studies, and control and evaluation.

Disaster response. Decree 919 created the National Technical Committee to coordinate the work of national and international organizations, with the support of special commissions and advisory groups. Decree 919 also established a National Operative Committee, a front-line disaster management unit responsible for immediate operations when a calamity occurs.

Regional and local administrations throughout Colombia are beginning to organize local emergency committees to prepare for and handle disasters in each municipality. These local committees helped in 1988 when Hurricane Joan struck the northern coast of Colombia and when the Galeras and Cumbal volcanos created emergencies. Local assistance was significantly improved during that 1988 rainy season — the worst winter in Colombia's recorded history, affecting 400,000 people in 21 of the country's 30 territorial subdivisions. The work of high-level and local emergency committees, together with a full public information campaign, created the conditions needed for successful disaster prevention and adequate assistance in providing food, health care, and temporary shelters.

To maintain the basic commodities needed in an emergency, reserve emergency centers are being created in easily accessible locations around the country. The commodities stored in these centers are national property in the custody of local authorities, for use when needed locally. All parts of the national communication system have been integrated into a true emergency network.

Rehabilitation is focused on repairing and improving roads, providing agricultural credit programs for crops, and rebuilding and repairing housing. To reach

these objectives, the National Disaster Fund provided more than $7 million, in addition to funds other national organizations provided.

Disaster prevention. Risk prevention, now part of Colombia's development policy, has been incorporated in the Urban Reform Law as well. National organizations must now incorporate this concept in their development plans, in the design of regional and urban projects or civil works of great magnitude, and in industrial activities that could present a threat of any kind to the population. They must keep in mind that ecological degradation and inadequate environmental protection help precipitate, and worsen, disasters. Government planning offices at all levels must now define and initiate actions aimed at risk prevention and mitigation.

Long-term, high-cost programs to preventively relocate towns and villages located in high-risk areas have begun. First, those parts of the country where danger is imminent must be identified town by town. Several towns in dangerous locations have begun programs to relocate to safer areas. The Urban Reform Law provides the basic legal framework in which this type of activity takes place. This kind of activity is likely to grow in importance.

An alternative is being proposed for the traditional approach of establishing temporary settlements in an emergency. Under the new approach, displaced Colombians are housed in the homes of those unaffected by a disaster who voluntarily offer their homes. A small fee is paid to the host family.

For homes scheduled for partial or total reconstruction after a disaster, the priority is location in low-risk areas. Reconstruction programs are to emphasize community participation and efficient institutional support. The solution for new housing is to provide a basic unit for immediate occupancy, leaving all refinements, additions, and subdivisions for later, under established credit programs. (Gone is the concept of free housing.) In the aftermath of last year's rains, 2,500 houses are either repaired or being repaired, and 2,000 new homes are under construction.

Important progress has been made in developing a national risks inventory, coordinated by the national Technical Committee. More than 800 of the 1,009 municipalities have provided information. The National Geologic Institute (INGEOMINAS), which operates the National Vulcanologic Observatory, is in charge of volcanic surveillance — seismological and deformation data on Ruiz, Galeras, Cumbal, Tolima, and Machin volcanos. Preliminary risk maps are available for these volcanos and Huila. Aerophotographic surveys of all active volcanos in the country are made periodically. In 1991, a seismic network via satellite will begin operating nationwide, with a receiving center in Bogota and a portable network as well. For this program INGEOMINAS has the support of the UNDP and the Canadian government. The National Institute for Water Management (HIMAT), with technical support from the UNDP, has made substantial progress in systematizing a network via satellite of hydrometeorologic alerts. When this system is operating it will be used to survey the nation's waterways.

To build the concept of prevention into Colombian culture, a program has been defined to incorporate prevention issues in school programs, both formal and nonformal, at all levels. Efforts are also being made to include in all school textbooks prevention issues appropriate to conditions in each region.

The UNDP's role

Immediately after the tragedy of Armero and the landslide in Villa Tina, the UNDP was called upon to help the government assess damages, mobilize international support (for Nevado del Ruiz, an international appeal by the UN Secretary General), and implement followup activities. The UNDP (with UNDRO) provides information to the international community. A $2 million project later expanded by the government was approved for rehabilitating and rebuilding the area affected by the Nevado del Ruiz eruption. Part of this project is to improve the government's ability to mitigate the risks and respond to emergencies. ONAD and the National System for Disaster Prevention and Assistance were created as part of this effort. This project is being evaluated so lessons learned can be shared with other countries.

As a result of the 1988 floods, the UNDP has supported a project to rehabilitate the zones affected in Cordoba. In addition to support for the National Seismologic Network, the Hydrometeorologic Alert Network, and the Volcanic Surveillance, the UNDP is helping to support a project on integrated management of prevention and disaster assistance in the urban zone of Medellin.

With ONAD, the UNDP has given administrative support to developing an UNDRO program for risk management for 60 local and national groups. In this pilot project, a first step in the UN's International Decade for Natural Disaster Reduction work is being undertaken in several high-risk areas: in Cali, on seismic risk; in Tumaco, on tsunamis; in Ibague, on the Tolima and Machin volcanos; along the Combeima River, on sudden floods; in Paz del Rio, on landslides; and in several parts of the country on industrial risks.

One of the most important lessons from the Colombia experience has been that projects to rehabilitate and reconstruct areas affected by disasters should build prevention and risk mitigation programs into development planning.

This case study was prepared in consultation with Colombia's National Office for Disaster Prevention and Assistance.

The role of nongovernment organizations in Sri Lanka

Austin Fernando

In developing countries, the words "people's participation" are often viewed as a catch phrase more than a reality. But nongovernment organizations (NGOs) can help make them a reality by serving as catalysts and mobilizers in group formation and activity — as Sri Lanka's Emergency Relief and Rehabilitation Program demonstrated. NGOs must be encouraged to play this role — partly, perhaps, through training in skills and management, partly through exposure to new experiences directed at changing NGO attitudes. The underlying goal should be to change NGOs from a charity and relief orientation to a development orientation.

In July 1983, violence broke out in Sri Lanka in the wake of conflict initiated by terrorist groups in the north. At first, about 125,000 people were displaced. With further violence in the north and east, the displaced population grew — at one point to about 800,000 — and to some extent migrated from one district to another, its situation aggravated by the efforts of security forces to quell violence. The loss in government assets has been assessed at US$500 million. Losses in revenue and produce probably cannot be assessed with accuracy.

Sri Lanka and India signed an accord in July 1987 and the international donor community responded to the government's call for foreign aid for reconstruction and rehabilitation with pledges of up to US$493 million made at a Special Donor Group meeting held in Paris in December 1987. This aid was intended to strengthen the peace process and to rebuild affected areas to a state of normalcy.

The donors were basically prepared to work through existing government agencies, although a few — mainly Australia, Canada, Norway, Sweden, the Netherlands, the United Kingdom, and the United Nations High Commissioner for Refugees (UNHCR) — were also interested in working through nongovernment organizations (NGOs). The total commitment to the NGOs from these countries and organizations was small except for Norway, the UK, and the Netherlands. (Dutch assistance has not yet been finalized, although some assistance has seeped to the affected areas through NGOs.)

NGOs have been used in Sri Lanka's Emergency Reconstruction and Rehabilitation Program (ERRP) in several ways: through involvement in government-sponsored programs (for example, the Thrift and Credit Cooperative Societies' involvement in housing); through independent NGO projects or programs (such as grassroots sanitation and nutrition programs); through support to the local NGO community by foreign donors and NGOs; and through activities involving cooperation between foreign and local NGOs. The legal framework in which

NGOs function is less restrictive in Sri Lanka than in neighboring countries, so their freedom of action is more or less unlimited. Government policy on NGOs is said to be so positive that it "goes beyond noninterference to a policy of positive facilitation."

Levels of NGO involvement

Broadly speaking, organizationally NGOs are involved in relief, rehabilitation, and reconstruction in Sri Lanka at the village, district or divisional, national, and international levels.

NGOs existed at the grassroots (village) level before 1983 and have by and large continued to function since — some more effectively and some less. Examples of local NGOs include the rural development societies (RDSs), women's rural development societies (WRDSs), thrift and credit cooperative societies (TCCSs), dairy cooperative societies, funeral aid societies, school development societies, and hospital development societies.

Although sometimes dominated by rural elites or prone to factional politics, local NGOs are in a good position to help affected communities help themselves in reconstruction and rehabilitation activities. The important Multipurpose Cooperative Societies (MPCSs) — although politicized to some extent — have historically been the main suppliers of relief goods in disaster situations. One important NGO created by statute is the Gramodaya Mandalayas, in which almost all accepted NGOs in a village headman's area are represented.

District or divisional NGOs are typically either new organizations that emerged after 1983 to meet specific relief needs in times of crisis, or NGOs that had existed before 1983 but whose main function or experience had not previously been in relief and development (for example, local Rotary Clubs or Young Men's Hindu, Christian, or Buddhist Associations). These NGOs are usually better able to involve local communities and to operate cost-effectively than international NGOs.

National NGOs, sometimes with a provincial/district presence, typically have some relief and development expertise. Some, such as the Saukyadana Movement, concentrate on a specific sector — namely, health. Others, such as Sarvodaya or SEDEC, are involved in a wide range of activities such as community organization, income generation, health, and education. More experienced, trained personnel are found in national NGOs, sometimes funded by foreign sources.

Some *international* NGOs were working in Sri Lanka before 1983, but others began operations after 1983, to assist in relief, rehabilitation, and reconstruction. Some have specific sectoral mandates. Medicins Sans Frontieres, for example, has been providing professional health personnel to four hospitals in the northeast since 1987, besides helping UNHCR repatriate refugees from India. Others have geographical mandates agreed upon by mutual consultation among NGOs or by government requests and help in a range of activities, including housing, health, and income generation. Some, such as Redd Barna and CARE, are largely operational — that is, they run their own projects or programs with their own (mostly local) staff. Others, such as OXFAM, largely confine their role to supporting district and national NGOs through funding and training. Personnel in the international NGOs are better trained and more experienced than personnel in other NGOs.

Limitations of the NGOs

Certain characteristics of the NGOs limit their effectiveness in reconstruction and rehabilitation and these limits must be acknowledged. These limitations include local constituencies, a largely middle-class (male) leadership, an orientation toward relief and charity, financial weakness, and a somewhat diffused accountability.

Local constituencies. Some national or provincial NGOs have bravely tried to work with all communities, but many of the indigenous NGOs have focused on their own local constituencies. The international NGOs are at an advantage in terms of their relative ease of access to all communities, perceived neutrality, and acceptability to all parties in the conflict. Not that they have no bias at all, but accountability to their donors and attitudes in headquarters limit it.

