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## IV. GENERAL EPIDEMIOLOGIC PATTERNS OF DISASTERS

Despite their apparent dissimilarity, disasters as different as an outbreak of plague in Vietnamese refugees and a nuclear explosion over Hiroshima have common features which can be analyzed and compared. The four general epidemiologic patterns of disasters relate to space, time, their destructive effects, and the problems they produce.

### A. SPATIAL ZONES OF DISASTERS

There are five distinct spatial zones identifiable in a disaster area. Wallace (1956) has depicted these zones as a series of concentric circles (Figure 1). Although the circular configuration of the zones should not be taken literally, their concentric relationship to one another is helpful in conceptualizing the problem. The five spatial areas are the zones of 1) total impact, 2) fringe impact, 3) filtration, 4) organized community aid, and 5) organized national (or international) aid.

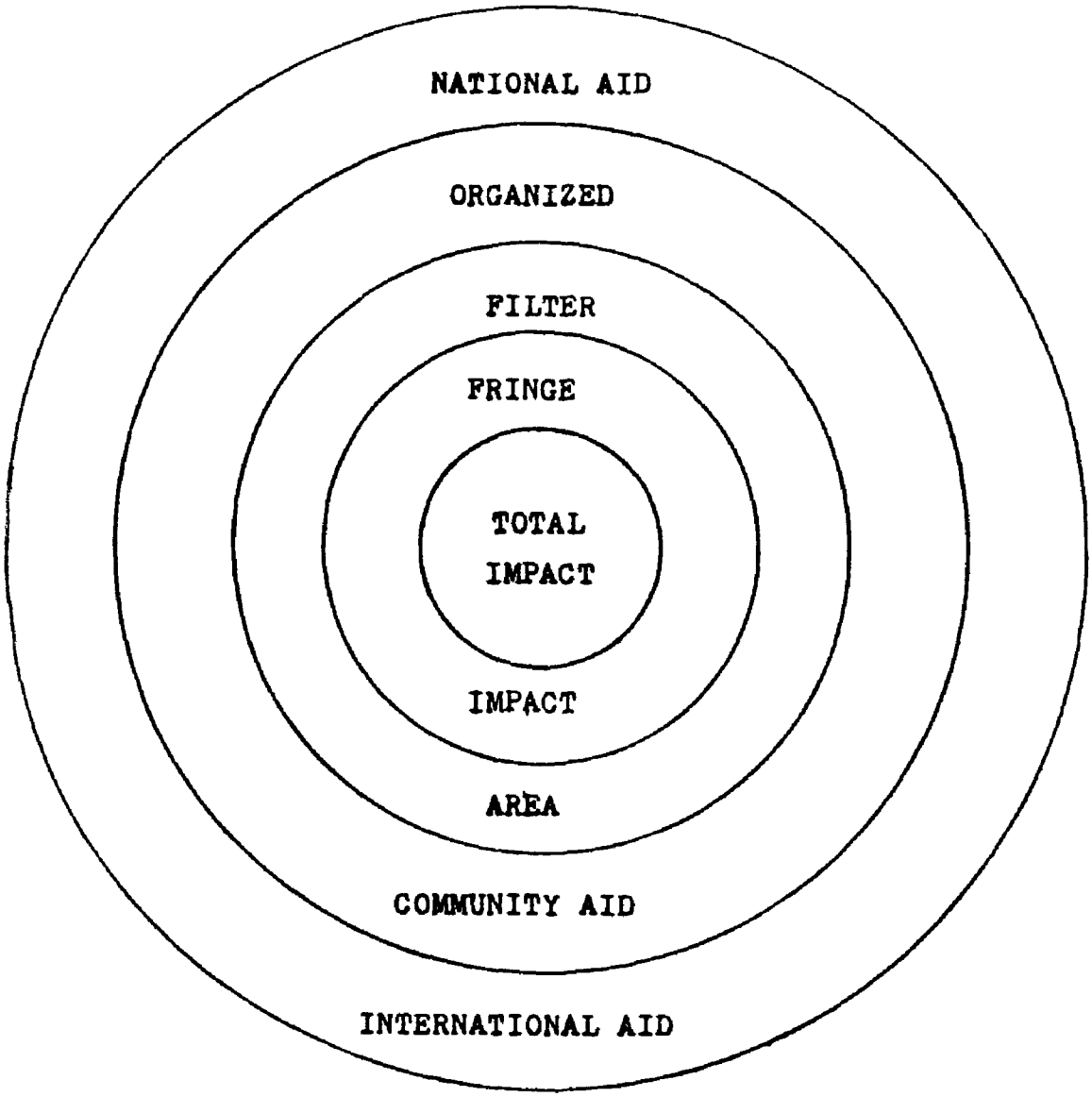
#### 1. Zone of Total Impact

The zone of total impact is the central area which receives the full force of the disaster. Its limits are easily recognized by relief workers outside the zone. Destruction and death in the total impact zone is usually not complete, but more severe than surrounding areas.

