

Part II

The Management of Disaster- Created Environmental Health Conditions

Chapter 1

Factors to Consider for Effective Management

Deciding on Appropriateness of Measures

To alleviate conditions in disaster-stricken areas, appropriate measures must be taken to halt the deterioration of predisaster levels of environmental conditions and the disruption of environmental health services and normal community life. Environmental health control measures must be undertaken before and in the aftermath of disaster and, whenever possible, during the disaster itself. In determining courses of action at these various stages, a given measure should be judged not only according to its technical feasibility and the availability of resources, but also according to the extent to which the measure is directed at returning environmental conditions to predisaster levels.

Factors to consider in making decisions about actions include areas of priority of intervention, the priority of needs for the various environmental health services, and the availability of manpower. The major factor that determines the priority of areas for intervention is the presence or absence of disease-related risks in the areas in which disaster victims reside. The relative risk of disease merits particular attention in the peripheries of urban centers and in camps and other temporary settlements.

The highest priority should be accorded to environmental health services that are essential to the protection of the well-being of individuals in high-risk areas. The cooperation of persons in high-risk areas should be sought, and they should be actively involved in the provision of services. The minimum levels of necessary services that must be provided are the following:

1. adequate shelter for displaced persons
2. sufficient quantities of accessible drinking water
3. facilities for excreta and liquid waste disposal
4. protection of food supplies against contamination
5. the protection of individuals in affected populations against vector-borne diseases through vector control activities and through chemoprophylactic methods.

Unavailability of appropriate environmental health manpower can be a limiting factor in emergency intervention after a disaster. The use of locally available experts therefore should be given first consideration. Because they are familiar with the predisaster and socioeconomic conditions in affected areas, and—even more important—because they have experience in working under conditions similar to those of disaster-stricken areas, these individuals are usually best equipped to



J. Vizcarra Brenner/PAHO

Women collecting water from a common pump in rural Bolivia. Guaranteeing sufficient water is a health priority after natural disasters.

handle the emergency contingencies caused by natural disaster. In contrast, outside experts often are unfamiliar with both predisaster conditions and the particular environmental health standards of a given disaster-stricken area. Their lack of knowledge may in fact hinder the success of relief activities, so caution should be exercised when foreign experts are recruited.

The Timing of Emergency Measures

Environmental health problems created by natural disaster should be managed in three major phases. These are presented with recommendations about the appropriate timing for initiating the measures; the duration of the phases, however, will vary according to the nature of the problems created by each actual disaster.

Phase One consists of measures undertaken before a disaster strikes in order to develop and maintain a state of preparedness. Preparedness planning focuses on areas of known high risk of natural disaster—areas with a history of occurrences, or areas that have been designated as sites of potential natural disaster.

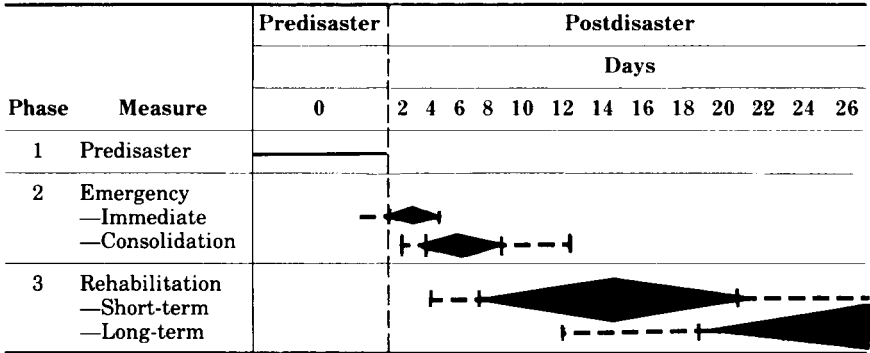
Phase Two begins when the disaster strikes. The emergency-related activities of Phase Two are taken during the event, if possible, and in the aftermath of the disaster. Usually, the environmental health control measures of this phase take place within the first seven days following the disaster. They are, however, divided into subphases: *immediate measures*, taken within the first three days after the natural disaster strikes; and *consolidation measures*, initiated once the immediate measures of the emergency phase have been put into effect.

Phase Three involves the rehabilitation of the environment. Consideration of appropriate rehabilitation measures should actually begin as soon as the emergency-related measures of Phase Two have been initiated. Like Phase Two measures, those of Phase Three also take place in two subphases: *short-term measures*, to return environmental conditions and services to predisaster levels; and *long-term measures* of reconstruction, consisting of all the steps taken to improve environmental conditions and services that require long periods of time to accomplish.

It is recommended that all postdisaster measures except for long-term reconstruction activities be carried out within three weeks of the occurrence of the disaster. Table 3 presents a guideline for the timing

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Table 3. Anticipated Schedule of Measures for Emergencies Created by Natural Disasters



— Anticipated duration of measure

- - - Possible extension of measure

of the adoption and completion of all postdisaster measures.

The specific environmental health measures that should be taken during each of these phases are elaborated in the following chapters. Although exhaustive discussion of long-term measures for rehabilitation is beyond the scope of this document, some basic recommendations are offered.

