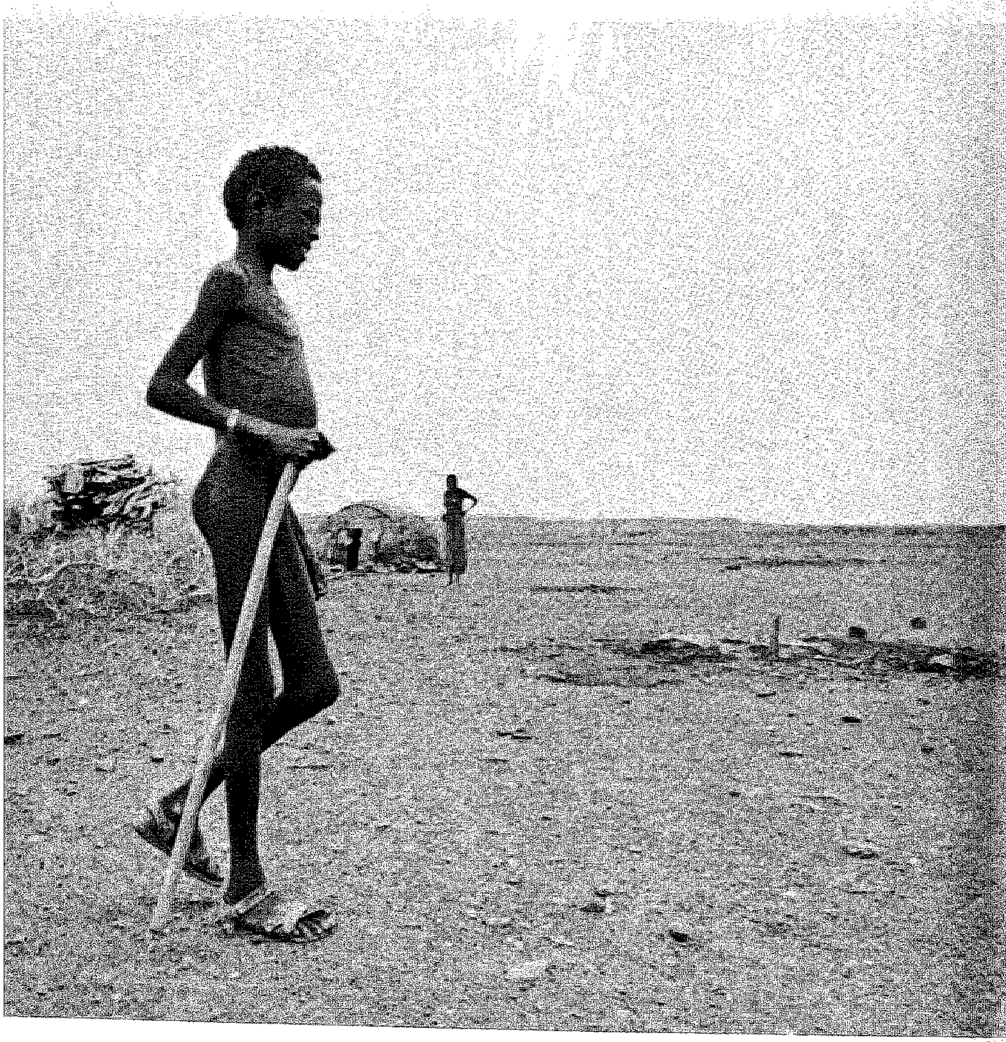
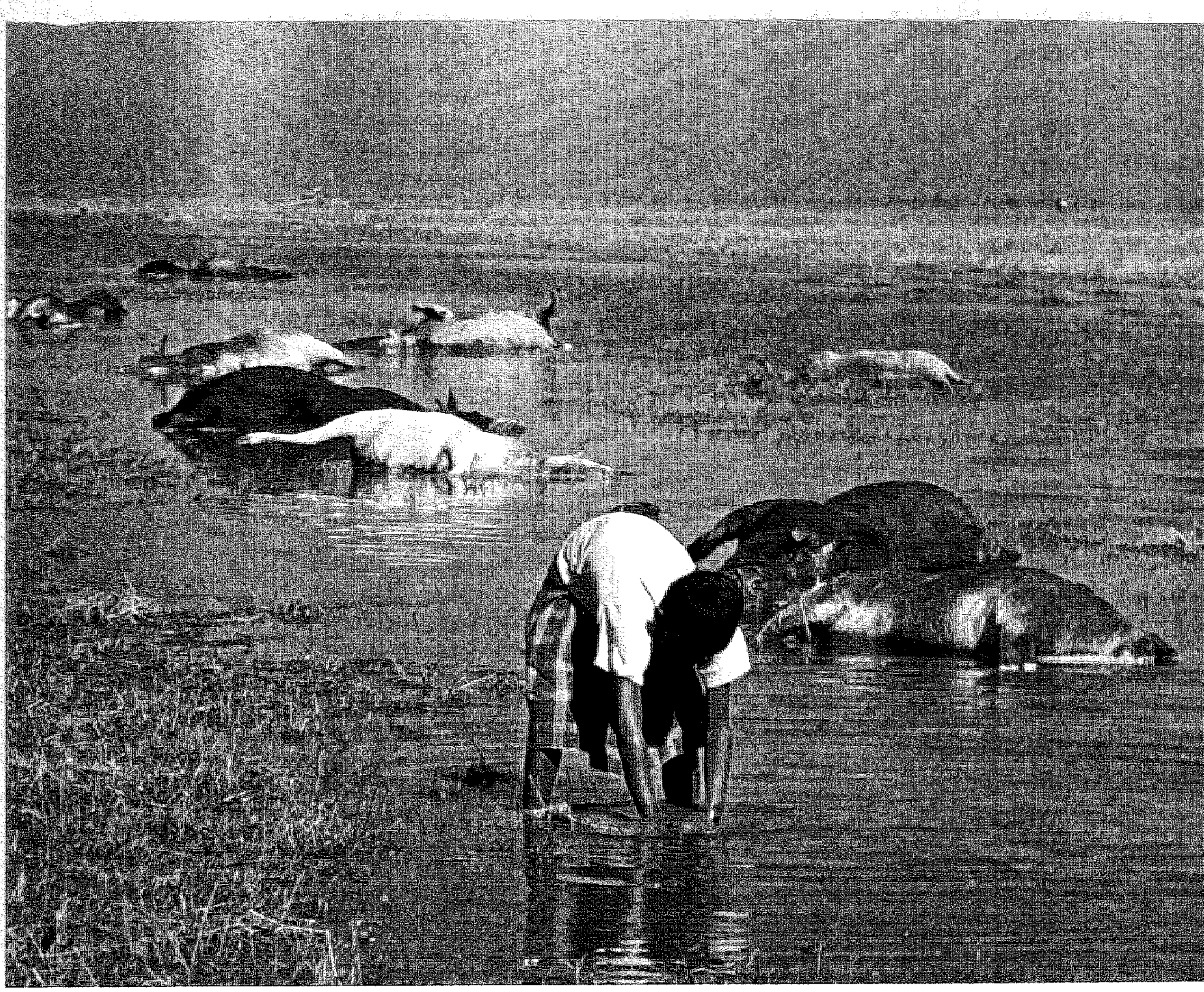
Kates, R. W., 1976. "Dealing With Disaster", Science Year, pp. 166-179.



