CHAPTER 4.
DISASTER MITIGATION IN THE HEALTH SECTOR

It is virtually impossible to prevent the occurrence of most natural hazards, but it *is* possible to minimize or mitigate their damaging effects. In most cases, mitigation measures aim to reduce the vulnerability of the system (for example, by improving and enforcing building codes). In some cases, however, mitigation measures attempt to reduce the magnitude of the hazard (e.g., by diverting the flow of a river). Disaster prevention implies that it is possible to completely eliminate the damage from a hazard, but that is still not realistic for most hazards. An example would be that of relocating a population from a floodplain to an area where flooding has not occurred or is unlikely to occur. In such a case, the vulnerability will be brought to zero, since from a public health or social point of view there is no vulnerability where there is no population.

Medical casualties could be drastically reduced by improving the structural quality of houses, schools, and other public or private buildings. Although mitigation in these sectors has clear health implications, the direct responsibility of the health sector is limited to ensuring the safety of health facilities and public health services, including water supply and sewerage systems.

In the last two decades in Latin America and the Caribbean, nearly 100 hospitals and more than 500 health centers have suffered damage as a result of hazards. In the worst cases, hospitals collapsed, killing patients and medical staff. More commonly, services to the community were interrupted, jeopardizing the health of the population. In many instances, even years after an event, repairs have not been completed. When water supplies are interrupted or contaminated, public health consequences can be severe. In addition to the social costs of such damage, the costs of rehabilitation and reconstruction severely strain economies.

HEALTH SECTOR DISASTER MITIGATION PROGRAMS

Because of the variety and cost of mitigation activities, priorities for implementing these measures must be established. In the health sector, this is the function of the national health disaster management program, working with experts in such areas as health and public policy, public health, hospital administration, water systems, engineering, architecture, planning, education, etc. A specialized unit within the national health disaster management program should coordinate the work of these professionals. Mitigation complements the disaster preparedness and disaster response activities of the program.

The mitigation program will direct the following activities:

1. Identify areas exposed to natural hazards with the support of specialized institutions (meteorology, seismology, etc.) and determine the vulnerability of key health facilities and water systems.
2. Coordinate the work of multidisciplinary teams in developing design and building codes that will protect the health infrastructure and water distribution from damage in the event of disaster. Hospital design and building standards are more stringent than those for other buildings, since hospitals not only protect the well-being of their occupants, but must remain operational to attend to disaster victims.
3. Include disaster mitigation measures in health sector policy and in the planning and development of new facilities. Disaster reduction measures should be included when choosing the site, construction materials, equipment, and type of administration and maintenance at the facility.
4. Identify the priority hospitals and critical health facilities that will undergo progressive surveys and retrofitting to bring them into compliance with current building standards and codes. The function of a facility is an important factor in establishing its priority. For example, in earthquake zones, a hospital with emergency medical capacity will have higher priority in the post-disaster phase than a facility that treats outpatients or those who could be quickly evacuated. Create mitigation committees at the local level to identify key facilities and ensure that mitigation measures are implemented in all projects.
5. Ensure that disaster mitigation measures are taken into account in a facility's maintenance plans, structural modifications, and functional aspects. In some cases, the facility may be well designed but successive adaptations and lack of maintenance increase its vulnerability.
6. Inform, sensitize, and train those personnel who are involved in planning, administration, operation, maintenance, and use of facilities about disaster mitigation, so that these practices can be integrated into their activities.
7. Promote the inclusion of disaster mitigation in the curricula of professional training institutions related to the construction, maintenance, administration, financing, and planning of health facilities and water distribution systems.

Annex I describes the steps involved in establishing a national disaster mitigation plan for hospitals in an earthquake-prone region.

VULNERABILITY ANALYSIS IN HEALTH FACILITIES

The first phase of the disaster mitigation program is to conduct a vulnerability analysis, i.e., to identify weaknesses in the system that may be exposed to hazards. Since the objective of this analysis is to establish priorities for either retrofitting or repair, there is no reason to perform the study if there is no intention of implementing the recommended mitigation measures.

