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Human Impact of the Managua Earthquake

Transitional societies are peculiarly vulnerable to
natural disasters.

Robert W. Kates, J. Eugene Haas, Daniel J. Amaral,
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... [T]he framers of the existing constitution of the State, in view of the rivalry and jealousy which exist between the cities of Granada and León, and in order to relieve the Legislative Assembly from the overawing political influence of the latter, designated the city of Managua as the place of its meeting. The choice was in many respects a good one; Managua is not only central as regards position, but its inhabitants are distinguished for their attachment to "law and order," and their deference to constituted government.

When the men of Granada and the men of León made a compromise decision in 1855 to locate the capital of Nicaragua on the shores of Lake Xolotlán (1), they made a political accommodation and a geophysical blunder. No other city of similar size has had a more recurrent record of destruction than Managua. It has experienced severe shaking in 1885, destruction in 1931, severe but localized damage in 1968, and enormous destruction in 1972. Thus it is not surprising that, in the days and weeks following the 23 December 1972 disaster, at least 39

groups of geologists, seismologists, and engineers from seven different countries converged on Managua to examine in detail this latest experience, for each such major geologic event provides field data for earthquake science and engineering.

Less common was the mission that we, as geographers, sociologists, and political scientists specializing in natural hazard and disaster preparation, prevention, and research, undertook. Of some 40 major earthquakes in the last 25 years for which detailed scientific and engineering reports are available,

only four have been seriously studied and reported upon by social scientists. Reasons for this discrepancy lie partly in the organization of science: earthquake study is a well-organized component of the disciplinary structure of the physical sciences and of engineering, but comparable organization is only beginning to emerge in the social sciences. Underlying such organization is the view that the measurement and observation of earthquakes and their physical impacts is the proper activity of the physical sciences and engineering; the measurement and observation of human impact and response is in the purview of journalists, relief organizations, and governments.

But the extraordinary quality of the 23 December earthquake in Managua cannot lie in its magnitude, physical mechanisms, impact on the crustal structure, or assemblage of seismic observations. An estimated 1000 shocks of equal or greater magnitude occur each year, the fault traces and mechanisms are unexceptional, and the seismic record is sparse. What brought at least 114 geophysicists, seismologists, and engineers to Managua in the month following the earthquake was the extraordinary destruction wrought by this earthquake, the potential for recurrence, and the hope of gaining from the Managua experience insights that would reduce earthquake loss elsewhere in the world. We share this hope and consider this article complementary to the extensive geophysical, scientific, and engineering documentation that will surely appear. But we also place our brief and hurried observation of human response (2) in the context of the major questions of natural hazard and disaster research: How do men survive and even prosper in environmental settings of high risk and recurrent loss? What is the nature of human response to catastrophe?

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Human Adjustment to Natural Hazards

Society, groups, and individuals risk natural hazards in the search for that which is useful in the natural world. Resources and hazards are linked, however—the rain that waters the fields poses, in its maximum and minimum, the threats of flood and drought. Particularly attractive for human settlement have been boundary areas, those between land and water, mountain and plain, hill slope and valley. Such areas pose opportunities for exploiting or integrating two different resources and climates and are especially advantageous for settlement and travel. The circum-Pacific seismic risk area is one such attractive zone—a band of intense settlement where mountains meet the sea. If men are to reap the climatic, locational, and topographic benefits of a Japan, California, or Nicaragua, they must risk seismic hazard.

In all societies, men survive and even prosper in such areas by accepting the occasional, even catastrophic, loss; by making adjustments to modify the impact of natural events or to reduce human vulnerability; and, more rarely, by making fundamental adaptive changes in their livelihood, habitation, or location. Empirical findings from studies of 15 natural hazards in varied settings within 20 countries now enable us to specify more carefully this process and to identify trends (3). In every case, adjustments are determined both by the characteristics of the natural events and the material and organizational resources of the society.

Severe earthquakes, compared to other natural events, rarely recur in a small area, release a great deal of energy, and occur extremely suddenly. Such a hazard does not favor extensive human adjustment, and what adjustment does take place is strongly oriented toward building earthquake-resistant structures, controlling the secondary effects, and minimizing pain and loss of life.

Developing countries are peculiarly vulnerable to natural disasters. Their societies normally contain substantial elements of an industrial society, which are concentrated in a capital or primary city, as well as elements of a folk society, which are found in outlying areas. Adjustments in the folk society, while often mystical and arational, are aimed more at modifying human behavior than at controlling nature, are flexible and easily abandoned, are low in capital requirements, and require action only by individuals or small groups.

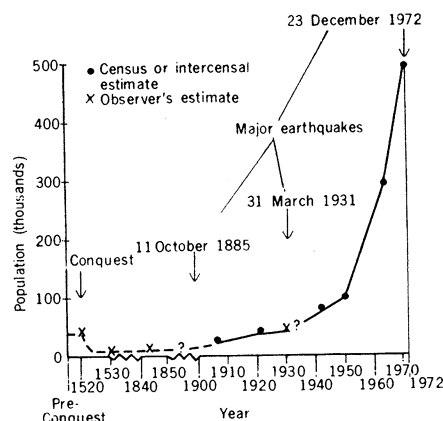


Fig. 1. Population of Managua over the last 400 years (6).