Dealing With Disaster

By Robert W. Kates

Powerful and unpredictable, nature has always been risky, but, in an increasingly crowded world, man must come to terms with her hazards, and his own



"At midnight we heard a great roar growing louder from the southeast. I looked out. It was pitch black, but in the distance I could see a glow. The glow got nearer and bigger and then I realized it was the crest of a great wave," said Kamaluddin Chodhury, who managed to survive the great wave on Nov. 13, 1970. During that night, high tides and a tropical cyclone with winds up to 150 miles per hour (240 kilometers per hour) combined to slam a crushing wall of water as high as a two-story building onto the shores of East Pakistan (now Bangladesh), the most densely populated nation in the world. On the morning after, at least 200,000 people were dead, most of them women, children, and the aged. Unofficial estimates ran as high as 600,000. Crops worth $63 million were destroyed and about 280,000 cattle were killed. It was the worst natural disaster of the 20th century.

Few places were hit harder than the chars, a farming area of sand bars and reclaimed land in the Ganges-Brahmaputra Delta. In the

Mississippi Delta, such land is considered fit only for waterfowl. But crops raised on the chars support a population of up to 1,300 people per square mile (520 per square kilometer).

On a warm, dry, winter day two months after the disaster, I sat in a small hut that served as a tea shop on Char Jabbar, talking with 10 men who survived the cyclone. They had lost a total of 130 relatives. My colleagues, Bangalee geographer M. Aminul Islam of the University of Dacca, and U.S. economist Howard C. Kunreuther of the University of Pennsylvania, and I were piecing together the unnatural history of this natural disaster. We were seeking answers to some pressing questions: Why do people live in areas they know to be hazardous? How do they measure hazard? How do they cope before, during, and after a disastrous event?