A multidisciplinary team (composed of health administrators and specialists in natural hazard assessment, environmental health, engineering, architecture, planning, etc.) conducts the vulnerability analysis. The team will identify potential hazards, classify the location of the system (soil quality, access routes, etc.), determine the expected performance of the system, and analyze maintenance operations. The team will then be in a position to present the results of this initial, low-cost study to the "owner" or "client" and propose mitigation measures, taking into account political willingness and financial constraints. Based on the decision taken, a quantitative vulnerability analysis study is then performed.

Professionals with expertise in natural hazard evaluation, methods of risk analysis, and conducting retrofitting projects generally are hired from outside of the hospital or water system being targeted. Training should take place during the analysis, so that institutions gain the basic capacity to lessen their vulnerability.

Vulnerability analysis must take place regularly, as both hazards and vulnerability change over time.

DISASTER MITIGATION IN HEALTH FACILITIES

Building standards for health facilities are different than those for most buildings, particularly those health facilities that will be under increased pressure to attend to medical emergencies in a disaster's aftermath. Mitigation measures in hospitals have to be oriented, first, to avoiding loss of life of patients and staff, and second, to ensuring that the hospital will function properly after the hazard's impact. Each component of the hospital must undergo vulnerability analysis.

The following factors are considered when conducting vulnerability analysis and preparing mitigation plans for medical facilities:

1. Structural elements, which include a building's load-bearing components, such as beams, supporting columns, and walls;
2. Nonstructural elements, including architectural elements (exterior non–load-bearing walls, in-fill walls, partition systems, windows, lighting fixtures, and ceilings); lifeline systems (water, power, and communication systems); and the building's contents (medicines, supplies, equipment, and furnishings). Nonstructural damage can be severe, even if the building structure remains intact;
3. Functional elements, which include the physical design (site, external and internal distribution of space, access routes), maintenance, and administration. The administrative and operational aspects of the facility (including disaster plans and performance of simulation exercises) are addressed as part of preparedness activities.

The analysis of structural components should be carried out first, since these results are used to determine the vulnerability of nonstructural and functional elements.

Once a facility's weaknesses are identified, a mitigation plan can be developed. Considering the costs and technical complexity of different measures, it is quite legitimate to begin with the least expensive measures. If resources permit, the structural components, which generally are the most complex and require substantial investment, will be retrofitted. The cost of applying seismic-resistant measures to existing structures ranges between an estimated 4% to 8% of the total cost of the hospital. In the case of mitigation measures for structures exposed to hurricanes, the percentage is even less.

Functional elements, while requiring only modest capital investment, may be surprisingly complex and time consuming. In situations where there are severe political or financial obstacles to undertaking mitigation projects, the application of simple, low-cost measures, such as those applied to nonstructural elements, will reduce the probability of failure of systems in the event of small-scale hazards, which occur most often. The role of maintenance engineers is important in such cases.

All parties concerned (the clients or owner of the institution, financial officers, and technical personnel) should discuss the decision to undertake a mitigation program at the national or local level. Where there are limited economic and technical resources, the mitigation plan should be programmed for completion over a period of several years.

DISASTER MITIGATION IN DRINKING WATER SUPPLY AND SEWERAGE SYSTEMS

Drinking water supply and sewerage systems in urban and rural areas are particularly vulnerable to natural hazards. The systems are extensive and often in disrepair. When water supply is contaminated as a result of disasters, the population is at increased risk of contracting disease, and sanitation quickly deteriorates. Indirect health consequences are often difficult to evaluate and the costs to repair the system are generally very high. For example, as a result of the Mexico City earthquake in 1985, an estimated 37% of the city's population did not have access to water in the weeks following the disaster. As a result of the effects of the El Niño phenomenon in 1997–1998, the population of Manta, Ecuador, went without water for three months. Costs to repair the damaged infrastructure in this case exceeded US$ 600,000; losses to the water authority due to uncollected receipts exceeded

TABLE 4.1. Hospitals and health centers damaged or destroyed, by selected natural disasters, Latin America and the Caribbean.