The damage to the zone of total impact may be modified by

Figure 1.

THE FIVE SPATIAL ZONES INVOLVED IN DISASTER SITUATIONS




Adapted from: Wallace (1956)

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precautions against disaster and, on occasion some effects may be less severe than elsewhere. The inhabitants of coastal

areas frequently hit by wind storms may have learned through experience to build wind-resistant structures and to evacuate the area on command. The effect of the wind storm on the coast, therefore, might be less than in areas further inland where the houses are flimsier and the population was not evacuated.

2. Zone of Fringe Impact

The zone of fringe impact is the circle adjacent and peripheral to the zone of total impact. This zone is directly affected by the disaster agent, but the damages and casualties are considerably less. In some types of disasters, the zones of fringe and total impact are remarkably distinct; in other types the two zones merge almost imperceptively. A tornado may come down one one side of an urban street wrecking havoc and yet cause minor damage to houses on the other side. Seismic tremors, on the other hand, radiate outwards from the epicenter producing damage in gradually diminishing fashion.

3. Zone of Filtration

The filtration zone is adjacent to the disaster area, but has escaped direct damages and casualties. Large numbers of injured, homeless persons, and refugees may filter into the area and overwhelm existing facilities. As a result, the zone of filtration often is severely affected by overcrowding, poor sanitation, and communicable diseases. The Bengali refugees in India before and during the 1971 Indo-Pakistani War pro-

vide an excellent example how social, economic, and medical problems are thrust upon a zone of filtration.

4. Zone of Organized Community Aid

The zone of organized community aid in the developed countries is the primary source of organized emergency personnel and services (i.e. fire and police departments, medical and hospital services, and relief agencies). Poorer countries, however, invariably do not have sufficient personnel and resources to deal with disaster problems in the immediately adjacent communities. If this be the case, regional or central authorities may be directly in charge of relief operations--even though the disaster is local and well-circumscribed (Roth, 1970).

5. Zone of National and International Aid

The distinction between the zones of organized national and international aid is related primarily to the size and resources of the affected country. Large countries such as the United States and the Soviet Union can organize assistance from regions several thousands of miles away and still consider the disaster a domestic problem. If a small, flood-prone country like the Netherlands orders blankets from Belgium, the aid is international in origin.

The resources of developing countries are more likely to be strained by a disaster of a certain size than if it were to affect a richer country. Even large developing countries

will often request international assistance in relatively minor disasters rather than depleting currency reserves or curtailing essential development programs (Steele, 1971).

## B. TIME PHASES OF DISASTERS

All disasters can be divided into five time phases--1) the predisaster state, 2) warning, 3) impact, 4) emergency, and 5) recovery phases. The time phases and their important subdivisions are listed in Table 3 and matched with the reactions and activities of the community during that time period.

### 1. The Predisaster State

The phase before the disaster strikes is of critical importance because it, more than the others, determines the seriousness and individual characteristics of the calamity. The geographic features, population density, economic standards, housing construction, sanitary facilities, transportation system, and communications are all important factors in case studies of individual disasters. Recent studies also suggest that familiarity with actual disasters is more critical than the best designed disaster drills preparing for an event the community has never experienced (Anderson, 1969a). The aphorism that "every disaster is different" rises from the difficulties of considering and properly weighing these predisaster conditions in planning or relief operations.

### 2. The Warning Phase

The warning phase in disasters is the period of time

Table 3.

THE FIVE TIME PHASES IN DISASTER CORRELATED WITH THE REACTIONS AND ACTIVITIES OF THE COMMUNITY

| PHASES | REACTIONS AND ACTIVITIES |
|---|---|
| A. PREDISASTER CONDITIONS | 1. Environmental, demographic, economic and and technical resources<br>2. Previous experiences with disasters<br>3. Disaster planning and training |
| B. WARNING | |
| (1) Alert | 1. Preliminary precautions<br>2. Search for additional information |
| (2) Threat | 3. Action for protection and survival |
| C. IMPACT | 1. "Holding on" |
| D. EMERGENCY | |
| (1) Isolation | 1. "Disaster shock" syndrome; panic rare<br>2. Social system disrupted<br>3. Survivors deal with urgent individual or family needs<br>4. Elementary first aid<br>5. Prevention secondary threats (i.e. fire) |
| (2) Rescue | 1. Uncoordinated assistance from fringe and filter zones<br>2. Rescue of surviving victims<br>3. Emergency medical assistance |
| (3) Remedy | 1. Arrival of organized assistance from unaffected areas<br>2. Arrival outside relief supplies<br>3. Medical triage and effective assistance<br>4. Disposal of the dead<br>5. Attention to sanitary measures and public health problems |
| E. RECOVERY | 1. Rehabilitation and adjustment of individuals and families<br>2. Restoration of community organization<br>3. Repair of community damage<br>4. Initiation of preventive measures |

