Emergencies and Disasters in Drinking Water Supply and Sewerage Systems: Guidelines for Effective Response

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Contents

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Preface

This book is a joint production of the Pan American Health Organization (PAHO/WHO) and the Inter-American Association of Sanitary and Environmental Engineering (AIDIS). It is based on the technical handbook *Planificación para atender situaciones de emergencia en sistemas de agua potable y alcantarillado*, written in 1993 by Jorge Escalante-Gafau for the Pan American Sanitary Engineering and Environmental Sciences Center (CEPIS).

The book is the result of common concerns on the part of AIDIS and PAHO/WHO after the disasters that have affected Latin America and the Caribbean in recent years, such as hurricanes Georges (the Caribbean, 1998) and Mitch (Central America, 1998), the Armenia earthquake in Colombia in 1999, the landslides in Venezuela (1999), and most recently the El Salvador earthquakes of 2001. These events showed that, while there were plans for disaster response in the water supply and sewerage sector, they had not been guided by the specific vulnerabilities of water supply and sewerage systems. The result was commonly a delay of several weeks in restoring these services, even months in the case of some of the affected cities.

Managers, administrators, planners, designers, and the operations and maintenance staff of the water supply and sewerage sector should find this guidebook helpful in trying to expedite their response to emergency situations and in developing emergency and disaster preparedness plans that take into account existing hazards and vulnerabilities.

As such, the current book complements *Natural Disaster Mitigation in Drinking Water and Sewerage Systems: Guidelines for Vulnerability Analysis*, published by PAHO/WHO in 1998, which provides the basic tools for helping drinking water and sewerage services to engage in disaster mitigation planning by using an integrated approach.

Finally, this publication tries to highlight the principle that the adoption of disaster preparedness procedures in water supply and sewerage systems should strive, above all, to plan an effective response in order to guarantee the quality and continuity of these services, thereby protecting and preserving the health of the affected population.

Introduction

Drinking water and sewerage systems are exposed to both natural and man-made hazards that are common in Latin America and the Caribbean. Earthquakes, hurricanes, floods, landslides, drought, volcanic eruptions, vandalism, and accidents involving hazardous materials are part of the wide variety of events that cause death, injury, and significant economic losses for the countries affected. Table 1 summarizes the impact of disasters between 1972 and 1999.[1] The impact of these disasters on the water supply and sewerage systems has been considerable.

Table 1. Damage caused by disasters in Latin America and the Caribbean, 1972-1999

Years	**Affected population**		**Economic losses**
	Deaths	Evacuees and other affected individuals	(millions of US$, in 1998 dollars)
1972-1979	38,042	4,229,260	8,523.0
1980-1989	33,638	5,442,500	17,821.0
1990-1999	36,320	2,414,485	23,755.0
Total	108,000	12,086,245	50,099.0

In the Dominican Republic, for instance, the passing of Hurricane Georges in September 1998 affected 214 water supply systems out of a total of 352, or 61%, causing direct and indirect damages worth US$16.4 million.[2] As for Hurricane Mitch (October 1998), which hit several countries in Central America, its adverse effects can be seen in Table 2.

Everyone knows how vital water supply and sewerage systems are for the health and development of any community. This makes it a priority for such services to operate optimally at all times, since a significant degradation of their quality can affect most of the population. The main objective of water supply and sewerage companies, therefore, must be to maintain systems that qualitatively and quantitatively meet the needs of the population so that interruptions in the supply of drinking water and/or the collection, treatment, and disposal of waste water are as brief as possible.

[1] Ricardo Zapata, *El impacto económico de los desastres* (conference paper), Economic Commission for Latin America and the Caribbean, Dominican Republic, September 1999.

[2] Pan American Health Organization, *Huracanes Georges y Mitch, Crónicas de desastres, No. 7* (Washington, D.C.: PAHO), 1999.

Given the negative effects that different phenomena may have on water supply and sewerage systems—such as the rupture of mains and distribution pipes, the contamination of springs or damage to treatment facilities—mitigation and prevention are very important. Moreover, it has been proven that it is always less expensive to invest in prevention than to pay for rehabilitation after a disaster. A case study of the 22 April 1991 earthquake in Limón, Costa Rica, concludes that response and rehabilitation costs were US$9 million, whereas the timely application of mitigation measures before the disaster would only have cost US$5 million—all this without considering the economic value of preventing the unnecessary exposure of the population to health hazards.[3]

Table 2. Summary of damages to drinking water and sewerage systems caused by Hurricane Mitch (October 1998) in Central America

Country	Damage to water supply and sewerage systems[4]	Damages (millions of US$)[5]
Honduras	>90% of the population were without access to water services in early November; 40% were without access by late November	58
Nicaragua	32% of water service infrastructure damaged	19.8
Guatemala	396 communities with damaged systems; 20,000 latrines destroyed	16.1
El Salvador	32% of water service infrastructure damaged	2.4

While acknowledging that it is impossible to achieve 100% disaster-safe systems, it is imperative for both public and private firms in the sector to be capable of resolving, in the best fashion and the shortest time possible, the problems that may arise during and after the impact of some of the hazards mentioned above. Experiences with emergencies and disasters in the last decade of the twentieth century prove conclusively the need to prepare for such contingencies.

[3] Pan American Sanitary Engineering and Environmental Sciences Center (CEPIS), *Estudio de Caso: Terremoto del 22 de abril de 1991 Limón, Costa Rica* (Lima: PAHO), OPS/CEPIS/PUB/96.23, 1996.
[4] Pan American Health Organization, *Huracanes Georges y Mitch, Crónicas de desastres, No. 7* (Washington, D.C.: PAHO), 1999.
[5] Direct and indirect damages, except in the case of Nicaragua, where only direct damages were recorded.

Water supply and sewerage agencies and institutions have been undergoing a process of transformation and modernization. These changes provide opportunities to incorporate issues related to emergencies and disasters in their management plans.

Similarly, advances in information management, thanks to the availability of technological resources such as geographic information systems (GIS), must be incorporated into emergency and disaster management in order to have the best possible information available for effective decision-making.

Proper planning and appropriate organizational development that facilitate a speedy response to an emergency must be one of the priorities of any water supply and sewerage agency or company, whether private, public (national, municipal) or mixed. This calls for the total commitment, involvement and support of the key decision-makers in the sector, so that the necessary material, human and logistical resources can be made available to ensure an appropriate response.

The urgent need for disaster reduction planning by water supply and sewerage systems administrators has been stressed repeatedly in recent years. This manual for designing emergency and disaster plans strives to meet this need without disregarding key issues such as vulnerability analysis and prevention and mitigation programs, which must be in place before emergency and disaster plans can be implemented in such systems.

This manual can be used to improve the organizational structure of the agency or company and to guide its response to any emergency. However, it is important to make sure that such efforts will have a long-lasting effect and, even more importantly, that they will be reinforced with the knowledge and involvement of a significant number of the agency's or company's technicians and professionals.

Chapter 1

General Issues

Disasters are mostly caused by natural phenomena, even if many of their consequences must be attributed to human actions or negligence.

In order to control or minimize natural hazards, it is essential to know the characteristics of common adverse natural phenomena and how they impact on our environment. The study and proper management of such hazards is also a prerequisite for developing operational, planning, training and simulation programs.

These actions, which will be examined at greater length in the pages that follow, comprise several stages:

1. Becoming familiar with, analyzing, and assessing the presence of natural hazards and their effect on the equipment and infrastructure of the area under study, based on the vulnerability associated with such phenomena;
2. Estimating the potential impact of natural hazards on routine as well as longer-term development activities, and on the components of water supply and sewerage systems;
3. Devising and adopting measures to reduce vulnerability and mitigate the effects of hazards;
4. Programming emergency operations.

Types of Hazards

Depending on their origin, hazards can be of two types:

a) Those related to natural events, i.e., physical phenomena arising in nature;
b) Those caused by human activity.

This classification cannot be employed rigidly, since we often find interactions between natural phenomena and human actions. For instance, a landslide may be caused by erosion as a result of deforestation, by failures in channeling runoff or wastewater, or by settlements in unstable areas.

Another way of classifying hazards is by the way they occur:

a) Sudden onset, as in the case of earthquakes;
b) Gradual onset, as in the case of drought.

The various types of hazards manifest themselves as events that can have adverse effects and can potentially lead to an emergency or even reach the level of a disaster. However, it is common for the classifications above to be applied to disasters.

Following is a summary of the main characteristics of some hazards of natural origin.

Earthquakes

Dislocations in the earth's crust, the main cause of earthquakes, deform the rocks below the earth's surface and build up energy that is suddenly released in the form of seismic waves that shake the surface.

Earthquakes are one of the most serious hazards, given their enormous destructive potential, the extension of the areas affected, and the impossibility of forecasting their occurrence.

The main effects of an earthquake, depending on its magnitude, are:
• Fault lines along rocks and below the surface;
• Sinking of the surface;
• Avalanches, landslides, and mudslides;
• Liquefaction.

Earthquakes are classified according to their magnitude and intensity. Seismic magnitude refers to the amount of energy released, which is usually measured using Richter's logarithmic scale. Intensity is measured by the degree of destruction, normally using Mercalli's modified scale, which goes from I (intensity detected only by highly sensitive devices) to XII (total destruction).

The significance and type of damage relate to the magnitude of the earthquake and the area covered, the degree to which buildings and infrastructure are seismic resistant, and the quality of soil where structures are located.

An earthquake has a specific magnitude, but its intensity varies depending on the location of the area under study with respect to the epicenter, the geological characteristics of a site, as well as materials used for structures.

Following are some of the types of damage that an earthquake can inflict on water supply and sewage systems:

- Total or partial destruction of intake, transmission, treatment, storage, and distribution systems;
- Rupture of transmission and distribution pipes and damage to joints between pipes or tanks, with consequent loss of water;
- Interruption of electric power, communications, and access routes;
- Deterioration of the water quality at the source due to landslides and other phenomena;
- Reduction in yields from groundwater sources and flow in surface water sources;
- Changes in the exit point of groundwater or in the phreatic level;
- In coastal areas, inland flood damage due to the impact of tsunamis. Introduction of salt water into coastal aquifers.

Volcanic eruptions

Volcanic eruptions result from the release of energy caused by the movement of magma near the earth's surface. The volume and magnitude of the eruption varies depending on the quantity of gases, the viscosity of the magma and the permeability of the ducts and chimneys of the volcano. The frequency of these phenomena is highly variable: some volcanoes erupt continually, while others remain dormant for thousands of years.

Two kinds of eruptions constitute volcanic hazards:

- *Explosive eruptions*. These occur when gases dissolved in molten rock (or magma) expand and escape into the air. The force of escaping gas violently shatters solid rocks.
- *Effusive eruptions*. Here it is the flow of lava, and not the explosions themselves, that constitute the major threat. Lava varies in its composition and quantity.

A volcanic eruption can generate associated events that can have more severe consequences than the eruption itself. The following are two examples:

- Seismic events due to volcanic action;
- Avalanches, landslides, and mudflows (or lahars).

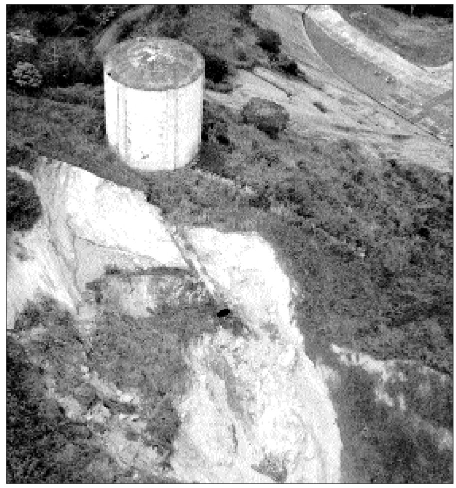
Needless to say, the eruption itself can be quite destructive, ejecting ashes, toxic gases, rocks and lava, sometimes over large distances.

The main potential effects of volcanic eruptions on water supply and sewerage systems are the following:

- Total destruction of the infrastructure in the areas directly affected by pyroclastic flows and surges. These flows tend to follow valleys and can destroy everything in their path;
- Obstruction with ash of surface water intakes, intake screens, transmission pipes, flocculators, clarifiers, and filters;
- Deterioration of the water quality at surface intakes and open reservoirs due to ash falls;
- Contamination of rivers, streams and springs in lahar deposition areas;
- Destruction of access roads to system components, communications and power lines;
- Fires;
- Collapse of or damage to structures due to ash accumulation.

Landslides

Landslides are the result of sudden or gradual changes in the composition, structure, hydrology or vegetation of sloping terrain. They are often closely linked to primary hazards such as earthquakes or water saturation caused by hurricanes or intense rainfall. In urban areas they are also associated with human actions such as providing drinking water services to communities located on slopes with unstable soil. Leaks in these systems lead to excessive moisture in the soil and can result in landslides. The situation can be critical when drinking water is supplied without providing proper sewerage at the same time.



Landslide at storage tank.

J. Grases, 1998

The magnitude of the impact of landslides depends on the volume of the mass in motion and its speed, as well as the extension of the unstable zone and the disintegration of the mass in motion.

Landslides can often be predicted, since they can be preceded by cracks and undulations in the terrain.

The most common effects of landslides are the following:

- Blockage or damage to roads along slopes;
- Changes in the normal flow of surface waters, such as rivers and streams, may result in dams or accumulations of water. Rupture of the dam can cause the violent discharge of great volumes of water or mud;
- Soils may sink or be displaced altogether, affecting houses, schools, roads and other structures.

Effects of landslides to be prevented in areas where water supply and sewerage system components are located include:

- Changes in the physical or chemical characteristics of intake water, which will affect treatment;
- Total or partial destruction of the works, particularly intake and transmission components in the path of active landslides;
- Contamination of the water at surface intakes located in mountainous areas;
- Indirect impacts due to the blocking of roads and the disruption of power and communications;
- Blockage of sewage systems due to buildup of mud and stones.