Disaster	Hospitals and health centers damaged	Beds out of service
Earthquake, Chile, March 1985	79	3,271
Earthquake, Mexico, September 1985	13	4,387
Earthquake, El Salvador, October 1986	7	1,860
Hurricane Gilbert, Jamaica, September 1988	24	5,085
Hurricane Joan, Costa Rica and Nicaragua, October 1988	4	…
Hurricane Georges, Saint Kitts, September 1998[a]	1	170
Hurricane Georges, Dominican Republic, September 1998	87	…
El Niño, Peru, 1997–1998	437	…
Hurricane Mitch, Honduras, November 1998	78	…
Hurricane Mitch, Nicaragua, November 1998	108	…

[a]In the 35 years that the Joseph N. France Hospital in Saint Kitts has operated, it has been seriously damaged by hurricanes on 10 occasions.

— Not available.

US$ 700,000. Costs to repair damage to the aqueduct system resulting from the Limón, Costa Rica, earthquake in 1992 exceeded US$ 9,000,000.[1]

Authorities that operate and maintain water systems should have strategies directed at reducing these systems' vulnerability to natural hazards and procedures to quickly and effectively restore services in the event of a disaster. As with health facilities, vulnerability analysis is the first step in identifying and quantifying the effect of potential hazards on the performance and components of the system. This process is complicated by the fact that drinking water and sewerage systems are spread over large areas, composed of a variety of materials, and exposed to different types of hazards, including landslides, flooding, strong winds, volcanic eruptions, or earthquakes.

The analysis of the water and sewerage system is conducted by a team of professionals with expertise in natural hazard assessment, environmental health, and civil engineering, along with water service company personnel who are familiar with service operation and maintenance. Their focus is on operation and maintenance, administration, and potential impacts on service, as outlined below:

- **Operation and Maintenance.** The team analyzes how the overall system performs. Important factors for drinking water are the capacity of the system, the amount supplied, continuity of service, and quality of water. For the sewerage system, coverage, drainage capacity, and quality of effluents are evaluated. Information on the vulnerability of specific components (intakes, pipelines, treatment plants, storage tanks, drainage systems, etc.) indicates how the failure of one component will affect overall performance.
- **Administration.** The team ascertains the ability of the water service company to provide effective response by reviewing its disaster preparedness, response, and mitigation program. This includes mechanisms to disperse funds in emergency situations and necessary logistical support (personnel, transportation, and equipment) to restore water service. The analysis reveals whether disaster mitigation measures are included in routine maintenance, if necessary equipment and replacement parts are available for emergency repairs, and staff are trained in disaster response.
- **Impact on Service**. The team analyzes the potential impact of different hazards on specific components. Special attention is given to the location of a component and risks in the area, its condition (for instance, corrosion in pipes), and how critical it is to overall performance of the system. The team also estimates the time required to make repairs, the potential number of broken connections, and decreases in water quality or quantity that would result in rationing.

This information is used in the disaster preparedness plan to indicate the need to provide alternative water sources, the amount of time required to restore water service, and connections and installations that have priority for special monitoring, repair, or replacement.

[1] Pan American Health Organization. Centro Panamericano de Ingeniería Sanitaria y Ciencias del Ambiente (Publicación N°. 96.23). Estudio de caso: terremoto del 22 de abril de 1991, Limón, Costa Rica. Lima: OPS / CEPIS; 1996.

Mitigation measures for water systems include retrofitting, replacement, repair, placement of back-up equipment, and improved access. The mitigation plan may recommend such measures as relocation of components (as in pipelines or structures located in unstable terrain or close to waterways), construction of retaining walls around installations, replacement of rigid joints, and use of flexible piping.

Applying mitigation measures to existing systems is complex and costly. Water authorities, administrators, and operators must take responsibility for ensuring that disaster mitigation measures form part of the design and routine operation of these systems, and are included in the master plan and execution of any expansion to the system.