Chapter 2

Phase One: Predisaster Health Measures

Most natural disasters are sudden, and the warning period in which protective action can be taken is usually very short or nonexistent. With current technology we can at best predict some disasters only a few days before they strike. Often the warning is available only moments ahead of when the disaster hits. The only effective method of responding to a disaster, therefore, is to develop a state of preparedness in high-risk areas.

The principal objective of predisaster environmental health measures is to eliminate or reduce the hazards to environmental health in affected areas once disaster has actually hit. The way to achieve this is to develop a plan for environmental health control activity during the emergency, to adopt routine measures to protect environmental health, and to develop an emergency education and information program aimed at both public health personnel and the general population.

The Plan for Emergency Environmental Health Operations

Effective response to disaster depends heavily on planning the emergency environmental health operations. Once plans are drawn up, they should be revised every five to ten years, generally speaking. Actual experience with a disaster most likely will necessitate revisions immediately thereafter.

An emergency plan is not the *intention* to make a plan; rather, it is a well-developed but simply and clearly defined prescription for the *who*, *when*, and *what* of activities, using existent local resources, once disaster strikes. Guidelines and priorities for action should be stated in

the plan, but lengthy descriptions of the functions and duties of particular persons should be avoided. This is not to say that the functions and responsibilities of individuals within organizations are unimportant, but such descriptions usually emerge after it is determined how existing resources can best be used under the unique circumstances of each natural disaster.

The overall operations plan primarily entails a guide for coordinating all the activities that will be undertaken, after prediction (or occurrence) of the disaster, by personnel of the various types of environmental health and related services. Separate subplans should be developed for water supply service, solid waste service, and so forth. Detailed steps for the development of emergency plans by environmental health and related services are presented in Annex 1. The integration of these subplans forms the basis for finalizing the overall predisaster preparedness plan.

An overall plan contains seven basic components. The first is a statement of the extent of damage that is likely to result from the type of disaster to which the area is subject. The next three components consist of demonstrating how to estimate the resources that would remain after a disaster strikes; indicating how to calculate the needs of affected communities; and, finally, stating how these requirements will be matched with the resources. An assessment of vulnerability and of the inventories of supplies, equipment, and personnel yields the basic data for determining which emergency steps should be taken during the warning period (if there is one), the time immediately after impact, and the postdisaster period.

The last three components of the emergency plan are carried out after the disaster has taken place. These steps jointly make up the Emergency Operations Action (EOA) Plan. The EOA Plan should specify the schedule for addressing specific community needs (for example, providing food or shelter or water or sanitation before taking measures to ensure personal hygiene); indicate the best program for using existing resources; and assign specific tasks to environmental health control personnel assumed to survive the disaster. It must be stressed that the EOA Plan should be drawn up only *after* assessing existent measures.

At this point, it may be worthwhile to repeat the priority measures listed previously: to provide adequate shelter from inclement weather and ensure that the shelters do not burden environmental health

conditions and services; to provide at least the minimum quantity of safe drinking water; to remove human excreta and liquid and solid wastes from the immediate surroundings to nonharmful disposal sites; to bring the control of vectors to a level at which they will not transmit disease or affect the supplies of available food; and to ensure that food sanitation practices do not contribute to the spread of disease.

Finally, the emergency plan should be explicit about the way to disseminate information during the emergency period and about providing protection and accommodation for relief personnel. All relief workers should receive appropriate vaccinations. Personal protection in the form of clothing and washing facilities should also be ensured. Staff members should be instructed about the proper handling of equipment and supplies.

Protective Measures

Taking protective measures involves a wide spectrum of activities that range from considering appropriate design to putting decisions into effect before, during, and after a disaster. The most effective approach to planning such a variety of measures is to first review the effects of disaster, to then think about which protective measures mitigate the effects most common to *all* types of disasters, and finally to consider those measures that are related to specific disaster types or that are applicable to unique local conditions.

In reviewing the known effects of disasters on environmental health, it is evident that damage to civil engineering structures, the contamination of food and water supplies, power outages, and transportation failure all are of high probability and often are critical elements of a state of emergency. Appropriate measures to counteract each of these effects will be discussed.

Civil Engineering Structural Damage

Any natural disaster can destroy or severely damage civil engineering structures: buildings; water structures (such as pipelines, pumping stations, intake structures, and dams); retaining walls; electrical poles; roads; and platforms. Damage of these structures can cause casualties to nearby individuals, and it may lead to either partial or total disruption of lifeline services to the communities they serve.