Adapted from: Tyhurst (1951), Rayner and Finesinger (1953), Wallace (1956), Saylor and Gordon (1957), and Beach (1967).

from the first possible danger signal to the moment of impact. It is useful to divide the warning phase into the alert and threat periods.

a. The Alert Period

The alert period is the portion of the warning phase in which the possibility of a disaster is recognized. Biological phenomena (locust swarms and epidemics) and meteorological events (wind storms and floods) are disasters which allow sufficient time to prepare for the impact. Simple precautions such as bringing the children indoors, listening to the local radio or buying provisions may be indicated. The individual still needs further information before taking definitive actions.

b. The Threat Period

The threat period begins when a disaster is perceived as an immediate danger. In most situations the alert period is long compared to the period of threat. The sighting of a tornado funnel or the rising of the wind are examples of disaster signals during the threat period.

Most disasters give some warning--even though it may be too short for all victims to take effective action. Minor seismic tremors sometimes precede a major earthquake. Survivors of mass explosions tell of a blinding flash the instant before being struck by the impact (Blocker and Blocker, 1949).

There are three problems with disaster warnings. First, many disasters do not permit dissemination of the warning to the community. Second, where warning is possible, the community must recognize the danger signals or accept the decision of some responsible authority. Third, frequent false alarms are likely to jeopardize mobilization in the future.

3. The Impact Phase

The impact phase is the period during which the disaster strikes and is recognized as the cause of death, injury, and destruction. Impact may last from seconds to a few minutes (explosion, avalanche, and earthquake) to weeks (floods) to several months (droughts and epidemics). The people affected do not doubt they have been hit by a disaster.

Two facts, however, are often not fully appreciated. First, authorities in the zones of organized aid may not even know a disaster has taken place--let alone know which areas are affected. Second, communities in the zone of fringe impact may think they have been devastated when, in fact, they have been marginally affected. These misconceptions (particularly the second) are major reasons for dissatisfaction with relief distribution systems by many recipients.

4. The Emergency Phase

The emergency phase begins at the end of the impact and continues until the community is clearly into organized recovery and rehabilitation. The epidemiology of disasters is

easier to understand if the emergency phase is divided into three periods: 1) isolation, 2) rescue, and 3) remedy.

a. The Isolation Period

The period of isolation is the interval when the survivors are utterly and completely on their own. It ends with the arrival of outside assistance from the zone of filtration. The length of isolation depends upon predisaster conditions and the nature of the catastrophic event. Disasters in isolated regions or developing countries cut communications and transport which were marginal before the event. Certain disasters such as floods or nuclear explosions may have prolonge periods of isolation because of the hazards they pose to relief workers (drowning and nuclear irradiation) in addition to the usual transport problems.

Survivors' actions during the isolation period range from a state of withdrawal described as "disaster shock" (Wallace, 1956) to rather patterned attention to the needs of the individual and his family (or companions). Professionals--including scientists--are torn between their roles as community leaders and heads of families. In North America their behavior is often determined by whether the disaster caught them in a professional situation or at home (Beach, 1967).

Individuals and communities without previous disaster experience or training will react in a completely uncoordinated and non-productive fashion. Following a tornado, for ex-

nmple, a fireman at home might see to his own family's safety and then drive an injured neighbor's child to a distant hospital. Only experience or disaster training will result in his reporting immediately at the firehouse for duty or checking the homes in his immediate area for dangers of fallen electrical wires and secondary fires.

Contrary to scenes from television news and Hollywood, panic is are and occurs only when individuals see no hope of escaping with their lives (Beach, 1967). Looting and crimes in the zone of total impact are rare in the early emergency phase and are perpetrated by outsiders from the zones of filtration (Fritz and Matthewson, 1957).

b. The Rescue Period

The rescue period dates from the arrival of the first <u>unorganized</u> aid from filtration zones to the development of organized and coordinated relief operations. Activities during the rescue period may be extremely beneficial or unbelievably harmful (Saylor and Gordon, 1957). How many victims are rescued alive and whether their most urgent medical and personal needs are cared for is a measure of the community's prior organization, experience with disasters, and training in rescue and first-aid. Availability of resources is an important, but not deciding factor (Smith, 1957).

Perhaps the most difficult problem during the rescue period is the mass convergence of relatives, friends, and "vol-

unteer" workers into the filtration and impact zones (Adams, 1970). Roads to peacetime disasters are jammed not with refugees, but with people wanting to help. The authorities must try to reduce the convergence as diplomatically as possible and insure that the "volunteers" who refuse to leave do not impede organized, trained relief efforts. The convergence phenomenon is not limited to personnel. Appropriate relief supplies always compete for transport with donated goods hurridly gathered and shipped forward. In many instances little thought is given to how these goods are to be sorted and distributed in the disaster zone--or whether they are even needed.