Hurricanes

Depending on wind speeds, these natural phenomena are called tropical depressions (winds up to 63 km/h accompanied by changes in atmospheric pressure), tropical storms (winds between 64 and 119 km/h accompanied by intense rainfall), or hurricanes (wind speeds of 120 km/h or higher, accompanied by heavy rainfall and significant changes in atmospheric pressure).

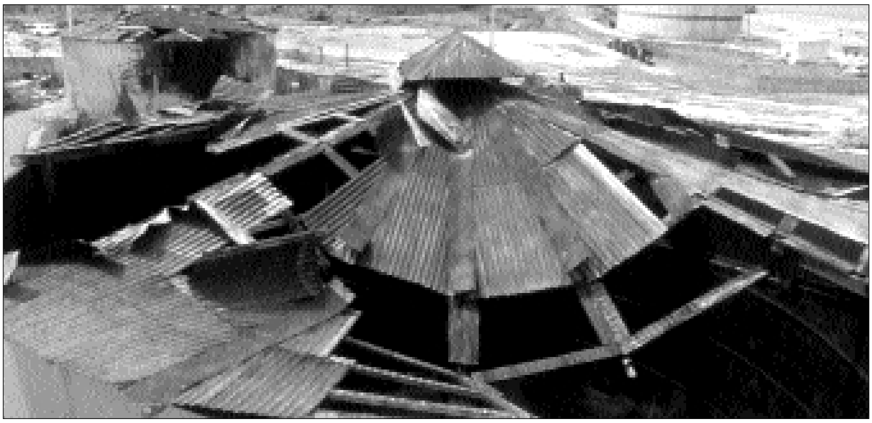
Hurricanes arise from the interaction of hot, humid air coming from the ocean and cold air. These currents gyrate and travel at speeds between 10 and 50 km/h, with an erratic trajectory. Some models are now available to predict the possible course of hurricanes, which can be adjusted as the event unfolds.

Hurricanes may have the following effects:

- Damage to power lines, including the collapse of posts and high-tension towers as a result of the high winds;
- Damage to infrastructure located near waterways;
- Damage to homes due to the strong winds, particularly in coastal areas;
- An increase in precipitation that may give rise to severe urban flooding.

The impact of hurricanes on water supply and sewerage systems can include the following effects:

- Partial or total damage to facilities, command posts and buildings, including broken windows, damaged roofs, and flooding;
- Rupture of mains and pipes in exposed areas, such as over rivers and streams;
- Rupture or disjointing of pipes in mountainous areas due to landslides and water torrents;
- Rupture and damage to tanks and reservoirs;
- Damage to electrical transmission and distribution systems.

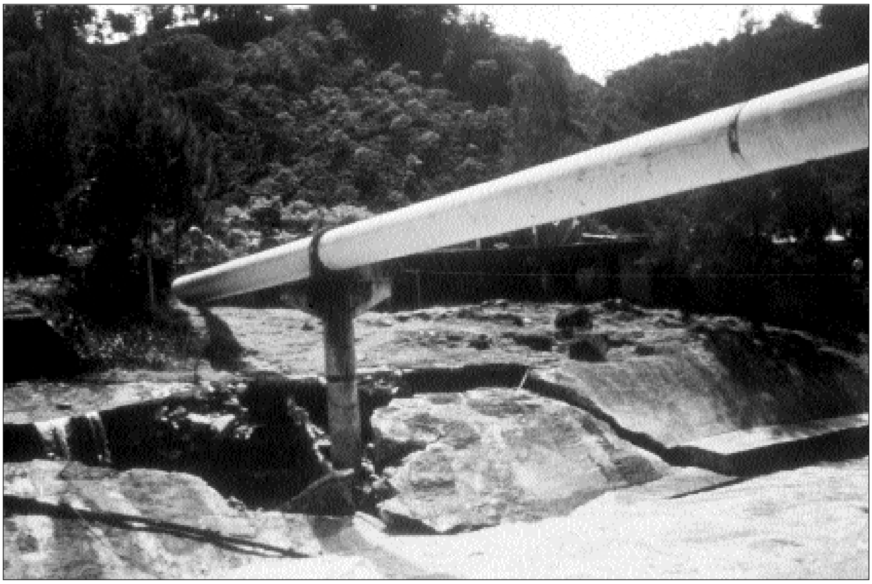


Damage to the roof of a water tank sustained during a hurricane.

PAHO/WHO

Floods

Floods are the result of excessive rainfall, unusually high sea levels, or the rupture of dams and dikes. Increasingly, floods result from human activity causing environmental degradation, deforestation, and inappropriate land use. On the other hand, some floods are the result of the geomorphology and climatology of water catchment areas.



Flood damage to the bridge supporting the main water pipe of the Orosi system in Costa Rica in October 1999. Some 500 tons of concrete were displaced.

A. Rodríguez

The magnitude of the effects of floods is related to the level reached by the water, its speed, and the geographical area covered. Other significant factors are the design quality of the installations and the type of soil on which they are built.

The usual impacts of floods are the following:

- Damage or destruction of housing built close to waterways;
- The flooding of urban areas—even entire cities—built in low-lying areas, affecting the economy and the provision of services;
- Accumulation of water in low-lying areas, creating breeding opportunities for disease-carrying insects.

The main effects of floods on water supply and sewerage systems are the following:

- Total or partial destruction of river water intakes;
- Damage to pumping stations close to flooding waterways;
- Blockage of components due to excessive sedimentation;
- Loss of intake due to changes in the course of rivers and streams;
- Rupture of exposed pipes across and along rivers and streams;
- Contamination in water catchment areas;
- Power cuts, road blockages, and disruption of communications;
- Intrusion of salt water into continental aquifers, contaminating or reducing the availability of groundwater.

Drought

Droughts are prolonged dry periods during natural climatic cycles, caused by a complex set of hydrometeorological elements that affect the soil and the atmosphere. They do not necessarily start when it stops raining, since enough water might have been stored in dams or in the ground to maintain the hydric balance for some time.

Among the effects of drought are the following:

- Reduction of surface water due to lack of rainfall, putting agriculture and animal husbandry at risk;
- Changes in the fauna where waterways are affected;
- Changes in the standard of living due to the negative impact of drought on the economy.

The potential impact of drought on water supply and sewerage systems includes the following effects:

- Loss or reduction of surface- and groundwater sources and deterioration of water quality;
- A decline in water levels at intake points and in storage facilities;
- The need to distribute water with water trucks, affecting quality and increasing costs;
- Damage to the system due to lack of use;
- Accumulation of solid matter in sewage systems.

Table 3 summarizes the impact of these adverse events on water supply and wastewater systems, as well as the severity of the impact.

Table 3. Magnitude of effects caused by hazards

Effects on water supply and sewerage systems	**Earthquake**	**Volcanic eruption**	**Landslide**	**Hurricane**	**Flood**	**Drought**
Structural damage to system infrastructure	●	○	●	●	●	○
Rupture of mains and pipes	●	○	●	◐	●	○
Obstructions in intake points, intake screens, treatment plants and transmission pipes	○	●	◐	◐	●	○
Pathogenic contamination and chemical pollution of water supply	◐	●	○	●	●	○
Water shortages	◐	◐	○	○	○	●
Disruption of power, communications and road system	●	○	◐	●	◐	◐
Shortage of personnel	●	◐	◐	◐	◐	○
Lack of equipment, spare parts and materials	●	○	◐	●	●	○

Symbols used: ● **Severe effect** ◐ **Moderate effect** ○ **Minimal effect**

Hazard Assessment

As will be seen further on, one of the key steps in vulnerability analysis is identifying and assessing the hazards prevalent in the area where the water agency's or company's systems are located, which calls for a review of the company's historical records and a description of the damage suffered by each system over time.

If the assessment reveals a high level of risk—such as the possibility of a major earthquake—it is best to hire specialists to carry out a seismic risk assessment of the system's structures. In any case, disaster planning available through professional evaluation will always be of use.

Assessments must be carried out for each of the hazards to which the site is exposed, and should consider the likely frequency, intensity, the area of impact and the potential damage. The highest priority should be assigned to those hazards most likely to affect the agency or company, its physical structures and its services.

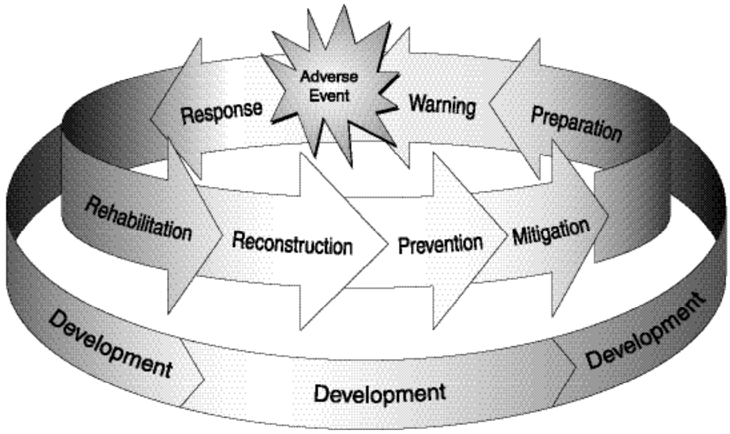
A given hazard may not affect the company's systems but rather the environment, including the population (which will logically include many of the firm's employees) as well as other companies or institutions that provide key services, such as electrical utilities or telecommunications networks. There may likewise be certain hazards that can affect some of the components of the system without affecting the company's customers.

The Disaster Cycle

The disaster cycle includes different stages, which can be summarized as three phases or periods:

- **Before the disaster,** which may be a period of calm or a declared state of alert depending on the event being analyzed;
- **During the disaster,** a stage that may be very brief or very long depending on the characteristics of the phenomenon;
- **After the disaster,** in which the focus is on recovering from the impact of the disaster, and which may be a short-, medium- or long-term endeavor.

Since it is difficult to identify precisely the beginning and end of each of these phases, it is preferable to speak of the different stages in the disaster cycle, which are summarized in the following figure.



Planning for emergency operations—also known as preparedness—involves designing a series of activities that, properly executed, should make it possible to prepare in advance for a disaster and respond promptly once it occurs. It is important to identify the activities to be carried out at each stage of the disaster cycle, particularly those involving the stage prior to the event, and the response stage, which must include the uninterrupted operation and maintenance of water supply and sewerage systems.

In planning for emergencies and disasters, the stage before an adverse event is the most important. It is then that one can anticipate the performance of the company and the physical components of water supply and sewerage systems.

Three sets of activities prior to the occurrence of a disaster or emergency are required:

- Prevention
- Mitigation
- Preparedness

After the disaster has occurred it is time for response activities, which may involve search and rescue, relief, and aid to the victims. Water supply and sewerage companies and agencies must respond quickly and effectively by implementing the emergency plan, and by trying to maintain the largest possible volume of water in the storage tanks until the actual condition of the systems can be verified.

The following set of activities is required after the onset of a disaster:

- Response
- Rehabilitation
- Reconstruction

The rehabilitation of water supply and sewerage systems is of crucial importance, since the speed with which these services can be restored will have a significant impact on the health of the population.

With reconstruction, the essential thing is for the company to incorporate prevention and mitigation measures when designing the new construction or retrofitting plans, so as to prevent the same weaknesses the systems had before the disaster.

Vulnerability Analysis and Measures for Prevention and Mitigation

Vulnerability analysis involves assessing the risks of physical, operational, or administrative damage to the various components of water supply and sewerage systems in the face of potential hazards. The results of the assessment should indicate those hazards threatening the entire system, as well as those that would affect only certain components.

After completing the assessment, one should have all the information required to carry out specific activities to reduce possible damage to the system through the prevention and mitigation program. If a given component cannot be modified to reduce its vulnerability, this contingency should be noted in the emergency plan. Since it takes time to carry out prevention and mitigation measures, the emergency plan must reflect current conditions, including those structures that are being retrofitted to reduce their vulnerability. Annex 1 presents two matrices identifying impacts of various hazards on water supply and sewerage components and measures that can be taken to mitigate these effects.

