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a. Relative Importance of Various Disasters

Although every disaster situation has the same administrative elements in common, the environmental effects vary considerably from disaster to disaster. The disasters which produce the six environmental effects are outlined in Table 4. The disasters are ranked after considering both the frequency and severity of the effect produced.

The ranking of disasters in Table 4, however, should not be taken too literally for three reasons:

1. The list will not be applicable to individual countries. Instead, it is intended as a composite of the world's experience in recent years. The United States, for example, is peculiarly vulnerable to property damage by tornadoes (Lemons, 1957). A country like Switzerland is concerned with avalanches (Montandon, R., 1938).

2. The rankings are only gross approximations. It is impossible to put an absolute value on the environmental effects of disasters. How does one assess the loss of a $40,000 insured home from earthquake in California with a $40 structure, a bullock, and an infant son swept away by cyclone in Bengal? Ambraseys (1972) has tried to assess the "value" of human life in terms of property damage from disasters. In West Pakistan an individual dies in a disaster for every $600 of property damage. The figure for the United States is $960,000.

3. Any disaster can result in any environmental effect under certain conditions. Let me cite just one extreme example. Can a drought produce serious flooding (with the concommitant environmental effects)? Early in this century engineers constructed a massive irrigation canal from the Colorado River in Arizona to the Imperial Valley of California to relieve the chronic drought. Unfortunately, the water table flowed downhill the entire 150 miles. In 1905 a swollen Colorado River diverted a considerable portion of its flow into the canal system, creating the Salton Sea (Chambers's Encyclopaedia, 1950).

With these considerations in mind, some general statements about the disasters listed in Table 4 are in order. Warfare--in which I include violent social disruption--has by far the most serious effect upon the environment. War is the most sustained of the disasters and extremely prevalent. At this moment armed conflict is going on throughout South East Asia, Northern Ireland, Portugese Africa, Ethiopia, and Burundi. A state of war exists between India and Pakistan as well as between the Arab States and Israel.

Floods are the most destructive natural disasters. Although often seasonal, floods affect most areas of the world. Tidal floods in areas like the Thames may occur suddenly throughout the year (Spiegal, 1957). Floods occur in low-lying river basins where the incentives for agricultural and industrial development are greatest. Low-lying coastal areas are also

subjected to wind storms and concommitant flooding in many parts of the world.

I will now go on to a discussion of each of the six environmental effects produced by disasters.

1. Destruction and damage to homes and buildings: Damage to homes and buildings increases with the severity of the disaster, the economic development of the community, and the density of the population. Modern warfare, for example, is extremely destructive in an urban industrialized society. Rural, guerilla revolutions will produce less physical destruction. We have seen that the damage caused by floods, wind storms, and (to some extent) volcanic eruptions is due to the fact that they tend to occur in areas attractive to man for settlement and development. Earthquakes, tornadoes, landslides, and avalanches do not have a predilection for areas favored by man. Destruction of homes, industries, and public buildings can be considered coincidental to the event.

2. Decreased quantity and/or quality of water supplies: Droughts and sieges reduce the absolute amount of available water. The human and animal population may die from thirst or be driven to impure water sources. Floods and sea surges, on the other hand, directly contaminate surface water and wells. Earthquakes and wind storms (without flooding) ordinarily have minimal effects upon the water supply of underdeveloped areas without lined wells or piped water. In more developed or urban

areas, however, seismic tremors or winds often disrupt sewage systems and piped water supplies. Typhoid or shigella organisms in the sewage may gain access to the water supply (Rice, 1972).

3. Destruction of crops and/or food stores: Crops in the field are most commonly destroyed by drought. Occasionally, floods are extensive enough to destroy crops over a wide area. Swarms of locusts (Vayssière, 1959) and hail storms (Masefield, 1963) are rare causes of local food shortages. Although plant and animal diseases result in serious economic losses, the repeated failures of the Irish potato crops in the 1840's due to fungal infection are the only instances of famine (Woodham-Smith, 1962). Food stores are most commonly affected by war and floods. The loss of food stores in natural disasters is usually local and supplies can be brought in from the zones of organized assistance. Nation-wide stores of food are destroyed or depleted only in wartime. Seige and blockade in particular depend upon shortages of food to reduce the enemy (Masefield, 1967).