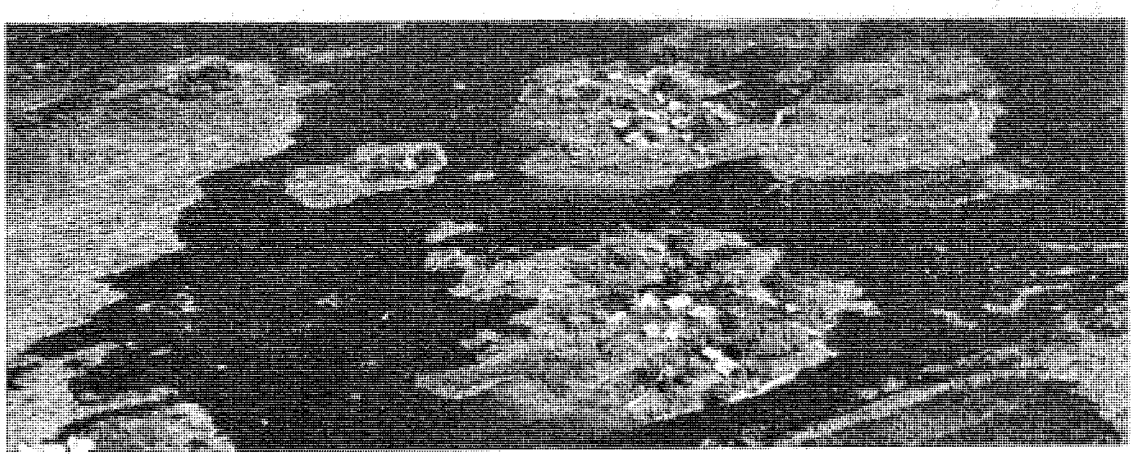
Our work on Char Jabbar was part of a 40-year-old quest that began when two geographers, the late Harlan H. Barrows of the University of Chicago and Gilbert F. White, now at the University of Colorado at Boulder, asked these questions about the people who lived in the American Dust Bowl and the flood plains of the Ohio and Mississippi rivers during the 1930s. Today, over 100 economists, engineers, geographers, psychologists, and other scientists in 20 countries, linked through the International Geographical Union, continue the study. We share certain working definitions: There are natural events in the complex cycles of weather and geological change. These events become hazards in the presence of people, and they become disasters when they greatly affect people, causing death, injury, and loss of property. To live with nature, as we all must, is to risk hazard. But the extent of the hazard or disaster is determined only in part by the forces of nature. The actions people take–or do not take–in the face of these natural events are important as well.

The author:
Robert W. Kates, professor of geography at Clark University, has been studying how people perceive and respond to natural hazards for many years.

Since 1969, we have been making field studies to determine how people adjust to hazards. We have spoken to people threatened by drought in Australia, Brazil, Kenya, Mexico, Nigeria, and Tanzania; floods in Great Britain, India, Malawi, Sri Lanka, and the United States; tropical cyclones in Bangladesh, Puerto Rico, the United States, and the Virgin Islands; volcanic eruptions in Costa Rica and Hawaii; earthquakes in Nicaragua; and erosion, frost, high winds, and heavy snow in the United States.

The frequency of damaging events varied widely from place to place. Residents of Boulder, Colo., reported windstorms exceeding 50 miles per hour (80 kilometers per hour) on an average of three times per year; farmers on the Ganges flood plain in India noted serious floods that caused crop damage and loss of property on the average of once in five years. By contrast, San Francisco, which was almost destroyed by a 1906 earthquake and the fire that it caused, has not had a serious tremor since.

Just as doctors distinguish between chronic and acute illness, we classify those natural events that are potentially hazardous. We class