Vulnerability Analysis

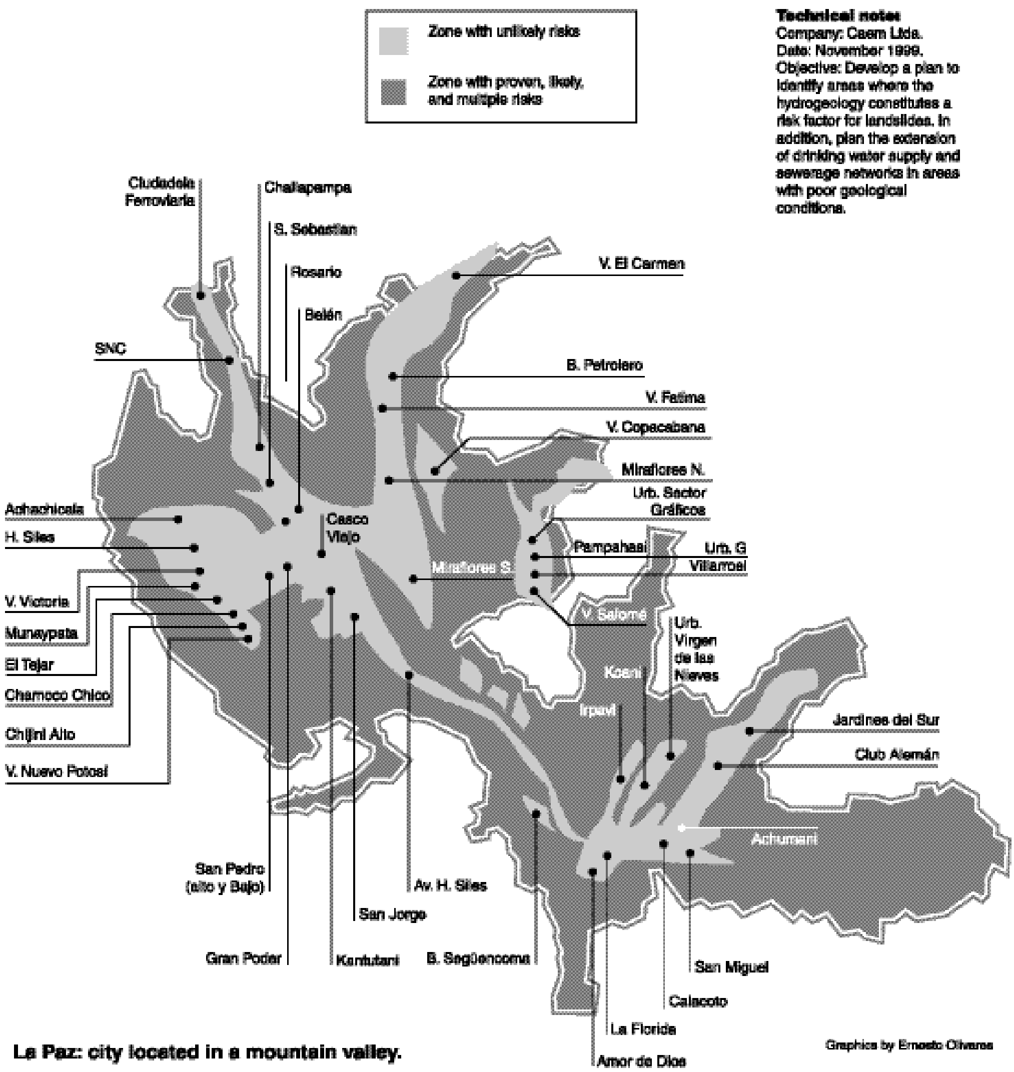
As already noted, vulnerability assessment is the starting point for effectively reducing the impact of disasters through prevention and mitigation programs as well as the design of emergency plans. This section presents some guidelines in this regard.[6]

The methodology for carrying out vulnerability analysis is based on the use of up-to-date and reliable information. One of the first steps is the collection of data about the components of the system, including information about the operational methods as well as the building plans of the structures to be protected. Attention must be paid to all the potential hazards in the vicinity of the system.

This first step makes it possible to present all the relevant information in

[6] For more information please see the book *Natural Disaster Mitigation in Drinking Water and Sewerage Systems: Guidelines for Vulnerability Analysis* (Washington D.C.: PAHO, 1998).

Risk Map of La Paz, Bolivia



1952 The engineer Ernest Drobovolny made the first geological studies of the La Paz valley. This study revealed two major landslides that occurred during the colonial period, affecting the Tembladerani and Santa Barbara neighborhoods.

1952 A slide occurred in Capitán Ravelo Street and there were frequent breaks in the Cotahuma and Pokeni streams. During this period, urban expansion began to take over the slopes of the mountains, and settlements were established in hazardous areas.

1990 - 2000 Various events were recorded in Callapa, Tejar, Alto Tacoma, Cotahuma, IV Centenario, Kupini, Alto Seguencoma, Alto Tacagua, Valle de las Flores, and Ventilla I. Other smaller slides occurred, but they are significant because they affected housing, roads, and the service infrastructure.

Hazard map prepared by Aguas del Illimani, La Paz, Bolivia, 2000.

maps or diagrams that clearly identify the existing hazards and the areas that might be affected.

The results of the physical vulnerability analysis of the system's components can thus be represented in diagrams specifying the most vulnerable or critical components. These diagrams should be produced with the assistance of the most experienced and technically capable personnel of the company, and of external consultants, private or academic, if needed.

When the system's plans are annotated to indicate the most vulnerable components and superimposed on the hazard maps, a system risk plan can be produced for each of the likely hazards.

In addition to the above, it is customary and advisable to procure hazard maps produced by universities, civil defense institutions, national emergency commissions, or professionals in each of the relevant fields.

The following is a summary of the steps that must be taken to carry out a vulnerability analysis. Although reference is made to the drinking water supply system, the steps are also applicable to sewerage systems.

1. Identify the relevant national or regional disaster reduction institutions, as well as the legislation and standards regarding emergencies and disasters.
2. Describe the area under study: location, climate, urban infrastructure, public health services, geological, geomorphologic and topographic data, level of socioeconomic development, etc.
3. Identify and describe each of the components of the system and their subcomponents.
4. Identify and provide a functional description of the system (flow volume, level, pressure, quality of the service).
5. Identify the system's operational aspects (capacity, demand, deficit or surplus volume).
6. Identify and describe the administration and response capacity of the company or agency responsible for the system under study.
7. Determine hazard parameters and hazard assessment, taking into account the likely impact on the system.
8. Estimate the system's vulnerability based on the determination of the likely effects of the emergency on the system's components.
9. Quantify the capacity of each component and subsystem to operate in certain conditions, bearing in mind quantity, quality, and continuity (operational vulnerability).
10. Identify the critical and vulnerable components of the system that may

affect capacity to meet basic demand, and of the priority points of supply (physical vulnerability).

11. Estimate the organizational response capacity (organizational vulnerability).
12. Determine the mitigation, preparedness and emergency measures required to reverse the impact of the hazard on the system's components in administrative, operational, and physical terms.
13. Determine the minimum demand of the population in priority supply points, both during and after the impact of a disaster.
14. Draft the final report and vulnerability maps. Several reports can be produced to cover the various hazards that can affect the system.
15. Develop the Emergency Plan and the Prevention and Mitigation Programs.

For each of the hazards, steps 7 through 13 should be repeated.

The vulnerability of a drinking water supply or sewerage system is analyzed from three points of view:

- **Physical:** Estimation of the possible damage to infrastructure components;

- **Operational:** Assessment of the surplus or remaining capacity to provide the needed services, including an estimate of the time required to rehabilitate the systems.

- **Organizational:** Determination of the institutional or company response capacity, bearing in mind the organization, its expertise, and its other resources.

In some cases it may prove necessary to consider the cultural and socioeconomic characteristics of the community that benefits from the water supply and sewerage services, since improper use of the systems contributes to their vulnerability.

Each vulnerability analysis is related to a specific hazard, and this determines the structures and equipment that are susceptible to direct damage (for instance, the flooding of a pumping station) or indirect damage (failures in power supply).

The internal features of the company that support operations and maintenance (for instance, transportation, communications, and the supply of materials) must be analyzed, as well as features outside of the company (electrical power, telephone services, firefighters, and so on).

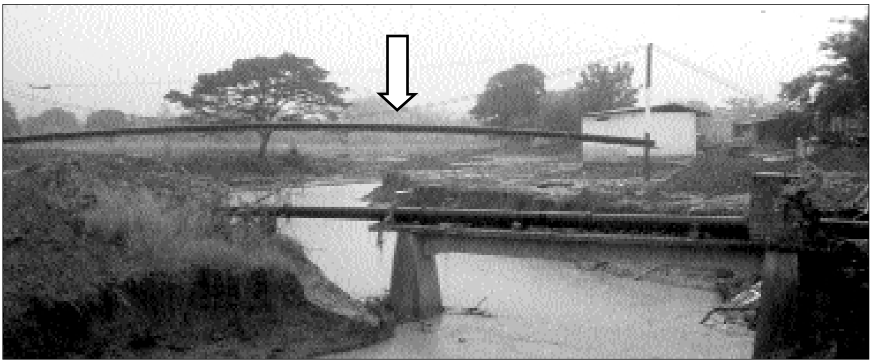
The organization of the company or institution is often the most vulnerable element to hazards if there is a lack of effective preparedness and training to confront emergency situations. Other factors are the obstacles to rapid response, such as bureaucratic barriers to prompt outsourcing or direct purchasing.

Within the organization, operations and maintenance activities are the most important during an emergency, since it will be necessary to work at a fast pace, with additional burdens and under pressure.

In order to systematize the key facts needed to produce a qualitative estimate of current vulnerability based on the information mentioned above (both regarding hazards and the water supply and sewerage systems), one option is to produce tables or diagrams regarding such matters as rehabilitation times, immediate surplus or remaining capacity, and the impact of potential disasters on the services in the area under study.[7]

Prevention and Mitigation Measures

The correct application of prevention and mitigation measures requires strong corporate or institutional will to support emergency planning. The effects of a hazard cannot be reduced without allocating the necessary resources. Even a modest, but continuing, budgetary allocation can produce significant results.



This photograph shows the effects of flooding during El Niño in Ecuador in 1999. The construction of a river overpass is a mitigation measure for piping.

C. Osorio, 1998

After carrying out the vulnerability assessment, the next step is to identify the most effective prevention and mitigation measures. This will make it possible to program the necessary actions to reduce the potential impact of any given hazard on the system. Such measures must include devising emergency operations, signing agreements with other institutions, preparing and carrying out the necessary training activities, allocating material and other resources, and choosing the most important retrofitting projects to reinforce the current system components.

[7] PAHO, *Natural Disaster Mitigation in Drinking Water and Sewerage Systems: Guidelines for Vulnerability Analysis*, Washington D.C., 1998.

Preventive measures reduce the vulnerability of systems. Exposed piping in Ecuador.
A. Rodriguez, 1998

Operations and maintenance activities provide an outstanding opportunity to incorporate mitigation measures into daily, routine actions.

The efficient use of resources calls for good administrative practices based on up-to-date staff training, particularly if new techniques or equipment are to be used. Training must take place at all levels of the company so as to maximize the use of resources.

The execution of a prevention program in companies responsible for water supply and sewerage systems will be effective if the following issues are borne in mind:

- The timely application of preventive measures based on the most likely and severe potential disasters and the availability of appropriate information in the short term;
- Integration of measures in a single program containing different levels or areas of execution based on existing resources;
- The identification of the key areas where the application of preventive measures is most needed and hence most urgent;
- Appropriate management of resources and their timely application;
- The introduction of preventive measures in the everyday activities of the agency or company.

Measures involving physical actions and establishment of standards require the greatest financial investment. They include improvements to existing infrastructure, new construction, and the implementation of improved design and building codes.

The creation and promotion of a culture of prevention and mitigation in the workplace ensures that the adoption of measures to improve potentially vulnerable structures can be carried out in a planned, progressive fashion, both in times of calm and during states of alert.

Other measures—particularly preventive ones—involve the institutional actions needed to respond to emergency situations (including the drafting of an emergency plan). Preventive maintenance, professional training in new operational methods, and the signing of agreements with other bodies are some of these actions. Such measures ordinarily do not demand major investments.

Even as the prevention and mitigation measures are being implemented, the components identified as most vulnerable should be included in the emergency plan, so that the company has a clear idea of how to respond in an emergency or disaster.

The Road to Disaster Mitigation

A proactive program enables a company to organize its activities in such a way as to begin planning for emergencies and disasters long before they occur, for instance by designating who should be in charge of this effort.

As noted elsewhere, responding to emergency situations in water supply and sewerage systems calls for the participation of the company's technical and operational units and the various support units, as well as from representatives of other organizations involved in environmental health and hazard management.

An obvious first step is to appoint a Central Emergency Committee (described in greater detail in Chapter 2), which would focus on strategic decision making both before, during, and after an emergency or disaster, as well as an emergency and disaster response office or unit, and/or some other technical committee, to serve as a tactical coordination mechanism under the guidance of the Central Emergency Committee. The second task is to become familiar with the hazards in the region, the weaknesses of the systems, and the goals that are to be pursued, keeping in mind the available resources.

The following section describes key activities, organized in four sequential stages, for developing and applying the emergency and disaster prevention, mitigation and response program.

A. Design of the Emergency and Disaster Prevention and Response Program

As the preliminary results of the vulnerability analysis become available, it is possible to start working on the Emergency and Disaster Prevention and

Response Program. Such a program must include:

- National and institutional standards for emergency situations;
- Description of the water supply and sewerage systems;
- Vulnerability analyses;
- Prevention and mitigation measures;
- Emergency operations plans;
- Annexes and supporting documents.

These components of the program must be incorporated sequentially, based on the information obtained and the resources available. It should be apparent that such a program covers all aspects of emergency and disaster situations, from the legal framework to the vulnerability assessments, as well as the Emergency Operations Plans. Once the program has been drafted, it must be approved by company or agency authorities and immediately released to all employees.

It must be stressed that such a program has to be carried out immediately after the weaknesses of the components and the system as a whole are known in sufficient detail, with the resources available at that time. As the program is being designed, the various operational levels should draft their own operative emergency plans, specifying the procedures for their application, as will be shown below.

The water supply and sewerage agency or company should include in this program administrative and normative aspects, the terms of reference for the vulnerability analyses, the prevention and mitigation measures to be taken, and the Emergency Operations Plans—all this in order to provide the greatest possible degree of security in the provision of water supply and sewerage services—in terms of quality, quantity and continuity—in the event of an emergency or disaster.

All actions outlined in the program must be mandatory for each of the departments of the company or agency to which they apply. The Emergency and Disaster Prevention and Response Program is, in general terms, a strategic document that should specify exactly who within the company or agency will carry out which actions when responding to emergencies and disasters. Once again, the operative program must consider the concrete, specific aspects of each of the potential hazards identified in the vulnerability analyses.

Finally, we should mention that it is important for the organizational structure of the company or agency to change as little as possible in the event of an emergency, so that employees can continue to carry out routine activities, even though the pace of work will increase in order to respond to the disaster situation.

B. Compiling and Evaluating Necessary Information

Given the nature of the work normally carried out by a water supply and sewerage company or agency, its response to an emergency or disaster is often considered adequate. However, there is no assurance that the decisions taken are the best ones. Even if the affected systems are brought back into operation, the facilities will not necessarily be more secure or able to withstand future disasters in the most cost-effective fashion.

The emergency and disaster plan must be based on the most reliable and up-to-date information available. Only then will there be a reasonable degree of certainty that the decisions taken in an emergency or disaster are the most appropriate, both technically and financially. The following is a checklist of the basic information needed to plan emergency response in water supply and sewerage systems.