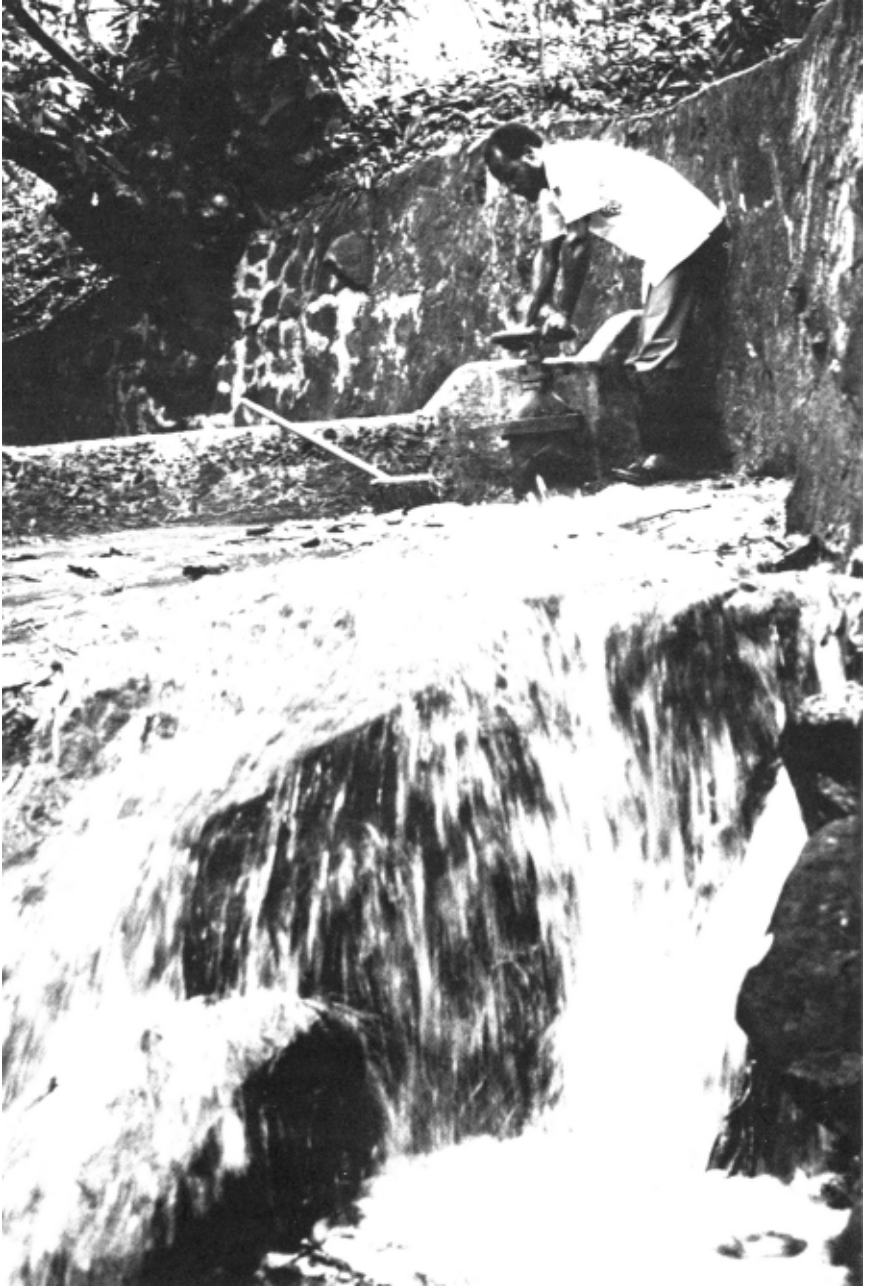
Making advance preparations for the possibility of destruction and modifying existing facilities are major ways in which the damage can be reduced or eliminated. Structures can be reinforced to withstand the impact of a disaster. Likewise, the anchorage and support of machinery, equipment, and storage tanks can be improved. Bypass facilities can be provided; for example, in preparation for the possibility that a water plant, its equipment, or processes may fail, the plant can be bypassed to a point where raw water can be chlorinated. Finally, the adoption of standard operating rules and procedures will maximize readiness for any disaster.

Another way to reduce the impact of disaster on civil engineering structures is to improve the planning of the data base and of design standards. Conducting meteorological, topographical, hydrological, geological, and soil engineering studies in newly chosen sites will enable planners to avoid vulnerable locations. Vital structures can be located in areas known to be protected from the impact of disasters. Specific design methods can be prepared, used, and updated to protect structures, equipment, and supplies from disaster. For example, water distribution reservoirs can be sized with a storage factor of 1 1/2 to 2 times their normal capacity in order to guarantee emergency supplies.

Contamination of Food and Water Supplies

Contamination of food or water is one of the major public health hazards associated with the occurrence of disaster. Contamination can take place at the source of the supply, during transport, at the treatment or processing plant, during storage, or at various times during distribution. The primary cause of contamination after a disaster is damage to civil engineering structures.

Unless there are good reasons to suspect that chemical contaminants have found their way into food or water supplies, microbiological contamination should be the first concern of the decision maker in emergency cases. It is recommended that means to identify and monitor microbiological (and, whenever possible, chemical) characteristics of food and drinking supplies be found in emergency periods. Food analysis, however, is feasible only if the requisite laboratory services were available prior to disaster. Highly technical resource requirements make analysis of food products more difficult than that of



J. Vizcarra Brenner/PAHO

A water caretaker in Saint Lucia diverts surface water to a reservoir for disinfection. Preparedness includes assessing the vulnerability of water treatment plants and reservoirs.

water. Inspection techniques and field test kits can be used for a quick assessment of food contamination.