In contrast, adjustments in modern industrial societies involve a limited range of technological actions that emphasize the control of nature; are uniform, inflexible, and difficult to change; have high capital requirements; and require interlocking and interdependent social organization, but tend to be individually more effective than those in a folk society. In developing societies that combine aspects of both folk and industrial society, much of the folk wisdom may disappear or atrophy. The expectation of support and relief may shift from the family and clan to government or other organizations before their actual capacity to provide such aid has been realized. And the applications of technology, limited by scarce resources, may actually increase the potential for catastrophe. Thus a series of national comparisons (4) for drought, flood, and tropical cyclone show the costs of hazard for the three developing countries studied (Tanzania, Sri Lanka, and Bangladesh) to be 10 to 20 times greater in average relative income and up to 1500 times greater in annual loss of life than the industrialized countries (Australia and the United States). The urban history, seismic record, and social organization of Managua created a similar setting of heightened vulnerability.

Urban History of Managua

Managua, on the south shore of Lake Xolotlán, is no stranger to massive human tragedy. In the past 400 years, this site has witnessed repeated bloody wars, uneasy truces, and natural catastrophes of great magnitude. At the time of the Spanish Conquest, it was the location of an extensive settlement of Dirianes, whose condition then and whose fate

thereafter are concisely summarized by Spaniard Gonzalo Fernández de Oviedo y Valdés (5):

It [Managua] was inhabited by Chorotegans, and, to tell the truth, it was a beautiful and populous village . . . composed of isolated houses, at considerable distance from each other . . . at the time of its prosperity, it was the finest place of the province, and contained 40,000 inhabitants, of which 10,000 were archers, or slingers. But when I visited it, six years after the Conquest, it was the most completely abandoned and desolate place of the government. It now contains 10,000 souls. . . .

In the 1840's, when E. G. Squier traveled extensively in Nicaragua (1), the population of Managua had barely increased. Except for the fact that the town had become the de facto capital (it did not become the official capital until 1855) of a nation torn by internecine conflict between the Liberales of León and the Conservadores of Granada, Squier's description leads one to believe that it had also changed little in ethnic makeup and daily custom (1, pp. 402–415).

The total number of inhabitants of Managua probably did not exceed 20,000 until the early years of the 20th century; it did not again reach its pre-Columbian estimate of 40,000 until the late 1920's, a period of growth in the commodities export economy and of civil war, replete with U.S. intervention (6, 7). Recovery (in terms of population) from the Conquest took 400 years; recovery from the 1931 earthquake took considerably less than a decade. By 1940, the city's population had passed 50,000; by 1963, it had passed the quarter-million mark, and the best estimates on the eve of the December 1972 earthquake put it at somewhat greater than 400,000 (Fig. 1).

From a town of predominantly Indian tradition and culture, Managua, under the impetus of commodities export and a growing commercial industrial sector, had become a city typical of its kind in the developing world. The city's streets were filled with cars, trucks, and buses during the working day and were nearly empty after 6 p.m. and on weekends. North American and European foodstuffs might be purchased in a modern, shiny supermarket, and iguana and pitahaya might be bought from wicker baskets in the Mercado Central. Wood shanties sheltered thousands in the shadow of high-rise bank buildings. The now-dead heart of Managua was archetypical of the contrast in the developing world.

Seismic History

The plains of Managua lie in the Nicaraguan Graben, a long laguna-dotted depression lying 30 to 40 kilometers inland from the Pacific Ocean and cut by innumerable fault lines, generally running parallel to the coast (Fig. 2). Made up of recent alluvial and volcanic sediment, the plains are bounded on the north by Lake Managua, on the west and south by the Sierra de Managua, a chain of volcanic material and collapsed craters, and on the east and south by a major chain of volcanoes having a northwest, southeast orientation (8).

In the century prior to the 1972 earthquake, Managua was damaged in 1885, 1931, and 1968. Comparative data are presented in Table 1 and brief descriptions follow.

1885. As might be expected, very little information exists other than the fact that a very damaging earthquake struck Managua on 11 October. There were no estimates of casualties or damage except as implied by statements that the earthquake produced enormous material damage.

1931. This devastating earthquake has been well documented (9). It occurred at 10:10 a.m. on 31 March. In addition to the 1000 to 2000 deaths, there were several thousand injuries. About 35,000 were made homeless. Property losses were estimated at \$15 million to \$30 million (1931 values). Serious damage covered an area of about 10 square kilometers, and minor damage was noted over about 23 square kilometers. Reinforced concrete buildings were reported to have fared well, even those poorly constructed, but the dominant wood frame with mud and rubble-filled walls survived poorly, and fire contributed to the overall damages.

1968. Unlike the 1931 and 1885 earthquakes, this one strongly affected a highly localized area on the southeast outskirts of Managua. It occurred at 4:04 a.m. on 4 January. Except for two housing developments, the area was lightly populated. These two developments and nearby schools, a dormitory, and orphans' home were damaged. There were no reports of deaths or serious injuries, and we could not locate any figures for property damage.