Modern communications and transportation have internationalized the problem of convergence. Without stringent control measures, a well-publicized disaster in a developing country is followed by the uninvited appearance of strange goods and experts from Europe and North America. Many of these "guests" come entirely at their own initiative (Rennie, 1970).

### c. The Remedy Period

The remedy period of the emergency phase begins with the establishment of organized, professional relief operations. The confusion of the rescue period subsides as the remedy period gets under way. Whether a semblance of order and efficiency comes to relief efforts depends upon the naming of an authority to coordinate all relief activities. The best coordinating authority varies with the society, the nature

of the catastrophe, and special circumstances. National Red Cross societies, civil defense units, the military, national governments, and international agencies have on occasion assumed the dominant role.

The coordinating agency is responsible for accurate assessment and surveillance of the situation, instituting an efficient distribution system of appropriate supplies, and subordinating differences among participating agencies to the goals of the relief operation. The major goals are definitive medical assistance, disposal of the dead, and sanitation and public health problems. Many relief agencies terminate their assistance when these problems have ended.

5. The Recovery Phase

The recovery phase following a disaster begins during the emergency phase and ends gradually as the community returns towards normal. Communications, transport, and reconstruction are well under way or in the advanced planning stages. The early recovery phase is the optimal period to draft or modify disaster plans and initiate reforms in areas such as building codes and other legislation.

C. THE DISRUPTIVE EFFECTS AND PROBLEMS CREATED BY DISASTERS

The large number of disaster agents we outlined in Table 1 are capable of producing a rather limited number of disruptive effects. The disruptive effects in turn produce predictable problems associated with disasters. I have found it useful to separate the disruptive effects and the problems created by disasters into four elements. The four elements are determined by the relief specialists with primary responsibility for problem solving in a particular area.

The four elements and the responsible specialty groups are:

Administrative Elements--Administrators concerned with policy and logistics.

Environmental Elements--Physical scientists (civil engineers, sanitary engineers, and geophysicists), design specialists, and agricultural experts.

Medical Elements--Physicians, nurses, nutritionists, sociologists, and psychologists.

Long-Term Elements--Planners, economists, legislators and national or international agencies concerned with rehabilitation and development.

Each of these elements will be considered in some detail.

Before I do so, however, it is worth pointing out that the four elements operate simultaneously and in a collaborative fashion during an emergency situation. Following a flood, administrators marshal helicopters to assess damage and boats

to transport medical supplies and health personnel. Government planners visit the scene during the emergency phase to determine the scope of national assistance (Office of Emergency Preparedness, 1971).

In organizing a distribution system for medical supplies, administrators consult physicians on what is needed and depend on medical personnel in the field to feedback how well the system is meeting the changing medical needs. A similar state of mutual dependence exists between the administrators and the environmental or rehabilitational specialists.

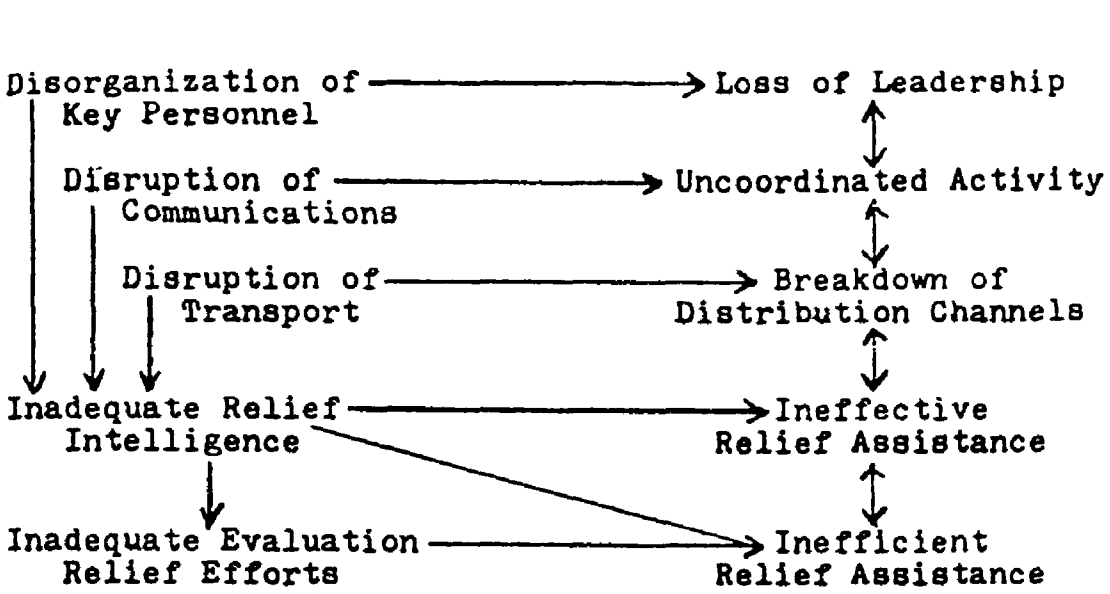
1. Administrative Elements of Disasters

I regard the solution of the administrative problems following disasters as the key to understanding the epidemiology of disasters and organizing an effective relief operation. Failure to solve the administrative problems results in incomplete or misleading data on which to base inductive conclusions.