Company or Agency Information

1. Technical information
   - Up-to-date description of the systems, including manuals, tables, figures, plans, maps, flow charts, etc.;
   - Official register of water supply and sewerage networks and up-to-date technical files;
   - Operational procedures, make-up of maintenance and other teams, fields of specialization of staff, etc.;
   - Background information on previous disaster experiences, rupture of mains, major maintenance jobs, labor strikes, etc.;
   - Projects under development and technical studies.

2. Administrative information
   - Description of human, material, and financial resources of the company or agency;
   - Organization of the company or agency (objectives, goals and strategies);
   - Legal framework;
   - Current technical and business plans;
   - Commercial information, including information on the expansion of the service;
   - Personnel training programs.

3. Operational information
    - Availability of heavy machinery;
    - Inventory and condition of vehicles;
    - Inventory of equipment (pumps, compressors, soldering equipment, etc.);
    - Personal protection equipment;
    - Stock of spare parts and chemical products.

Information from other institutions and bodies

1. Legislation and regulations pertaining to disasters at the local level (provincial, departmental) and the national level;

2. Information on hazards, including:
    - Earthquakes, hurricanes, floods, landslides, etc. (provided by civil defense, firefighters, municipalities, universities and other institutions);
    - Land use, urban planning (provided by environmental groups, universities, etc.).

3. Information on support and rehabilitation projects.
    - Construction companies, equipment and material suppliers, consultants;
    - Fuel suppliers, owners of water trucks and privately owned drinking water wells;
    - Information on other water supply and sewerage companies, both national and international;
    - Information on priority supply points, including:
        - Hospitals, health centers, Red Cross, firefighters, the police;
        - Shelters, military barracks, prisons, markets, schools;
    - National emergency commission or civil defense.

Since this information cannot be improvised, enough time should be assigned to collecting it, verifying its reliability, and analyzing it.

C. Vulnerability Analysis of Systems and Mitigation Measures

Once the components of the water supply and sewerage systems have been identified and described, as well as the potential hazards prevalent in the region, the process of vulnerability analysis should begin.

Some practical aspects to bear in mind at this stage are the following:

- Those responsible for the analysis must be identified;
- While the information is being analyzed, any gaps in the information must be identified and filled through additional data collection;
- The relevant human resources involved in the analysis must be identified, both those within and outside of the company;
- The training needs of the staff must be defined;
- The hazards must be described;
- The strengths and weaknesses of the system and its components must be identified;
- Prevention and mitigation measures and works must be defined, based on the early draft of the vulnerability analysis regarding each of the major hazards;
- Specialized studies (such as risk maps of the region) must be ordered, if needed;
- A financial assessment of the costs of prevention and mitigation measures must be undertaken.

D. Implementation and Evaluation of the Program

The directors of the company or agency must approve the Emergency and Disaster Prevention and Response Program so that it can be implemented as soon as necessary. They must also approve the budgetary allocations required to carry out the prevention and mitigation measures specified in the program, as well as to support the professional training process and follow up on it to make sure it achieves its objectives.

The directors should also establish a periodic review and evaluation process regarding the Emergency Operations Plan, for which they can use emergency drills and simulations at the relevant levels of participation. They must also review regularly the legal framework in order to propose the necessary adjustments to the relevant national, provincial, or municipal legislative bodies.

Since each prevention and mitigation measure that is carried out modifies the conditions that are the basis of the program, it must be revised as often as needed to make sure it remains up-to-date and reflects the current situation.

Chapter 2

Emergency and Disaster Preparedness and Response

Designing an Emergency and Disaster Prevention and Response Program essentially involves carrying out the tasks outlined in the previous chapter, as well as others that will be described below. This chapter will focus in greater detail on the Emergency Operations Plans.

If you would like more information on disaster prevention and mitigation measures for water supply and sewerage systems, please consult the bibliography at the end of this book.

Emergency and Disaster Management

Objective: To ensure, in emergency and disaster situations, the least possible impact on water supply and sewerage services, as well as an effective response that contributes to preserving the health of the population.

Generally, water supply and sewerage companies and agencies have standard procedures for routine repair of damage to canals, pipes, and other infrastructure, responding to electrical power failures, fluctuations in the quality and quantity of the water supply, etc. Such procedures might be described as the first level of intervention in emergency management, which makes it a natural starting point and foundation for the development of actions aimed at responding to disasters or major emergencies. This first level of intervention has also served to

Distributing emergency drinking water supplies following Hurricane Pauline in Mexico in 1997.

C. Osorio, 1997

provide water supply and sewerage companies with a certain degree of experience in disaster management whenever major adverse events have taken place.

History reveals that greater attention has been paid to rehabilitation and reconstruction efforts than to making them unnecessary in the first place. This approach should be changed by setting in motion emergency and disaster reduction plans. These must focus on the preventive maintenance of structures and equipment, as well as the establishment and updating of those operational procedures and manuals that help to integrate the accumulated expertise of the staff.

As noted elsewhere, emergency and disaster management consists of a coherent set of planning, organization, control, evaluation, and training activities, involving all institutional, human, and operational resources that should be developed and integrated into the agency or company. The objective is to restore in the shortest time possible those water supply and sewerage services most essential to the population.

In order to launch the emergency and disaster management process, an official state of alert must first be declared. This should immediately set in motion the units or departments of the company or agency in charge of responding to each stage of the disaster cycle. (It should be noted that prevention and mitigation activities have a role to play even after a disaster has struck.)

Bearing in mind that each company or agency must act within the constraints of its own resources, the following is a list of those organizational components that should play a role, followed by a description of what that role should be.

1. Company or Agency Directors
2. The Central Emergency Committee
3. The Emergency and Disaster Office or Unit
4. The Emergency Operations Committee
5. The Situation Room
6. The Declaration of States of Alert and Emergency

The Company or Agency Directors

The highest decision-making body of the company or institution must establish all policies and strategies concerning emergencies and disasters. Depending on the structure of the company or institution, the relevant body might be a Board of Directors, Executive Board or the General Manager's Office.

The intervention of the decision-making entity with the greatest executive capacity will be most effective and relevant to the extent that there is, under its direct supervision, a specific unit or office responsible for emergency and disaster management. The organizational structure of the water supply and sewerage service company or agency will determine whether the following groups play an advisory role or are in the direct line of command.

In addition, attention must be paid to regulatory authorities, which might have established emergency and disaster response policies to ensure that water supply and sewerage services remain available in a crisis. The conditions for continuity of these services will be included in the Emergency Plans.

Functions and Responsibilities

- Set the general company or agency policy regarding emergency situations;
- Approve the establishment of an emergency and disaster office or unit;
- Appoint the members of the Central Emergency Committee;
- Approve the Emergency Plan and the protocols for declaring a state of alert or an emergency within the company;
- Declare a state of emergency for the company or agency;
- Ask relevant government authorities to declare a state of emergency regarding the water supply and sewerage system if justified by the situation;
- Give consent and support to actions taken before, during, and after an emergency.

The Central Emergency Committee

The Central Emergency Committee is the functional organ in charge of planning, organizing and guiding the use of human, material and financial resources, and any mitigation, prevention, preparedness, response, rehabilitation or reconstruction activities regarding emergencies or disasters. It is a decision-making committee that should be directly accountable to the company's directorate or other relevant top-level body, and will assume maximum authority in emergency and disaster situations.

Structure of the Committee

The Committee should comprise, whenever possible, the company's highest-level decision-makers, including those in charge of the operational, administrative and financial divisions and other units relevant to emergency and disaster management. One option is to invite professionals from other institutions and sectors to be part of the Committee as a way of furthering inter-institutional and cross-sectoral coordination. The Committee should at the very least include representatives from the following areas:

- The general management office;
- The heads of the production, operations and maintenance divisions;
- The head of the administrative and financial division;
- The head of procurement (supplies and transportation);
- The heads of the development, works and engineering departments;
- The head of the planning department;
- The head of the company's public relations department;
- Representatives of the committee that drafted the Emergency Plan;

- The official responsible for representing the company or agency in its interactions with civil defense bodies (in case he or she is not the same as the representative from the company's management office);
- The person in charge of the company's Emergency and Disaster Office or Unit.

The chair of the Committee should be occupied by the highest formal authority among the representatives appointed to the group.

Depending on the size of the organization or the complexity of the system, this Central Emergency Committee may be replicated at a smaller scale in the various geographical regions or sectors in which the company is involved, so as to respond just as effectively to regional emergencies. Whenever necessary, the various committees should be called "operational committees."

The relations of the Central Emergency Committee with civil defense or the national emergency commission, which normally includes representatives from several ministries, the police, and firefighters, are extremely important, particularly for coordinating the actions needed in a disaster situation. Accordingly, it is essential to make sure that a representative of the water supply and sewerage sector is a member of the national emergency commission.

Functions and Responsibilities

The chief role of the Central Emergency Committee is to make the decisions needed to ensure that water supply and sewerage services can be restored in the shortest time possible after an adverse event. This calls for carrying out specific actions at each of the various stages in the disaster cycle.

Its members should meet periodically, at least twice a year or more frequently depending on their work-load, and obviously as often as needed during a state of alert or emergency. They should also discuss and approve the general guidelines for the unit or group entrusted with designing the emergency plan, including guidelines on mitigation, prevention, and preparedness.

The functions of the Central Emergency Committee will depend on the company's policies, characteristics, and organizational structure. In broad terms, however, the following functions should be mentioned:

- Declaring a state of alert based on the relevant protocols established by the company's directors;
- Setting up the emergency and disaster office or unit;
- Monitoring the drafting and implementation of the emergency plan;
- Coordinating the working program with the emergency and disaster unit;
- Monitoring the ongoing staff training on emergency procedures, which should include both theory and practice;

- Assigning priorities, coordinating, and overseeing the appropriate use of resources during an emergency;
- Forging and maintaining communications and coordination with the public institutions responsible for emergency and disaster management, both at the local and national level;
- Maintaining contact with private companies such as suppliers of equipment, chemical products and pipes, professional associations, and subcontractors;
- Coordinating emergency and disaster response efforts with the Emergency Operations Committees;
- Supporting the actions of the Emergency Operations Committees whenever there is a need for intervention at higher levels;
- Establishing the communication procedures, both within and outside of the company;
- Approving and securing the necessary financing for prevention and mitigation programs.

The Emergency and Disaster Unit

It is the responsibility of this office or unit to carry out, on an ongoing basis, the company's internal disaster prevention, mitigation and preparedness actions required by the Central Emergency Committee, as well as to coordinate mitigation and response efforts with other institutions.

In the case of some water supply and sewerage companies or agencies, this office has a formal and permanent place in the organizational chart, which evidently makes it possible to effect improvements in less time. When such a unit is not official, the functions described below must be assigned to the company's operational unit or other units selected for this purpose. Regardless of its internal status, this office is the executor of the guidelines provided by the Central Emergency Committee.

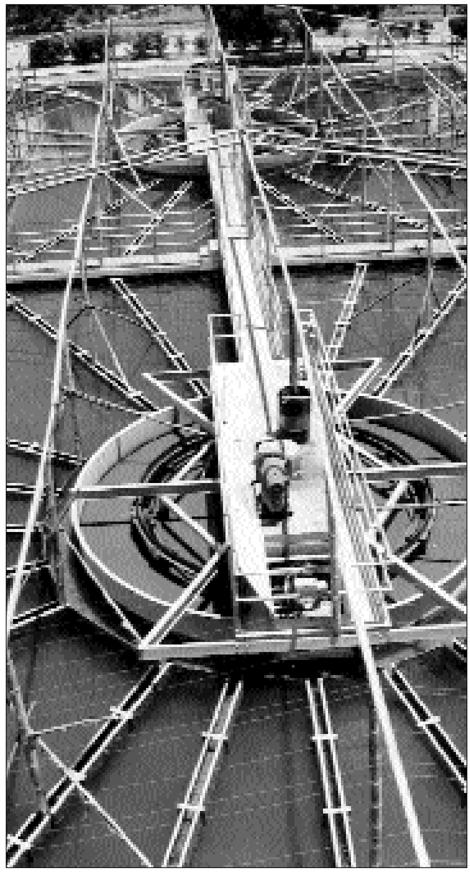
Structure of the Unit

The Emergency and Disaster Unit—or whichever other organizational component is entrusted with the same functions—should comprise a coordinator who is assisted by professionals in operations, maintenance, planning, and engineering, as well as any others who may be needed. The office will work as a technical committee entrusted with specific goals, employing whatever existing technology may be required (such as geographic information systems or GIS). It should be provided with the necessary budget to outsource any specific studies that the company or agency cannot carry out on its own due to lack of specialized personnel. Such studies may include hydrogeology, structural, or soil assessments.

This unit should also be able to requisition technicians and professionals on a part-time basis to engage in specific tasks such as the vulnerability analysis of a treatment plant. This would also require the collaboration of the head of the plant and other professionals.

Functions and Responsibilities

The chief responsibility of the unit must be the formulation, evaluation, control and monitoring of the Emergency and Disaster Prevention and Response Program. To fulfill this mission, the unit must procure vulnerability analyses of each of the components of the company's water supply and sewerage systems, follow up on the design of the operational plans, and carry out periodic evaluations to ensure that the plans remain up to date. In order to perform this work, it is essential for the unit to remain in direct and close contact with the Emergency Operations Committees.



As an emergency measure during the eruption of the Pichincha volcano in Ecuador, in 1999, temporary coverings were installed to protect the water treatment plant from ashfall.

C. Osorio, 1999

Depending on the size and characteristics of the company, this office may transfer some of its responsibilities to the various Emergency Operations Committees.

The following are some of its main functions:

- Coordinate vulnerability analysis of the water supply and sewerage systems with the Emergency Operations Committee or Committees;
- Coordinate specialized vulnerability assessments with private or academic consultants;
- Assess the training needs of all staff regarding emergencies and disasters, including the type and level of training required by the various departments and employees;
- Promote, together with the company's training unit, the training required in the various relevant fields;
- Coordinate training activities with government agencies and universities;
- Review and periodically update the Emergency Plan;

- Ensure that all relevant information has been collected, including personnel and logistical data, plans and diagrams, descriptions of the systems, etc., required for vulnerability analyses and emergency plans;
- Oversee and assess the process for documenting emergencies so that the Emergency Plan remains up to date;
- Gather and document the lessons learned from various emergencies and disasters;
- Represent the company when dealing with civil defense or national emergency agencies.