Other measures to avert the effects of contamination are to identify alternative sources of safe food and water if regular supplies are unusable, and to identify standby or portable water processing or treatment units for use if the system fails. When economically feasible, means should be provided to drain or reduce water supply levels as quickly as possible and to use large dilution capacities to reduce the strength of contaminants. Actions to take against contaminants in the vicinity of source supplies need to be devised.

Power Outage

Power outage—mostly due to damaged transmission lines, damaged civil engineering structures, and equipment failures—is a common occurrence both while a disaster is in progress and in its aftermath. Outages tend to exacerbate problems with delivering lifeline services. They cause the disruption of operations in pumping and treatment plants in water systems and in pumping fuel. They also interfere with the refrigeration essential for safe food storage, and they limit the ability of hospitals to provide their services.

Measures to overcome the effects of power outages include providing nonelectrical means of maintaining limited power distribution (by taking advantage of gravity flow in providing water supply, for example) and supplying alternative electrical and auxiliary power systems to such critical facilities as pumping stations, processing and treatment plants, and hospitals. It is better to use portable generators than standby generators. Fuel for auxiliary power must be stored in sufficient quantities for three to five days of operation. Finally, power systems should be designed to allow the bypassing of plants and equipment, thus preventing total disruption of service when power fails.

Transportation Failure

Transportation is critical to the success of disaster relief efforts. Its failure can cripple the provision of lifeline services, particularly water and food supply distribution and solid waste disposal.



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All means for transportation of water during an emergency should be identified.

The effects of transportation failure can be reduced by constructing alternate secondary roads to vital locations of the water supply system. All other means of transportation that can be used during the emergency also should be identified. Rough terrain vehicles, such as those with four-wheel drive, and animal-traction vehicles are particularly useful after disaster. They are excellent for transporting both people and goods over short distances. In addition to taking these measures, a list should be prepared outlining the priority means of transportation to be available in the aftermath of disaster.

Basic materials, such as chemicals and spare parts, should be stockpiled against the possibility of transportation failure. It is recommended that arrangements be made with local distributors of chemicals, fuel, spare parts, and food to stock a small percentage of essential items that can become available during an emergency. In Barbados, for example, an agreement has been reached with local distributors of food to keep enough of certain items in stock to last five days. This not only guarantees the availability of essential foods after disaster, it also eliminates the costs of maintaining food stocks for long periods by the national relief organization.

Education of Personnel and the Public

A primary consideration in developing a state of preparedness in a disaster-prone area is the proper education of both personnel and the public. Each environmental health service, public and private, must develop training programs for emergency operations. Such training programs may offer an orientation course to all personnel about emergency measures for natural disasters. The course should be of a general nature, providing information regarding what may happen, what can be done by whom, and how to do it. It should be repeated at least once a year as a means to instruct new personnel. The course should be complemented by a more detailed one prepared for essential emergency personnel—employees selected for training to perform certain tasks in emergency situations.

A program for preparedness also should include training exercises. Periodic drills are important for personnel to practice emergency operational measures. The training program can be reinforced by special courses about emergency situations or by conferences, seminars, and printed material about natural disasters.

Public education is of utmost importance in emergency situations. The aim of a public education program should be to win the acceptance of disaster preparedness in disaster-prone areas. Awareness of the emergency measures that may be necessary and of what may be expected of the public is a major step toward the reduction of operational problems.

Chapter 3

Phase Two: Measures Taken during Disaster and in the Aftermath

The emergency environmental health control measures of Phase Two are divided into three time frames, and these immediate emergency periods are followed by a period of consolidation. The first of the emergency periods, the *warning* period, is a few hours or a few days in duration. The second, the *disaster occurrence* period, lasts from a number of seconds or, when the onset is slow, a number of days. The third, the *postdisaster immediate emergency* period, lasts three to four days after the disaster. The consolidation period may also last three to four days. There are a number of measures to be taken in each of these spans of time.

Emergency Warning Period

Emergency environmental health control measures should be put into effect as soon as warning is received that a disaster is imminent (this obviously applies only in such cases where warning is available). The goals of environmental health management in threatened areas are to protect the population and to ensure a state of preparedness and the availability of water, food, shelter, and clothing.

Specific measures to be taken in the warning period include informing and mobilizing personnel of all environmental health services. Inventories should be obtained of the available recommended health personnel, equipment and supplies needed to address anticipated contingencies. Key elements of water and food supply and human waste systems should be protected against impact. The threatened

population should be informed about appropriate measures to take for self-protection. They should be requested to store ample quantities of water in clean containers, such as bathtubs.

If the onset of disaster will be relatively slow, as in the case of some floods or hurricanes, the criteria for a number of measures should be reviewed and disseminated. Among these criteria are those for the establishment of emergency shelters in camps or buildings, the use and development of resources, and proper procedures for issuing requests for aid.