The five disruptive effects disasters have on administration are 1) disorganization of key personnel, 2) disruption of communications, 3) disruption of transportation, 4) inadequate disaster intelligence, and 5) inadequate evaluation of relief efforts. The four major administrative problems are 1) loss of leadership, 2) uncoordinated relief activity, 3) breakdown of channels of distribution, and 4) ineffective and/or inefficient relief operations. The interrelationships

Figure 2.

THE ADMINISTRATIVE INTERRELATIONSHIPS BETWEEN THE DISRUPTIVE EFFECTS OF DISASTERS AND THE PROBLEMS CREATED

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between these five disruptive effects and the major problems that result is set out in Figure 2.

a. Disorganization of Key Personnel

Disorganization or loss of key personnel produces impaired leadership. Leadership is lost under three main circumstances: 1) poor training, 2) death and injury, and 3) local circumstances.

Disaster training is usually directed along categorical lines. Ambulance attendants learn first aid; physicians and nurses are taught the principles of triage. In North America

the principle has been accepted that the best disaster training for a community is frequent participation in disasters. As a result, training exercises try to simulate actual disaster situations (Brown, 1966; United States Public Health Service, 1959). Disaster simulation drills have shown poor performances by well-trained staff without disaster experience (Menczer, 1968; Rankin, 1968). The important principle here is not to doubt the benefits of disaster training, but to recognize that performance and leadership in an actual disaster situation may be disappointing.

Injury and death to leaders can be anticipated in a variety of situations. The duties of key personnel, for example, sometimes require that they congregate in a dangerous area. No firemen were available immediately following the Texas City disaster (Blocker and Blocker, 1949) because all the fire departments in the area were busy fighting the fire aboard the nitrite ship when it exploded. Medical personnel might be in a similar situation if exposed to a dangerous communicable disease such as typhus or smallpox (Zinsser, 1935).

The caliber of leadership may also be affected by local circumstances. Had the Hartford Circus Fire occurred over the Fourth of July holidays when the doctors in town were all at the sea shore, would Wells (1945) have had the courage to write the article? What effect did the 1,300 Alaska

National Guardsmen bivouacked outside of Anchorage have on the local rescue operations after the 1964 earthquake (Anderson, 1969b).

Natural leaders may not be available because of assassination (i.e. trained Bengalis during the West Pakistan occupation of Bangladesh) or because of fear. Only a handful of the several hundred Biafran physicians were found in the medical facilities at the end of the Nigerian Civil War because of their fear of Federal reprisals

b. Disruption of Communications

The crippling effect of poor communications on coordinated relief activities has been recognized by the major relief agencies (United Nations, 1971; Université catholique de Louvai 1972). Steps to remedy the situation include such measures as fuller utilization of the radio network of the International Committee of the Red Cross (ICRC, 1972). The International Telecommunications Union (ITU, 1972) has plans to sponsor the launching of satellites to improve warning systems and international communication with the field headquarters.

Stallings (1971) has recently completed the first operational analysis I have seen on the function of communications in disaster situations. Stallings points out that communications are primarily a social process and decries the concentration on sophisticated hardware. The two most serious

communication problems he identified in 24 American disasters were failure to communicate within a given relief agency and above all) failure to keep in touch with other agencies involved in the relief action.

c. Disruption of Transportation

The blockade of Biafra except by limited airlift provided relief agencies with a striking demonstration of inadequate internal transportation as a critical factor in field operations. Petrol and spare parts became more important than food during famine (Flaherty, J., 1969 - personal communication).

Current efforts to meet the anticipated food shortages in Bangladesh (Chen and Rohde, 1971) represent a new appreciation of the importance of transportation and normal distribution channels. First priority has been given to the rebuilding of roads and bridges and the encouragement of river transport rather than inundating the country with surplus food from rich countries which can not be distributed (Newsweek, 1972).

d. Quality of Relief Intelligence

A glance at Figure 2 will show that inadequate relief intelligence occupies a central position in the production of ineffective and inappropriate relief operations. As the technical problems of communications and transport are gradually overcome, the quality of relief intelligence will emerge more clearly as the factor that determines the success of relief

efforts. At present, administrators are forced to commit millions of dollars of relief supplies on the basis of field reports which may or may not be reliable.