Social Organization

A large city provides essentially a complete life-support system for its inhabitants and its visitors. For this to

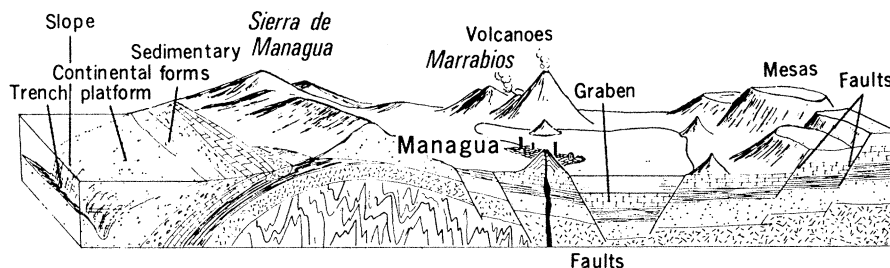


Fig. 2. A block diagram [adapted from J. Incer (7)] showing the setting of Managua, city and lake, in the graben that is parallel to the coast and offshore trench.

occur, however, there must be extensive interchange with the city's external environment. Managua, as is the case with many cities in developing countries, was very dependent on both the rural countryside and foreign sources and markets. Within the city itself, however, the range of basic activities relating to the community was fairly typical. The list includes activities centering around (i) preservation of life and health; (ii) provision of food, clothing, and shelter; (iii) economic functions (production, distribution, sales, and so forth); (iv) provision of basic community services (utilities, transportation, communications systems, and so forth); (v) maintenance of public order; (vi) leisure and recreation; and (vii) socialization (education, provision of information).

There were few unusual features in the conduct of these basic activities immediately prior to the earthquake. Schools were out for the Christmas holiday season, and the stores had the usual upsurge in buying. But there were some patterns of activity that would not be considered typical in a U.S. city of comparable size and that are particularly related to evaluating the earthquake experience.

Nicaragua, like other Latin American countries, has a pervasive, extended family system (10). Any given individual may reasonably anticipate assistance and social and psychological support when needed, not only from members of the immediate household, but also, to a significant extent, from uncles, aunts, cousins, and members of their households. While this pattern shows up in a variety of ways, it is perhaps most noticeable in the provision of food, clothing, and shelter. The nuclear family in Managua is not a little island unto itself as is often the case in U.S. cities, although most families did have their own dwelling unit, however small. The pattern of residence also differed. The central city contained many small commercial establishments within which the

owner-operator family also lived. Thus there was more residential occupancy in the commercial district than is typical for the United States.

Nicaragua was undergoing a year-long drought when the earthquake struck. During the preceding months, some voluntary relief organizations such as Caritas had operated a food distribution program for the most needy. However, Managua had no welfare clientele in any way comparable to that in most U.S. cities. The poor, no matter how desperate their plight, knew that no agency, whether government or private, would care for them on a continuing basis.

Citizens of Managua could move around the city with relative ease because of the large number of bus lines and the frequent schedules. Only the moderately well-to-do could afford automobiles, so the buses were heavily used and, except in the center city, traffic jams were quite rare. Many of the poor were accustomed to walking. Managua was not a city dominated by private automobiles and thus differs significantly from the prevailing patterns in the high-risk seismic areas of North America.

Managua did not have a city police force to maintain public order—no Nicaraguan city does. The National Guard was the only organization involved in law enforcement. It was reported that in recent years a small movement had been made toward dividing the city into something like police precincts, with a designated military officer responsible for law enforcement in each area. Reportedly there were only 5000 persons in the entire National Guard in all parts of the country before the earthquake. It is not known what proportion of the National Guard were in and around Managua on 23 December 1972. There was certainly no competing law enforcement agencies, as is sometimes the case in the United States.

A related pattern was the watching

and guarding of property. Yards of upper-class dwellings are almost always surrounded by a fence with sharp pickets or a wall with glass shards imbedded in the top. A private home is seldom left unattended. Either a family member remains home or a hired watchman is present. The underlying assumption seems to be that anything of value that is left unguarded is fair prey.

Thus the special quality of the situation in Managua prior to the earthquake was the unusually high occurrence of damaging earthquakes in a relatively new and rapidly growing city that contained 20 percent of the population, as well as the major industrial, commercial, and governmental capacity, of a small nation. Yet despite its seismic history and special, centralized vulnerability, pre-earthquake disaster prevention or preparedness measures were almost nonexistent (Table 1).

At least six major structures had been designed and constructed in accordance with U.S. design standards applied in seismically active areas. A law requir-

ing seismic-resistance of major structures had been recently passed but not implemented. Insurance was in force on upper-income housing [with a coverage, perhaps 50 percent, exceeding that for comparable housing in California, about 4 percent (11)], by virtue of being required by the local mortgage lenders. A radio frequency had been set aside for emergency broadcasts as part of a Central American network. To the best of our knowledge, this was the extent of significant pre-earthquake disaster prevention, planning, and preparedness.

The Earthquake of 23 December 1972

Three shocks produced most of the damage to Managua. They occurred at 12:30, 1:18, and 1:20 a.m. local time on 23 December 1972. A magnitude of 5.6 on the Richter scale has been computed for the first and largest of the three shocks. Foreshocks were reported locally, beginning about 10:00 p.m. on 22 December. As a result of these

foreshocks, some persons slept outdoors that night. Aftershocks continued for many weeks.