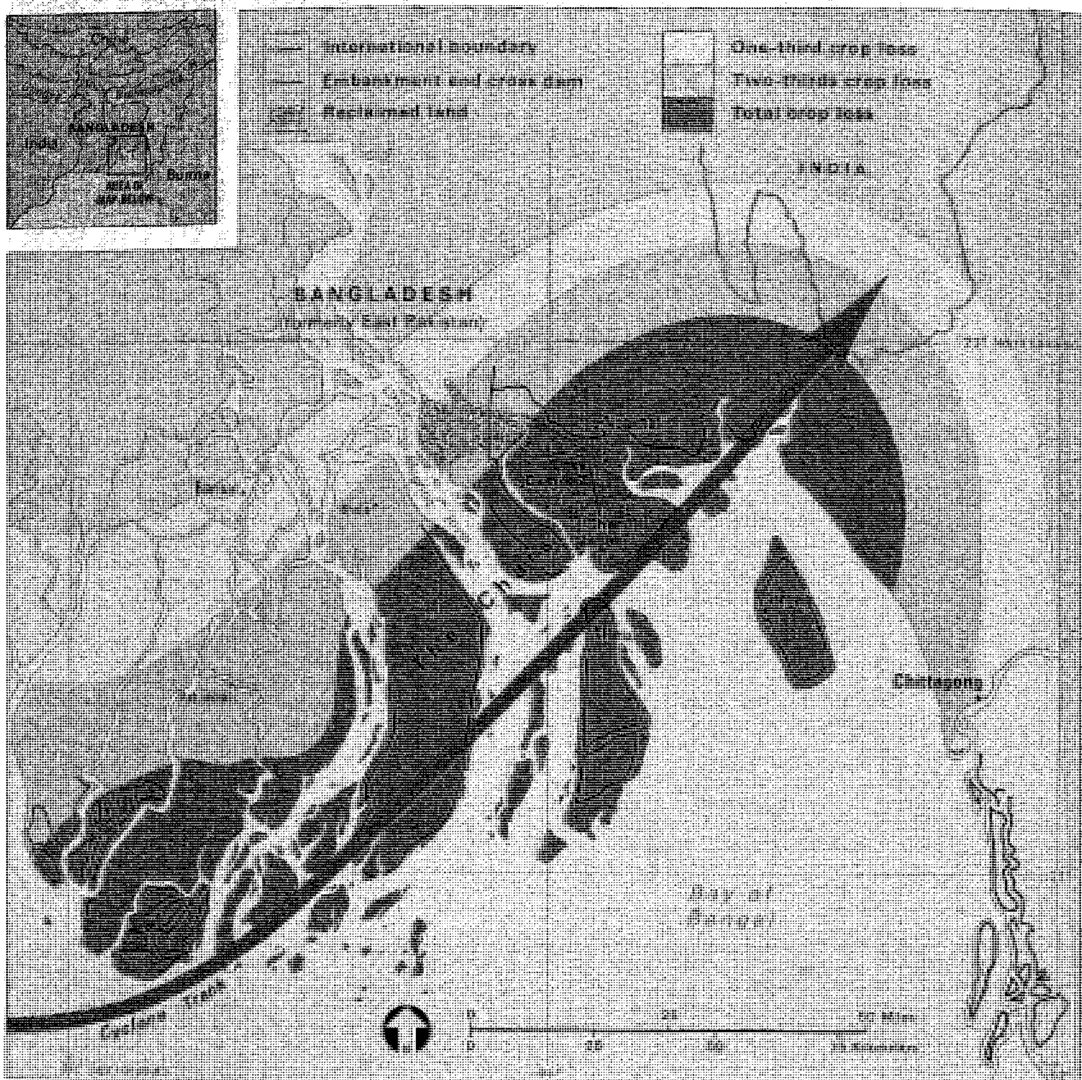


Small levees and rows of trees on the Chars were meant to protect crops and cattle from tides and floods, *top*. But these, along with larger embankments built by engineers, failed to prevent the devastation of the 1970 cyclone.

as *intensive* those sudden, unpredictable events that have great but brief impact in a relatively small area. Intensive hazards include earthquakes, tornadoes, landslides, hailstorms, volcanic eruptions, and avalanches. *Pervasive* hazards are those in which the impact is spread over a large area and a longer period of time. They develop more gradually and can be predicted more accurately. Drought, fog, heat waves, and excessive rainfall or snowfall are pervasive hazards. Floods, high winds, big sea waves, sandstorms, dust storms, and tropical cyclones are *intermediate*, with both pervasive and intensive features, depending on local geographic features as well as on such factors as the location or stage of the flood or storm.

For each study, we prepare a general description of the land and its use, the vegetation, and the people and their work. We also examine the historical record of the hazards in the area and assess their impact on the economy and social organization. In addition, we conduct and record detailed interviews with inhabitants of the area. Most of our talks are with heads of families–businessmen, craftsmen, farmers, fishermen, government workers, laborers, manufacturers, and teachers–at sites as varied as the lush citrus-growing areas of Florida and the

Tragedy Comes to the Chars



As it moved northeast through the heart of the Chars, the cyclone threw a 25-foot wall of water from the Bay of Bengal onto the reclaimed land.

arid scrublands of South Australia. Educational backgrounds range from almost total illiteracy among herdsmen in northern Nigeria to high school and college levels in the United States. Average income ranges from perhaps $2,000 per person per year in Shrewsbury, England, to less than $200 per year in Sri Lanka. Despite the many differences among the people we interview, we try to standardize the interviews as much as possible so that we can make comparisons across national and cultural lines. Each of the almost 5,000 interviews we have completed so far has added to our knowledge of how people feel about natural hazards and how they cope with them.

Islam, Kunreuther, and I went to the ravaged Char Jabbar because Islam had made a field study there in October, 1970, just before the cyclone struck. A month later, perhaps one-third of the villagers he interviewed were dead. His work remains the only such study of the perceptions, attitudes, and adjustments of people just before a major disaster occurred. We returned to link his findings with information gathered from the survivors.

Our interviews reinforced many of the conclusions we have formed over the past 20 years. Perhaps the most important of these is that human needs and choices have as much to do with causing a major disaster as do natural forces.