Middle-class leadership. Typically leadership of many NGOs — except for grassroots organizations — is mainly in the hands of an elite. Officers of these organizations tend to be middle-class, middle-aged men — often retired govern-

ment officials. In areas where such elite groups are scarce, NGOs are scarce too. There are good reasons why this is so. First, most donors — international NGOs, embassies, or High Commissions—need English-speaking counterparts to formulate proposals and prepare project reports. Retired public officials are not only more likely to have the time to take on this sort of voluntary work, but are more knowledgeable about government procedures—and are more likely to know which public doors to knock on or whom to approach to facilitate matters effectively. At a time of largely youthful conflict, donors are reassured by the "respectability" of such leaders. Further, Security Forces more readily give elite leaders access to affected communities.

So it is understandable why an elitist NGO leadership has emerged. In fact, with youths stirring up ethnic conflict, this elitism has been a blessing in disguise, ensuring the smooth execution of projects and programs. But it does mean that some NGOs have difficulty in effectively involving the poorer, more disadvantaged sections of the community in their own rehabilitation and reconstruction programs. Women, for example, who often bear the brunt of the conflict, are also often kept on the sidelines in NGO rehabilitation programs.

Several attempts have been made to establish NGO umbrella groups, to ease the donor agencies' grant-processing burden and allow for better coordination. But in practice high-profile "super-NGO" bodies have proved vulnerable to pressures from terrorist groups.

A charity and relief orientation. For NGOs that became involved in response to the critical needs of refugees or displaced people, the initial emphasis was rightly on supplying such items as food, clothing, medicines, and drinking water to those affected. This pattern of handouts encouraged a "charity approach" in NGOs, and a "dependency syndrome" in beneficiaries. Understandably, both NGOs and beneficiaries have had problems switching to the slightly harder-nosed development approach that may be required in reconstruction. Because of the frequent need for relief work between 1983 and 1989, many NGOs are structured more for relief work than for longer-term reconstruction work, which requires involving the affected communities in planning and implementation. Relief operations are by their nature apt to be top-down and nonparticipatory. It is not easy to change from being a "giver" to being a "mobilizer" or "catalyst," the role I believe NGOs could usefully play in reconstruction.

Financial weakness. Most of the indigenous NGOs have no regular source of income. They depend on local donations and grants from international donors for specific relief schemes or rehabilitation projects. Few receive regular financial support to pay their staff salaries and other running costs. Not surprisingly, they rely heavily on part-time voluntary workers and lack the time or staff for the more complex work of reconstruction. Limited funds prevent trained, qualified managerial personnel from getting involved with indigenous NGOs. Strengthening many of these NGOs through training and more regular funding is an obvious need.

Some local NGOs try to develop their capital assets and organizational infrastructure through reconstruction and rehabilitation projects, but because of their inability to pay competitive salaries, some of their most effective personnel leave for more lucrative positions in national or international NGOs that provide services to the ERRP. This higher pay has been possible because the NGOs have received donor assistance under the ERRP.

Accountability. The ethnic nature of the conflict in Sri Lanka affects the nature of NGO accountability. The smaller, relief-oriented, local NGOs are responsible and accountable to a limited community. Organizations such as the thrift and credit cooperatives are accountable to government functionaries as well, as expected by law. District and national NGOs are accountable to the management of foreign or local funding agencies and sometimes to government functionaries coordinating NGO rehabilitation and reconstruction activities. Foreign or international NGOs are accountable to the ministries with whom they register on arrival in Sri Lanka and to their headquarters and funding agencies.

A common feature of accountability was observed in the background in which the NGOs were functioning. With no parliamentarians in many of the affected areas, government officials became the sole authorities and representatives of the people. Their actions were guided by rules and regulations, and to some extent the NGOs were expected to be the medium through which the people's voice and feelings were represented to government officialdom.

Part of the design of the ERRP was a District Reconstruction Coordinating Committee in which NGO representation was permitted. The designers had in mind the need for the views of affected groups to be reached through such NGO representation. Both government officials and NGOs had an unwritten accountability to such groups. Some conflict arose when more than one group of terrorists in a village, district, or province was interested in being heard and represented. At different times the NGOs were accountable to different groups who made inquiries about any diversion of funds.

Contributions of the NGOs

Despite these limitations, the NGOs have greatly helped in Sri Lanka's relief and reconstruction program in the last seven years. Whenever there have been major outbreaks of violence or natural disasters such as floods or earthslips, NGOs have helped meet the *immediate relief needs* of the affected. In times of emergency, many indigenous NGOs — Sarvodaya, SEDEC, LEADS, and Saukyadana, to name a few — routinely tend the sick, remove the injured to hospital, and help install water and sanitation systems, among other activities.

NGOs have also *filled gaps in government services* when these have been interrupted by conflict. Medicins Sans Frontieres has provided doctors and nurses in severely understaffed hospitals in the north and east. Save the Children Fund's (UK) training and support of rural health assistants has compensated for the shortage of government primary health care workers in many areas. CARE's seed paddy production program has made up for shortages created by drought and interruption of the Agriculture Department's regular programs.

NGOs have helped the government and UNHCR with the *immediate resettlement* of refugees and displaced people returning to their home areas. Sarvodaya, OXFAM, Redd Barna, and SCF (UK), among others, have helped speed up the rehabilitation process by providing temporary shelters, cleaning drinking water wells, and providing seeds, agricultural implements, fishing nets, and other items needed for resettlers to resume their occupations.

NGOs have also provided valuable assistance at times when the government could not easily move into affected areas (for example, providing food during the Vadamarachchi operation). They have *supplemented government programs* (for example, by upgrading housing and sanitation) and have *supported families entitled to government benefits* (such as widows entitled to death assistance).

How NGOs can help in reconstruction

Now that NGOs are involved in long-term rehabilitation and reconstruction, what roles can and should they play? Areas in which they can be particularly helpful include housing, income-generation programs, the most-affected persons scheme, small-scale reconstruction, vocational training, counseling and reconciliation services, and special assistance to women.

Housing

Under the ERRP's Unified Assistance Scheme (UAS), formulated by the government, affected families with monthly incomes below Rs 700 are eligible for a grant of Rs 15,000 per house (about US$450). The National Housing Development Authority makes payments to beneficiaries at different stages of construction, although in some cases building materials donated by donor governments are supplied instead of money. In some areas beneficiaries have difficulty finding needed building materials such as bricks, tiles, and door and window frames. NGOs could help beneficiaries find or produce building materials. One possibility is to organize the salvaging of materials from debris, the collection of sand, or the operation of community brick kilns or carpentry workshops. Another possibility is to organize the community to make use of materials already available from donor governments. Some NGOs have already tried getting building materials to beneficiaries, or producing building materials in certain areas, but much more could be and has to be done.

Timber for building houses has been expensive and in short supply so there have been attempts to illicitly fell trees. Law enforcement on timber felling has been understandably weak and damage to the environment has been overlooked. NGOs and government authorities may have to educate the population on the dangers of this practice. Community forestry could be developed to prevent environmental degradation. It might be possible to mobilize women for this type of activity.

The Red Cross's changing role

Jurg Vittani

The League of Red Cross and Red Crescent Societies was founded in 1919 to coordinate international assistance for natural disasters. Increasingly its mandate has been extended to preventing disasters, including those resulting from human actions and degradation of the environment.

What is commonly called the "International Red Cross" is in fact a rather complicated federation of independent components that serve as auxiliaries to public authorities. The idea of the Red Cross was born on a battlefield. In 1859 Henry Dunant, a citizen of Geneva, was a chance witness of one of the bloodiest battles of the nineteenth century, near Solferino. Moved by the horrifying sights, he spontaneously organized help for hundreds of suffering soldiers. Back in Geneva, he wrote a book about his experiences, *A Memory of Solferino*, in which he suggested creating national relief societies that, in peacetime, would train voluntary members who would supplement the army medical services in wartime. Dunant also proposed that the wounded, and all those taking care of them, be regarded as neutral — even on the battlefield.

In 1863, specialists from 16 countries met in Geneva, adopted a resolution, and agreed on a founding charter defining the Red Cross's functions and working methods. This led, in 1864, to the first "Geneva Convention for the Amelioration of the Condition of the Wounded in Armies in the Field." Since then, the International Committee of the Red Cross (ICRC) has brought protection and assistance in time of conflict, in all situations requiring a neutral intermediary.

The League of Red Cross and Red Crescent Societies — the world federation of the 149 current National Red Cross and Red Crescent Societies — is the second component of the International Red Cross and Red Crescent Movement. The League was founded after the first World War, in 1919, when everybody hoped that there would never be another war. Since its foundation, one of the League's main tasks has been to coordinate international assistance for natural disasters. The League has coordinated more than 750 relief operations since 1919.

The changing nature of disasters

When the League's Secretariat in Geneva receives an appeal for international assistance from a National Red Cross or Red Crescent Society in a disaster-stricken country, after an on-the-spot assessment of needs, it relays the resulting appeal to its member societies. They in turn respond with contributions in cash, kind, or services. On the average, in the last 10 years, the Secretariat has received an appeal for international assistance every 10 days. Out of more than 750 interven-

INCOME-GENERATION PROGRAMS

The two main ERRP programs designed to help poorer affected groups generate incomes are the *Productive Enterprise Grant* (of Rs 4,000 for families with monthly family incomes below Rs 2,500 whose livelihood has been interrupted) and the *Microenterprise Loan Scheme* (under which government loans of up to a maximum of Rs 5,000 per borrower are available to district-level NGOs for onlending at 4 percent to affected people for income-generating schemes).

NGOs cannot directly handle the Productive Enterprise Grant (PEG), which goes directly to the beneficiary, but they can help beneficiaries prepare viable projects, initiate and organize group activities, purchase inputs, and market outputs. For instance, NGOs could help beneficiaries *organize* tractors or livestock for plowing in difficult areas, to maximize use of the PEG for agriculture (cattle herds were wiped out during the long conflict). They should be sure of enough supplies to make such a scheme manageable before participating. For activities such as fishing — which often cannot be done individually but requires joint participation for the purchase of boats, nets, and other equipment — NGOs can help mobilize and organize the fishermen or support existing fisheries cooperatives (people's organizations). The NGO's role should be that of a catalyst, not a provider.

Larger NGOs can also help with *marketing* — not by marketing produce themselves (for which they are usually not equipped), but by encouraging links with MPCSs and other local organizations and traders and by helping farmers and fishermen develop effective marketing strategies. To help compensate for the unpredictable,

tions in the past 71 years, more than 30 percent were for floods, and not quite 15 percent were for earthquakes, followed by drought-induced famine, typhoons or cyclones, and refugee operations.