Surface faulting was located in four zones (Fig. 3). The area has been mapped extensively by the U.S. Geological Survey (12). The greatest zone of damage was in the older downtown area (Fig. 3). Moderate to extensive damage, including collapses, extended virtually everywhere in the vicinity of Managua. Damage was caused by shaking, faulting, and fire in the downtown area. It is probable that these earthquakes had a shallow focus (epicenter close to the surface), which often intensifies damage. The epicenter of the main shock has been tentatively located northeast of the city under Lake Managua.

When the sun rose over the city of Managua on Sunday, 23 December, out of an estimated population of 420,000 at least 1 percent were dead, 4 percent injured, 50 percent (of the employed) jobless, 60 percent fleeing the city, and 70 percent temporarily homeless. In this nation of 2 million people, at least 10



Fig. 3. The shaded area is the estimated area of greatest damage. Lines A-D indicate major faults from December 1972 earthquake. Line Z indicates the major fault from the March 1931 earthquake. A solid line is a fault trace identified in the field, a dotted line is inferred only. [Based on preliminary data from U.S. Geological Survey]

percent of the industrial capacity, 50 percent of the commercial property, and 70 percent of the governmental facilities were inoperative. To restore the city would require an expenditure equal to the entire annual value of Nicaraguan goods and services. In a country where the per capita gross national product is about \$350 per year, the 75 percent of Managua's population affected by the earthquake had, on the average, a loss of property and income equivalent to three times that amount.

There is a unique epistemology of disaster reporting. No one will ever really know the precise magnitude of the human disaster. Estimates of death ranged from 2000 to 20,000; estimates of damage are almost certainly overstated. The methodology of loss estimation itself is not clear. Damages differ depending on whether they are considered as replacement value, restoration value, or the depreciated value of assets or property. In the aftermath of disaster, the actual costs and expenditures may become seriously inflated. Conversely, much opportunity for repair and salvage is underestimated initially. Losses differ by accounting stance as well. Much money will change hands among Nicaraguans. There are winners as well as losers in times of great tragedy.

Two weeks after the earthquake, a National Committee for Economic Reconstruction, with specialists from government, industry, and the Central American Institute of Business Administration, prepared the damage estimates given in Table 2. The estimates are based on simple and crude measures of damaged area, of employment, and of the distribution of rental and owned property, as well as assumptions about the average amount of space required per worker for commercial, industrial, and governmental purposes. These are not really damage losses; rather, they reflect, in the main, replacement costs. They include many transfer payments; for example, emergency expenditures for locally grown food stocks may only reflect a shift in the cost of food from private individuals to the government. Nevertheless, the estimates and the documents accompanying them are impressive when compared with early estimates made in other disasters [for example, in the 1964 Alaska earthquake (13)]. Based on our review of these estimates, we would calculate the losses of material wealth as between \$400 million and \$600 million.

Table 1. Selected characteristics of damaging earthquakes, Managua, Nicaragua.

Date	Population	Magnitude (Richter scale)*	Estimated duration of strong shaking (seconds)	Lives lost	Property damage
11 October 1885	20,000 (1906)	Unknown	30	Unknown	Enormous material damage
31 March 1931	40,000†	5.3 to 5.9†	6	1000 to 2000	\$15 to \$30 million
4 January 1968	317,600 (1963)	4.6	5	0	Unknown
23 December 1972	420,000†	5.6	5 to 10	4000 to 6000	\$400 to \$600 million

* For the earlier earthquakes (1885 and 1931) there were either no or poor quality instrumental records. † Estimated.

Where the burden of this enormous loss falls can only at this stage (and perhaps forever) be guessed at. A review of estimates of rents and the value of housing lost suggests that 40 percent of the homeless were among the poor, 50 percent were salaried or self-employed middle-class, and the balance well-to-do (14). The psychic distress, widely reported but inordinately difficult to assess, cut across the entire society (15).

A comparison of the 1972 Managua earthquake with the San Fernando Valley earthquake of 9 February 1971 illustrates the special vulnerability of the transitional society. For a seismic event an interval of magnitude lower, Managua's deaths were 100 times greater and injuries 10 times greater. Property losses were roughly comparable, but the relative impact in terms of income was 15 times greater (Table 3).

Response to Disaster

When massive physical and human damage is caused by natural forces, without significant prior warning, a reasonably well-known series of activities ensues. The following account of typi-

cal, immediate responses to disaster is based on what reportedly has occurred in modern times in North American, European, and Japanese communities struck by a large earthquake or similar natural disaster (13, 16). The sequence in which the activities are discussed is thought to be a rough approximation of the typical sequence following disaster, but the various activities overlap in time (17).

1) Initial assessment of physical and human effects: through direct observation and contacting others, seeking to discover what has happened, who is hurt and who safe.

2) Efforts to secure self, family, and organization: a quick, initial attempt to shore up and save those persons and property immediately around the individual.

3) Spontaneous search and rescue activity: cries for help and the sight of rubble are quickly followed by spontaneous, mostly individual, efforts to search for the injured, trapped, and dead.

4) Attempts to ensure or reestablish public order: responsible officials and other persons believing that public order has broken or is about to break down take hurried action to keep the

Table 2. Estimate of damages (millions of dollars) caused by the earthquake of 23 December 1972 (21).