Disaster Occurrence Period

The rescue and accommodation of displaced persons are the objectives of measures taken during this period. During rescue operations, special attention must be given to the establishment of camps for displaced persons. Environmental health technicians should be included as members of the teams that determine the criteria for choice of campsites and design of camp layouts. *This step is particularly important because once people are settled in particular locations, it is difficult to ask them to move again.* Areas proposed for accommodating displaced persons must be surveyed in order to determine whether basic environmental health services can be provided and whether use of the sites might upset the environmental health services of the area or of surrounding areas.

If the natural disaster persists, the impact of its progression should be monitored. Damage should be evaluated at this time and personnel should draw up lists of priority measures to resolve the problems identified.

Immediate Postdisaster Emergency Period

There are five major concerns to address as soon as the full impact of the disaster begins to diminish and the relief effort can be initiated: making basic quantities of safe drinking water available to the general populations and essential users; providing safe, adequate shelter to stricken populations; protecting water and food from contamination by human waste; ensuring that victims follow the principles of basic

personal hygiene; and protecting the affected populations against vector-borne diseases that are prevalent in the disaster-stricken area.

Addressing these concerns effectively will depend on evaluating the disaster's impact on environmental health conditions and services. Thus, an initial survey is required of the availability of health and other related services in the stricken areas. Particular focus should be placed on public supplies of water and food, human and solid waste disposal, housing, and power systems. An inventory is necessary of available resources, essential personnel, equipment, supplies, and logistics that can be used to meet immediate needs.

To determine which areas merit greater attention because of multiple risk factors for disease and other hazards of high population density, information should be gathered about population movements within or near stricken sites. For example, the presence of partially or totally evacuated areas and of settlement sites for displaced persons and relief workers needs to be known.

The specific environmental health concerns that must be addressed in the immediate postdisaster emergency period are described in detail below.

Water Supply

Drinking water, *the* most essential item provided to disaster-stricken populations, is both indispensable to the support of life and a major medium of disease transmission. Thus, although provision of adequate amounts of water for drinking purposes is of utmost importance after disaster, it is simultaneously necessary to ensure the potability of the water used for drinking in affected sites.

Adequate drinking water should first be made accessible to victims and relief workers and in essential locations, such as hospitals and treatment centers. Water can then be made available in peripheral areas of urban centers and in densely settled rural areas and scattered rural sites. After drinking water is secured within stricken areas, making water available for domestic uses (such as cleaning and washing) should be considered.

Drinking water should be obtained from operational water distribution systems. However, it also should be sought from undamaged,

private sources (such as power plants, breweries, and other similar establishments); from undamaged springs, wells, or rainwater cisterns; and from newly constructed water structures, such as bore-holed wells. All water supplies must be carefully evaluated in order to eliminate the risk of water-borne infection and poisoning. The advice of an environmental health specialist (e.g., a sanitary engineer or sanitarian) should be sought when auxiliary water supplies are chosen.

Water suspected of contamination by human or chemical waste should not be used until it has undergone laboratory analysis. Sources located in the vicinity of sewage outfalls, chemical plants, solid waste disposal fields, abandoned mines, and other hazardous places should be considered suspect until such time that an environmental health specialist familiar with local conditions recommends otherwise.

Water delivered to disaster-stricken populations must be kept safe until consumed. This is ensured by disinfecting all supplies, particularly from surface sources and flood structures (such as wells, reservoirs, and rainwater cisterns), within stricken areas. The systematic disinfection of unaffected supplies is not necessary, however; this would be wasteful of the already scarce human and material resources. Proper health education should suffice to reduce the use of unsafe water supplies.

Ensuring the safety of drinking water is a function of a large number of measures. First, water should be tested for the presence of *Escherichia coli* and unsafe concentrations of nitrate as soon as possible. Detection of *E. coli* indicates contamination by human waste and therefore requires immediate protective and corrective measures. High concentrations of nitrate are extremely dangerous for infants, so this age group must be protected.

The residual concentration of chlorine in the distribution system should be increased after disaster. This reduces contaminants that can enter the system because of inadequate water treatment and allows detection of any water already contaminated that penetrates the distribution system. The dangers posed by water collected and stored in a nonhygienic fashion also will be diminished.

From previous experience we know that great care must, however, be taken to avoid overchlorination of drinking water. It is important to ascertain that supplies, especially of public water, are free of chlorine residual. Before chlorination begins, whether through the distribution

of tablets or the issuing of instructions for the use of household bleach, it is recommended that the chlorination program be supervised by an environmental health specialist.

The monitoring of water quality should be restored or initiated immediately. During this phase of emergency measures, daily determination of the chlorine residual in public water supplies is sufficient.

Increasing water pressure compensates for pressure loss due to the breaks of mains and helps to control contamination. It is imperative to consider the importance of water pressure in multistory housing.

If water supplies in the disaster area are not being chlorinated because chlorination systems within the distribution networks are not functioning, water must be disinfected in small quantities. This can be accomplished by boiling the water or by adding agents in the form of pills, powder, or solution. Methods for disinfecting small amounts of water that the Pan American Health Organization recommends are enumerated in Annex 2.