The role of this unit is crucial when it comes to personnel training, an essential requirement when dealing with emergency situations. One of the key points is to disseminate relevant information to all employees and produce, in cooperation with the company's training unit, a structured training program involving different subjects and levels of detail to meet the needs of the various professionals and technicians who work for the firm. This training program must be carefully aligned with the objectives not only of the Central Emergency Committee but of the company or agency as a whole, so that it is not perceived as extraneous to the firm's core activities.

It is advisable to call upon members of civil defense agencies and universities to assist in training, particularly when it comes to specialized aspects.

A key component of the training must be emergency drills and simulations, which make it possible to assess the teamwork involved, especially decision making in high-pressure situations. Drills and simulations are generally carried out in the field and should cover the full range of potential scenarios, based on the existing hazards, so that the reactions by the staff, especially in terms of decision making, can be evaluated and serve as inputs to further refine the Emergency Plan.

The Emergency Operations Committee

The Emergency Operations Committee, which plays an executive and operational role in disasters and major emergencies, is subordinate to the Central Emergency Committee through the company's Emergency and Disaster Unit or, should one not exist, the Operations Unit.

Depending on the characteristics and complexity of the system or company, several Emergency Operations Committees may be needed: for example, one for the water supply system and another for the sewerage system, or even one for each of the major components of the system. For instance, within the drinking water supply system, one committee might be in charge of production and another one in charge of distribution, their functions differing in terms of the components involved, but complementary in terms of the benefits to the entire system.

The implementation of Emergency Operations and response plans will be in the hands of these Emergency Operations Committees, which should also participate actively alongside the company's Emergency and Disaster Unit in designing the Emergency and Disaster Prevention and Response Program.

Delegation of authority to the various Emergency Operations Committees during a disaster or major emergency is essential for their success.

Structure

The structure of the Emergency Operations Committees will vary depending on the characteristics of the firm, as already noted. In any case, they must include a top-level technical and operational authority as well as representatives from production areas (treatment plant and transmission lines), operational control, engineering and electromechanical maintenance, and administration and logistics.

Functions and Responsibilities

The main objective of the Emergency Operations Committees is to prepare Emergency Operations Plans to confront an emergency situation and carry out the rehabilitation of the services, as well as to cooperate in the execution of the vulnerability analyses and the prevention and mitigation programs.

Other functions it might assume include the following:

- Designing the Emergency Operations Plans;
- Keeping the Emergency Operations Plans up to date;
- Coordinating and guiding emergency preparedness, response and rehabilitation efforts in their respective fields of action, as well as other functions designated by the Central Emergency Committee;
- Participating in post-disaster reconstruction to ensure that the system's vulnerability is reduced;
- Designing or carrying out, with the support of the Emergency and Disaster Unit or Office, the vulnerability analyses and water supply and sewerage mitigation programs;
- Participating in the development of the company's Emergency Plan and helping to ensure that it remain up to date.

The Situation Room

In order to respond in a coordinated fashion to an emergency or disaster, there must be a physical space available that is secure and contains all the resources needed to function optimally during the most critical moments. Such a space is generally known as the "situation room."

This room is the meeting place of the Emergency Committee and all other key personnel. It is from there that all decisions will be made in response to an emergency. Control of the situation room will be entrusted to the highest ranking member of the agency or company until the person who chairs the Central Emergency Committee arrives.

One option is for the situation room to be located where the systems control center is in normal situations, taking advantage of the telecommunications and control infrastructure if such is available.

Depending on the characteristics of the agency or company, the situation room may play a national role and be supported by additional situation rooms in each of the regions in which the company or agency operates, or else by situation rooms for each of the systems into which the company is divided. What is outlined here applies to each of these situation rooms.

It is important that the location of the situation room be chosen strategically to allow for easy access and good communications. Above all, it is essential that

Costa Rica's National Risk Prevention and Emergency Response Commission (CNE).

R. Madrigal, 2000

the situation room not be affected in any way by the adverse event. It should be located next to the company's communications center and be permanently equipped with the following items:

- A list of telephone and fax numbers of the company's main officials as well as of key outside contacts;
- A connection to an electrical generator;
- Radio transmission equipment with the necessary communications protocols and power source;
- Radio and television receivers;
- Telephone and fax equipment;
- An Internet connection;
- Copies of the Emergency Plan and annexes;

- Technical specifications and plans of the system;
- Operations control panel or operational information system;
- Desks and meeting-room tables;
- Computer equipment and office equipment and supplies;
- Food and drink;
- Set of keys to all vehicles and infrastructure;
- Basic tools;
- General information, maps and plans of shelters, hospitals, health centers and other strategic facilities in the country.

It is advisable for the Emergency Plan to identify two alternative situation rooms, properly supplied as indicated above. These alternative rooms may be located in production facilities such as treatment plants.

Declaring States of Alert or Emergency

Alerts may be issued by the company or by a governmental agency at the national or provincial level.

A state of alert covers the period between the moment an alert is issued and the mobilization of resources begins, and the moment of impact. In these situations it is prudent to establish two or three levels of alert, depending on the proximity and likelihood of impact. It is also advisable for colors to be assigned to each level of alert. In order to prevent confusion with the states of alert issued by civil defense or national emergency authorities, however, it may be better to employ other systems of classification.

As an example, Table 4 shows the hydrometeorological hazard alert system employed by Costa Rica's National Risk Prevention and Emergency Response Commission (CNE). Boxes 1 and 2 illustrate the phases of alert planned by water supply and sewerage companies in Latin America for response to earthquakes and heavy rainfall.

Safe drinking water in shelters, Hurricane Mitch, Honduras, 1998.

C. Osorio, 1998

Box 1. Declarations of State of Alert and State of Emergency Employed by a Latin American Water Supply and Sewerage Company in Response to Earthquakes

EARTHQUAKES

Declaration of a State of Alert

When a seismic event occurs surpassing level V in the Modified Mercalli Scale, a seismic alert is issued immediately to all members of the Crisis Committee and the Emergency Operations Committees. One explicit indication of an earthquake of such intensity is the interruption of the power supply.

Declaration of a State of Emergency

Its objective is to activate the organization, coordination and resource allocation mechanisms included in the Emergency Plan by declaring an internal state of emergency.

First phase: The deputy managers of the various geographical areas serviced provide information on the condition of the system components compiled during the preliminary damage assessment. It is to be presented to the Emergency Committee no later than 12 hours after the event. During the Emergency Committee meeting, a state of emergency may be declared within the company, part of it, or one of its systems, if the level of damage is catastrophic. The decision to declare a state of emergency is the responsibility of the Chair of the Committee, as stipulated in the Chair's functions and responsibilities contained in the Emergency Plan. If the general state of the components is not catastrophic after the preliminary assessment, a more detailed assessment will be carried out to review the situation, as described in the second phase.

Second phase: Area deputy managers are convened to report to the Emergency Committee on the information compiled during the detailed damage assessment, which should be completed no later than two days after the event. The meeting will be convened on the third day after the impact of the catastrophic event, and its members will discuss whether to declare a state of emergency for the company, and whether it should be company-wide or only apply to some of its parts or systems. The Chair of the Committee will decide whether to declare a state of emergency.

Depending on the impact of the adverse event, whether sudden onset (earthquakes, floods down slopes, volcanic eruptions or certain types of landslides) or gradual onset (drought, flatland floods, environmental degradation, or certain types of landslides), different states of alert may arise. The Emergency Plan must specify in various protocols how to handle each of these types of emergencies. The protocols must be approved by the Board of Directors of the company and be widely known by the company staff.

States of emergency declared outside of the country (e.g., by the civil defense, National Emergency Committee, state or municipal governments) should immediately activate the Central Emergency Committee. Such external declarations need not coincide with the company's internal declarations of states of emergency, or vice versa.

In the event of sudden-onset emergencies or disasters, the Emergency Plan should be activated immediately, and it should stipulate clearly what procedures to apply. In the case of gradual onset emergencies, states of alert of different levels may be declared in order to take preventive measures and mitigate the potential effect of the phenomenon in question, such as preventive maintenance actions, specific training and drills, guidelines issued to the company's customers, or the signing of agreements not previously arranged with other institutions.

Box 2. Declaration of State of Alert and State of Emergency Employed by a Latin American Water Supply and Sewerage Company in Response to Heavy Rainfall

HEAVY RAINFALL

Each area deputy manager's office must obtain and analyze meteorological forecast information that makes it possible to identify the likely or potential effects of unusually heavy precipitation levels. It should also produce a report indicating the likely damage scenario and the works needed to mitigate it. The report should be submitted to the Engineering and Planning Manager's Office. For the winter season, forecasts should be submitted by 30 April. Estimates of water volume resulting from snow thaw should be submitted before 1 December.

Declaration of a State of Alert

Based on the forecasts contained in these reports, the Engineering and Planning Manager will declare a state of alert for any given water supply or sewerage system, or all of them. Measures will also be taken to reduce the impact of extreme precipitation by carrying out some or all of the works contemplated in the Plan.

Declaration of a State of Emergency

To the extent that the system components are damaged due to floods, power outages, blocked roads, or major leaks, the production and network supervisors must inform the Engineering and Planning Manager, who, based on the information received, may convene the Emergency Committee. At the meeting, the decision may be taken to declare a state of emergency and to take all the measures planned for such a situation, such as contracting personnel and services, or the acquisition of required materials.

The state of emergency is that which follows the actual impact of the disaster or emergency. It should be declared when the event is imminent or, in the case of sudden catastrophes, as soon as it has occurred.

The declaration of the state of emergency requires that the members of the Central Emergency Committee meet immediately, and activate all legal, administrative, logistical and operational measures stipulated in the various procedures and protocols agreed upon beforehand.

Table 4. Hydrometeorological hazard alert system –CNE

ALERT	DESCRIPTION	ACTIONS	RESPONSIBLE INSTITUTIONS
GREEN	Inform	Inform CNE's Chairman and Board of Directors, Regional Emergency Committees (CREs), Local Emergency Committees (CLEs), other institutions and the media	National Meteorological Institute Risk Management Directorate
YELLOW	Prepare for: Indirect Effects	Inform CNE's Chairman and Board of Directors Activate CREs and CLEs Manage public information Verify supplies at central level, CRE level, CLE level Contact suppliers Arrange transportation Convene situation room personnel Activate additional resources of the Information and Analysis Center (CIA) and the Emergency Information System (SIE) Mobilize CNE personnel, based on priorities, to headquarters and the affected area Establish communication points for CLEs	National Meteorological Institute Risk Management Directorate Executive Directorate
	Direct Effects	Inform CNE's Chairman and Board of Directors Activate the Public Emergency Information System (SIPE)/ SIE Prepare supplies Activate security and traffic procedures Open temporary shelters Declare Emergency Operations Center (COE) in permanent session Mobilize CNE personnel to the affected area	
RED	Evacuate Indirect Effects	SIPE activated CIA activated CREs and CLEs proceed to carry out preventive evacuation of high-risk areas Temporary shelters open Resources mobilized Damage and needs assessment	National Meteorological Institute Risk Management Directorate Executive Directorate Board of Directors President of the Republic
	Direct Effects	Massive evacuation SIPE, COE, SIE, CIA activated Security operations underway Temporary shelters open Resources mobilized Damage and needs assessment Rehabilitation of lifelines and key infrastructure	

Emergency Operations Plans

The purpose of Emergency Operations Plans is to foresee, in as much detail as possible, all activities that must be carried out by each of the company departments and employees immediately after a disaster has struck in order to rehabilitate water supply and sewerage systems in the shortest time possible and provide the affected population with clean, safe water. Box 3 outlines basic principles of these plans.

Emergency Operations Plans, which, as already noted, form part of the Emergency and Disaster Prevention and Response Program, play an administrative role in the technical and operational area, since they specify which actions each employee must carry out. Having such plans is critical when the effects of a disaster or major emergency could lead to widespread confusion or when, as a result of the emergency, not all required personnel are available.

Bearing in mind the various components of the company and the existing units for system operation and maintenance, Emergency Operations Plans must be tailored to specific hazards prevalent in the area. Thus, the unit in charge of water diversion and treatment (production) should have Emergency Operations Plans for earthquakes, volcanic eruptions, drought, floods and other potential hazards in its area of coverage. The same is true of the units in charge of maintaining the electromechanical equipment, drinking water distribution networks, waste water collection systems, and so on.

These Emergency Operations Plans have two well-defined features: the first, the type of hazard it is meant to respond to; the second, the type of work that needs to be carried out to rehabilitate those components that have been compromised as a result of a disaster.

For instance, if a landslide has affected the drinking water supply by causing leaks in the distribution network, two kinds of action must be taken: one involving operations, the other involving maintenance. In order to prevent loss of water through leaks in sections damaged by the landslide, the company's operational personnel must take specific actions such as closing check valves to cut off the water supply to the affected areas while ensuring that most of the customers in other areas continue to receive services. Meanwhile, the maintenance staff must carry out a prompt inspection and repair the affected sectors in order to rehabilitate the system in the shortest time possible. Necessary security measures are necessary to protect the staff members involved in the repairs.

Given the two main features discussed above, the design of the Emergency Operations Plan should include pre-disaster actions, including possible simulations.

The plans must contain clear and precise instructions for responding to each of the situations that may arise in a given emergency, based on the vulnerability studies. Each of the hazards analyzed must have its own set of instructions, contained in individual manuals.

One such manual, for example, may cover the actions should an earthquake affect a given component, such as shutting the exit valves of storage tanks. The manual would describe which tanks should be shut down, by name and location, which valves must be shut, and what their number and location is. If necessary, a map or diagram should be included to help with the location of the valves.