Let me quote from a recent LRCS Relief Bureau Circular (1970c)to show how this intelligence gathering operates under ideal conditions:

> "During the night of Saturday to Sunday, 28/29th March, 1970, a very severe earthquake (of 9 to 10 degrees on the Mercalli scale) devastated wide areas in Western Turkey...Tremors continued during Sunday and heavy rain made the condition of the homeless more miserable and the task of rescue workers more difficult. An extensive fire in the town of Gediz following the disaster considerably increased the damage. Communications were completely disrupted by the disaster, but unofficial figures estimate the number of dead at over 1,000, some 2,000 persons injured and tens of thousands homeless (Relief Bureau Circular dated 31st March, 1970)".

The Turks have reasonable census data, considerable experience with earthquakes, and a well-equipped Red Crescent Society. Despite the loss of communications and the distance from headquarters in Ankara, the Society obtained some detailed and helpful estimates of damage to life and property in a disaster affecting some 322,000 people.

In rich countries and well-organized developing countries, these initial estimates are confirmed by field visits and on-the-spot assessment of the damage. It is essential that these studies be carried out in a standardized fashion by qualified, impartial personnel. By 3 April, for example, the Turkish Red Crescent Society reported that there had been 1,086 known fatalities, unknown numbers missing and 3,000 peo-

ple (approximately) who had been injured and treated. The most pressing relief needs were tents and blankets, not medical supplies (Relief Bureau Circular, 1970d). Six weeks later the final report on structural damage was circulated by League headquarters in Geneva (Relief Bureau Circular, 1970e).

Unfortunately, in very large disasters or in countries with poor organization, the reporting system breaks down. The Peruvian Earthquake of 31 May, 1970 is a case where the true magnitude of the disaster and needs of the population were not appreciated for ten days or more (Relief Bureau Circular, 1970f, 1970g). The Peruvian Red Cross had had experience with destructive earthquakes as recently as 1966, 1968, and 1969 (USAID, 1970), but was overwhelmed by a disaster affecting two percent of the country's area and inflicting 66,794 registered deaths and 143,331 injuries treated by medical teams. Many of the embarrassing aid fiascos reported later in the relief operations had their origins in this long hiatus where no one knew what was really needed.

The second serious drawback to data gathered by national societies with no independent verification is that it can not be trusted. This is particularly true in highly political situations where the affected government is less likely to encourage inspection and reporting by foreign press and experts. The response of official sources in a sensitive situation may range from outright denial and minimization

to grossly exaggerated figures in order to be sure of sufficient relief supplies.

If a government denies rumors of disaster which persist in the press, the relief agencies are powerless. Throughout most of the Nigerian Civil War, Federal authorities rejected reports of famines in Biafra. The Government of Bangladesh does not accept that the Bihari minorities are being persecuted (Times, 1972c); the Bihari in turn deny ever persecuting the Bengali. The Shah of Iran reports from a ski resort in Switzerland that his Government has been unable to confirm rumors that a snow storm had buried several thousand Iranians and left unknown numbers stranded (Times, 1972a). The relief agencies accepted the decision of the Shah--there had been no disaster in Iran.

The tendency to exaggerate relief needs in certain situations should also be recognized. This may be due to poor intelligence. Quarantelli (1970b) has devised a rule that the excess of rumored deaths over registered deaths increases with the distance of the disaster from the capital city. The exaggeration may also be motivated by the desire to ensure adequate relief assistance or advance a political cause. This trend may be counterproductive in the long run. The economic conditions and attitudes of major donor countries towards relief assistance are changing. In the United States, the largest donor country, the feeling has been growing that

America is sometimes "conned" into overreacting in disaster situations.

This attitude is fostered by recent disasters. The Government of Biafra, for example, had no census data, a poorly equipped Red Cross Society, and no experience with mass famine. Nevertheless, official population estimates of nine to twelve million, 60,000 starvation deaths per week, and a starving population of 3,120,00 (Atlanta Journal, 1969) were accepted by the world press and agencies as facts. Neither the Biafrans nor the agencies had conducted field surveys to determine the prevalence of famine. When a single survey was carried out in November, 1969, the data indicated that the population was slightly more than three million, that about a million people had famine edema, and that it was impossible to arrive at an objective determination of the number of people dying (Western, 1970).

Eighteen months later, the Government of India claimed that ten million refugees from East Pakistan had entered India (Newsweek, 1972). The Government of Pakistan, on the other hand, submitted population figures indicating that the number of refugees was in the order of three million. The Indian figures were accepted, even though the Indians refused to allow census surveys of the camps or inspection of registration procedures.

In summing up, I find it hard not to apply the statistician's aphorism about the value of computers to the value of

unconfirmed relief data: "Garbage in--garbage out." It is beyond the scope of this dissertation to go into detail about how the current assessment techniques could be improved (LRCS, 1970a). Two principles, however, are clear. First, eye-witness accounts are subjective, often contradictory, and amount to one person's word against another's. Second, information of value must be objective, standardized, and subjected to verification by independent sources (Western et al, 1971).

e. Evaluation of Relief Activities

If a relief effort does not regularly evaluate the effectiveness of its operations, it will also become inefficient and fail to adjust to the changing needs of the stricken population (Figure 2). At the present time very little field analysis of relief operations is done.