It is usually worthwhile to use mobile water purification plants during natural disaster emergencies if they are available locally. However, they produce limited quantities of water. In most cases mobile units are not essential and are of low priority in requests for aid. For the relatively minimal benefits they bestow, they are expensive; also, when shipped they occupy valuable space that is better used for drugs, medical supplies, food, and clothing.

Large volumes of water that will be hauled to camps or other settlements and to consumers in affected areas also should be disinfected. This can be accomplished with a chlorine compound (e.g., calcium or sodium hypochlorite) in the dosages and at the contact times recommended.

Tanks used for transporting and storing drinking water must be free of and protected against contamination. Mosquitoes should not be permitted to use such tanks as breeding sites. Tanks available locally from commercial water companies, dairies, breweries and so forth can serve to transport water if they are cleaned and disinfected before use. The general rule is to avoid placing drinking water in adapted gasoline, chemical, or sewage trucks and containers.

The final measure for protecting the safety of water is to repair and restore all public supplies. This should be undertaken immediately. All repaired mains, reservoirs, wells, cisterns, and similar units should be cleaned and disinfected.

Environmental Sanitation

Environmental sanitation measures are necessary for protecting the environment from the human wastes normally responsible for the contamination of food and water. Such measures also counteract the development of breeding sites of disease vectors and pests. Excreta disposal should receive primary consideration. Improper disposal not only leads to the contamination of water and food supplies; it also attracts flies and other disease-carrying pests. Other measures that should be taken are providing a sanitary solid waste system, including receptacles, means of transportation, and incineration and burial facilities at camps; providing a disposal system for liquid wastes; and restoring municipal disposal services.

For appropriate excreta disposal, trench latrines should be dug at camps and relief worker settlements. When this is not feasible, toilet facilities such as portable units should be provided. The trench latrines should be made accessible in densely populated areas if excreta disposal facilities have been destroyed. Tools and other materials should be given to the population, who should be instructed about constructing such facilities under the supervision of an environmental health specialist. Moreover, a health education program in latrine usage is essential to the sanitary upkeep of latrines.

As soon as excreta disposal systems have been provided, attention should be turned to public sewage systems. First, sewer lines and manholes that cause flooding in the streets and basements of densely populated areas should be unclogged. The next step is to repair sewer lines, manholes, sewer outfalls, and treatment units. Sewage tank trucks can be used to empty the overflow from septic tanks in public buildings used to accommodate displaced persons, casualties, and relief workers.

Shelter

As soon as rescue work has started, accommodating displaced persons under conditions that will not lead to the deterioration of public health and the environment should be considered. Immediately following a natural disaster, displaced persons usually seek accommodation with families or friends. In some cases, public shelter has to be provided temporarily until more permanent locations can be planned.

Existing public buildings—schools, meeting halls, churches, and hotels—often are chosen as temporary shelters because they can be converted easily into dormitories. They are also likely to have sources of water supply and waste disposal and bathing and washing facilities. Some even have cooking and mass feeding facilities.

It is important to underscore the fact that once individuals have been located and established on a site, it is difficult to ask them to move again. This point should be considered carefully especially in the establishment of camp settlements.

After the first two or three days following a disaster, more permanent shelters may become necessary. At this time, accommodating displaced persons should receive priority. To reduce the number of displaced persons who require shelter, they should be encouraged and assisted to stay with family or friends. As soon as possible, they should be helped to return to their own homes. If adequate resources exist to provide them with materials for constructing temporary shelter on their own property, this step should be taken. Wherever they locate, however, they must have access to water and food and a sanitary means of waste disposal.



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The crowding and lack of sanitary facilities characteristic of temporary settlements create health hazards. Displaced persons should be helped to return to their own homes.

Accommodating displaced persons in tent camps should be considered only as a measure of last resort. The use of uncompleted public housing projects instead has, for example, proven a very effective way to provide temporary shelter.

Food Sanitation

Locally available food products can become degraded or contaminated as a result of a natural disaster. Food usually becomes contaminated by polluted flood waters and, in some cases, by disease vectors and by unsanitary handling, especially in mass feeding facilities. Degradation results from long periods of power outages that disrupt refrigeration and from contact with water, fraudulent adulteration, and the use of old stocks of food products.

Since consumption of contaminated and degraded food leads to poisoning or infection, it has serious health implications. These consequences are best dealt with by locating available food supplies and investigating their fitness. Priority should be given to the consumption of uncontaminated, perishable food, particularly if the food supply originates in areas where there has been a power outage. *All* food, however, needs to be inspected. The analysis of food products should be of low priority, because it often is too complex an undertaking to initiate in areas affected by the disaster. Adequate inspection nevertheless can be made with simple kits for testing food, such as phosphate determination kits.

A qualified environmental health specialist should inspect all damaged places of food production and distribution before operations are carried out. The activities at mass feeding facilities also should be supervised by a specialist.

To avert health problems related to food degradation and contamination, the public should be informed about measures that can be taken to guarantee the safety of domestic supplies. The public should know which foods are safe to consume and the best methods of preparing them.