Box 3. Basic principles of the Emergency Operations Plan

- The Emergency Operations Plan should not be a plan to develop a plan. It must be the plan itself.
- The Plan should not be an organizational guidance project that merely lists functions and responsibilities. It must describe the objectives and methods for using resources to achieve these objectives.
- The Plan must specify who will do what, where, and when, based on the existing resources and organizational structure.
- The Plan must be dynamic. It should be updated whenever there is a change in resources, personnel training, or the vulnerability of the system.
- The Plan must be clear, concise, and complete. Emergency operations should not be described in excessive detail. Rather, the Plan should be a guide to action that specifies certain key details.
- The Plan must be designed with the participation of those employees of the various operational areas who have hands-on experience and knowledge of the system. Such staff might include operators of treatment plants and pumping stations, water quality technicians, network maintenance staff, and other operational control personnel.
- The Plan must be widely disseminated and known by the staff.
- The Plan must be complemented with instructions on the most relevant actions in case of an adverse event.

The Development of an Emergency Operations Plan

- The main attribute of an Emergency Operations Plan is that it provides the mechanisms needed to facilitate effective and swift decision-making.
- The Plan should include objectives, strategies, and actions required to confront emergency situations.

- The Plan is activated immediately after the declaration of a state of alert or emergency, as the case may be.

To illustrate the three points highlighted above, consider the impacts of a flood that reduces the quality of the water supply. Assuming that the objective of the company is to provide drinking water, the correct strategy would be to suspend the inflow of water of poor quality into the storage tanks. Measures would be taken to ration the water already in the tanks so that there is enough at least for basic human consumption until the quality of the incoming water makes it possible to return to normal distribution.

This procedure, which is part of the company's decision-making process and takes into account technical criteria and existing restrictions, must be presented in the Emergency Operations Plan in a clear, precise manner.

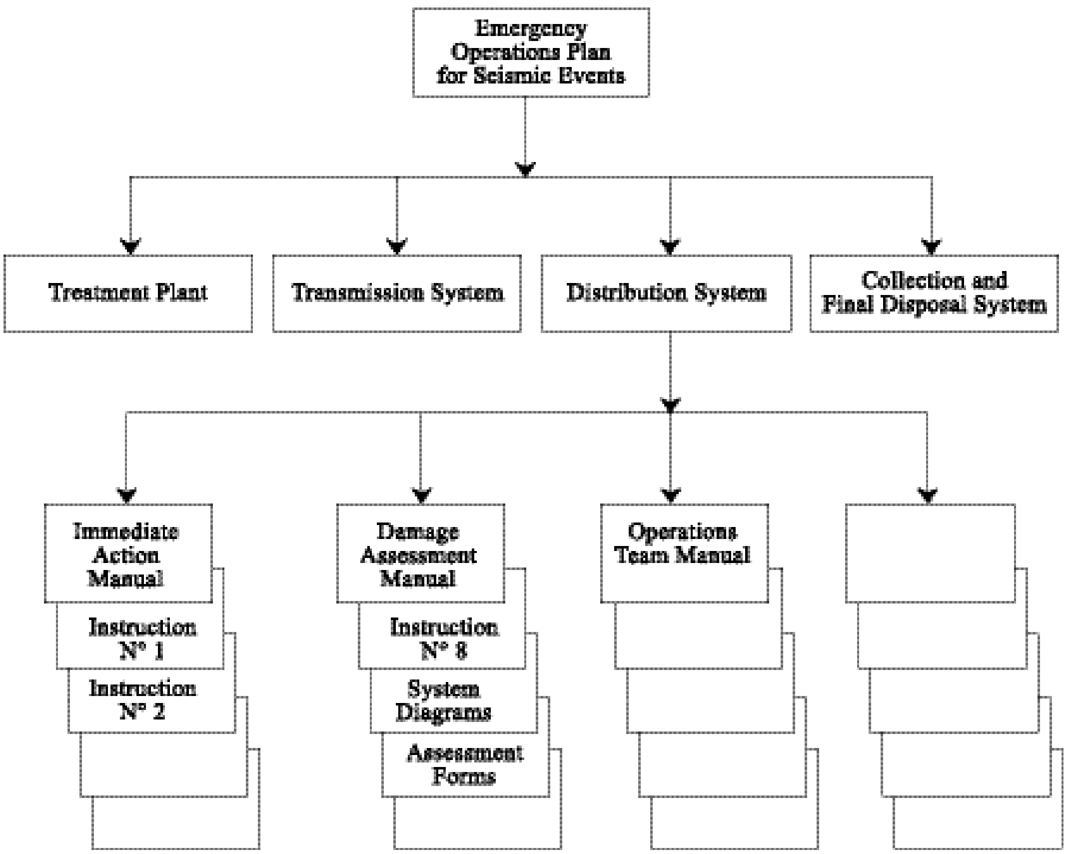
When the time comes to design the Emergency Operations Plan, a key input will be the technical procedures manual for the operation and maintenance of the company's drinking water and sewerage systems. If such a manual is not available, the task of developing an Emergency Operations Plan will be a great deal more difficult.

Instructions for Emergency and Disaster Situations

The Emergency Operations Plan contains a series of instructions that each staff member or company unit must carry out in the face of a potential adverse event, including the assessment of the current condition of the company's systems. It presupposes the participation of employees with a great deal of knowledge and experience in the management of the systems.

Table 5 shows the structure of the Emergency Operations Plan. Two examples of instructions in the event of an earthquake follow (Tables 6 and 7).

**Table 5. Structure of the
Emergency Operations Plan in the Event of an Earthquake.**[8]



[8] Pan American Health Organization, *Planificación para atender situaciones de emergencia en sistemas de agua potable y alcantarillado. Cuaderno Técnico N°37* (Washington, D.C.: PAHO ,1993).

Table 6. Activation of the Emergency Operations Committee—Operating Instructions[9]

Purpose: Activation of the Emergency Operations Committee

Event:	Earthquake
Action:	Immediate actions
Activity:	Activation of the Emergency Operations Committee
Responsible unit:	Emergency Operations Committee

During Working Hours:

Activate the Emergency Operations Committee and all its regular or alternate members, who should gather in the situation room.

The members of the Emergency Operations Committee comprise the following officials:

- Highest technical and operational authority;
- Representatives from production, operational control, engineering and electromechanical maintenance, administration, and logistics.

An up-to-date list of all members, their positions, addresses and telephone numbers should be available.

Should some of the members be away from the workplace, they must get in touch with the situation room and indicate their location and possibility of returning to the workplace.

Outside of Working Hours:

Should there be an official in charge at the time of the earthquake, he or she must remain in the situation room and take charge of all immediate actions needed until a higher-level member of the Committee arrives.

The other Committee members must arrive as quickly as possible at the situation room. In the event of any delay, they must call the situation room as soon as possible.

General Considerations

Once all or some of the Emergency Operations Committee members have gathered in the situation room, they will assume full command over all emergency operations and proceed to carry out Instruction 2: Organization of the Emergency Response Teams.

Moreover, the Chair of the Emergency Operations Committee, or whoever is acting as his or her substitute, should contact the Central Emergency Committee and establish ongoing communications as indicated in Instruction 4, Communications.

Situation Room

Complete address, telephone numbers, radio frequency and code.

[9] Ibid.

Table 7. Instructions for Convening Emergency Response Teams – Operating Instructions

Purpose: Activation of the Emergency Response Teams

Event:	Earthquake
Action:	Immediate actions
Activity:	Activate the Emergency Response Teams, allocate resources and working areas
In command:	Head of Operations and Maintenance (Name)

Guidelines:
The activation of the Emergency Response Teams occurs much as in a normal situation, except for the Damage Assessment and Quality Control Teams, which must comprise staff specifically trained for these purposes.

1. The basic teams that will act within the jurisdiction of the distribution unit in charge of the system will be the following:
   - Damage Assessment Team (name of the team, members, and shifts);
   - Operations and Distribution Team (name of the team, members, and shifts);
   - Water Quality Control Team (name of the team, members, and shifts).

If the jurisdiction is large and ordinary operations and maintenance tasks have been divided into sectors, this arrangement should continue as long as the existing and available resources allow it. These sectors apply to the Distribution and Rehabilitation Teams. Damage Assessment and Quality Control Teams will act according to their own program functions, which are outlined in the corresponding instruction manual.

2. Next, the boundaries and the zones or units that make up the sectors must be described. These sectors must be represented on the Emergency Operations Committee.

3. The structure of the Emergency Response Teams must be described succinctly, based on the activities each is meant to carry out, taking into account the following:
   - Activity to be carried out;
   - Minimum staff required;
   - Tools for carrying out the activities (including the relevant manuals, which will guide the teams' actions).

The following are some aspects that must be taken into account when preparing the emergency instructions of some of the key departments of the company involved in emergency and disaster response, as well as other aspects that must be a part of the Emergency Operations Plans.

• *Finance*

The finance department must carry out several activities in preparation for emergency situations, and others following the impact of a disaster.

Before the disaster or emergency, normal procedures must be reviewed so that, while guaranteeing their correct use, available funds can be mobilized quickly and effectively for the procurement of supplies and payment for services during the emergency. For example, if there is rule that all acquisitions above a certain amount require three different quotes from suppliers, it should be stipulated that in an emergency situation supplies or services can be purchased directly. In short, it is advisable to have a protocol regarding the declaration of states of alert or emergency that can activate financial procedures for exceptional cases.

Immediately after the event, it is important to make the necessary resources available for procurement, feeding the staff, contracting equipment and machinery, etc., while carefully monitoring the use of the funds.

Depending on the location of the emergency and the prevailing conditions, it may be necessary for financial staff to travel to the affected areas in order to provide support in the application of budgetary controls and other functions.

• *Supplies and Services*

In the supplies and services area, there should be early identification of resources (both internal and external to the firm) that may be needed in an emergency situation, such as staff, equipment, or machinery. In emergencies, outsourcing and acquisitions must be expedited, as well as the loan of materials and resources by other companies. A common example is the need for water trucks, which may be loaned by another water supply company or hired from private firms such as breweries or dairies, preferably having negotiated in advance the fees that will be charged.

As in the case of the financial unit, it is necessary for units responsible for procuring supplies and services to review standard procedures in view of current vulnerabilities and the potential impact of emergencies and disasters on the system, so that the actions required during an emergency can be carried out with maximum efficiency.

A truck is adapted to distribute water tanks because of a shortage of water trucks in El Salvador.

R. Saenz El Salvador, 2001

Units responsible for procuring supplies and services should provide support to the operational area by establishing agreements or contracts with private companies that can provide the necessary services, such as construction companies or engineering consultants. An updated list of suppliers and contracts or agreements signed specifically for emergency response will help expedite solutions to the many problems caused by an emergency.

Similarly, an inventory of available in-house and external vehicles and machinery must be completed so that in a crisis situation they can quickly be mobilized.

It is advisable for the Emergency Operations Plan to include measures to be taken should an emergency arise outside the normal staff working hours so that resources in storage areas and at other sites can be mobilized promptly.

• *Communications*

Communications are crucial in emergency and disaster situations. It is advisable to deal separately with internal and external communications. In both cases, it is important to define the communication flows and priority levels of communication to discourage interference and imprecise, inaccurate communications.

Damage to a water company's storage facility in Tegucigalpa, Honduras, following Hurricane Mitch.

SANAA -Honduras, 1998

As noted in the section on the establishment of the Emergency Operations Committee, it is advisable for an official from the public relations department of the company or agency to be a member, so as to assist in all matters related to the communications strategy, including internal messages and contacts with the mass media.

Internal Communications

The company's internal communications respond to various needs. Hence it is necessary to identify the proper communication channels and select the most opportune times to disseminate the required information.

As the Emergency Operations Plan is developed, along with the vulnerability analyses and prevention and mitigation programs, pertinent information about these activities should be provided to the staff. It is useful to employ the communication mechanisms already in place within the company, such as newsletters, technical publications, internal memos, meetings of heads of departments, and staff meetings of the various departments or plants.

Once the Emergency Operations Plan is available, it must be made widely known to all the staff, including evacuation plans and recommendations from the occupational health unit (regarding risks of accidents, vaccination needs, etc.). The resources of the training unit can play a role in these dissemination activities.

The Emergency Operations Plan must include all the information that may be required in an emergency, such as a list of key officials, their addresses, telephone numbers, and so on, since they will have to be contacted urgently and informed of the state of alert. During the impact, in addition to the predefined procedures for internal and external communications, the situation room must be able to gather all the information needed for decision-making.

External Communications

With external communications, as with internal communications, the target audiences must be clearly identified. These will include the company's suppliers, government authorities, other companies providing the same or similar services (e.g., other utilities), the media, users of the services, and the general public.

Depending on the situation, after a disaster has struck it may be necessary to report which locations will have access to the company's services, on what days and at what time. To disseminate these messages, a variety of channels and techniques may be used, such as mass media (radio, television, newspapers), megaphone vans, religious services, or community message boards.

The public relations representative is the official who, in coordination with the chair of the Central Emergency Committee and members of the company's directorate, will issue statements to the press, so that the information provided is accurate. Authorized and well-informed spokespeople, supported by the inputs of technicians and specialists, are crucial to ensuring that the information provided is clear and effective.

In such situations, radio, television, and print media are among the best ways to disseminate information, whether through paid announcements or press conferences.

It may happen that a disaster does not affect the water supply and sewerage systems. However, the company or agency is not isolated from its environment, and damages to other companies or sectors, such as power utilities or the road system, may in turn affect the operations of the water supply and sewerage systems. Open communications with other entities is therefore essential.

• *Coordination Between Sectors*

In a disaster, the degree to which the water supply and sewerage company or agency can coordinate its efforts with other sectors is crucial, both before and in the aftermath of the event. It is highly advisable for such coordination to be structured in advance, since this will greatly facilitate matters in a state of alert or emergency.