The number of interventions because of environmental degradation has increased regularly in the last few decades. The League's founding fathers would undoubtedly have referred to such events as "Acts of God." Nowadays the League sees them increasingly as "Acts of Man": the ruin of the environment, the destruction of forests, rapidly progressing desertification, and pollution of the atmosphere. Our environment is degenerating rapidly because of the technical revolution. The population explosion is also a problem. These are problems the League of Red Cross and Red Crescent Societies cannot tackle. They are the tasks of government. The League's principles and rules clearly state: "Prevention of disasters is first and foremost the responsibility of the public authorities."

The changing role of NGOs

As the world's largest humanitarian organization, with more than 250 million members and well-trained volunteers in 149 countries, the League and other nongovernment organizations (NGOs) can fulfill their role as auxiliaries to the authorities. As early as 1972, in Stockholm, in the first UN Conference on the Human Environment, the League — as spokesman for the NGOs in the plenary meeting — stressed the importance of timely and adequate assistance in natural disasters. Recommendation 18 from that conference is of particular importance to the League. It stresses the importance of observational systems and communication networks for disaster detection and warning — and particularly mentions close cooperation with NGOs.

In the late 1960s, with the aid of the Nordic Red Cross Societies, the League had already started to build a cyclone-warning network in what was formerly East Pakistan (now Bangladesh). In Cox's Bazar — an area hit often by cyclones and one of the most densely populated areas in the world — the Red Cross built a radar cyclone-tracing station and equipped Red Cross first-aiders with transistor radios and alert equipment (such as sirens and fire rockets) with which they could warn people. So-called "killas" (artificial hills) were built, upon which people could take refuge from approaching tidal waves.

After a devastating typhoon in 1977 that left more than 10,000 dead, the Red Cross built cyclone shelters in Andhra Pradesh. Between cyclone seasons, they are used as community centers. If the typhoons that hit that region in 1990 (with wind speeds higher than those in 1977) caused far fewer victims, it is certainly because of the preventive measures that had been taken.

In several African countries, the Red Cross is still actively involved in tree-planting operations, to prevent increased desertification. Red Cross youth play a particularly active role in such activities, combining practical action with educational programs that stress the importance of a healthy environment for future generations. Last year the National Red Crescent Societies in North Africa actively helped public authorities fight locust invasions. In overcrowded refugee camps in Africa, where overcutting of fuelwood represents a serious environmental problem, the Red Cross has provided alternative forms of fuel and promoted the testing of solar energy. These tests have not yet provided a final solution to the problem. Let us hope that in the not-distant future technical developments will help stop the vicious circle that results in degradation of the natural environment.

they could help organize manageable processing activities such as dry or salt fish production or paddy processing. In the Polonnaruwa district, MPCSs have fared extremely well in paddy processing. The added value gained by processing can be recycled to the affected population.

NGOs were slow in taking up the microenterprise loan scheme because of administrative difficulties and lack of expertise in project formulation. But now some local NGOs that have close contacts with national and international NGOs have come forward to participate in the scheme. With the changing attitude of donors such as the IDA — which, incidentally, funded this microenterprise loan scheme — toward using NGOs in rehabilitation, this opportunity to make the microenterprise loan scheme successful could be a starting point for more assistance, even in other fields of development.

The international and large NGOs could do more to strengthen and mobilize the smaller, grassroots NGOs to participate in the PEG and the microenterprise loan scheme. These smaller NGOs are more likely to be effective in getting people to participate in sustainable long-term reconstruction. Some work has already been done in this area. The Federation of Thrift and Credit Cooperatives Societies (TCCSs), for example, has sponsored and trained local TCCS branches, to revive effective credit mechanisms in affected areas. Priority must be given to credit management training. If operation of the loan scheme is unsuccessful, donors such as IDA who boldly ventured to try out the loan scheme through NGOs would be discouraged from doing so again. Also, this credit was meant to support

Learning from traditional responses

Charles Sykes

To improve communications and technology in disaster reduction strategies and sustainable development, NGOs and local groups should be involved in the planning and design of disaster mitigation programs and projects. Their knowledge of basic survival responses and practices — which multilateral and bilateral donors and northern NGOs have tended to ignore — should be the base for externally assisted disaster mitigation projects in the 1990s.

CARE was founded as a relief organization 43 years ago so North Americans could help the people of war-torn Europe, but its primary focus has long since shifted to development and relief in the low-income countries of Asia, Africa, and Central and Latin America. Support — under the banner of CARE-International — now comes from seven European and two Pacific countries as well as Canada and the United States.

Of the tens of thousands of nongovernment organizations (NGOs) in international and national development, few, if any, have as their primary purpose the prevention or mitigation of disasters. But an increasing number of NGOs are carrying out small to medium-size projects with a disaster mitigation dimension. Numerous projects focus, for example, on:

- Reforestation of fragile lands.
- Halting desertification.
- Erosion control.
- Improved housing in vulnerable areas.
- Hillside terracing.
- Introducing fuel-efficient stoves.
- Integrating agriculture and forestry practices.
- Road repair and maintenance.
- Immunization and oral rehydration.

Many of these projects address the inextricable link between disasters and natural resource depletion. The worst victims of this link are the environmental refugees from fragile lands, lands that have been severely depleted by overgrazing, fuel needs, and adverse climatic conditions.

One of the most challenging tasks of disaster mitigation for developing countries, NGOs, and multilateral and bilateral donors alike is how to fence off or protect ongoing development projects and programs during disasters. If development is viewed as a linear process and disasters as an interruption of that process, the challenge is clear: how can those resources be best used to shorten the interruption? More interesting, how do we best deploy relief resources to protect rehabilitation and development?

Most NGOs would probably look for answers to those two questions in the disaster-prone areas themselves, with the communities and people most likely to be affected. There, the first question we must ask is, what traditional forms of mutual aid and self-help are practiced in emergencies and under stress? Significant resources are available from the international community, but we have seldom assessed the resources made available by clan, tribe, kin, and community, which represent the first aid administered — well before external assistance arrives. With few exceptions, our first order of business in vulnerability reduction and mitigation is to learn from traditional responses and strengthen local capabilities.

In 1968, after severe flooding in the Chittagong district of what is now Bangladesh, CARE was engaged in a self-help housing reconstruction project using soil-stabilized blocks, working with local cooperatives. During floods, cyclones, and tidal bores, the home serves as a refuge for family, animals, and seeds for the next planting season. In the community motivation phase of the project, CARE prepared articles for the local newspaper to promote community support, and commissioned a local bard to set lyrics to music about the project and travel to local villages singing the praises of self-help housing. While the articles were being read by urban elites, the bard was far more successful in disseminating the message to the rural communities at the heart of the disaster.

Bangladesh was hit by devastating floods again in 1987 and 1988. This time, a Bangladeshi NGO, the Grameen Bank, responded with housing loans to its creditworthy borrowers, principally poor landless women. As a national development institution, the Grameen Bank's purpose is to improve the conditions of the rural poor. By building housing loans into its menu of productive credits to the poor, the Grameen Bank has dramatically altered the conventional wisdom that improved housing is simply a highly inflationary component of social welfare. In a disaster-prone country such as Bangladesh, adequate housing protects both the family and its limited but critical productive assets. The Grameen Bank also provides preparatory housing loans for the purchase of the land on which the house is built. The Grameen Bank provides the institutional lending base for the poor to effectively participate in disaster mitigation at the most basic level. A good deal can be learned from the work of developing country NGOs, much of it applicable in more affluent countries.

During the famine in Ethiopia in 1985-86, CARE worked with Borana and Gabbra pastoralists in the Sidamo region to bring ani-

mal populations into balance with scarce water resources. Lengthy discussions with tribal leaders and careful analysis of available water resources convinced us that the affected pastoralists had already pared their herds back to a level consistent with declining water resources. This was not a new experience for the herdsmen. They recognized they all had to make sacrifices and had done just that, without external assistance or advice. CARE's role then became one of supporting their wise decision by helping them rehabilitate wells, build ponds, boost calf production with improved fodder, acquire farm tools, and develop and market handicraft products.

More attention should be paid to training and education about disaster mitigation — that is, to translate science and technology into the vernacular. We must find out what traditional forms of self-help and mutual aid are practiced in times of stress and build on that knowledge. External assistance organizations must reevaluate their starting points. Local NGOs and communities in disaster-prone areas are too seldom consulted or involved in the planning and design of disaster mitigation programs and projects. Too often, they are simply "objectified," thus ensuring responses and solutions that are not sustainable.

youths who have given up education and job possibilities. Its failure would mean one more frustration to draw them back to the jungles. Every effort should be made to prevent that happening.

Most-Affected Persons (MAP) assistance scheme

Under the MAP scheme, families whose breadwinners have been killed in the conflict are eligible for assistance of up to Rs 50,000 per deceased breadwinner. NGOs have helped potential beneficiaries in some areas with the paperwork involved in filing claims. Few have been able to help widows use the money as productively as possible — despite the fact that some NGOs have provided some victims of conflict with the useful service of counseling, a service the government cannot provide. Combining the MAP and microenterprise project loan schemes could improve the long-range economic viability of many families. It is a pity this has not taken place as expected.

Small-scale reconstruction works

The ERRP allows communities plenty of scope for undertaking small-scale contracts — such as repairs to minor irrigation schemes, village roads, and small public buildings. Rather than leave small contracts to outside contractors, communities or groups could undertake these projects — possibly through existing organizations such as RDSs, cooperatives, and Gramodaya Mandalayas. This would ensure more accountability for the quality of the work and possibly earn profits for community organizations, allowing them to strengthen their operational and organizational capability. It may be necessary to provide technical assistance at the field level, but NGOs have a responsibility to be sure that the community or administration can take over such technical assistance when the NGO withdraws from operation.

It is possible for NGOs to organize groups that have benefited from PEG or MAP schemes. NGOs or government officials have not seriously considered the opportunities available under the Cooperative Law to mobilize the members to register a cooperative society or under the Companies Law to organize two people to float and register a company as a mechanism for long-term or permanent economic rehabilitation. Using and upgrading existing systems would be easier than creating new organizations. One advantage of organizing groups for local reconstruction projects is that the ERRP encourages the kind of income generation such projects would entail — in terms of carpentry, masonry, skilled and unskilled labor, and the like.