Vector Control

The impoundment of rain or flood water in empty receptacles or on the soil and other places creates unsanitary conditions because debris

and solid wastes accumulate, and it allows insects and rodents to proliferate. Certain diseases—malaria, yellow fever, typhus, tularemia, and diarrheal infections—are transmitted in this way; food supplies can be reduced; and other nuisances are created.

The goal of emergency activities is to control vector-borne diseases, especially where they are known to be prevalent. Environmental health control measures should be reinforced by other health measures (for example, chemoprophylactic efforts to control malaria).

Houseflies and rodents are nearly impossible to control in the aftermath of disaster. Environmental sanitation and personal hygiene measures are the only effective ways to combat the problems they create. Food and water should be stored in areas where flies and rodents cannot get to them, and all debris and solid wastes should be cleaned up and disposed of as soon as possible.

Many steps can be taken to ensure effective control of vectors during disaster-created emergencies.² All operations should be supervised by a qualified specialist in vector control, preferably one with experience in disaster-stricken areas.

Both the threatened population and specialists must work to eliminate breeding sites. The population should be informed about measures to eliminate such sites and about other means of protecting themselves from vector-borne diseases. Authorities should take permanent measures—drainage, filling, overturning receptacles, and so forth—to eliminate breeding sites. Locally obtainable larvicides should be utilized in large-scale water impoundments, since the direct elimination of such bodies of water requires excessive time, effort, and resources.

Potential breeding sites of mosquitoes should be identified by surveying campsites and other densely populated areas. These surveys should focus on specific diseases transmitted by the mosquitoes rather than on general mosquito control. Wherever malaria is prevalent, for example, the purpose of the survey should be to identify the breeding sites of the species of mosquitoes which carries malaria (the *Anopheles*).

These measures will greatly reduce the need to spray insecticides,

2. For detailed measures against specific vectors, see *Emergency Vector Control after Natural Disaster*, Pan American Health Organization, Scientific Publication No. 419 (Washington, D.C., 1982).



Marcelo Montecino/PAHO

Trash collection in Havana, Cuba, during the 1981 dengue fever epidemic. The sanitary disposal of trash and garbage is essential in vector control.

but outdoor spraying may be judged the best way to reduce proliferating adult mosquitoes. If this is necessary, locally available materials should be used. Use of sophisticated supplies and equipment is not recommended, because the benefits gained do not justify the high costs incurred.

If indoor spraying is to be used in flooded areas, it should be initiated as soon as possible. Flooded housing is of the highest priority for indoor spraying. In deciding whether to spray indoors, note that populations in tropical countries tend to stay outdoors; therefore, indoor or residual spraying of insecticides will not significantly reduce contact with vectors.

Finally, action must be taken against the spread of typhus. Displaced persons in settlement camps and other types of public shelter should be dusted. To control typhus in more established settlements, facilities for bathing and washing must be provided.

Personal Hygiene

Personal hygiene usually falls off in times of emergency, especially in densely populated areas, such as settlements for displaced persons. Consequently, the incidence of diseases associated with inadequate personal hygiene may rise.

Providing displaced persons with cleaning and bathing facilities will encourage attention to hygiene. Overcrowding in sleeping quarters should be avoided. Sufficient quantities of water should be made available to those who live in areas other than settlement sites and whose water supply has been interrupted. All disaster-stricken populations need to be informed about and encouraged to acquire the habits of personal hygiene that will protect them from disease.

General Public Information

In addition to the specific information stated in earlier sections, information should be made available to the public about such things as the location and kind of resources and environmental health services available, the location of settlement sites for displaced persons, and the names and titles of the authorities to contact to report emergency situations. This helps the public understand the extent of

the emergency, reduce confusion, and improve the effectiveness of emergency environmental health activities.

Environmental health measures applicable to emergencies created by natural disasters are summarized in Annex 3. These should be of value to decision makers in formulating and publicizing policies during emergencies.

Consolidation Period

A few days into the emergency period, those environmental health measures that have been taken should undergo consolidation. The measures to be accomplished in this period of consolidation include preparing lists of needed assistance and submitting them to relief agencies, receiving and distributing the aid, and establishing camps.

Providing Relief Agencies with Lists of Needs

By comparing current needs to the results of earlier surveys, one or several lists should be made of technical manpower, equipment, and supplies needed. Lists should be prepared for representatives of national and international agencies, giving priority to aid obtainable from local rather than foreign resources.

Receiving Aid

All aid received must be checked against the lists of aid requested in order to ensure that needed items actually have been provided. The suitability of equipment and supplies also needs to be checked; this may require assistance from a local expert, such as a chemist or an engineer. To avoid damage and waste of incoming aid, all equipment and supplies should be handled properly.

Distributing Aid

A list should be made of priority areas to receive aid. Distribution of goods should be guided by good judgment of actual needs so that local capabilities are not overwhelmed. When aid is distributed improperly, valuable supplies may be wasted.