Coordination procedures may be within the sector or between different sectors. In the former case, they apply to suppliers, subcontractors, other companies providing sanitation services, and communities. Coordination with other sectors implies activities targeting the ministries of health, of public works and transportation, of energy and the environment, as well as civil defense and national emergency commissions, the armed forces, the police, municipal governments, hospitals, organized community groups, and other key institutions.

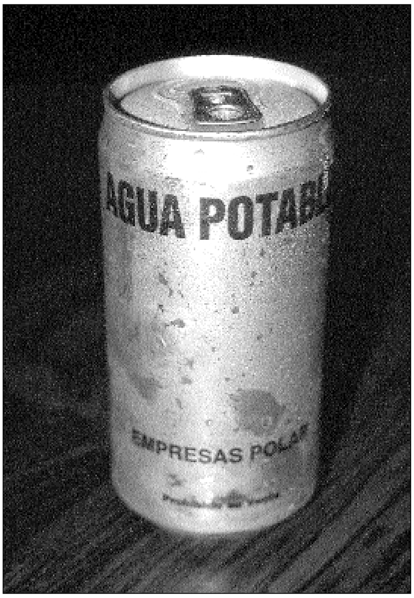
For coordination to be effective, a work plan must be in place. The first step is to identify the likely needs of the water supply and sewerage company or agency, as well as the needs of other facilities dependent on water supply and sewerage systems, such as hospitals, shelters, or firefighter units. Exchange of information among these entities is needed. For instance, the power utility should guarantee that it will assign a high priority to the power lines that feed pumping stations and treatment plants. Similarly, drinking water distribution areas must be identified and prioritized, so that hospitals, health centers, shelters and prisons are guaranteed an adequate supply of water.

Finally, the procedures for carrying out coordination activities must be agreed upon, preferably in protocols regarding each likely scenario. One of the aspects to bear in mind is land-use management, since water supply and sewerage systems must often service highly vulnerable areas.

• *Community Participation*

Community participation within the Emergency Operations Plan involves several aspects, including:

- Community cooperation in response activities and rehabilitation of the water supply and sewerage services, given their own interest in these services, particularly in the case of rural water supply and sewerage systems;
- The role of the community through its representatives in municipal governments and civil society organizations;
- The organization of the community for the distribution of drinking water during the emergency.



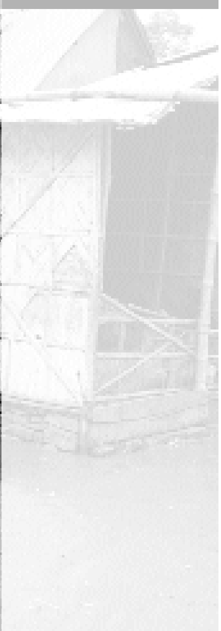
A private company cooperated in the distribution of drinking water following devastating landslides in Venezuela in 1999.

C. Osorio, 1999

The community, as the primary users of water supply and sewerage systems, must also be involved in training efforts and be adequately informed of what to do when emergencies and disasters disrupt normal services.

During an emergency, it is frequently necessary to rely on the help of members of the community, whether individually or as part of an organization. For instance, they can help locate new water sources, manage some of the water distribution points, or distribute chlorine for disinfection of drinking water.

Each region has its own characteristics. It is therefore wise to analyze the local culture and incorporate, in the development of the emergency plans, the most active community groups. Just as agreements can be reached in advance with the private sector, agreements should be made with community groups. The community should be trained so that its organizations can contribute to prevention and response efforts.



Chapter 3

Damage Assessment and Needs Analysis

After a disaster has struck water supply and sewerage systems, damage assessment is of the greatest importance in obtaining a rapid diagnosis of the remaining functions and operational capacity of the systems, the damage suffered, its causes and required repairs and rehabilitation. Such an assessment will obviously help to locate and quantify the needs that must be met in order to re-establish key services, and to estimate the time needed until they can be back in operation. While the services are being restored, other measures must be taken to distribute water essential for human consumption. Moreover, the resources needed to rehabilitate the affected components and the service must be estimated so they can be allocated as quickly as possible.

Damage assessment, in short, involves the identification and qualitative and quantitative examination of the effects of the event on the affected systems.

Types of Assessment

Bearing in mind what has been said in previous chapters, two kinds of damage assessment can be performed after a disaster has struck. The first is the preliminary damage assessment, providing the most essential information no later than eight hours after the impact. The second, or general damage assessment, provides a greater degree of detail. Finally, there are specific assessments.

Preliminary Assessments

The preliminary assessment must be carried out by operations employees who are well acquainted with the systems. It will be based on the relevant assessment manual included in the Emergency Operations Plans. These manuals are meant to help focus the inspectors' attention on the most relevant aspects of the emergency, and including all affected components. The manuals also help to organize the information by quantifying the damage. In order to gather the largest amount of data in the shortest time possible, it is customary for the operations staff to divide into teams, each of which focuses on a given component or set of components, collects the information, and transmits it to the situation room, either personally or by radio, telephone, fax, or some other medium.

This preliminary assessment is meant to gather the basic information needed by decision-makers to assign priorities based on the resources available in the region and to plan the actions that can restore water supply services to the largest number of users in the shortest time possible.

Assuming that vulnerability analyses were completed prior to a disaster, the damage assessment can focus first of all on those components that were previously identified as representing the greatest risk for the system.

General Assessments

The second, or general, assessment, provides a more detailed account of the damage suffered by the systems, and it must be completed no later than 72 hours after the onset of the disaster. On the one hand, this assessment helps to make the necessary adjustments to the actions initially undertaken; on the other, it makes it possible to identify those needs that cannot be met by the company's own resources. Unlike the preliminary assessment, the general assessment is usually carried out by a team of specialists which may include external consultants.

Specific Assessments

There is an additional type of assessment, known as the specific assessment, which is undertaken in those cases where the initial assessors have identified situations that must be evaluated by specialists. An example would be the need to carry out a structural analysis of a treatment plant or a dam.

The specific assessment also includes those evaluations made by experts who are participating representatives of the national government or international agencies.

The instruction manuals included in the Emergency Operations Plans must specify how soon the various types of assessments are needed. Should the Plans not be ready at the time of the emergency, the highest ranking authority in the situation room must make this determination.

Techniques for Data Gathering

Information Gathering

- ***On-the-Ground Assessments***

  Information gathering through on-the-ground assessments is normally carried out—if conditions allow—by staff members who know the affected system and are in its vicinity at the time of impact. This is probably the best way to collect information since the system can be assessed stage by stage, determining at each stage the condition of its components. As noted earlier, attention must be paid to the difficulty of access to each of the key points and the time required to reach them.

  Bearing in mind the area covered by the system and the difficulty of access to affected components, this type of assessment should give priority to the inspection of those components previously identified as high-risk. After verifying that personnel are available to carry out the inspection, they must be provided with a checklist to rapidly identify the various types of damage.

If, after disaster has struck, not enough employees are available to carry out all the inspections needed, priorities must be assigned based on experience and the characteristics of the event. For instance, if the volume and quality of the water flowing into the treatment plants has not varied significantly—bearing in mind the time it takes for the water to travel from its source to the plant—assessment of these components may be postponed until later, mobilizing the staff instead to sites that have suffered greater damage.

This does not preclude the need for examination of the entire system. For instance, the conditions of water catchment areas may be affected hours or days after the initial impact, and this must be monitored.

- ***Reconnaissance Flights***

  The second way to gather information is through low-level reconnaissance flights. Flights are used when access by road to the relevant parts of the system is difficult or impossible. It is required above all when dealing with very large water catchment areas, since it makes it possible to identify not only the damage suffered but also potential damage as a result of unstable soil or the accumulation of dammed-up water. The likelihood of landslides or mudslides can affect not only the water supply system but also homes and infrastructure—above all, they can put human lives at risk.

- ***Interviews and Other Techniques***

  Interviews are seldom used in assessing damage to water supply and sewerage systems, but they can be helpful. They consist in talking to witnesses or victims of the emergency or disaster. Those interviewed can provide valuable information especially about areas that are not accessible and where there is likely damage to local water supply and sewerage systems.

Other sophisticated techniques include aerial photography, satellite imaging, and remote sensor systems. These can provide important information about the magnitude and extent of the damage and other changes wrought by the disaster.

Instruction Manuals and Assessment Forms

Instruction manuals for damage assessment are part of the Emergency Operations Plan. They must be prepared in advance and cover each of the potential hazards in the areas where water supply and sewerage systems are located.

The purpose of the instruction manuals is to ensure that each of the system components, particularly those that are most vulnerable, are inspected, paying special attention to the most vulnerable features.

For each component, the best format must be chosen for the orderly and comprehensive collection of information on the condition of the structures (for example, the specific types of damage, potential problems that may arise in the short term, performance, percentage of the systems or components that have been affected, or the remaining system capacity expressed in volume). As already noted, personnel carrying out the assessment must be familiar with the system components and with the assessment process.

The information collected in the field must be processed in a thorough and orderly way so as to assist the decision-making process. Table 8 presents a simple damage assessment form. Annex 2 includes forms from *Guidelines for Assisting Caribbean Governments in the Event of a Disaster* (PAHO/WHO and CPC, Barbados, 1999).

When thinking of wastewater and sewage systems, it is easy to underestimate the impact of the disaster, since much of the damage may be hidden in the course of the preliminary assessments, only becoming apparent once all the systems are working at full pressure.

Table 8.
Sample Form for Damage Assessment – Operations Manual

Event: Earthquake
Action: Immediate actions
Activity: Completion of the damage assessment form
In charge: Engineer or technician carrying out the assessment

Date: ..../.........../........... Time:............................ (1)

Damaged components: (2)..
....
Description of damage: (3)..
....
Location of the damaged component: (4): ....
....
Loss of water: (5)
Loss of flow or volume .... Unit of measure (m^3/s, l/s, other)...........
Considerable: ....
Medium:..
Little:..
Other (please specify):..
Potential danger (please specify): (6)..
....
Needs: (7) ....
....
Estimated time required for rehabilitation (in days): (8) ....
Recommendation: (9) Put out of service YES ( ) NO ( )
Comments (10)...
....
Completed by : ....

Table 8 (continued).
Instructions for Filling Out the Damage Assessment Form—
Operations Manual

(1) Write down the date and time the assessment was carried out.

(2) Identify and describe the damaged component.

(3) Briefly describe the damage to the component, whether direct or indirect.

(4) Specify the precise location of the component.

(5) Estimate, if possible, the lost flow (volume) of water.

(6) Specify if there is any danger of the component collapsing or causing further damage.

(7) Estimate the human, material, and logistical resources needed to repair the damaged component.

(8) Estimate (in days) the time required to rehabilitate the component.

(9) If the component should remain out of service, indicate the likely number of days; if not, specify the measures needed to keep it in operation.

(10) Write down any information not included in the rest of the form, such as the state of the access routes, alternative routes of access, etc.

Note: Please include any additional information required, or a sketch or diagram of the damage, on the reverse of this form.

Information Analysis

The first step in information analysis is to compare the information collected previously about the system with the information gathered from the field inspections, in order to define the situation of the affected area. The information collected on the impact of the event will assist in carrying out the needs assessment.

The damage assessment should not be seen as the final assessment. Changing circumstances and the actions undertaken will generate new situations, which will require follow-up. Those components identified as high-risk call for greater control and continuing surveillance.

After needs have been assessed, it is necessary to identify the locally available resources. If these are insufficient, additional resources must be allocated, whether at the regional, provincial, national, or international level.

Needs must be classified and ranked in order of priority. The following is a list of potential needs for water supply and sewerage system companies:

- Human resources (professionals, technicians, labor);
- Equipment for the system, such as pumps;
- Supplies for the treatment of drinking water;
- Construction teams needed to rehabilitate the services;
- Water trucks needed for water distribution;
- Tanks needed for distribution points (hospitals, shelters, etc.);
- Pipes for urgent repairs and special accessories;
- Vector control;
- Excreta and waste management;
- Latrines;
- Provision of drinking water (in bags, plastic containers, etc.);
- Communication systems.

If the assessments have taken into account, in a clear and orderly fashion, both immediate needs and those related to the rehabilitation phase, it will be possible to set priorities when organizing urgent external aid, whether provincial, national or international.

In parallel, the impact must be quantified based on the losses reported. The impact may be subdivided into different kinds, such as damage to the water supply and sewerage system infrastructure, impact on the environment (preferably in terms of the time needed to reestablish certain environmental conditions such as recovery of the water catchment area), and socioeconomic impact as a result of the destabilization of organizational structures.

Decision-making

One of the first actions that company or agency employees should take is verifying that their loved ones are safe, the same as anyone else in similar circumstances. This should reassure the employees and allow them to carry out their tasks. In the case of staff in charge of damage and needs assessment who may have been personally affected by the disaster, it is essential for them to remain in control of their emotions and retain their objectivity in analyzing and observing the situation.

After the first damage assessment has been completed, and the preliminary needs assessment made, the decision making process should begin. The following aspects should be considered:

- The actual situation of the water supply and sewerage systems;
- The availability of local resources for emergency response;
- The need for support from other local companies and institutions;
- The identification of problems in the vicinity that may indirectly impact the systems;
- Priority problems to be addressed involving the service itself;
- The provision of drinking water in small quantities to the affected population in the first hours after the impact. If the water is unsafe, the population must be informed of this fact and of the measures they need to take;
- Verify the condition of the wastewater systems, ensuring that there is no contamination of water for human consumption by wastewater or sewage;
- The organization of work teams (professionals, technicians, and repair teams) so that excessive working hours and other stresses do not compromise the work required in the coming days and weeks;
- The design of the provisional or final works needed, paying special attention to disaster mitigation measures in order to prevent the same kind of damage from occurring in the future.

Producing Reports

All the activities carried out as outlined above must be recorded. It is recommended that a minimum of three reports be produced.