The men of Char Jabbar are not innocents. Like others we have talked to all over the world, they understand the hazards of the place they live in, and have done what they can to cope with them. They accept the dangers of cyclones–there had been seven other severe storms in the area in the previous 10 years–because of the benefits of living on the chars. The population of this land of hunger has quadrupled during this century. These men recognize the advantages of the larger farmholdings available on the reclaimed land, and of supplementary fishing in the delta. "It is true many have died," one farmer told us, "but where else than by the sea can we both fish and farm?" The shores of sea, lake, or river have always been good places for human settlement. That is why so many of the world's people live in such places. Shores are boundaries between ecosystems, and provide fish from the sea, rich plant and animal life in the tidal zone and marshlands, and, in the deltas of great rivers, enriched and renewed farming land. People live on the chars of the Ganges-Brahmaputra Delta not out of ignorance and foolhardiness but primarily because they can fashion a better life there.

In every pervasive hazard site we studied, we found that at least 80 per cent of those interviewed consider the hazard a significant one. Even where major disasters have not occurred for many years, 40 per cent of the people rate the potential hazard as significant and few are totally unaware of it. Yet, no more than a few of the people suggest moving permanently or changing their livelihood as a way of dealing with the hazard. Within limits, they adapt and adjust, employing practices, devices, and plans which might all be lumped together as "folk strategies," or "folk wisdom." With these strategies, they survive and even prosper in areas of high and recurrent danger. We found this store of folk wisdom at all our sites, though it was much more prominent in less developed countries. But as these preindustrial societies become more developed, much that is done in the name of improvement may be harmful if it leads to technological or social change without compensating adjustments. Tragedy came to Char Jabbar when reclamation of the land was unaccompanied by plans for emergency evacuation of the people living on it.

The farmlands of the chars are protected from tidal water and its salt and shifting river channels by some 2,000 miles (3,200 kilometers) of earthen dikes and cross dams, standing 15 to 30 feet (4.5 to 9 meters) high. This earthworks system, an impressive technological feat, was planned by Pakistani government officials, designed by Dutch engineers, and financed by international bankers. It created new farmlands and helped greatly to increase the population of the area and thus the potential for tragedy. But the system was not designed to protect against fierce cyclones, and the local and national governments had no organizations or programs that could have moved the people out of the threatened area.

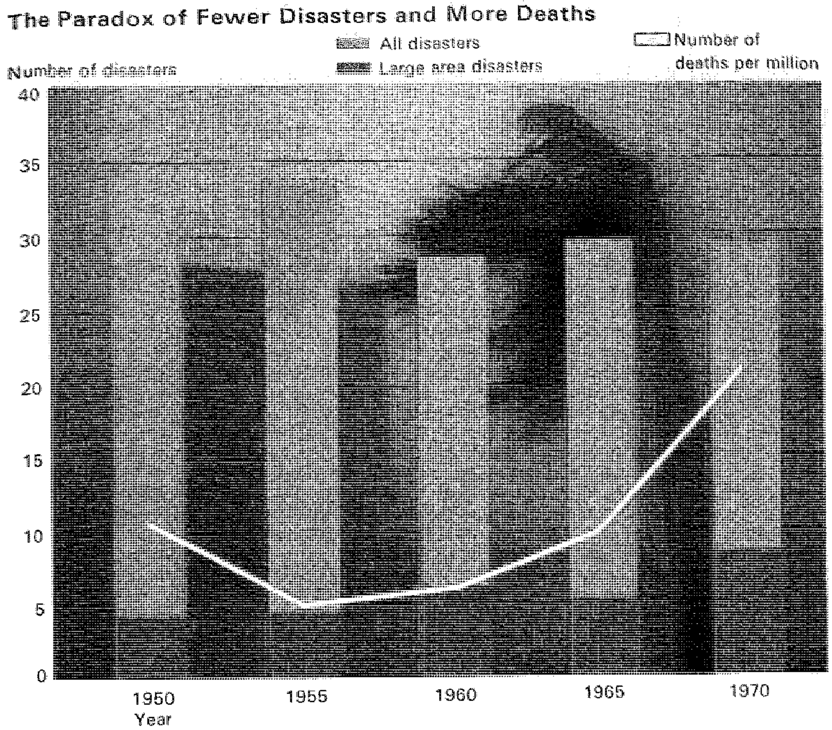
A weather satellite, an even more complex technological triumph, provided early warning of the storm, but the radio station that relayed the satellite's message was using a new storm-warning system with terminology and definitions devised by officials but never explained to the people. The engineering works that made habitation possible could have provided an excellent escape route. The 11-mile (17.6-kilometer) -long Cross Dam 2 led inland to higher ground. But no warning reached Char Jabbar. There are no telephones or telegraphs there. A policeman would have had to bring the warning by bicycle from the town of Noakhali, about 15 miles (24 kilometers) away. Even if a warning had been sent, the unorganized farmers might not have responded to it, afraid of leaving their homes for distant places on a dark, uncertain night. Many thousands died on the chars because new technology was not followed by social planning.

Two years later, I sat with other colleagues by the railroad station in Masaya, Nicaragua, talking with the survivors of the 1972 Managua earthquake, another major disaster. A series of quakes on Dec. 23, 1972, destroyed most of the city and killed an estimated 10,000 persons in this capital city of 400,000. Seven of every 10 residents were left homeless. Managuans have always lived with danger. The city was built on a fault in the earth where many tremors occur and it has been struck by disastrous earthquakes four times in the last century.