Sector	Buildings	Equipment and furniture	Inventories	Emergency costs unrecoverable*	Accounting losses and others	Total
Government	22.5	9.0	1.0	38.6	30.3	101.1
Industry	3.0	15.0	2.9	2.6	17.1	40.6
Commerce	60.6	12.0	31.5	3.0	21.3	127.8
Housing	312.3	50.0	2.1			364.4
Services	28.5	11.4	4.5	4.4		48.8
Infrastructure	101.4	30.8	5.8	20.8	3.3	162.1
Total	527.7	123.2	47.8	69.4	71.7	844.8

* This column includes costs of feeding, medicine, temporary facilities, wages, and so forth, that have been incurred as a result of the earthquake, as well as government income that will be lost.

Table 3. Comparative data for human impact of 23 December 1972 Managua, Nicaragua, earthquake and 9 February 1971 San Fernando, California, earthquake; n.a., not available.

Disaster characteristics and human impacts	Managua (22)	San Fernando (23)
Magnitude (Richter scale)	5.6	6.6
Duration of strong shaking	5 to 10 seconds	10 seconds
Area of Mercalli intensity VIII-XI	66.5 km ²	500 km ²
VII-VIII	100.0 km ²	1,500 km ²
Estimates		
Population of affected area	420,000	7,000,000
Dead	4000 to 6000	60
Injured	20,000	2,540
Evacuees	220,000 to 250,000	80,000
Housing units		
Destroyed (unsafe)	50,000	915*
Damaged	n.a.	29,560†
Commercial-industrial		
Destroyed	n.a.	575
Damaged	n.a.	1,125
Hospitals	4	20
Schools	740 classrooms	180‡
Unemployment	51,200	?
Damage (restoration value)	\$400 to \$600 million	\$504,950,000§
Per capita loss	\$1050	\$70

* Includes 65 apartments. † Includes 1707 mobile homes and 58 apartments. ‡ Of which 35 received major damage and 18 were located as unsafe. § Of which \$250 to \$257 million was public property.

curious and most of the altruistic out of the damaged area, to direct vehicular traffic, and to take steps to minimize the likelihood of looting.

5) Spontaneous, sporadic attempts to limit secondary effects: for example, a blockade is quickly thrown up next to a fallen bridge, valves are shut off to stem the flow from obvious ruptures in the water system, attempts are made to stamp out small fires and to take quick corrective action against a few obvious fire hazards, and so forth.

6) Attempts made to mobilize previously existing organizations relevant to the emergency: calling in off-duty personnel, preparing directives for action, getting equipment and supplies assembled, all combined with a continuing effort to ascertain needs and priorities.

7) Beginning actions of emergent groups and organizations: where certain needs are obvious and are not being met (for example, search and rescue, traffic control, examination of buildings for safety), new groups form and carry out activities.

8) Systematic attempts to limit secondary effects, including systematic evacuation: preexisting local organizations, in some instances with assistance from nonlocal organizations, take immediate steps to reduce any further threat to life and property.

9) Systematic efforts to provide needed emergency services: careful search and rescue with records being kept, assured care for the injured found, identification of the dead, programs of

inoculation, organized distribution of food and water, organizing shelter for the homeless, provision of critical services to emergency organizations.

10) Organized debris removal and the beginning of emergency repairs: efforts to normalize the physical setting so that the full range of activities can be carried out with relative efficiency.

11) Efforts by public officials to boost the morale of local citizens: through news releases and public appearances, citizens are told that the worst is over, that help is forthcoming, that the community will be rebuilt, that "we shall overcome."

Word of a disaster spreads quickly. The result is that the affected area acts as a magnet for persons, food, medicines, clothing, and all manner of material. In the early hours and days, much of the influx is not in response to specific requests or expressed need. This convergence appears to spring largely from a naive, altruistic impulse to help those who have suffered unexpected loss for which they are not responsible.

In addition to the convergence of persons and material, there is a communications convergence. Every mode of communication is soon jammed with inquiries concerning the location and health of residents and of offers of help. Representatives of the news media quickly arrive at the disaster scene and attempt to question already harried public officials. The convergence is a mixed blessing. It creates all manner of logis-

tical and other problems, but often in the cornucopia are some of the critically needed specialists, equipment, and supplies.

The Managua Response

Community-relevant activities in and around Managua differed from the typical response of industrialized societies previously studied in the following ways.

The early, spontaneous actions involving the assessment of effects and search and rescue were almost totally oriented to family, friends, and neighbors in dire need. With large dispersed families for whom responsibility was felt, immediate assessment and survival efforts were lengthier and more laborious. Public and private organizations and institutions, some of crucial importance in the emergency period, were given little or no attention.

Very early attempts to ensure or re-establish public order simply did not develop. Indeed, some evidence suggests that those persons who might be expected, in the countries previously studied, to initiate such early actions either reported in later or abandoned their posts of public responsibility. Looting began almost immediately and was apparently widespread. Commandeering of private property (for example, automobiles and trucks) took place to an unknown extent without any effort at record-keeping or promise of compensation. The flow of traffic, although slow, did not become a major problem.

Early, usually sporadic, efforts to limit secondary effects seem to have been absent, with only a few exceptions.

Generally speaking, serious attempts to mobilize previously existing emergency organizations started late and proceeded slowly. It appears that for approximately 48 hours the city's population had no significant support or direction from public or private organizations in the country.

Emergent groups from the local populace consisted principally of neighbors assisting each other in rescue and, less frequently, in retrieving property from damaged homes. One emergent group conducted a survey of the families still in the Managua area.