Vocational training

There is a great need for vocational training for many reasons. First, many vocationally trained personnel have deserted their vocations and conflict areas. Second, many youths who have returned to the mainstream lost between six and 10 years of their education, so they will not be qualified for public and private sector jobs requiring normal qualifications. Third, launching a rehabilitation and reconstruction program as large as the ERRP calls for skilled workers. Fourth, the ability to earn a decent living will tend to bind people to a normal life pattern, rather than to a return to militancy. Thus, the social benefits of vocational training cannot be underestimated.

Some NGOs have launched programs toward these ends. CARE has sponsored skill develop-

ment in such areas as masonry and carpentry in the Northern Province, and the World University Services of Canada (WUSC) has a program in the Eastern Province to develop such vocational skills as typing and shorthand. It may be possible to combine these efforts with UNHCR programs run through the National Youth Service Council and the Department of Labor. Combining MAP and PEG assistance schemes with vocational training could really help the target groups that need training — and could be done using existing mechanisms.

Improving conditions for women

The ERRP was designed partly to improve the assets, earning capacity, and quality of life of the affected population — to give affected families an opportunity to have better homes and access to better drinking water, sanitation, and health services. Hardest hit in the conflict were women, children, and the poor — as conditions for women were not good even before the conflict.

NGOs — especially established local and international NGOs — could be supportive of women. They could help women-based organizations make more credit available to women and educate them about women's rights, population control, sanitation, general and special production technologies, and how to prevent environmental degradation. They should improve access to training and help raise awareness of the problems women might face. Some NGOs have already taken the initiative: SCF (UK) in sanitation and health, WUSC in vocational training, and OXFAM in agricultural programs. These efforts should be accelerated. NGOs should seize this opportunity to chip away at male dominance of development and to strengthen women's role in it. The government should help but NGOs could play an enormous role in improving women's productivity and quality of life.

Counseling and reconciliation services

People who suffered the trauma of terrorism and counterterrorism often have severe psychological problems and need counseling. A group of medical doctors in Jaffna has held seminars to evaluate this problem but there is no government program to rehabilitate men, women, and children who have been physically and psychologically affected. Therapy programs are needed that government institutions are not equipped to provide. NGOs must fill this need.

This is a sensitive problem, so an action plan must be carefully prepared, participants carefully selected, and personnel well-trained. Well-established NGOs and international NGOs may be qualified to undertake this activity or bring in qualified personnel from abroad. The Sri Lankan government is deeply committed to finding a lasting solution to its problems through political negotiations, but political negotiations should be followed by a reconciliation process — and that will take time. It is not too soon to plan for it now.

The need for an NGO consortium

In Sri Lanka's Emergency Relief and Rehabilitation Program, relief, rehabilitation, and reconstruction are interconnected. NGO activity has been geared toward relief and rehabilitation but NGOs could help get local people involved in reconstruction projects and rehabilitation programs.

As a developing country, Sri Lanka needs government guidance on development activities and strategies, in rehabilitation and reconstruction or otherwise. NGOs have worked well with the government but it is not clear that a durable dialogue has been created either among the NGOs or with the government. Ad hoc behavior seems to prevail. Regular structured meetings would formalize the coordination that exists between concerned ministries and national NGOs and between district government authorities and district NGOs.

An effective NGO consortium could help NGOs think beyond their corporate images. An existing NGO consortium has been reasonably effective in coordinating NGO relief work, but less effective in coordinating long-term planning of rehabilitation and reconstruction. Corporate images sometimes take precedence over cooperation. The ERRP has provided an opportunity for NGOs to develop and for NGOs to encourage community participation and development. NGOs could perform valuable services in reconstruction. So far their performance has not lived up to its full potential.

Japan's outreach

Kenzo Toki

As a nation continually threatened and beset by earthquakes, typhoons, and floods, Japan has developed considerable expertise in — and a full array of advanced hardware and software for — disaster prevention, response, and recovery. And as the world's second largest economic power, it has recognized and accepted its responsibility to share that expertise with and offer economic assistance to developing nations crippled by disasters.

Japan's government has helped other countries with grants, loans, technical assistance, and cooperation with international organizations. Several government ministries and agencies are deeply involved in international disaster prevention. Those engaged in technical assistance and funding for cooperative efforts include the Japan International Cooperation Agency (JICA), established in 1974 to provide technical assistance and help in the socioeconomic growth of developing nations; and the Overseas Economic Cooperation Fund, credits from which promote industrial development and economic stability in developing regions.

Cash grants, together with technical assistance, are the pillars of official development aid. Grants are made for general aid, fisheries, cultural purposes, food and food production, and disaster relief. Of the $1.2 billion Japan budgeted for aid to other countries in 1986, $10 million was distributed as disaster assistance grants. Much of this aid goes to Asia but Japan also extended aid to Cameroon (after a volcanic eruption that emitted poisonous gases) and El Salvador and Ecuador (which were struck by major earthquakes).

In addition, Japan is generous in funding and endowing UN organizations deeply involved in disaster planning (contributing about $100 million in 1986). Japan also makes loans as direct yen-denominated government credits that the recipient country is obligated to repay, but at low interest rates. Loans made through the Overseas Economic Cooperation Fund, for example, have been used for civil engineering works for forestation and flood control.

Various government agencies help train personnel from developing countries in the basics of disaster prevention. The Japanese government also provides machinery, equipment, and training needed in technical cooperation centers such as Indonesia's Volcanic Sabo Technical Center and Peru's Center for Earthquake Disaster Prevention Measures. The recipient nations bear the cost of building construction and operations.

Japan is particularly in a position to share information about its experiences with and experiments and research done on:

- Land protection (through reforestation and flood control).
- Meteorological observation and warning systems and disaster prevention information and communication networks.
- Methods for assessing disaster, such as identifying danger spots and testing for earthquake resistance.
- Disseminating advice (under the Basic Disaster Countermeasures Law) on disaster prevention.
- Setting up disaster prevention systems.
- Firefighting and flood control.
- Recovery work.
- Earthquake forecasting and warning systems.

In 1985, after Mount Nevado del Ruiz erupted in Colombia and a major earthquake devastated Mexico City, Japan provided funds and dispatched medical teams as part of the Japan Medical System for Disaster Relief (inaugurated in 1982). The direct relief work provided by Western nations proved to be far more effective, however — which heightened awareness in Japan of the need to establish a better framework for dispatching rescue and relief personnel. In 1987, Japan developed a plan for more swiftly dispatching appropriate Japanese Disaster Relief Team personnel to help nations crippled by natural disasters.

Japan's private sector provides assistance through the Japanese Red Cross and other volunteer organizations. Japan's Red Cross Society engages in humanitarian and disaster relief projects. Volunteer organizations provide help for refugees and others in need — in particular, victims of severe African drought.

Managing natural hazards

Stephen O. Bender

Natural hazard management is one of several environmental concerns awaiting integration into development planning. Rapid population growth, particularly among the urban poor, makes it urgent that governments reduce the vulnerability of economic production and service infrastructure. Planning agencies — working with research and engineering organizations and disaster response agencies — must first identify vulnerable elements of the population and of lifeline networks, sector facilities, and proposed investment projects. They can generate that information using geographic information systems, remote sensing, the community, and existing planning mechanisms. Then they can integrate that information into their development planning. But many countries need help doing this. Working together, the development, scientific, and engineering communities and the agencies in charge of disaster preparedness and response must provide technical assistance, training, and technology transfer to countries vulnerable to disaster.

The 1990s are the self-proclaimed "Decade of the Environment." Natural events and the hazards they pose are part of environmental problems to be addressed during the decade.

Natural events help sustain environments: shaping the topography, depositing volcanic soils, flushing estuaries, watering the land, exposing buried resources, disposing of combustible materials, and keeping cycles of regeneration in motion. But natural hazards are also part of the environmental problems to which society is increasingly attuned. They damage the habitats of endangered species, expose and heighten the impact of the degradation of natural systems, and spread human damage to the environment in uncontrollable ways.

Natural hazards are a global concern that should hold our attention because they affect such large portions of the earth's surface and population. The international development assistance community should adopt the issue of disaster mitigation as its own and bring to it a greater sense of urgency, because a great deal of money is spent repairing and replacing what natural disasters destroy or damage — yet the risks of disaster are amenable to study, mitigation measures are available, and actions to reduce vulnerability immediately benefit the populations that might be affected by disaster.

Few constituencies exist for preventing natural disasters, despite their frequency, high cost, and predictability. Constituencies abound to prevent or mitigate other environmental problems — particularly those affecting wildlife and wildlands — of which the risks and consequences are far less certain. The threat of nuclear war

appears to be greatly diminished, for example, yet enormous energy goes into antinuclear campaigns. We are uncertain about global warming, but conjecture about its impact is bringing about policy changes that affect long-term economic policy. We are unsure about the effects of the ozone layer's depletion and are not certain if sea levels will rise, or how much. Calls for preserving the biodiversity of species are based on theoretical arguments, not measurable risks. And we don't know how much it would cost to resolve the political causes of tropical deforestation or what benefits that resolution would yield.

Not that these issues should be ignored, but they get headline attention although the risks associated with them are uncertain. The forgotten issue is increasing human vulnerability to the natural hazardous events that have occurred repeatedly and are certain to recur, often because of human activity — including development, the goal of nations.

Natural hazards are consistently ignored in discussions of the environment. Yet of all the environmental issues they are the most readily predicted in terms of place, time, severity, and probability of occurrence. And their impact is the most certainly and effectively mitigated. Moreover, of all hedges against risk, natural disaster mitigation is the most dependent on changing the way development takes place. Methods already exist for identifying vulnerable populations and capital investments and for defining and implementing appropriate mitigation measures.

The endangered poor

The world's poor are increasing in number faster than the general population. And the poor (half of whom are children) are the most vulnerable to disasters because of the buildings in which they live and the sites upon which those buildings are constructed. More than 80 percent of all international funds for nonemergency disaster mitigation (preparedness and response) in developing countries, and more than 90 percent of all funds spent on all types of disaster mitigation, go to saving lives in an emergency and replacing lost investments later. Most of these activities are in direct response to the needs of the poor. The rest goes to support nonemergency preventive efforts — through development planning and implementation — to reduce vulnerability to loss of life and property.

Lives can be saved and the economic effects of disaster reduced:

- As an emergency response to injury and damaged property immediately after an event.
- By reducing the vulnerability of basic service and production infrastructure (nonresidential structures).
- By reducing the vulnerability of human shelters and settlements.