4. Population migrations from the disaster area: Populations leave a disaster area only if living conditions are impossible or they perceive the disaster as a continuing threat (Barton, 1963). This migration may be temporary or permanent. Evacuees from wind storms and floods invariable return to the area as soon as they are able. Landslides, avalanches, and volcanic

eruptions may permanently destroy the usefulness of an area and force survivors to permanently migrate. Usually, the migration is only some short distance. Only war is perceived as enough of a continuing threat to produce large numbers of permanent refugees. The care of displaced persons and refugees is an extremely expensive operation because the victims are completely dependent upon relief assistance. Furthermore, if no government accepts responsibility for the refugee, he may become the ward of an agency for the rest of his life. The Palestinian refugees are now well into their second generation (United Nations High Commissioner for Refugees, 1971).

5. Unburied bodies and carcasses: Once again, the problem of burial of the dead is most severe in times of warfare or serious civil disturbances. Under these conditions, large numbers of able-bodied survivors may not be available or circumstances permit safe burial details. The extent of these difficulties in a city from which the civilians were not permitted to flee is graphically described by Orth (1959) in his account of the recapture of Manila from the Japanese. The stench and risk of disease from decaying bodies and carcasses is most severe following war, earthquakes, and floods. Recovery, identification, and burial also have important psychological and legal benefits to survivors. Landslides, avalanches, and volcanic eruptions tend to bury victims so completely that the public health dangers are reduced and recovery is impossible.

6. Destruction of economic resources: This is an area in which I have located little published information. The listing in Table 4 is essentially an estimate on my part.

b. The Environmental Problems Created by Disasters

The environmental effects of disasters create problems in four major areas. The four problem areas are: 1) environmental exposure, 2) potable water supplies, 3) adequate sanitation, and 4) sufficient food.

1. Environmental exposure. In almost all disasters, adequate protection from the environment is of immediate importance for the psychological and medical well-being of the community. The five most serious environmental stresses after a disaster are: a) wind, b) wetness, c) solar radiation, d) cold, and e) snow. There are four possible control measures: a) evacuation, b) temporary shelter, c) personal supplies (i.e. blankets, clothing, and fuel) and d) permanent shelter.

The five environmental stresses may occur singly or in a variety of combinations. The type of environmental stress following a disaster varies with geographic location, season of the year, and chance changes in the weather. This unpredictability and variety of stressful agents makes a fixed response after disaster virtually impossible.

Evacuation must be limited to focal disasters (tornadoes, volcanic eruptions, landslides, and avalanches). So long as the population affected is small, survivors can usually find

adequate shelter in nearby, unaffected communities. As the severity of the disaster increases, the evacuees will become too numerous for existing facilities. Mass evacuation always requires detailed planning and training. It is possible before impact (impending war, cyclones), but not afterwards when the community is disorganized and transport out of the area may be disrupted (Ikle and Kincaid, 1956).

Temporary shelter within or near the disaster area can either be simple or very difficult to construct on short notice. Protection from a prevailing wind, gentle rain or the tropical sun may require no more than a sturdy, vertical windbreak in the first instance or a waterproof awning in the last two. The cold and snow will require enclosed structures with sloping roofs and warm blankets, clothing, and fuel. Combinations of the stresses can be particularly demanding. The Peruvian highlands after the 1970 earthquake, for example, were isolated, cold, extremely windy, and without fuel sources or local building material.