Managua was chosen as the capital of Nicaragua in 1855 as a political compromise; it stands between the less hazardous cities of Granada and León, whose citizens had been feuding. The Indians of the area probably informed the new settlers of the site's instability, but the men of Granada and León overlooked the geophysical implications of their political compromise. In 1931, an earthquake leveled 4 square miles (10 square kilometers) of the city, which had more than 50,000 people. Nicaraguans spurned the opportunity to rebuild elsewhere or to build better; the city was rebuilt on the same site in substantially the same form. Over the next 40 years, Managua's population increased almost 8 times and so did its potential for disaster. Despite its seismic history, there was practically no planning for disaster. Instead of decentralizing its fire-fighting equipment, for example, the authorities kept the entire fleet of seven fire engines in a single central fire station–which was flattened in the 1972 earthquake.

Nevertheless, the interviews made in Managua reinforce those in Bangladesh. The advantages of living in hazardous areas often out-

The Paradox of Fewer Disasters and More Deaths



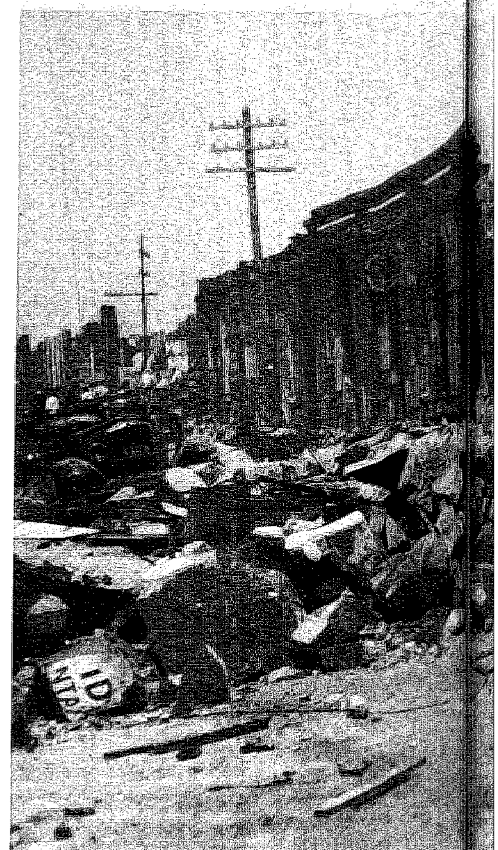
While the annual total of disasters decreased from 1950 to 1970, the number of large-area disasters and disaster deaths increased. This was caused in part by increased population density and also by the increasing use of risky, marginal land.

weigh the high risks. But a specific location may eventually burden a society to a degree far beyond the initial advantage or gain. Or, the benefits of living in a certain place and exploiting its resources may change with time. Although a city can be moved, once it is built it takes on an independent existence of its own. The investment in building, the particular activity of its people and their attachment to the place make moving difficult. In 1972, at a cost 10 times greater than in 1931, Managua again had a choice–to move, to build better, or to repeat its mistakes. The Nicaraguans have chosen to remain, but, by establishing a series of parks and open areas along the fault lines, and constructing stronger public and commercial buildings they hope to avoid another disaster.

Managua's options emphasize one finding of our studies. There are relatively few things that individuals and societies can do to cope with intensive hazards, short of leaving the hazardous zone entirely. Man can protect himself better against intermediate hazards such as floods because there is some warning. Pervasive hazards allow the widest latitude of adjustment. People can cope with drought, for example, by employing a wide range of actions–simply bearing minor losses, irrigating fields, planting drought-resistant plant varieties, using special cultivation techniques, shifting between herding and farming, or migrating to new areas.

Opportunities for adjustment to the same, or similar, hazards differ greatly among societies. For much of human history, those directly

How Hazard Grows With a City



As Managua's population increases, *above*, the potential for loss of life and property grows. The 1931 quake, *above right*, flattened a city of more than 50,000; the 1972 quake, *far right*, struck a city grown nearly 8 times larger.

affected by drought or flood had to cope as best they could on an individual or small-community basis. The nation, if it existed, had little in the way of resources or technical expertise to provide help. Our interviews with farmers in preindustrial societies reveal the enormous ingenuity of people under these circumstances.

Rice farmers facing flood in Sri Lanka, for example, have a wide range of folk adjustments. They may shift the time of planting rice, or the method of cultivation. They may choose different varieties of rice seed, or plant an entirely different plant crop. They may even change the layout of their fields in order to minimize the extent of the flooding. In all, our researchers found that the Sri Lankans had several hundred options to choose from.