Systematic attempts to limit secondary effects did not begin until the third and fourth day, later than is typical for North American and European cities.

Systematic provision of needed emer-

gency services was mixed. Organized search and rescue with careful record-keeping never did take place. It was assumed that families would bring their dead and injured to a few centralized locations. Organized care for the injured started later than usual and was built around field hospitals sent in by other countries. Some injured were flown to other countries. Identification of the dead would have been a monumental task, even in a well-prepared city. In Managua, most of the dead were buried without any written record. Mass inoculation efforts were considered but, on the advice of foreign medical experts, were not initiated. No epidemics developed.

The distribution of potable water, although later than in the industrialized countries, was better organized, in the beginning, than the distribution of food. The latter was a source of friction among different parts of the government and between the government and the voluntary agencies helping distribute food. The government declared itself the sole distributor of food, and all others had to cease doing it or else come under government supervision. As a result, it took much longer than usual for organization in the food distribution process to develop.

Much of the usual need for planned emergency shelter for the homeless was obviated by the extended family system. An estimated 75 percent of the refugees went to live in or around the homes of relatives. An enormous, spontaneous, self-reliant evacuation and relocation to cities up to 80 kilometers away took place in the immediate aftermath, only later to be organized and enforced by governmental services.

The provision of work space and utilities for emergency organizations was a very difficult task because most buildings were no longer usable. Tents and the homes of agency heads became temporary offices since these persons had some of the basic utilities available by the end of the first week. Only the electric power company came close to the usual timing for industrialized countries in getting its service to emergency organizations, possibly because its headquarters and maintenance equipment survived well and a power surplus was available elsewhere in the grid.

Efforts by officials to boost the morale of citizens were usually late and meager. Even the provision of simple information about what was taking place was very late and sporadic in presentation.

Interpreting the Social Response

The ways in which any city performs in disaster are determined by a variety of factors. Principal among these is the community normative structure. It includes widely held values, which are rather general and abstract notions about what is right and important, and social norms, which encompass fairly specific ideas about required, preferred, and forbidden behavior. Some social norms appear in the form of legal statutes, but the majority are simply understood by most adults without ever existing in written form. The significant point is that, during normal periods in the ongoing life of any city, there is a comprehensive normative structure, widely known, which can act as a blueprint for almost any set of circumstances that may arise.

In this context, there are three principal observations that help in understanding the social response in Managua. The first is that there was a highly centralized government, thin on human and material resources and operating in a delicate political matrix. Second, the tradition of the extended family was still very strong in this urban setting. Finally, there was wide disparity in socioeconomic status among the population, combined with high visibility of these differences.

It is not at all unusual to have highly centralized governments, military or nonmilitary, in developing and near-industrial societies. Their pervasiveness, however, should not blind us to the significance of such centralization in times of disaster. These governments rarely have an established civil service force of adequate size and discipline to continue administrative and operational functions when the physical or political environments are undergoing upheaval. Nicaragua was no exception. And the more centralized the power structure of such governments, the less dependable and effective will be the civil service units that do exist. When communications break down and directives from the sole source of power are not being received as usual, the actions of usually subservient organizations become less predictable. They are not likely to conduct business as usual. And when, in addition, there is ignorance as to whether the government may be in power at all, organizational functioning becomes even more problematic.

It appears to us that the early, near total absence of concerted action, effec-

tive or otherwise, by governmental agencies must be viewed in this context. It is true that these organizations had not considered and planned for such an emergency and that lack of preparedness did take its toll on the organizational response. In disasters elsewhere, however, other organizations have been caught without any semblance of preparation, and yet, with some innovation and inputs of heroic energy, they have managed to get going again within 12 to 24 hours. In addition to the usual disbelief and shock, agency heads in Managua hesitated to take early actions because their attention was first turned to their families. In the midst of the confusion, there was also an unwillingness to act without new directives from top authorities.

In addition, at the time of the earthquake, the nation was governed by a three-man junta—an uneasy alliance of the two major parties—with former president Anastasio Somoza Debayle at the helm of the National Guard. The disaster left the nation in political conditions of extraordinary ambiguity. Effectively, the government began operating only when the Somoza family took charge of emergency operations and located them on their own estate. Fernando Agüero Rocha, the leader of the opposition party, resigned from the junta.

Immediately after a disaster strikes, the family, especially the extended family, is both a boon and a hindrance for societal functioning. Within the family unit, all sorts of help, including social and psychological support, are available because the well-being of the family is usually given exceedingly high priority. Individuals survive and recover in large measure because of this strong tendency to seek out, help, and protect members of one's own family first.

In Nicaragua, this family priority provided an amazing resource. An estimated 75 percent of the homeless of Managua found shelter in and around the homes of relatives on the fringes of the city or in more distant towns. The food stored in these host homes constituted a huge, dispersed warehouse, which supported an estimated 200,000 persons for several days.