It would be very desirable to have an all purpose family unit which would be suitable for every disaster situation. At the moment no such unit exists--and not because architects have not been trying. In recent years several designs have been introduced after major disasters. As I see it, there are six hurdles to the development of the unit. The unit should be:

a) familiar to the society in which it is to be used;

b) sufficient size to satisfy both the European atomic and the West African extended family;

c) inexpensive and incorporate local materials and labor in so far as possible;

d) simple in design so that it can be put up quickly in large numbers by inexperienced volunteers under direction.

e) useful for a finite period so that it does not become part of the instant and permanent slums which spring up after disasters; and

f) evaluated in the field to assess the above parameters.

At a recent symposium considerable claims were made for a styrofoam "igloo" large enough to sleep twenty adults. The "igloo" was constructed by spraying chemicals over a half-sphere--a process which took one hour. The cost per unit was about three hundred dollars. Although used in Peru, no information about its actual suitability or permanence was available (von Ballestrem, C.W.; 1971 - personal communication).

Blankets and clothing have long been mainstays of domestic relief activities in Europe and North America. These items are invaluable in the cold, wet, windy disasters that occur there. Heavy blankets and clothing are of limited value in the heat of summer or the tropics. Furthermore, blankets without waterproofing are useless in the tropics during the rainy season.

Even in situations where blankets and clothing are clearly high priority items, the logistical problems in using them efficiently are considerable. When needed for protection against the cold, they will be needed very quickly. This involves either local stores within the country or the air shipment of these very bulky items. Blankets made from lightweight, waterproof aluminium material are now on the market. Although expensive, they are suitable for conditions in all climates and may prove economical when blankets must be shipped by air or helicopter.

Donated clothing presents some very special problems in a disaster relief effort. There are five perennial problems: 1) the weight of the cloth may not be suitable for the local climate; 2) the people may refuse to wear cast-off or bizarre styles of European clothing; 3) donated clothing contains an inordinately high percentage of clothes for adult women--they have more clothes and fewer young children than in the tropics; 4) the sizes may not correspond to local standards--shoes present a particular problem; and 5) bulk clothing often must be hand-sorted. It is my opinion that more effective use can be made of clothing purchased through local commercial channels.

2. Potable water supplies: The provision of adequate amounts of safe drinking water is an immediate medical and public health problem after any disaster. Water often has higher priority than food or shelter in dry or very warm climates. Three method

of assuring a safe water supply are generally recommended: a) distribution from tankers; b) boiling of all drinking water; and c) water purification by iodine or chlorine tablets (Gleason, 1957; Assar, 1971). Nonpotable but safe water must also be provided for washing and general sanitation.

Even if large numbers of tankers are available in the stricken area, their usefulness is limited to disasters in which the area involved is focal and the roads that exist have not been destroyed. This problem may be particularly severe in wartime or poor countries without a good transport system into the disaster area. Tankers may be particularly effective in evacuee or refugee camps outside the affected area.

Boiling of drinking water may be impossible following heavy flooding or during heavy rains. In other situations pots, cookers or fuel may be limiting factors. Finally, many societies in the tropics do not understand the need to boil water and may refuse unless the water is boiled for them by a central authority.

Chemical water purification with iodine or chlorine requires prior planning and attention to the details of distribution and education of the population on proper technique. The practicality of more sophisticated methods of water purification needs to be critically evaluated in the field.

Citizens can be encouraged to store water before the disaster in areas where the supply is known to be safe. During the

1950's, the Office of Civil Defense in the United States encouraged this practice with changes at monthly intervals (Gleason, 1957).

3. Adequate sanitation: Assar (1971) has just written a guide for acceptable practices and goals following natural disasters for the World Health Organization. Mr. Assar is a sanitary engineer with a high position in the Iranian Ministry of Health. As such, he has been responsible for the environmental health problems following the earthquakes and floods which affect Iran.

The guide gives a detailed description of how waste disposal, temporary camps, mass feeding services, burial of the dead, and vermin and vector control should be organized and carried out during the emergency, assistance, and early reconstruction phases of a disaster. Approximate personnel and supply requirements are included for most of these operations.