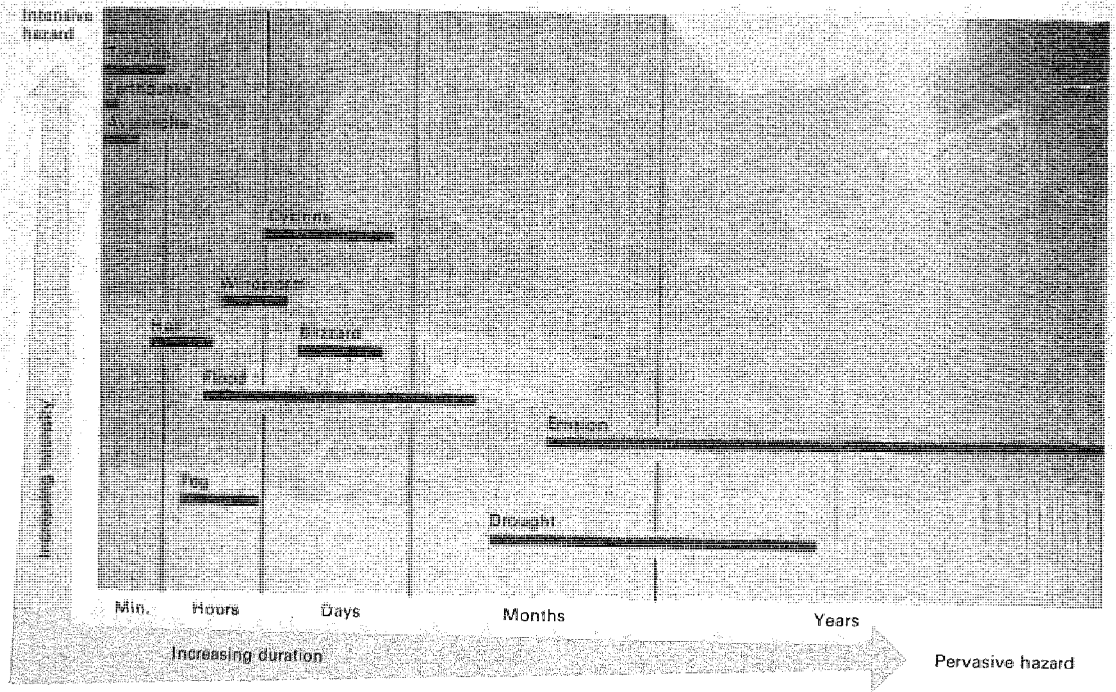
We found similar adjustment patterns in our studies of drought in Tanzania and cyclones in Bangladesh. In general, folk strategies are numerous and widely adopted. They are flexible and economic and can be added gradually. The people tend to modify their behavior or agricultural practice to harmonize with natural rhythms rather than attempt to control or manipulate the environment. For example, when the rains fail, a Tanzanian farmer plants his crops in land that is normally too wet but is just right during drought. Or he may plant less

desirable but still useful food crops that require less moisture. He can do this because he has communal access to other land or because he grows the crops to feed his family and does not depend on the commercial demands or consumer tastes of a distant market. Similarly, farmers in Mexico's Oaxaca Valley will plant one of two available varieties of corn, depending on the rainfall. One variety survives drought better, but the other variety provides higher yields of corn when it has sufficient moisture.

Such adjustments are effective in coping with many hazards, but they fail to prevent major disasters. More government or social organization may be needed when a major disaster occurs, such as an earthquake or widespread, long-term drought. Most developing countries can at best offer only emergency food supplies and some relief assistance after a disaster.

The governments of industrialized nations have become increasingly involved in major adjustments designed to protect citizens from hazards. In addition to extensive relief, they employ their impressive technological capacity to manipulate and manage the environment by building huge dams, major irrigation projects, sea walls, and complex monitoring and warning systems.

Measuring Risks: How Lethal for How Long?



Intensive hazards are sudden, brief, and affect small areas. Pervasive hazards develop slowly last longer, and generally affect larger areas

How a person adjusts to a hazard depends on his appraisal of its probability and likely intensity. The best-appraised events are the frequent, the recent, and those that greatly affect everyday life and livelihood. To test people's notions of probability, we included a simple story about the recurrence of hazard in our questionnaire. At each site, we used the common local hazard in the story. In a hurricane-prone area the story would go like this: "Once, after a hurricane, four men spoke about a hurricane coming again. The first said that a hurricane 'would come again soon' because when a hurricane happens, more are soon to come. The second thought that a hurricane 'would come again but he did not know when' because hurricanes can happen in any year. The third said that 'he knew when' the hurricane would come, for there is a regular time and that time must pass before it comes again. The fourth thought that a hurricane 'would not come again.' Which man has the best idea about the coming of hurricanes?"

While some people saw order in the random events, in most places, more than 60 per cent agreed with the second man in the story, who chose the proper random explanation of the probability of a hazard occurring. All in all, their judgments were surprisingly close to the record of past events and the judgments of trained observers about the likelihood of future events.