Instead, the usual procedure is that the affected area tells the relief agencies what is needed in the field immediately following a disaster. Over the years, by trial and error, a standard list of emergency relief supplies has grown up. Consider this list which the League of Red Cross Societies has drawn up for potential donor countries (LRCS, 1970a):

> "The appeals which during the last years have been sent out by the League show that:
> i) after all natural disasters, blankets, tents, foodstuffs, clothing are needed.
> ii) after earthquakes, antibiotics, housing are specially needed.
> iii) during and after floods, disinfectants, medicaments, multivitamins, vaccines (TAB, tetanus, cholera).

iv) after tropical storms, bandages, medicaments, multivitamins, vaccines (tetanus), and
v) for refugees: beds, bedding, mattresses, comfort kits, cooking utensils."

Several of the items on this particular list strike me as strange. I am especially concerned with its relevance for the tropics, where over ninety percent of international relief efforts take place (Tripp, 1970).

1) Are blankets and warm clothing such high priority items for the tropics? Is it necessary for tents to be imported when cheap local building material and experienced labor might be available?

2) Why is there such a demand for antibiotics following earthquakes? Do surgeons somewhere in the world still believe that routine preoperative antibiotics are effective in preventing wound infection?

3) Why should the victims of floods and tropical storms require multivitamin tablets immediately after the event? As there is no evidence they serve a nutritional purpose (Yudkin, 1971), do they function as placebo tablets?

4) Do sufficient traumatic injuries occur during flooding to diminish local supplies of tetanus toxoid or anti-toxin?

5) Is there really a greater need for bandages after tropical storms than after earthquakes?

6) Do refugees used to sleeping on mats in their home country need to be supplied with European beds, bedding and mattresses? Would a subsistence farmer in the tropics know how

to use a comfort kit packed in the United States? Why no immunization programs for refugees?

These are simple but important questions which relief administrators should be investigating. Instead of answers, a review of LRCS Relief Bureau Circulars suggests that a vicious circle has been set up. Following a major disaster, local representatives have no idea of conditions in the field. The liaison officer and the local representative initiate emergency requests for assistance on the basis of what was asked for the last similar disaster or what is spelled out in the relief manual. Headquarters passes the request on to potential donors. At the same time donors are spontaneously making arrangements to supply items on the list. The relief supplies arrive. The next entry is usually a warm news letter or report thanking all the donors for their assistance. The circle is complete and ready for the next disaster. Only rarely does the affected country point out useless donations--and then only to ask the donors not to send more of a particular item.

Invariably, it is the enterprising reporter or magazine writer who brings deficiencies to light rather than the agencies themselves at an earlier date. Every recent disaster of major proportions has had its share of muckrakers. A relief agency has given first priority to sending heavy woolen blankets to Bangladesh, a region which is cool at night only one month a year (Newsweek, 1972). American "vacation" tents which

blew away in Costa Rica in 1968 have blown away again in Peru. Helicopters have been flying powdered milk to Peruvian Indians whose crops were not affected by the earthquake. Peruvian Indians do not drink cows milk. The tents cost $500,000; the helicopter carrier Guam was rented from the United States Navy at $100,000 per day (Glass, 1970). Piles of unsorted clothing arrive in Biafra when the agencies have virtually no petrol or relief food.

I could continue to cite other examples of relief wastage, but will stop. These four examples are sufficiently dramatic to indicate that the items thought to be needed after all natural disasters (blankets, tents, food, and clothing) are not always necessary. If reporters and a medical student like Glass (1970) can discover such damaging facts, why can not the relief agencies? The simplest answer is that no one in most relief operations has a clear-cut responsibility to assess how well or poorly things are going.

Yet at least two recent studies have shown that valuable information about the status of a relief effort can be obtained rapidly with a minimum of people. I carried out a one-man evaluation of relief operations within the Biafran enclave in 12 working days (Western, 1970).

The study was carried out in November, 1969 and involved 36 widely separated survey sites selected at random in rural areas. At this time, food supplies were desperately short,

but petrol and transport were more limiting factors. Because administrators were restricted to headquarters, conditions in the field had been assessed by verbal reports rather than an organized surveillance system.

Despite the shortage of petrol, the three major relief agencies (Caritas, ICRC, WCC) covered the entire country with three independent and overlapping distribution systems. The ICRC and WCC distributed by recognized political boundaries (i.e. province--district--town council). Caritas distributed along parochial lines (i.e. archbishop--bishop--priest). There was no coordination of efforts in the field or sharing of information.

Thirty-four of the 36 sites received some form of relief supplies. Nearly seventy percent of the sites, however, took delivery from more than one agency. I found one remote site where WCC distributed food on Mondays, Caritas on Wednesdays, and the ICRC on Fridays. The rations distributed were not constant. Some areas near main roads seemed satisfied; a refugee camp claimed not to have had a delivery for two weeks. Feeding policy also varied--even within the same relief organization. At 15 sites the decision had been made to limit distribution to children and pregnant or lactating women. In the other 19 sites the food was distributed to all age groups or along traditional tribal lines.