Establishing Settlements for Displaced Persons

Safe water, food supplies, and basic sanitation facilities must be available in all camps for displaced persons. Sanitation teams, which will provide services and educate camp dwellers, should be designated for each campsite. Teams can be composed of volunteers, but they should be supervised by an environmental health technician. They should develop sanitation regulations for the sites and make the residents aware of them.

Finally, settlement dwellers must be encouraged to return to their homes as soon as they can do so safely. They should return to the sites of their homes even if they need to be given construction materials for erecting temporary shelters on their property.

Chapter 4

Phase Three: Rehabilitation Measures

Although *rehabilitation* implies the reconstruction of services to predisaster levels and therefore involves long-term postemergency activity, some rehabilitation measures have to be taken during both the emergency and immediate postemergency periods. Environmental health rehabilitation measures should be initiated as soon as possible in the emergency phase. The specific rehabilitation measures to be undertaken during the emergency phase are to restore lifeline services immediately, to return environmental health surveillance back to its normal state, and to evaluate the emergency operations plan once it has been implemented.

Restoration of Lifeline Services

All of the lifeline services—water supply, sewage and solid waste disposal, electricity, transportation, communication, and, in some instances, heating fuel—should be given primary consideration. The first short-term measure to address breakdowns in lifeline services is to create a national committee of representatives of all local and government service agencies and at least one environmental health specialist. The committee should assume responsibility for planning, monitoring, and coordinating all reconstruction activities. If necessary, a subcommittee for health and environment may be formed to oversee responses to specific public health problems.

Technical surveys for evaluating and planning the restoration of lifeline services should be conducted by specialists familiar with the affected areas and their predisaster conditions. They should gather information about specific equipment and supplies needed, in addition

to information concerning general reconstruction needs. The survey should enable officials to establish the order in which measures must be taken to achieve both the short-term and the long-term restoration of services.

Once the emergency period has passed, replacements for partially and totally destroyed supplies and parts will have to be purchased. The list of items to be ordered should be drawn up during the technical surveys. Purchase orders for these should be completed at the earliest possible time, since procurement frequently is delayed.

Supplies and parts should be ordered from abroad only if they cannot be purchased locally. In the same vein, expertise and manpower resources to carry out repairs and the construction of environmental services should be contracted locally whenever possible. The cost of manpower and material resources usually increases substantially in emergency situations; thus, employment of members of the stricken population is socially and economically beneficial.

Plans for restoring lifeline services should be designed to strengthen environmental health services in stricken areas. This may call for improving upon the human, material, and financial resources and operating methods of the predisaster services.

Restoration of Essential Environmental Health Surveillance Activity

Essential environmental health surveillance activities should be initiated or restored as soon as environmental health services are in operation. The purposes of surveying environmental health services primarily are to ensure that no increased risk of disease exists and to measure the progress of the activities conducted during both the emergency and rehabilitation phases. Only essential surveillance activities should be considered; it may be judged necessary, however, to develop special environmental health surveillance programs on either a short-term or a long-term basis. The essential activities discussed below are presented in order of importance.

Water Quality

Routine testing of chlorine residual in the water should begin immediately after the disaster occurs. Routine determination of levels

of *Escherichia coli* and nitrates should be initiated thereafter. Once municipal water distribution systems have been restored, routine testing should begin for chlorides, sulfates, magnesium, total dissolved solids, and pH level. If the concentration of chloride changes dramatically, it may indicate contamination of the water by human waste. The presence of high levels of sulfates, magnesium, and totally dissolved solid concentrations needs to be checked, because these can have a laxative effect.

Food Supplies

Utmost in importance is surveillance of the sources and quality of the water supply used in food preparation, the cleanliness of the premises where food is handled and prepared, washing facilities, sanitary storage of food supplies (including refrigeration), and facilities for sanitary excreta disposal. Testing of milk quality to determine



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An open market, South America. It is important to monitor the cleanliness of areas in which food is handled and prepared.

if water has been added may be done routinely if phosphatase determination kits are available.

Environmental Sanitation

During this phase, surveillance of latrine construction projects, solid waste handling, and general sanitation in high-risk places (such as settlements for displaced persons, hospitals, and schools) should be restored or initiated.

Evaluating the Emergency Operations Action (EOA) Plan

Upon consolidating the emergency and postemergency measures, it is necessary to evaluate comprehensively all of the activities that have taken place. Both the strengths and weaknesses of the predisaster, emergency, and immediate postemergency measures should be underscored. This information can be used to improve the entire emergency plan handling postdisaster problems. It also reinforces policy decisions about rehabilitation, such as those concerning changes in the design and construction of civil engineering structures and replacing equipment and supplies.

The questions to be posed during the evaluation are the following:

1. What happened during the disaster?
2. What did not happen? Why?
3. Who was or was not there?
4. What should be done to improve the entire EOA Plan?
5. What laws or regulations need to be changed to improve the EOA Plan?
6. What material should be stocked for emergency use in the future?

The report of this final evaluation should be offered to the local governmental and nongovernmental agencies of concern and to international relief organizations. An evaluation of this kind will also ensure proper coordination of routine activities, essential for improving preparedness for the future occurrence of disaster.