But, in a special Canadian study of London, Ont., a town of more than 200,000, we found out something else. We compared the perceptions of a large random sample of the population with scientific esti-

One person's hazard can be another's fun, and a snowbound commuter's feelings about snow may differ from those of his children at home. Such different perceptions may influence the way people prepare for and cope with hazards.

mates on how often five different hazardous events will occur. The people's estimates for tornadoes, hurricanes, and floods agreed closely with the scientific estimates. But, curiously, the estimates for the hazardous events that occur more commonly in Ontario–ice storms and blizzards–differed from citizen to scientist and citizen to citizen. We think the people viewed the seriousness and frequency of ice storms and blizzards differently because they are more familiar with them. Some do not think of them as hazards at all. Thus, individual judgments, and therefore the action taken concerning common hazards, may have much to do with an individual's psychological makeup.

Overall, each community develops a variety of ways to cope with a given hazard. Each person in a Tanzanian village may suggest one or two adjustments for drought, such as planting a hardier crop or going to live with relatives elsewhere until the drought ends. But if you canvass the entire village you may compile a list of 8 or 10 different actions. Similarly, each government office can tell about its own activities, such as building dams or providing insurance, but one must canvass all offices to determine the total governmental response to hazard. Many people know several actions to take to reduce damage in a hazardous area. But few act much in advance of a disaster. Some do nothing. So we find yet another question at the end of one long road of inquiry. Taking into account the important differences between hazards and societies, and the differences in individual appraisal, why do some people act to reduce their vulnerability while

Many citizens' groups are calling for closer study of the disaster potential of nuclear power and other new man-made hazards.

their neighbors do nothing at all? Why does one Puerto Rican farmer buy food, matches, candles, and lanterns and store water when a hurricane is predicted while another does not? We cannot adequately explain these individual differences. Psychologists, who are more concerned with individual behavior and thought processes, are still exploring these important questions.

White and Ian Burton of the University of Toronto and I are moving in two somewhat different directions. First, we are working to explain our major findings—that natural hazards are inevitable in the use of the earth but natural disasters are not. Both the rich and the poor are vulnerable to hazard. The poorest nations face a greater risk to life and property than do rich nations. In poor countries, the folk wisdom that helped people survive for so long is disappearing faster than the new governmental and social institutions can effectively replace it. In 1969, for instance, a small local drought struck the few areas of Tanzania where grain was grown commercially to feed that country's expanding urban population. This increased urbanization, coupled with the modernized farming methods and the consequent reduction of flexible family-style farming, magnified a localized natural event into a national problem. The drought was minor as measured by rainfall, but major as measured by production losses and relief costs to feed Tanzania's people.

Introducing technology too rapidly without making needed social adjustments at the same time can make such problems worse. The poor nations cannot escape completely the human toll of hazard, but their losses can be substantially reduced if these nations can combine the best of their own folk wisdom with the proper advanced technology of the developed nations.

Peculiarly, we have found that the developed nations are vulnerable, too, victims of their own technological success. Theoretically, their engineering achievements should enlarge the storehouse of useful actions for coping with hazard. Instead we find that for a long time technology tends to supplant all alternative adjustments until, belatedly and at very high cost, it is recognized that dams and levees are not the only answers to floods, or irrigation and water transfer the sole answers to drought. In time, of course, the lesson is learned. The United States is now paying greater attention to changing and restricting the use of flood plains than to simply protecting them with levees. Israel is developing crops that require less water rather than simply increasing irrigation systems for its farmers. Our goal is to encourage more of these solutions which compromise between man's needs and his environment.

We are also trying to apply our scientific techniques to a new and potentially more serious range of environmental hazards—those created by the technological environment. We are studying problems related to water supply and treatment, nuclear power, and man-made climatic change, and we have found one significant difference from our work on natural hazards.

Human experience played a central role in coping with an uncertain environment. But we have no pool of experience to draw on in dealing with most of the hazards of technology. They are too new and shrouded in great uncertainty. They affect us before we can detect and control them. For example, injecting particulate matter and heat from burning fossil fuels into the atmosphere certainly affects weather and climate, but we could be well on our way to a little Ice Age or, conversely, to a melting of the polar icecaps by the time that we experience the effects or are certain about them. Radiation or industrial chemicals may severely damage human genes before there is enough visible evidence of mutation for us to recognize the danger. There is a special and necessary role for scientific and technical assessors of such hazards, and for public and governmental guardians of the environment. Our new studies are especially focused on these groups. We hope that our techniques and findings may help these people to discover, measure, and deal with man-made hazards before the hazards become great—perhaps global—disasters.

But this new aspect of environmental risk worries us. Over the last 20 years, we learned to respect greatly the thousands of people living and working in the hazardous areas we have studied. We have confidence in their skills and common sense. But no such pool of common wisdom exists to deal with the new hazards created by man. Because of this, the world is a more threatened place.