In developing countries, priority is given to the first two activities, pursued through local, national, and international mechanisms. But it is up to citizens — particularly poor citizens — to reduce the vulnerability of their own domestic environments. Like all populations, the poor depend directly on their environment to live: for air to breathe, water to drink, food to eat, fuel to burn, clay to make bricks, and wood for roofs. To meet their basic needs, they change their environments, using free natural goods and services as much as they can. If they deplete the goods and services available in one area, they move to another — often in the hinterlands, where those goods and services are often poorer in quality and insufficient in quantity. The way the poor acquire food, fuel, building materials, and building sites — not for cash, and with no value added — is often at odds with the best management practices and with social, legal, and economic norms and policies.

The poor need safe building sites. But the supply of building sites relatively invulnerable to natural disasters is scarcer than the demand for them and no system exists for increasing the natural supply. Indeed, there is evidence that human activities — particularly for development — decrease the number of less vulnerable sites. And even at zero opportunity cost, with the poor providing their own labor, it is almost impossible to transform a vulnerable building site into a less vulnerable building site. Except in the way a shelter and its immediate surroundings are designed in response to site-specific natural hazards, it is generally beyond the efforts of individuals to reduce vulnerability to natural disasters.

Managing change

Apart from postdisaster emergency response, the steps that must be taken to save lives and

reduce the economic impact of natural disasters are best taken collectively as part of general environmental management. Those steps should begin with public sector policy, and public and private actions to protect productive natural systems, and basic service and production infrastructure. Humanitarian assistance in emergencies and efforts to reduce the vulnerability of shelters and settlements must be accompanied by efforts to reduce the vulnerability of infrastructure. Longer-term efforts to prevent disasters through development planning and implementation must be a higher priority in environmental management.

This will require technical cooperation between the development community, the scientific and engineering research community, and the agencies in charge of disaster preparedness and response. Together these three groups must provide technical assistance, training, and technology transfer — regionally, nationally, and internationally. The public sector must provide continuity, support, and more focused direction than it has provided in the past, and should encourage the increased participation of the private sector.

The activities outlined below should be given a high priority in development planning. Some are already under way in some regions, if only at the demonstration level.

Technical assistance must be supplied in development project preparation. The following activities are recommended for all development projects but should be mandatory in postdisaster reconstruction programs because receptiveness to disaster prevention is highest in that period.

- Country overview documents should be prepared for each developing country, giving a history of natural disasters in that country, describing natural hazards and their relationship to natural resource and environmental management issues, identifying basic technical documents available and key professionals and national institutions to be consulted, and providing related information about the population, infrastructure, and natural resources. Much of the information needed to prepare these documents is available. The documentation for Latin America and the Caribbean could be prepared in two years.
- Sectors should be assessed nationally for their vulnerability to natural hazards. Sectoral assessments should indicate what investment projects are under way to mitigate losses according to defined mitigation strategies. They should also indicate which sector components are vulnerable, with no significant short- or medium-term possibility of reducing that vulnerability. Assessment models for priority sectors exist or are in preparation. The information needed should be generated by the country overviews, which the assessments will supplement.
- A brief on natural hazards should be included in initial project documentation for all capital investment projects — drawing in part on the country overviews. Much of the information already exists and processes are in place to begin this activity.
- Each phase of project preparation should address issues of vulnerability reduction. The final loan document should define and approve a specific vulnerability level and measures to take to achieve it.

Training — in skills, knowledge, and attitudes — must accompany technical assistance.

- Technicians in developing countries should be trained to prepare and update the country overview documents. They should participate in regional and then national workshops as each country progresses through the series of activities. Training models exist in Latin America and the Caribbean.
- Professionals from selected sectors should be trained in techniques for assessing vulnerability as part of natural disaster mitigation programs. Regional workshops should be followed by national assessments as countries complete the activities described in the section on technical assistance. Training models exist in Latin America. Regional sectoral agencies should be trained in techniques for continuing program development, as applicable.
- Professionals involved in project preparation for different sectors should be trained in how to use information on natural hazards in formulating sector investment projects. Basic training materials and instructors are available.
- Professionals involved in sectoral planning and project identification should be trained in natural hazard assessment and sectoral planning to fortify their understanding and use of information on natural hazards in sectoral policy, programs, and courses. Courses should be offered in:

(1) Integrated planning for large river basins, with emphasis on basic infrastructure (energy, transportation, and water resources) in regions near international borders.

(2) Integrated management of urban watersheds, with emphasis on reducing natural hazards and on using natural resources to meet the needs of the poor for food, fuel, safe building sites, and building materials.

(3) Assessment of landslide areas, with emphasis on areas where there are urban settlements or energy, transportation, and production infrastructure.

(4) Assessment of desertification processes, with emphasis on integrated river basin development, food production, forest management, and expansion of settlements.

Technology transfer should be part of technical assistance and should generate the subject matter for formal training activities.

- Techniques for managing information about natural hazards — both manual and computer-based approaches — should be made available for staff in charge of national planning and project formulation. Experts on selection and installation of relevant technology are available.
- Both manual and computer-based techniques for mapping information about natural hazards, natural resources, populations, and infrastructure should be made available to staff in charge of national planning and project formulation. Experts on the selection and installation of relevant technologies are available, particularly to match mapping needs with existing country experience and equipment.
- Emergency information management systems should be made available to both emergency preparedness and response agencies and to other appropriate national agencies, including those responsible for critical infrastructure (health, energy, transportation, public safety, communications, and the like) — for use immediately before, during, and after a natural disaster.

Case study: Taiz Flood Disaster Prevention and Municipal Development Project

Alcira Kreimer and Martha Preece

The Taiz Flood Disaster Prevention and Municipal Development Project represents an important step forward in urban development. For the first time, environmental protection and prevention have taken precedence over other types of investment — in a project that aims, among other things, to improve drainage systems in one of the Yemen Arab Republic's major cities. One aim of the project is to prevent recurrent floods from disrupting the city's economic activity, damaging roads and other infrastructure, and plugging up sewers with sediment and refuse, causing water contaminated by garbage and human waste to overflow on the streets. Another aim is to organize a unit within the Ministry of Municipalities and Housing to coordinate that ministry's activities with those of the National Committee for Natural Disaster Mitigation and Emergency Relief. What began as an effort to upgrade urban services and strengthen government institutions developed into an integrated approach to urban development. It incorporated the urgent need to resolve an environmental crisis into longer-term plans to reduce the city's vulnerability to natural disasters and improve its ability to service a rapidly expanding population.

Taiz, the second largest city in the Yemen Arab Republic and its principal trading and agricultural processing center, suffers many of the problems of rapid urban population growth. The population of 150,000 (about 12 percent of YAR's total urban population) is growing more than 15 percent a year and has more than doubled in the past five years. A survey undertaken during preparation of an International Development Association (IDA) project revealed that about 28 percent of the homes in the project area and nearly 280 shops are flooded every year, and 32 percent of the homes are flooded every 10 years.

The last severe flood occurred in March 1982, when three days of consecutive rain caused widespread damage. Events of this magnitude occur once every 20 years or so, but floods that cause moderate property damage and disrupt traffic for two to three hours occur five to 10 times a year. With moderate flooding, sediment accumulates up to one meter deep at major intersections. Streets erode substantially and in many places underground utilities (water, sewerage, and electricity and telephone lines) are exposed to pedestrian and vehicular traffic. About 15 percent of the 5,134 households in the project area, or 770 households, live below the poverty threshold, and an equal number of families live within 10 percent of it. These homes and small-scale businesses are generally hurt most by the floods. The annual direct loss

from floods is about YR 29.24 million (US$2.7 million), mostly in property damage to and missing stock from households and shops.

Flooding directly affects the "Old Town" and the areas immediately north of it, but they also suffer the indirect costs of production losses caused mostly by the destruction of physical infrastructure (such as roads, canals, drainage, and electric power networks). This important market and commercial area provides jobs for people residing in other neighborhoods.

Not only does the flooding of roads and the deposit of sediment, boulders, and refuse disrupt traffic and business activities, but it is costly to clean up and repair damaged infrastructure. Cleanup and road reconstruction cost an average YR 1.8 million a year (US$170,000) for the project area, which is grossly insufficient to restore the street pavement, given the budget constraints of the Taiz Branch Office (TBO).

The city's vulnerability to disasters

Three factors make the Taiz area vulnerable to natural disasters: (1) environmental degradation, caused mostly by the unplanned expansion of human settlements; (2) poorly maintained infrastructure and services inadequate to cope with increasing demand; and (3) the managerial and financial weakness of regulatory and policy institutions, which result in inadequate planning, programming, budgeting, and technical staff.

Rapid growth and scarce resources have made it difficult for national and local institutions to deal with the pressures that urban development exerts on the environment. High-income housing and road construction are extending onto steep hills, destabilizing the slopes and increasing soil erosion. Depleted of their weight-bearing capacity, these unstable lands are unsuitable for residential development. Moreover, wadis (drainage courses) are being used as roads and houses have been built on the floodplains, so there is little protection against floods. Residential neighborhoods have sprung up over the original drainage channels, which have been transformed into main streets of residential areas. Erosion, degradation of the land, and reduction of the soil's absorptive capacity have weakened the region's resistance to catastrophic flooding.

Attempts have been made to drain rainwaters from some major streets by providing drainage channels, but these measures are insufficient, and authorities often use sanitary sewers to discharge water runoff. This increases the health hazards caused by floods, as sewers plug up with sediment and refuse, causing water contaminated by garbage and human waste to overflow on the streets. The accumulation of urban wastes outstrips the city's ability to collect and dispose of them.

Rapid urban population growth in the 1970s and early 1980s brought major changes in urban land use and the uncontrolled, haphazard, inefficient spread of informal housing in urban areas. Despite the government's struggle to cope with escalating demand for urban services, their provision lagged behind demand. Weak local institutions were not prepared to handle development pressures. And recurrent floods in Old Taiz hampered every effort to provide municipal infrastructure. Contributing to the deficiencies in urban service have been (a) the absence of urban land management policies and a formal land registration system, (b) the failure to fully recover the cost of urban services, which eroded the government's ability to finance such services, and (c) building standards that are unrealistic because much of the population cannot afford them. YAR has struggled to establish the basic institutional framework for urban development and to keep ahead of the backlog in urban services, but it has been handicapped by inadequate funds and a lack of qualified technical, administrative, and managerial manpower.

Government strategy

Until 1979, government intervention in the urban sector was ad hoc, with different agencies implementing their own projects independently. In 1976, the Ministry of Public Works (MOW) initiated the preparation of master plans for the YAR's five main cities. Those plans were an appropriate framework for directing urban growth, but they proposed standards that exceeded the urban agencies' financial and implementation capabilities.