The best-fed areas were those which had not been directly affected by the war for two or more planting seasons. These areas had experienced severe famine in 1968 and had been the targets of the relief agencies since that time. Areas undisturbed by the war varied in their nutritional status according to their agricultural potential and overpopulation by refugees. The worst areas were those in which fighting had reduced or destroyed the spring plantings. Food distribution to these remote areas was made doubly difficult by the summer rains.

Sommer and Mosley (1971, 1972) directed two more comprehensive surveys of field conditions two and eight weeks after the 1970 Bay of Bengal Cyclone. The first survey involved aerial assessment of conditions and then sending four two-man teams to 16 selected areas. The survey was finished in five days. The first survey indicated that food, clothing, and shelter were the first priorities. Water purification, field hospitals, and emergency vaccinations against typhoid fever, tetanus, and cholera were far less urgent.

The second survey lasted 22 days and was done by ten two-man teams drawn from the Bengali field staff of the Cholera Research Laboratory in Dacca. The teams interviewed over 3,000 families in nine of the most affected thanas (1.4 percent of the estimated precyclone population) and 475 families in a thana not affected by the cyclone. The teams also assessed

the standing crop, housing, and the nutritional status of the population.

The cyclone overall mortality was 16.5 percent (at least 225,000 people). More deaths occurred in the young and the very old; females were more at risk than men. There were few serious injuries during the wind storm and few serious post-cyclone medical problems. Following the cyclone, illnesses and deaths as well as nutritional status compared favorably with the control population.

More than 180,000 homes were destroyed; three months after the disaster, 600,000 people were still without adequate shelter. Although the relief effort had maintained the nutritional status of the population, about one million people were completely dependent on outside food. The authors calculated that about 125,000 ploughs and draft animals would be needed to restore agriculture to its predisaster state.

This epidemiological approach to disaster was introduced into relief operations on the Federal side during the Nigerian Civil War (Foege, 1971). The medical epidemiologists initiated a weekly surveillance report from all relief teams which included the population being fed, the tons of food distributed, patients treated for malnutrition and general medical problems, and serious communicable diseases (smallpox, measles, whooping cough, and meningitis).

When there was insufficient food to distribute to the entire needy population, Foege and Conrad (1969) developed a selective feeding system based upon objective evidence (height/weight). Later in the relief operations, the system was adapted to the "quac" stick, a device for determining height/mid-arm circumference in children (Arnhold, 1969). Feeding priorities were determined in several millions of people (Davis, 1971; Loewenstein, 1971; Merchant 1971). Eventually, this system proved very useful in withdrawing feeding from populations which had returned to a normal nutritional state (Berall, 1969).

2. Environmental Elements of Disasters

Disasters produce six environmental effects. The six effects are:

a. Destruction and damage to homes and buildings;

b. Decreased quantity and/or quality of water supplies;

c. Destruction of crops and/or food stores;

d. Population migrations from the disaster area;

e. Unburied bodies and carcasses; and

f. Destruction of economic resources

This section is divided into two parts. The first part is a discussion of which disasters produce which environmental effects. In the second part I will discuss the problems which result from the six effects of disasters upon the environment.

Table 4.

## THE RELATIVE IMPORTANCE OF VARIOUS DISASTERS IN THE PRODUCTION OF ENVIRONMENTAL DISRUPTION

A. Destruction and Damage to Homes and Buildings

1. Warfare
   a. conventional
   b. nuclear
2. Floods
3. Wind Storms (Cyclones, Typhoons, and Hurricanes)
4. Earthquakes and Tsunamis
5. Volcanic Eruptions
6. Tornadoes
7. Landslides
8. Avalanches

B. Decreased Quantity and/or Quality of Water Supplies

1. Floods
2. Droughts
3. Warfare
4. Earthquakes and Tsunamis
5. Sea Surges
6. Wind Storms

C. Destruction of Crops and/or Food Stores

1. Warfare
2. Droughts
3. Floods
4. Locust Swarms
5. Hail Storms
6. Plant and Animal Diseases

D. Population Migrations from the Disaster Area

1. Warfare
2. Floods
3. Wind Storms
4. Landslides
5. Avalanches
6. Volcanic Eruptions

E. Unburied Bodies and Carcasses

1. Warfare
2. Earthquakes and Tsunamis
3. Floods
4. Landslides
5. Avalanches
6. Volcanic Eruptions

F. Destruction of Economic Resources

1. Warfare
2. Floods
3. Droughts
4. Earthquakes
5. Wind Storms

Adapted from: USAID (1968, 1969, 1970); LRCS (1970a); Lemons (1957); and Smith (1957).