I have two reservations about the usefulness of the guide. The less serious is that the specific detail into which Assar goes leads to a certain dogmatism. I wonder how well the procedures recommended can be applied to different types of disasters around the globe. The more serious criticism is that the guide assumes the presence of a well-organized health and sanitary service operating along a national disaster plan. As previously mentioned, few developing countries have a disaster plan, let alone the infra-structure to put these recom-

mendations into effect.

Three problems are not covered to any great extent. They are: a) how to get relief administrators to recognize the importance of sanitation in disasters; b) how to develop the infra-structure for adequate sanitation; and c) how to educate the population in the proper use of what may be strange sanitary facilities.

These three problems are not confined just to the poor countries. Following the Los Angeles, California Earthquake of 1971, a large reservoir in the foot hills was thought to have suffered severe structural damage (Office of Emergency Preparedness, 1971). Hundreds of families at risk of being swept away were hurridly moved to schools and school yards out of harm's way. In the excitement of the moment, there was no obvious attention to the increased demands which would be made upon the schools' toilets and trash facilities. Portable toilets, extra facilities for washing (and bathing), and garbage bins were either not thought necessary or had been diverted elsewhere. The people themselves had had no training or ideas about policing the area. Within two days many of the schools were filthy, the middle-class evacuees very upset, and incidents of diarrheal disease were reported in the local press (Los Angeles Times, 1971).

4. Sufficient food: The two Great Wars and the British administration of India stimulated a considerable literature on food shortages and famine relief. Keys's (1950) two volume The Biology of Human Starvation remains a classic and contains an exhaustive bibliography of earlier publications. Masefield (1963, 1967) discusses disasters and famine relief from the viewpoint of an agronomist with experience in Europe during World War II and drought-stricken East Africa. Bhatia (1963) summarizes the famines in India from 1860 to 1945, but emphasizes the administrative and economic aspects. As a direct result of its involvement in famine during the Nigerian Civil War, the Swedish Nutrition Foundation (Blix et al, 1971) has published the 18 papers from a multidisciplinary symposium on Nutrition and Relief Operations in Times of Disaster.

I want to make two comments before I discuss in more detail the role food should have in disaster relief. First, despite the lessons to be learned, I think it is dangerous to generalize from experiences in Europe thirty years ago or in one area of West Africa to the present in every other area of the world. Second, I regard famine as a sequela of a large number of primary disasters (war, drought, flood, etc.). Furthermore, famine occurs months and even years after the primary event. Famine relief, then, is an admission of failure to identify and tackle the primary event. Famine is the one disaster situation with a long enough incubation period that

it should never occur on a mass scale.

Masefield (1967) has provided us with a convenient schema for the place of food in disasters. He divides the food needs after disasters into three categories: a) short-term--up to several weeks; b) medium-term--loss of a staple crop; and c) long-term--two or more years.

After short-term disasters the need for shelter, safe drinking water, and sewage disposal is more urgent than food. The value of a warm drink or bowl of soup is psychological immediately after the event. Given the basic amenities, healthy people can go without food for a fortnight or more with no permanent ill-effects. Even high risk groups (children, pregnant and lactating women, the elderly, and the injured) will suffer more from exposure and thirst than hunger.

The vast majority of natural disasters cause short-term shortages of food. Despite the tons of food which are sent by donor countries (often by air), sufficient food stores are always available in surrounding, unaffected zones. Throughout the massive famines in India during the nineteenth century, there was never an absolute food shortage for the entire country. Famine disappeared after the construction of the railroads and more efficiently administered Famine Codes. The responsibility for the procurement and distribution of local food rests with the local government. The massive importation of strange foods will not solve the underlying prob-

lems of poor communication, transportation, and administration (Bhatia, 1963; Masefield, 1972).