The main problems are accelerated urban growth, inadequate basic infrastructure, and weak managerial and financial capabilities in the urban agencies. The government's strategy in the urban sector is to provide essential municipal infrastructure and to strengthen central and local institutions.

IDA activities in the urban sector

Aware of the country's difficult economic situation, the mounting pressure of urban problems, and the poor coordination among ministries and agencies responsible for planning and implementing investment projects, IDA's short-term strategy in the urban sector is a well-targeted project work addressing central and local institutional and structural weaknesses (urban infrastructure maintenance, municipal resource mobilization, land registration, and housing finance) requiring a minimum, directly recoverable investment and making maximum use of existing resources. By building on the achievements of the first two ongoing urban projects, this project aims to prepare the groundwork for broader policy-oriented sectoral involvement and to set the stage for long-term urban development by creating a viable administrative system that will delegate more responsibility to the municipalities while maximizing private initiative.

The Taiz project grew out of discussions between the director of the Taiz Branch Office of MMH and an IDA mission carrying out an urban sector study in YAR, in February 1984. Initially, the project was to address problems upgrading the Old Town of Taiz, to develop serviced land suitable for low-cost housing, and to improve urban transport in Sana'a. The project was to include funding for a major study of flood control, with physical implementation deferred until a later phase. But a feasibility study carried out under the Second Urban Development Project (Credit 1441-YAR), completed in 1988, concluded that flood control should take priority over any other type of improvement — as failure to control the floodwaters from the main drainage system could wipe out any investments in urban upgrading.

Because of YAR's economic problems, it was agreed to divide the project into freestanding phases of construction, and limit project implementation to the most essential flood control structures. Urban upgrading components were to be postponed until after the flood control works were completed.

The objectives of the Bank-financed project were to address the problem of flooding in the city of Taiz, to finance the implementation of cost-recoverable infrastructure investments, and to correct structural weaknesses in the central and local government through technical assistance and training and policy reform. The project covers the "Old City" (Medina), an area of about 100 hectares in the valley and foothills of Jebel Sabir, and the adjacent area to the north (about 80 hectares). Three drainage courses pass through this area. Surface materials are alluvium (sand and gravel) to varying depths in the valley and rocky outcrops in the south where groundlevels rise. The main residential area of multistory houses was built to the south on steep slopes. The old marketplace occupies the flatter alluvial section at the northern edge of the Old City.

Estimated cost for the project is US$22.25 million equivalent (YR 267 million), of which US$15 million equivalent represents the foreign cost component (or about 67 percent of total project costs). IDA will finance all of the project's foreign exchange, and the government will finance the local cost (US$7.25 million equivalent).

The Ministry of Municipalities of Housing (now the Ministry of Housing and Urban Planning) is responsible for the physical planning and administration of the five main cities and of the secondary towns. The Taiz Branch Office is the ministry's local operating arm for both the city of Taiz and the surrounding smaller cities and rural areas in the Taiz Governorate.

The ministry's core unit, the Physical Planning Department (PPD), prepares master plans and issues buildings permits. PPD's work is hampered by a shortage of trained personnel in middle-level positions, lack of reliable physical and socioeconomic data, financial constraints, and no overall strategy for urban planning and management. The department has a physical plan but it does not take an integrated approach to preventing and mitigating natural disasters through appropriate urban development and spatial planning.

The Urban Development and Housing Department (UDHD) is in charge of formulating and implementing objectives and strategies for national urbanization and housing programs. UDHD was responsible for the execution of the two previous IDA-financed projects and will be the implementing agency on the Taiz project. Its operational and policymaking capabilities must be strengthened, especially at the municipal level. Its technical and managerial staff is its main weakness; it needs training to improve

its engineering and planning capabilities and to strengthen its delivery of urban services.

The National Water and Sewerage Authority (NWSA) provides water and sewerage, the Yemen General Electricity Corporation (YGEC) provides power, and the Highway Authority is in charge of interurban road construction and maintenance. YAR also has institutions for land survey and registration, health and education services, public transport, cooperatives and popular participation, and housing finance (the Housing Credit Bank). All capital projects and maintenance activities are centrally prepared and approved.

Project design

During project preparation several design standards and drainage routes were considered. The basic design for all of them incorporated drainage channels and box culverts through the built-up sections of the city, sediment and boulder traps upstream, the channelization of secondary wadis originating from Cairo Hill (south of the project area), and soil conservation measures.

Two alternative flow parameters were considered for the design of hydraulic structures. The minimum acceptable protection was for the type of flood that occurs only once every five years (a 1:5 year flood), and the economically acceptable maximum protection was for a 20-year flood. The narrowness of the streets limited the design capacity that could be economically provided. It was concluded that a hydraulic system designed to carry all of the flows of a 20-year flood and about 90 percent of a 50-year flood was the least-cost alternative that would yield the maximum possible protection against any reasonable risk to human life.

Several drainage routing alternatives were studied to determine the least-cost solution that yielded maximum benefits and adequately protected life and property. Economic costs and the ability to preserve historical buildings were among determining factors in the selection of flood control designs for the three main local wadis (Seena, Al Nassar, and Madam).

The project provides

- The flood control structures needed — open channels, box culverts, and sediment and boulder traps — to protect the parts of the city most affected by floods (Wadi Seena, Al Nassar, Madam, Al Kamet).
- The restoration of street pavements, the terracing of unstable slopes, and surface drainage footpaths in narrow streets (to control erosion).
- The purchase of maintenance equipment for roads and flood control works.
- Technical assistance for strengthening the Ministry of Municipalities and Housing and its main branch offices.
- Technical assistance for project construction management.
- The introduction of a new municipal resource mobilization policy initiated under an ongoing urban project.
- The implementation of project cost recovery.
- The preparation of a future urban development project.
- Staff training for MMH and its main branch office.

Because of financial constraints, the project was to be implemented in several phases, with essential flood control works provided first to protect other investments, including the urban upgrading that would enhance land development in areas bordering the wadis. Further urban upgrading will be considered when it becomes possible to mobilize local funds.

Disaster prevention a development priority

The Taiz project represents significant progress in IDA's approach to urban development. For the first time, environmental protection and prevention took priority over any other type of investment program in YAR and environmental considerations are integrated into the planning, management, and coordination of urban investments. Implicit in project design is the recognition that poor planning and inadequate urban infrastructure result in degradation that puts people at risk from natural hazards.

The project aims to improve the human and natural environments by preventing sewage overflows and by minimizing hazards now posed by domestic refuse, sand, gravel, and boulder that floodwaters deposit on main streets.

In a remarkable effort to incorporate disaster prevention and mitigation strategies into national and municipal development planning,

the project contemplates improving the Physical Planning Department's ability to integrate natural disaster mitigation and warning systems into urban development of the major cities. It also contemplates strengthening MMH and its municipal branch offices to improve service and operating efficiency and to help MMH establish and organize a Disaster Preparedness and Relief Unit to coordinate the ministry's activities with those of the National Committee for Natural Disaster Mitigation and Emergency Relief.

Writing an action plan for disaster preparedness in Africa

Idris M. Nur

Many African countries suffer from drought, desertification, and other disasters that have created acute, large-scale food shortages in some countries, mounting food import bills, and increased dependence on food aid. Limited agricultural production inhibits Africa's economic and social development and sustains the specter of famine and malnutrition. Many African countries, UN agencies, regional and international donors, and other organizations have made significant efforts to combat disasters in Africa, but each country must prepare its own disaster preparedness and response plan. The elements that should be included in such a plan are outlined. Disaster does not necessarily require costly services and equipment. Rather, it requires sensible analysis of possibilities with a view to determining how authority and responsibility for action should be delegated, what local human and material resources exist, and how they should be earmarked and deployed.

In Africa, the main causes of disaster are drought, locusts, wars, civil strife, floods, cyclones, food shortage, epidemics, and technological failure. Disasters have become the order of the day in Africa. They occur more often than they used to and are deadlier and more destructive. Disasters in Africa have caused disability, displacement, epidemics, health hazards, psychological problems, famine, malnutrition, and the deterioration of the environment.

Disasters take a severe toll on the world's poorest continent. As a result, African countries suffer many deaths and development goals are often set back years. Population growth, urbanization, and development have increased vulnerability and the possibility of even greater tragedies.

Disasters in Africa

Climatic changes brought heavy rains in the late 1980s, but many African countries still suffer from drought and desertification. These and other disasters in the 1980s have led to acute, large-scale food shortages in some countries, mounting food import bills, and increased dependence on food aid. Limited agricultural production inhibits economic and social development and sustains the specter of famine, hunger, and malnutrition.

Africa's population is growing 3.3 percent a year but growth in food production has not exceeded 2 percent and has decreased in per capita terms. At 26 percent, Africa's urbanization rate remains the highest in the world, so the

limited labor supply in rural areas has become a major problem. Increased demand for agricultural output to meet basic nutritional needs is a challenge to available resources. A disaster can endanger food supplies and thus the affected population's nutritional status.

Bacterial, viral, and parasitic infections are capable of causing epidemics of disastrous proportions. Control of cholera, malaria, meningitis, and yellow fever is far from satisfactory in Africa. Surveillance and control technologies are not as widely and effectively used as they should be. National capabilities must be strengthened and technologies adapted to the national health systems. Africa's health problems are exacerbated by a food crisis the proportions of which have grown because of the vast migration of people from rural to urban areas. This crisis is reflected in young people whose body weights are too small for their ages and in the malnourished people who fill refugee camps and swell the ranks of displaced persons.

The African continent has been vulnerable to many kinds of natural disaster. Drought has hit the Sahelian zone 20 times since the sixteenth century. The prolonged drought Africa is now experiencing is moving quickly beyond the Sahel toward southern and eastern Africa. Usable pastoral areas in arid and semiarid regions have been reduced an estimated 25 percent since the drought of 1968. It is generally believed that drought occurs somewhere in Africa every year, that drought affecting large areas of the continent occurs twice or more each decade, and that widespread, protracted drought occurs once every 30 years.

Today most desertification is caused by escalating human and livestock populations, overgrazing, expansion of agriculture, and demand for fuelwood. About 450 million Africans burn about 300 million cubic meters of firewood each year. In the first half of the 1980s, an estimated 742 million hectares — about 26 percent of Africa's land area — were undergoing desertification. The desert is creeping into the land area at the rate of 6 million hectares a year.

Severe storms, heavy floods, and torrential rains have caused considerable damage to crops, physical infrastructure, and transport systems in Djibouti, Malawi, Somalia, Tanzania, and the Sudan. Between 1987 and 1989, 21 countries and 3.2 million people were affected by floods and 326 were killed.