But for persons who hold positions in organizations responsible for emergency operations to give priority to their families at the expense of their organizations means that those activities in which the community as a whole func-

tions will suffer unnecessarily. Only specialized organizations are good at fighting large fires, restoring electric, gas, water, phone, and sewer facilities, and treating the badly injured. Emergency organizations can function effectively, if at all, only when most of their trained and disciplined regular members are available for operations. For 3 to 5 days, most of the emergency organizations in Managua were denuded of personnel, principally because of this family-organization role conflict. Much of the looting and perhaps many of the fires are attributable to the absence of law enforcement personnel. One can only guess how many of the injured need not have died and how many of the dead could have been identified before burial. But the normative structure of communities in Nicaragua specifies that the family must come first, and organizational responsibility is, at best, a distant second.

Socioeconomic differences are also related to the response to the earthquake in Managua. The differences in life-style between the small, very wealthy upper class and the large lower class that exists in poverty is obvious even to the casual observer. One gets the impression that they are almost two separate cultures. In Managua, as in other cities, the material products from industry are clearly visible in the small shops of the emergent middle class and in the large stores. Everywhere the poor can see what they might have but can't afford.

When, then, in the middle of the night the walls came tumbling down and windows shattered and the affluent, in the form of hired guards or the National Guard, were not there to protect these much-desired possessions, the result was almost inevitable. The overwhelming evidence suggests that people took what they could get from homes, shops, supermarkets, department stores, and even warehouses. Persistent rumor has it that many of the fires were intentionally started as a means of diverting attention from organized looting or qualifying for fire insurance benefits if earthquake coverage were not in effect. The community normative structure provided a justification, if not positive support, for the taking of ungarded property. In the absence of special norms for disaster situations, it would be assumed that the usual community norms regarding property would apply after the earthquake. They did.

The Unplanned Experiment

For those interested in reducing losses resulting from earthquakes, a major earthquake becomes an unplanned experiment testing building materials and construction techniques, on the one hand, and social organizations and human endurance, on the other, against the accumulated experience of past disasters in the same location and similar disasters in other parts of the world. What seem to be the significant lessons that can be learned at this early writing?

Each decade, a cumulative toll of lives and property equivalent to a city of half a million disappears beneath mud or ash, is reduced to rubble and splinters, or shrivels in the parched ground. Managua underscores the global inequity of such loss. In comparison with the San Fernando earthquake, losses in lives were 100 times greater, per capita losses of material 10 times greater.

But if developing countries suffer more from natural disasters, they also do less to prepare for and prevent them. Many features of the 1931 earthquake were faithfully reproduced in 1972, yet no significant emergency planning, seismic-resistant construction, or redundancy and decentralization of emergency services was developed during the 40 years between earthquakes. The low national priority given to reduction of seismic losses, however, is not peculiarly Managuan. Natural disaster may be costly to developing countries, but so is disease, unemployment, and public disorder. Planning horizons are short—attention is centered on increasing economic wealth. The international community is relied on to provide for the exceptional need; the small national surplus is needed daily.

In the emergency phase, the international community seems to have responded well. While organized assistance in Managua was fragile, sporadic, and unreliable during the period immediately after the earthquake (48 hours), when our observations began on 7 January relief and emergency restoration were well advanced (in comparison, for example, with the Sicily earthquake of 1968). In part this was due to the fact that the earthquake occurred in a capital city; the location amplified the damages, but also enabled the government to draw on the largest pool of skilled manpower in the nation. In good part, however, the relative speed with

which relief was provided was due to the growing sophistication of the international community in providing relief. Central American countries functioned as neighboring states or provinces; U.S. disaster stockpiles in the Canal Zone were providential; organized units of engineers from the U.S. military, the Mexican highway department, and the Southern Bell Telephone Company played strategic roles in restoring services. Symbolic of the increased skill in both providing and receiving aid, and coupled with the best humanitarian responses, were the offer and the acceptance of a Cuban relief team, despite a decade of enmity. While we were impressed by the speed with which aid was marshaled and the improved skill with which it was used, there is reason for both some hope and serious concern for the future.

A central weakness in reducing the high cost of natural disasters for humankind lies in our understanding and handling of the critical post-emergency policy decisions for reconstruction (18)—and the need for this understanding is not limited to developing countries. With the haste to restore facilities, encourage economic activity, and reassert the security of familiar surroundings in the face of disaster, great pressure is generated to put back things exactly as before.

In Managua, the public arguments for maintaining the existing location of the city noted such factors as the survival of 90 percent of the heavy industry, 20,000 housing units, and the enormous investment in waterlines, sewers, connecting highways, and the like. Also cited was the deep attachment of Managuans to their city, the lack of alternative, risk-free land nearby, and the potential to rebuild with structures that could withstand future earthquakes. Privately, it was widely believed that the city would remain where it was because of the value of land held therein by wealthy, influential families.

Six months after the earthquake, relocation is not a serious consideration, but alternative patterns of reconstruction are still possible. Such patterns include: (i) regional decentralization, the provision of housing and employment, and the diversion of future growth to the major refugee centers as alternatives to the return of the refugees to their pre-disaster locations; (ii) reduced urban density—a decrease in intensity of land use by relocation to the pe-

riphery, controlled reconstruction in the center city, and increased open space; and (iii) increased seismic resistance by improving construction techniques and discouraging repair of greatly weakened structures.

Some progress in all three of these directions can be observed. External aid agencies have moved rapidly, compared to their normal pace, to provide alternative housing and employment opportunities. Large sections of the center city have been leveled and await further planning and risk delineation studies. Guidelines for seismic reconstruction techniques have been published, and a new building code patterned on Acapulco, Mexico, is being reviewed. New building permits have been restricted mainly to single-family dwellings.