Droughts, floods, and locust swarms produce the majority of medium-term food deficits. Long-term shortages result almost entirely from war and may continue for several years. Imported food may not be the best solution in medium- and long-term situations. An effective administration can develop and enforce rationing, price controls, and incentives for farmers to produce more. Several systems were developed and used with considerable success in Europe during World War II (Dols and van Arcken, 1946; Lindberg, 1946). Although conventional wisdom holds that these sophisticated techniques are beyond the capacity of poor countries, there is encouraging evidence that centralized societies like China and federal systems like India have had some success in coping with famine (Masefield, 1972; Berg, 1971).

During special situations like the blockade of Biafra, no local food will be available. Experiences in Biafra (Western, 1970) and Bangladesh (Newsweek, 1972) have demonstrated again that it is far easier to import donated food than to efficiently transport and distribute it within the area threatened with starvation.

A perennial problem with relief food that arrives for distribution is that it must be familiar and acceptable to the population. Rice, fish, and sugar have been called the most

universally acceptable foods for the famine-prone areas of the world (Masefield, 1972). These commodities are not important surplus food items in North America and Europe. The developed countries instead offer wheat, powdered milk, and synthetic high protein foods such as "CSM" (maize, soy bean meal, and powdered milk). Although starving populations in Biafra rapidly adjusted to new items in their diet, marginally nourished populations facing an extended food shortage sold the food in the market. Similar problems were noted following the Peruvian Earthquake of 1970 (Glass, 1970).

At the present time two important changes are coming about in international attitudes about donated relief foods. The first controversy is whether protein-calorie malnutrition is due to inadequate intake of protein or inadequate intake of calories in the diet. Hegsted (1972) has written a concise summary of the problem. The answer to this debate will have enormous consequences for famine relief in the developing world. If it be true that a child develops kwashiorkor because he does not eat <u>enough</u> rice, maize or wheat, starvation can be prevented by increasing the consumption of these basic commodities. Imported, high-protein foods will have a place only in the cassava-based diets of Africa and the Pacific. Poor countries could become self-sufficient in food without investing in the development of animal protein or new staple crops like pulses.

The second change is that the development of new varieties of wheat and rice combined with more intensive fertilization (i.e. the "Green Revolution") has made it possible for Asian countries to produce a surplus of these commodities. India, for example, no longer needs North American wheat. Instead, she is interested in foreign exchange to purchase Indian wheat to give to the Bengali refugees; long-term loans are being negotiated with Bangladesh for the purchase of Indian grain. Bangladesh asks for the reconstruction of her communications and transport system--not surplus milk. This demand for foreign capital rather than surplus food which may not be needed nutritionally is coming about at a time when the rich countries' interest in international development has been falling for several years (Pearson, 1969).

3. Medical Elements of Disasters

There are four medical elements in disaster which traditionally have been the responsibility of physicians rather than sanitary and environmental engineers. The four medical areas are:

a) Traumatic injuries resulting from the disaster

b) Emotional stress

c) Epidemic diseases

d) Indigenous diseases affected by the disaster

Let us consider each of them in order.

a. Traumatic Injuries Resulting from the Disaster

In this section I will keep the discussion to answering three basic questions: 1) what disasters are likely to produce traumatic injuries?; 2) what types of injuries do disasters produce?; and 3) what administrative problems will the general practitioner or specialist surgeon face in a disaster?

1. What disasters are likely to produce traumatic injuries?: Those physicians who have seen military service know that in battle the number of wounded greatly outnumber the dead. Military authorities writing on disasters have always assumed the same for natural and man-made disasters affecting civilians. This line of thinking was reenforced by civil defense planning dominated by fear of nuclear attack (Casberg, 1954; Coone, 1956 Ziperman, 1957).

What few authors properly emphasize is that disasters often kill many more people than are injured. Disasters may not produce any traumatic injuries at all. I have reviewed a series of USAID Annual Reports and LRCS Disaster Relief Bureau Circulars looking at this phenomenon. It is possible to divide disasters into three general categories: a) injuries in excess of deaths; b) deaths in excess of injuries; and c) few serious injuries. These categories are summarized simply in Table 5.

Although there are frequent exceptions to the rule, explosions, wind storms, tornadoes, fires, famines, and epidemics