Earthquakes are rare in most African countries. Exceptions are Algeria, where risks are high, and Ghana, Malawi, Rwanda, Uganda, and Zaire, where they are lower. Volcanos erupted in Zaire in 1977 and in Cameroon in 1983 and 1986 (Lake Nyos). Seasonal disasters such as cyclones are confined to the Indian Ocean islands and coastal countries such as Mozambique. Snowstorms occur only in Lesotho.

Toxic wastes made headlines in mid-1988 when tons of toxic waste from outside of Africa were disposed of in African countries. This sparked off protests in and out of Africa by governments, international organizations, and environmental groups. Containers carrying toxic wastes are often corroded by the substances within, which then escape into the surrounding soil and work their way up through the food chain from the soil to vegetation and crops, or from the water system to reservoirs and household water, which humans ultimately consume. Exposure to radioactive materials is particularly harmful to human health and inflicts irreversible damage on the ecosystem, affecting agricultural production and related activities. So industrial waste that requires handling by sophisticated technology contributes to Africa's environmental crisis.

Current prevention and preparedness efforts

Many African countries are intensifying their efforts to mitigate disasters. Countries such as Ethiopia and Senegal have established early warning systems that serve not only their own but neighboring countries. There are a number of integrated programs to combat disasters in Africa. Some have been undertaken by disaster-specific African organizations, others by nondisaster-specific development organizations. In addition, some United Nations organizations and specialized agencies have disaster-specific programs, including the UN's Food and Agriculture Organization (FAO), the International Labour Organisation (ILO), the UN Development Programme (UNDP), the Office of the UN Disaster Relief Co-ordinator (UNDRO), the UN Environment Programme (UNEP), Office of the UN High Commissioner for Refugees (UNHCR), the UN Children's Fund (UNICEF), the UN Industrial Development Organization (UNIDO), the UN Statistical Office (UNSO), the World Food Programme (WFP), the World Health Organization (WHO), the World Meteorological

Organization (WMO), and the World Bank. National and international nongovernment organizations (NGOs) — particularly the Red Cross and Red Crescent — have made significant efforts to combat disasters. Some of these organizations can make resources available on request by national governments when a disaster strikes. Significant efforts to control insect pests and diseases have been made by such intergovernment organizations as the Common Organization Against Desert Locust and Granivorous Birds (OCLALAV), the Desert Locust Control Organization for Eastern Africa (DLCO-EA), and the International Red Locust Control Organization of Central and Southern Africa (IRLCO-CSE).

Disaster planning

Disaster preparedness — the readiness to predict, prevent, respond to, and cope with the effects of a crisis — should not be limited to short-term measures undertaken during a warning period before the disaster strikes. Those measures must be supported by legislation, contingency planning, national operational planning, emergency funding arrangements, the education and training of the general population, and the technical training of those responsible for emergency operations and the stockpiling of supplies. Each society is responsible for preparedness, but it also requires the commitment of the world community.

It is not possible to prescribe uniform national preparedness or contingency plans for all African countries because their resources, administrative structures, and infrastructure vary widely. It is not even appropriate to recommend the same guidelines for all disasters in one country because each disaster has its own peculiarities. Planning for disaster preparedness is a two-stage process. First, an outline plan should be prepared, identifying the types of hazards to be addressed and the procedure to be followed. Then comprehensive plans should be developed to deal with the management needs for specific disasters.

Disaster preparedness and response are usually multisectoral and interdisciplinary, requiring the involvement of a number of ministries, sectors, and areas at the same time. When guidelines for action do not exist or are inadequate, a disaster has a worse effect on the country and its people than it need have. In small countries, the guidelines for action can be executed satisfactorily at the national level, where the main business of government is managed. In larger countries, guidelines should be geared to regional, state, or provincial action because normal day-to-day government business is managed at those levels. Dealing with disasters should basically be an extension of normal government functions.

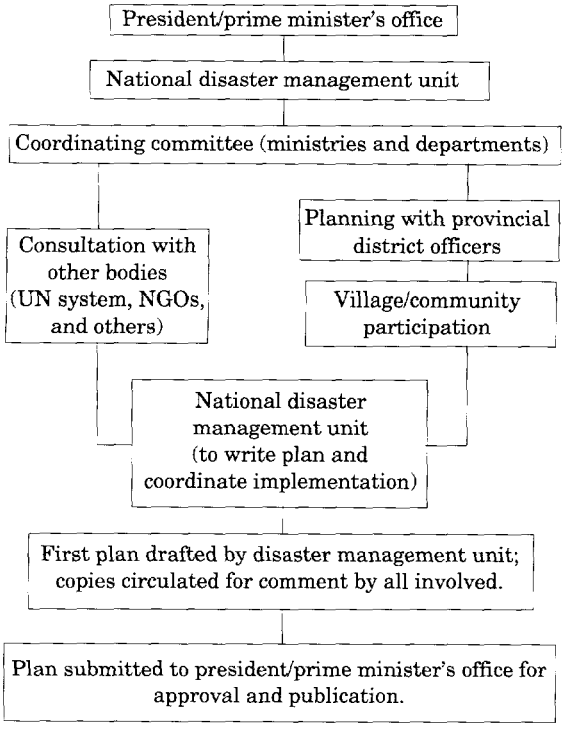
The central government's role is to initiate the program of disaster preparedness. The local administration is then responsible for implementing it and maintaining its effectiveness. But the effectiveness of government and nongovernment disaster relief operations can be greatly enhanced by developing community responsibility, understanding, and skills.

Disaster preparedness is the sensible analysis of possible disaster scenarios with a view to determining how authority and responsibility for action should be delegated, what local human and material resources exist, and how these can be earmarked and deployed. This precautionary planning should be complemented by a program of public education and training, so that all members of the population understand what is being done, what they must do, and how to do it. Preparedness involves strengthening institutions and expertise and creating stockpiles of food and supplies.

Countries vulnerable to disaster need to establish a mechanism to focus relief operations, coordinating activities at different levels. It is important to establish a national disaster management unit headed by a minister or a senior officer and affiliated with the office of the president or prime minister on a permanent standby basis. This unit helps with preparedness, advance planning, coordination, and organization of relief programs. The unit's specific functions depend on the country's vulnerability to disasters and the availability of resources. Figure 1 suggests how such a unit would help formulate a plan of action to mitigate disasters. The same structure could be used for operations.

The coordinating committee should be composed of senior officers representing all ministries dealing with food and medical supplies, imports, employment, storage, meteorology, and anything else relevant to disaster relief. The committee could be assigned the task of watching over the supply situation, receiving relief aid, and identifying any logistical, administrative, financial, or supply constraints. The committee

Figure 1 Suggested structure for drafting a disaster mitigation plan



could also identify activities at the local level, prepare a local plan, and periodically review implementation of the relief program. Some countries may need to establish a subcommittee for disaster management and planning at the field level. This subcommittee would study village life thoroughly and recommend how best to draw on village resources and traditions in mitigating disasters.

Preparing an action plan for disaster mitigation

The action plan should identify who declares that a disaster exists, who should release financial resources, and what its objectives and limitations are. It should be a practical document. The emergency plan could also be integrated into such development projects as the Primary Health Care (PHC) Program. There is no standard plan for disaster mitigation plan, but certain elements are essential. Generally, the plan must:

- Be written with the active cooperation and participation of those who will be required to execute it.
- Be simple, easy to read and understand, tested, revised regularly, updated every two to three years, and easily accessible to those who need it.
- Clearly define the situation for which it was designed and the magnitude of the threat.
- Show how the efforts of different organizations and institutions are to be coordinated.
- Use existing structures rather than create new ones.
- Identify available resources in each key area (manpower, equipment, and finance), so it is easier to figure out what else is needed.
- Specify local factors needed to respond to disaster.
- Spell out a command-and-control structure, including the procedure for collecting and receiving information and disseminating warnings.

The following elements are needed in a disaster plan of action:

- Introduction: state national policy, describe the general concept of disaster preparedness, and describe the potential for disaster. The purpose of the plan is to state national priorities. These should be identified early in the action plan. Who authorizes this plan?
- State how this plan relates to other plans.
- Describe the country (region, state, province) in terms of its climate, topography, industry, demography, government organizations.
- Provide a brief history or review of local natural events or disasters (by type), and indicate what the potential is for further natural events or disasters or for technological disasters (or other disasters generated by human action).
- Identify the main requirements for dealing with disaster in terms of people, equipment, material, funds, public institutions, legislation.
- Identify planning groups for different levels and sectors. Name emergency coordinators for key sectors such as health (medical), public works, police, fire brigade, power, reserves, transport, communications.
- Plan organizational structure:

  - Allocate roles and tasks at all levels.
  - Specify how to arrange for and manage international assistance.
  - Spell out how to coordinate planning and organization.
  - Formulate policies on who makes appeals

(to whom, for what?), who determines needs, and to whom information should go.
- Identify who is responsible for seeing that the plan is viable.
- Identify who is in charge of legislation, financial measures, organization, community participation, declaring that there is a disaster, communications, survey and assessment of the situation, logistics, procurement of supplies, distribution of supplies, evacuation, training and public education, and the protection of data and cultural heritage.

• Spell out how the following will be done (by whom, when) in disaster-prone areas:

- Plan logistics.
- Use indicators to predict disaster.
- Preposition food, medicine, and other supplies.
- Establish an early warning system.
- Establish an international communication system.
- Manage logistics for mobilizing local people and reaching isolated people.
- Distribute food, medicine, and other supplies.
- Initiate reforestation.

• Spell out how these support measures are to be carried out:

- Training at different levels.
- Public awareness programs.
- Financial procedures.
- National budget reserve.
- Deployment of supplies.

• Identify preparedness measures (general, national, provincial, or regional). Plan training and public awareness programs.
• Plan communications.
• Plan operational control and coordination. Identify who is in charge of:

- Coordinating operational control.
- National emergency operations center.
- Provincial or regional emergency centers.

• Plan warning arrangements. Describe generally and spell out:

- From which agency warnings will originate.
- How warnings will be transmitted.
- How warnings will be disseminated to the general public.
- How to broadcast warnings in different languages.
- Who should be notified, and how, in different service areas such as the police, fire brigade, medical, reserves, public works, power, and transport.

• Describe how plan should be implemented. List stages of implementation.

- Describe counterdisaster operations.
- Establish a suitable operations center that can coordinate the emergency responses of many services.
- Put through legislation needed for emergency power.
- Identify ongoing technical cooperation programs that can facilitate development of national disaster programs and objectives.
- Spell out how and who to activate emergency operations centers at different levels.
- Spell out how to control and coordinate operations.
- Spell out what happens for the duration of the disaster operations.