Countering these trends is the return to Managua of a sizable portion of the refugee population, the low utilization rate of the refugee settlements on the periphery, the many pressures for laissez-faire speculation and reconstruction, the enormous difficulties in code enforcement and inspection, the absence of critical information as to microzonation and long-term environmental risk, and a general atmosphere of indecision and confusion in a period in which major decisions are still to be made and the dissemination of public information is limited.

If the past is any guide to the future, Managua will experience further earthquake damage within the lifetime of most of the current earthquake victims. The seriousness of that damage is still very much in the balance.

Finally, Managua reminds us in North America of our own vulnerability. While we can be encouraged somewhat by the comparative experience of the San Fernando earthquake, there is much in the Managua experience that is sobering. The Managua earthquake was a low-energy, short-duration earthquake, and another, perhaps 1000 times greater, can be expected to occur on the West Coast of the United States within the lifetime of most readers of this article. One set of scenarios for the San Francisco Bay area envisages between 10,360 and 100,000 deaths and property damage of up to \$1.4 billion (19). The realism of such scenarios is underscored by three relevant aspects of the Managuan experience.

First, while the experience in Mana-

gua is reassuring as to the ability of construction built to current standards of seismic resistance to avoid structural failure, it is not reassuring with respect to functional failure. A building may be safe—that is, no one is killed or even injured by its collapse—but it may also be useless, unable to effectively house the functional activity contained therein. Managua provides a grim lesson as to what occurs when all the major hospitals that do not collapse become non-functional. Recent legislation in California now calls for hospital buildings to be not only safe but functional. Literal enforcement of such an act should require drastic changes in design practice (20).

Second, a center city disaster of the type envisaged in the scenarios, with a major fire, will necessitate massive evacuation of the surviving population. Three elements made the transport logistics in Managua possible: a simplified, one-level road transport system, a large pool of public transport equipment and a minimum of private automobiles, and the fortuitous survival of the oil refinery and its initiative in distributing gasoline to suburban stations. None of these elements would necessarily be present in California—indeed, the contrary could be expected. The freeway system can be fail-safe structurally but be rendered inoperative by unavoidable minor breaks and off-sets. The everyday operation of private automobiles under normal circumstances can result in massive traffic jams, and gasoline, while ample in the area, might be unattainable where and when needed.

Third, if a breakdown of public order takes place during such a major disaster and if extended aid, while forthcoming, is unable to penetrate effectively into the stricken area, a large West Coast urban center might suffer much of the social dislocation and none of the compensatory supports found in Managua. Already a norm similar to that of Managua prevails in many of our central cities—what is not watched is likely to be stolen. But the compensating norm of broad familial responsibility is missing. Thus, while 200,000 Managuans moved in with their kin and lived there for months, will 4 million Californians be able to double up with kin and strangers for an extended period?

These questions are perhaps the most one can derive from transferring the

results of an unplanned experiment. In any event, the experiment of major earthquake disaster will be repeated somewhere else, possibly in similar fashion. If there is any conclusion to be reached, it is that the Managua-type experiment need not recur, but it probably will.

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The Relative Operating Characteristic in Psychology

A technique for isolating effects of response bias finds wide use in the study of perception and cognition.

John A. Swets

Psychological measurements of an individual's ability to make fine discriminations are often plagued by biasing factors that enter as he translates his covert discrimination into an overt report about it.

Reliable, valid measures are desired of an individual's ability to make a great variety of sensory discriminations, along dimensions such as brightness, hue, loudness, pitch, and the intensive and various qualitative attributes of taste and smell and touch. Sometimes the focus is on the organism's capacity for discrimination, as when the functioning of the sense organs is under

study. At other times, interest centers upon the discriminability of the alternatives, as when the measures are used in the development of a product such as color film or tea.

Also sought are accurate measures of more complex perceptual discriminations. How well do individuals judge relative size, distance, direction, time, and motion? How noticeable is a given road sign, and how distinguishable are the signs that employ different combinations of shape, color, and notation to convey different meanings?

Further, it is important to develop unbiased measures of cognitive discriminations, such as those related to memory and conceptual judgment. Psychologists ask people to distinguish

objects they have seen before from objects they have not, perhaps nonsense syllables or advertisements; to tell from an article's title, descriptors, or abstract whether it is relevant or irrelevant to a particular need for scientific information; to say whether a given opinion is representative of source A or of source B; and so on.

The translation of covert discrimination into overt report is not direct and simple, according to psychological theory, either because the output of the discrimination process is not definite or because judgmental considerations can override that output. In any case, an inherent ambiguity makes an individual's report prone to influence by such factors as his expectations and motivations or, more specifically, by such factors as probabilities and utilities. Thus: The immediate evidence may favor alternative A, but alternative B is more probable on the whole, so I'll more likely be correct if I report B. Again: The evidence may favor A, but the penalty for incorrectly reporting A is relatively large (or the reward for correctly reporting B is relatively large), so I'd be wise to report B.

That probabilities and utilities influence outcomes of the important discriminations people are called upon to make is perfectly clear—as when the clinician reads an x-ray, when the pilot emerges from a low ceiling, or when the Food and Drug administrator suspects that a product is harmful. Less

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