• State what the policy is for recovery and who is responsible for the recovery program.
• Identify who is responsible for postdisaster review and indicate how they are to review the plan and organization in light of actual operations during an emergency.

The plan should contain (possibly in annexes):

A distribution list of essential relief items.
A list of definitions and abbreviations.
A list of resource people.
A functional diagram, showing organization and lines of responsibility and cooperation.
Duties and responsibilities of the national disaster management unit.
Detailed information on the warning system.
Precautionary measures to be adopted on receipt of warning.
Outline for public awareness program.
Outline for international assistance arrangements.
Outline for training.
Allocation of roles and tasks to resource organizations.

Clearances, if required.
Map references.

Strategy for regional and international cooperation

Natural disasters are often a regional problem, and often require regional solutions. So it is important to reinforce and strengthen regional disaster mitigation efforts in Africa. The following steps to be done jointly by international organizations and local governments would strengthen cooperative international and regional efforts to mitigate disasters in Africa:

- Organize a regional meeting on disasters in Africa to identify national, subregional, and regional project priorities and help implement them.
- Identify African regions susceptible to specific types of disaster and assess expected losses. This will facilitate the development of regional strategies for disaster response and planning.
- Make technical assistance available for subregional and regional studies on disaster mitigation. The threat of slow- and rapid-onset disasters is greater in Africa than on other continents and the implications are worse.
- Design and organize programs of counterdisaster education and training to develop national capabilities to plan for the disasters that strike Africa and to manage effectively when they do.
- Strengthen the ability of the Pan African Centre for Disaster Preparedness and Response (in Addis Ababa, Ethiopia) to deal with all disasters in Africa and establish networks in different subregions to help it in that effort. Promote subregional and regional cooperation in an integrated approach to disaster reduction. Evaluate the performance and problems of such subregional bodies as CILSS and IGADD and suggest ways to improve cooperation among them.
- Study ways to streamline procedures for getting emergency aid to disaster-prone landlocked African countries.
- Help develop applications of existing knowledge, close critical gaps in knowledge, exchange and disseminate information, provide technical assistance, and facilitate the transfer of adaptable technology.
- Help individual countries plan and implement an effective national program for mitigating disasters that includes hazard prediction, risk assessment, disaster preparedness, and disaster management.
- Create expertise and assemble the resources needed to reduce the death toll from disasters. Help replace old approaches with an integrated approach to managing disasters.
- Supplement and reinforce existing structures to combat disasters.
- Develop scientific research on different types of vegetation suitable in drought conditions.
- Promote the participation of African scientists in international scientific programs on the environment.
- Support pilot integrated land-management operations and practices, test research results, and develop ways to disseminate the results to the people.
- Develop a multiple-service database and train national personnel to handle it.

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Key to acronyms, initials, and abbreviations

ADB	Asia Development Bank
ADPC	Asian Disaster Preparedness Center
AIDAB	Australian International Development Assistance Bureau
AIT	Asian Institute of Technology
AODRO	Australian Overseas Disaster Response Organization
APELL	Awareness and Preparedness for Emergencies at Local Level
AVHRR	Advanced Very-High Resolution Radiometer
BANOBRAS	National Bank of Public Works and Services (Mexico City)
BAREPP	Bay Area Regional Earthquake Preparedness Project (Oakland)
BWDB	Bangladesh Water Development Board
CAMP	Coastal Area Management and Planning
CAP	Center for Analysis of Prediction (China)
CARE	Cooperative for American Relief Everywhere
CD	control department
CDPC	Cranfield Disaster Preparedness Centre
CEES	Committee on Earth and Environmental Sciences (NAS)
CEF	Caixa Economica Federal (Rio)
CEPAL	Economic Commission for Latin America and the Caribbean
CCD	Coast Conservation Department
CIDA	Canadian International Development Agency
CIDIE	Committee of International Development Institutions on the Environment
CILSS	Permanent Inter-State Committee for Drought Control in the Sahel
COE	State Operational Center (Brazil)
COPR	Center for Overseas Pest Research
CRDA	Christian Relief and Development Association
CRED	Centre for Research on the Epidemiology of Disasters
CZM	Coastal Zone Management
DF	Federal District (Mexico City)
DLCO-EA	Desert Locust Control Organization for Eastern Africa
DMT	Disaster Management Team (UN)
DXAL	Da Xing An Ling (China)
EC	European Community
EFRP	Emergency Flood Reconstruction Program
EOE	Emergency Operations in Ethiopia
EPPG	UN Emergency Preparedness and Prevention Group
ERRP	Emergency Reconstruction and Rehabilitation Program
ESCAP	Economic and Social Commission for Asia and the Pacific

FAO	Food and Agriculture Organization
FEMA	Federal Emergency Management Agency
FIDERE	Low-Income Housing Loan Recovery Trust Fund (Mexico City)
FONHAPO	Low-Income Housing Fund (Mexico City)
FOVI	Housing Foundation (Mexico City)
GDP	gross domestic product
GIS	geographical information system
GNP	gross national product
GOB	Government of Bangladesh
GTZ	German Technical Assistance Agency
HIMAT	National Institute for Water Management (Colombia)
HYVs	hybrid high-yielding varieties
IAEA	International Atomic Energy Agency
ICIPE	International Centre of Insect Physiology and Ecology
ICRC	International Committee of the Red Cross
IDA	International Development Association
IDB	Interamerican Development Bank
IDNDR	International Decade for Natural Disaster Reduction
IEF	State Forestry Institute (Brazil)
IFAD	International Fund for Agricultural Development
IGADD	Intergovernmental Authority on Drought and Development
IGPRA	Income Generating Project for the Refugee Areas (Pakistan)
ILO	International Labour Organisation
IMO	International Meteorological Organization
IMF	International Monetary Fund
IMSS	Instituto Mexicano de Seguridad Social (The Social Security Institute)
INGEOMINAS	The National Geologic Institute (Colombia)
IPF	indicative planning figures
IRLCO-CSE	International Red Locust Control Organization of Central and Southern Africa
ITCZ	Inter-Tropical Convergence Zone
IUCN	International Union for the Conservation of Nature and Natural Resources
JCIA	Japan Chemical Industry Association
JER	Japanese Earthquake Reinsurance Co. Ltd.
JICA	Japan International Cooperation Agency
LEADS	Line Equipment Assignment and Display System
MAP	Most-Affected Persons
MOC	Ministry of Construction (China)
MOF	Ministry of Forestry
MPCSs	Multipurpose Cooperative Societies
MPH	miles per hour
MR	Metropolitan Region (Rio)
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NDOA	National Disaster Organization (Australia, 1981)
NGO	nongovernment organization
NOAA	National Oceanic and Atmospheric Administration
NRIU	National Reconstruction Implementation Unit
NRTF	National Reconstruction Task Force
NSDPA	National System for Disaster Prevention and Assistance
NWFP	Northwest Frontier Province (Pakistan)
OAR	Office of Oceanic and Atmospheric Research
OAS	Organization of American States
OAU	Organization of African Unity
OCLALAV	Organization Against Desert Locust and Granivorous Birds

ODA	official development aid
ODA/UK	Overseas Development Administration (U.K.)
ODIPERC	Office of Disaster Preparedness and Emergency Relief Coordination
OECD	Organization for Economic Cooperation and Development
OFDA	Office of U.S. Foreign Disaster Assistance
ONAD	National Office for Disaster Prevention and Assistance
ONCCP	Office of the National Committee for Central Planning
OPDMC	Oxford Polytechnic (UK) Disaster Management Center Organization
OPS	Office for Projects Services
OSHA	Occupational Safety and Health Administration
OXFAM	Oxford Committee for Famine Relief
PAHO	Pan American Health Organization
PCDPPP	Pan-Caribbean Disaster Preparedness and Prevention Project
PEG	Productive Enterprise Grant
PHC	primary health care
RDSs	Rural Development Societies
RHP	Renovacion Habitacional Popular (Popular Housing Reconstruction)
RRC	Relief and Rehabilitation Commission
SCF (UK)	Save the Children Fund (U.K.)
SEDEC	Social and Economic Development Center
SEDUE	Secretariat of Urban Development and Ecology (Mexico City)
SHES	Seismic Hazard Evaluation System
SITREP	situation report
SNDR	Subcommittee for Natural Disaster Reduction
SOP	standard operating procedures
SPR	Special Programme Resources
SRES	Seismic Risk Evaluation System
SSB	State Seismological Bureau (China)
STASHA	Stanford Seismic Hazard Analysis
TCCSs	Thrift and Credit Cooperative Societies
TOGA	Tropical Ocean Global Atmosphere
TSOP	Timber Salvage Operation Plan (China)
TTC	Tropical Cyclone Committee
UN	United Nations
UNCHS	United Nations Centre for Human Settlements
UNIDO	United Nations Industrial Development Organization
UNDP	United Nations Development Programme
UNDRO	Office of the United Nations Disaster Relief Co-ordinator
UN-ECLAC	United Nations Economic Commission for Latin America and the Caribbean
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNITAR	United Nations Institute for Training and Research
UNSO	United Nations Statistical Office
USAID	United States Agency for International Development
WFP	World Food Programme
WHO	World Health Organization
WMO	World Meteorology Organization
WMO/ESCAP	World Meterorology Organization/Economic and Social Commission for Asia and the Pacific
WRDS	Women's Rural Development Society
WRI	World Resources Institute
WUSC	World University Services of Canada

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In the past three decades, the number of natural disasters has risen and the world has become increasingly aware of the relationship between the declining quality of the earth's environment and the frequency and severity of earthly catastrophes. On June 27–28, 1990, the World Bank sponsored a colloquium in Washington, D.C., to promote the exchange of experiences of and ideas about the environment and disaster management.

The papers in this book represent the concerns expressed at that colloquium. They explore the two-way relationship between environmental degradation and vulnerability to disaster — and their combined effects on both natural and man-made habitats.

One disaster often leads to another: high windstorms are followed by floods and landslides, floods by drought, and drought by pest epidemics. Such chains of disaster result partly from the tendency of natural disasters to debilitate the environment; they are aided in this by some human activities. The same cycle results whether the cause of degradation is natural or springs from human effort. But environmental degradation intensifies the effects of disaster.

Both disasters and environmental degradation threaten human and natural habitats, but disasters are often seen as motors of natural change quite beyond human control. This is not true. Prevention does not mean halting such trigger events as earthquakes and cyclones but rather minimizing their impact on our environment. Many of the papers in this volume suggest how to improve our management of disasters, the environment, and the important relationship between them.

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