The first should be a preliminary report based on the information gathered in the eight hours immediately following the impact of the emergency or disaster. This report must be addressed to the company's highest authorities, who must in turn decide who else should receive the information and by which means it will be disseminated.

The second is a general report, identifying the needs involved in the first response to the emergency and the critical points of the system needing rehabilitation and reconstruction. It should be produced no later than 72 hours after the impact of the event.

The third report should be the final one. It must describe the response to the disaster, the damage and needs assessment. The contents of the previous reports should be included, reflecting the most up-to-date and precise knowledge of the situation. The experiences of the damage and needs assessment teams may be included if relevant. Finally, the report should contain recommendations to improve the Emergency Operations Plans and the performance of the Central Emergency Committee and the Emergency Operations Committees, including key measures to be implemented as part of the reconstruction effort.

This final report may also incorporate information presented in any of the specific assessment reports. They should be produced during the first eight days after the impact of the disaster, and will assist in the following:

- Making requests for cooperation and collaboration in the rehabilitation process;
- Carrying out a detailed analysis of the damage and the condition of the specific components or functions involved;
- Incorporating mitigation measures needed during the reconstruction process;
- Evaluating the Emergency Plan and the Emergency Operations Plans.

Annex 1

Impacts and Mitigation Measures

A. Impact Identification Matrix (Water Supply Systems)

Problems and damages	Heavy winds	Heavy rains	Landslides	Earthquakes	Volcanic eruptions Lava and ash	Tsunamis and floods	Manmade
1. Watersheds	Siltation; soil erosion	Uprooting of trees; soil erosion; loss of retention capacity	Uprooting of trees; loss of vegetation; loss of retention capacity	Landslides	Mud flows; fires; ash deposits; destruction of watershed; pollution of water resources; siltation	Saline intrusion and destruction of coastal zone watersheds	Deforestation; siltation; fires; pollution
2. Sources (general)	Power outages; blocked access	Power outages; blocked access	Power outages; blocked access	Power outages; blocked access	Power outages; blocked access	Power outages; blocked access	Power outages; blocked access; contamination
2.1 Springs	Physical damage from windblown debris and falling trees; blockage of screens	Physical damage from floating debris; erosion; blockage of screens	Burying of spring; physical damage to weirs, walls, pipelines	Change of aquifer; loss of source; disappearance of physical structure; cracked retaining box, wall or weir; dislocated pipe; blockage of filters by silt, debris	Change of aquifer; loss of source; physical damage by lava flow	Undermining of structure; physical damage to weirs and pipes by floating debris; blockage of filters by silt, debris, etc.	
2.2 River Intakes	Physical damage from windblown debris and falling/uprooted trees; blockage of screens	Physical damage from floating debris; blockage of screens; siltation and filling of reservoir	Redirection of river bed; flow alterations; burying of intake; physical damage to walls, weirs, screens, pipes	Structural damage to weir, filter box; side- or under-cutting by water flow; dislocated or broken outlet pipe(s); valve controls dislocated or misaligned	Physical damage from lava flow and falling rocks; filling with rocks and ashes	Undermining of structure; physical damage to weirs and pipes by floating debris; side scouring of banks; siltation	
2.3 Dams and Impoundments	Physical damage from windblown debris and falling/uprooted trees; blockage of screens; wave damage to embankment	Physical damage from windblown and floating debris; blockage of screens; siltation and filling of reservoir; overtopping	Loss of impoundment volume; burying of intake; physical damage to walls, weirs, screens, pipes	Structural damage to weir, filter box, side- or under-cutting by water flow; dislocated or broken outlet pipe(s); valve controls dislocated or misaligned	Physical damage by lava flow and falling rocks; filling with rocks and ashes	Undermining of structure; physical damage to weirs and pipes by floating debris; scouring of banks; overtopping by flood wave; siltation	
2.4 Groundwater well	Physical damage to above-ground structures and equipment from windblown debris and falling trees	Flooding of above-ground pumps, motors and electrical equipment	Burying of well; physical damage to pumps	Shearing of the casing; collapse of casing wall; loss of well	Physical damage by lava flow and falling rocks; collapse of cover by ash load	Flooding of above-ground pump, motors and electrical equipment	

A. Impact Identification Matrix (Water Supply Systems) (continued)

Problems and damages	Heavy winds	Heavy rains	Landslides	Earthquakes	Volcanic eruptions Lava and ash	Tsunamis and floods	Manmade
2.5 Infiltration gallery	Little impact	Little impact	Burying of gallery; physical damage	Physical damage to box/ retaining structure; dislocation of outlet pipes	Physical damage by lava flow and falling rocks	Undermining of structure; physical damage by floating debris to roughing filter and screens; side-scouring of banks; siltation	
3. Trunk (raw and treated)	Breakage of under-ground trunks by uprooting trees; breakage of exposed pipes by falling trees	Breakage and washing away of mains at river crossings and along river beds	Breaks and loss of mains; filling of mains with silt and soil	Breaks of mains	Break and loss of mains	Break and loss of mains	Puncture of mains; thieving of water; vandalism; damage during road excavations
4. Treatment plant	Collapse of structure; roof damage; blockage by debris; power outages	Under-scouring of foundations; collapse of structures; flooding of buildings; short-circuits in electrical systems; fire; power outage	Collapse and/or removal of structure; blockage by debris and mud; power outage	Structural damage; collapse of structures; short-circuiting; fires; water main breaks; water damage; power outage	Structural damage; collapse of structures; short-circuiting; fires; water main breaks; water damage; blockage by lava; power outage	Structural damage; collapse of structures; short-circuiting; fires; water main breaks; water damage; power outage.	Explosions; chlorine gas leaks; power outage
5. Pumping/booster station	Collapse of structure; roof damage; blockage by debris; power outage	Under-scouring of foundations; collapse of structures; flooding of buildings; short-circuits in electrical systems; fire; power outage	Collapse and/or removal of structure; blockage by debris and mud; power outage	Structural damage; collapse of structures; short circuiting; fires; water mains breaks; water damage; power outage	Structural damage; collapse of structures; short circuiting; fires; water mains breaks; water damage; blockage; power outage	Structural damage; collapse of structures; short circuiting; fires; water mains breaks; water damage; power outage	Power outage; explosions; chlorine gas leaks
6. Storage	Collapse of structure; roof damage; breakage of mains from debris	Under-scouring of foundations; collapse of structures; breakage of mains from debris.	Cracking; collapse and/or removal of structure	Structural damage; cracking and/or collapse of structure; breakage of mains	Structural damage; contamination of stored water	Structural damage; removal of structure; breakage of mains	Pollution
7. Distribution	Breakage of pipes by uprooting trees and falling utility poles	Breakage and washing away of pipes	Washing away of pipes	Breakage of pipes	Breakage of pipes	Pollution	Vandalism; accidental damage; pollution

B. Mitigation Identification Matrix (Water Supply Systems)

Problems and damages	Heavy winds	Heavy rains	Landslides	Earthquakes	Volcanic eruptions Lava and ash	Tsunamis and floods	Manmade
1. Watersheds	Prevent deforestation; carry out reforestation	Prevent deforestation; carry out reforestation; contour plowing	Prevent deforestation; carry out reforestation	Prevent deforestation; carry out reforestation	Careful selection of resource watershed	Careful selection of resource watershed regarding flood zones	Prevent deforestation; carry out reforestation; install measures to control fires and pollution
2. Sources (general)	Standby generator; provide all-weather access roads (including for heavy equipment)	Standby generator; provide all-weather access roads, (including for heavy equipment)	Careful siting; prevention of deforestation; standby generator; all-weather access roads (including for heavy equipment)	Careful siting; standby generators	Careful siting	Careful siting; provide all-weather access roads (including for heavy equipment)	Careful siting; increased security
2.1 Springs	Keep site clear of loose debris; cover collection box and channels with protective slabs	Deeper foundations		Construct earthquake proof structures; use flexible joints	Decentralize sources	Deeper foundations	
2.2 River intakes	Install stop-logs upstream; install intake and sediment tank several feet upstream of weir and beside the main channel	Sheet piling under foundation; provide stop-logs; rock-fill river banks; construct rubble masonry wall		Construct earthquake proof structures;use sheet piling; extend wing walls; use flexible joints	Decentralize sources	Sheet piling under foundation; provide stop-logs; rock-fill river banks; construct rubble masonry wall	
2.3 Dams and impoundments	Remove trees from embankment; construct wave-protected embankments	Install stop-log (boom); install airjet cleaner behind screens; provide parapet wall	Careful siting; prevention of deforestation	Construct earthquake proof structures; use sheet piling; extend wing walls; use flexible joints; develop sloping banks below and above water line; provide parapet wall	Decentralize sources	Construct grout curtain; earth-fill corners; provide stop-logs; rock-fill river banks; construct rubble masonry wall	
2.4 Groundwater well		Raise the pump house; install exterior flood wall or dike		Increase strength of casing by adding liner, if possible	Decentralize sources; know location of alternative well sites	Raise the pump house; install exterior flood wall or dike	

B. Mitigation Identification Matrix (Water Supply Systems) (continued)

Problems and damages	Heavy winds	Heavy rains	Landslides	Earthquakes	Volcanic eruptions Lava and ash	Tsunamis and floods	Manmade
2.5 Infiltration gallery		Install wood sheeting or Gabion baskets along the bank, creating a sedimentation area		Construct earthquake proof structures; use flexible pipe joints	Decentralize sources	Construct deeper foundations and wider dams	
3. Trunk (raw and treated)	Lay mains away from trees and utility poles	Bury mains; reduce number of river crossings; affix main at downstream side of bridges; encourage vegetation for slope stabilization	Select main route away from landslide-prone areas; select pipe material suitable for soil conditions; promote vegetation for slope stabilization	Use flexible joints and appropriate pipe material.	Use flexible joints and appropriate pipe material	Use flexible joints and appropriate pipe material	Bury mains; indicate location of mains
4. Treatment plant	Design and construct to withstand high wind speeds; install standby generators	Ensure adequate drainage; install standby generators	Select site away from slide-prone areas	Design and construct to withstand earthquakes. Install standby generators; careful siting; use flexible joints and wall crossings	Careful siting; use flexible pipe joints at wall crossings; install standby generators	Careful siting of plant; adequate drainage; install standby generators	Careful siting; implement adequate safety procedures; install standby generators; increase security and security training of staff
5. Pumping/booster station	Design and construct to withstand high wind speeds; install standby generators	Ensure adequate drainage; install standby generators or use gravity systems	Select site away from slide-prone areas; follow topography	Design and construct to withstand earthquakes; install standby generators; careful siting; use flexible joints and wall crossings	Careful siting; use flexible pipe joints and wall crossings; install standby generators	Careful siting of station; install standby generators	Careful siting; implement adequate safety procedures; install standby generators; increase security
6. Storage reservoirs	Ensure reservoirs are filled during storms and close valves (to be installed if necessary)	Ensure adequate drainage	Select site away from slide-prone areas	Design and construct to withstand earthquakes; careful siting; use flexible joints and wall crossings	Careful siting; use flexible pipe joints and wall crossings; design and construct to carry ash loads	Careful siting of reservoir	Careful siting; increase security; implement adequate safety procedures
7. Distribution	Lay pipes away from trees and utility poles	Bury lines	Careful routing of pipes	Select adequate pipe material; use flexible joints and wall crossings	Select adequate pipe material; use flexible joints and wall crossings	Bury pipes and lay pipes away from trees and utility poles	Bury pipes; indicate location; proper mapping

Annex 2

Forms for damage assessment(*)

Summary **DATE:** ____–____–____ (dd mm yy)

J-1 **Water Supply Damage Assessment Form**

Name of Surveyor ______________________ **Function/Title** ______________________

Component	Name and Exact Location	Damage Description	Present Capacity %	Needs: Manpower/ Equipment	Estimated Repair (days)	Action Time	Condition of Access Routes
Source							
Collection							
Transmission							
Treatment Plant							
Storage Tanks							
Distribution							

(*) Adapted from *Guidelines for Assisting Caribbean Goverments in the Event of a Disaster*. PAHO/WHO, CPC Barbados, 1999.

Damage and Needs Assessment Forms (WATER SUPPLY)

DATE : ______ - ______ - ______
dd mm yy

J-2

Name of Surveyor ______________________ Function/Title ______________________

Name of Lab Technician ______________________

Sample Point	Nº	Date	Time	pH	Res. Cl_2	Turb.	F. Col.	Color	Odor

Damage and Needs Assessment Forms (WATER SUPPLY)

DATE: ______-______-______
dd mm yy

J-3	Water Source*

Name of Surveyor ______________ Function/Title ______________

Name of Water Source ______________

Access:
Truck ☐ 4WD-Jeep ☐ Car ☐ Foot ☐ Boat ☐ Air ☐ No Access ☐

Type of water source:
Spring ☐ River Intake ☐ Well ☐ Dam ☐ Infiltration Gallery ☐

Other (indicate): ______________

Is the source operating normally? (circle one) YES NO

Flow before disaster ________ l/s Flow after disaster ________ l/s

Describe turbidity/appearance of water:

Describe any blockage of roads	Describe needs to provide access

Describe damage to source	Describe needs to repair damage

* If water is treated at source, use form for Treatment Plant (J-6)
If water is pumped from source, use form for Pumping Station (J-7)

J-4	Storage Tanks

Name of Surveyor ______________________ Function/Title ______________________

Name of Water Source ______________________

Access:

Truck ☐ 4WD-Jeep ☐ Car ☐ Foot ☐ Boat ☐ Air ☐ No Access ☐

Type of tank

Steel ☐ Rubber ☐ Concrete ☐ Fiberglass ☐ Underground ☐ Above ground ☐ Elevated ☐

Shape of tank

Square ☐ Round ☐ Conical ☐ Rectangular ☐ Other ☐ Describe ______________

Size of tank ______ m^3

At ______ **hours (indicate time) the tank is:**

Full ☐ 3/4 Full ☐ 1/2 Full ☐ 1/4 Full ☐ Empty ☐

Tank outlet valve present?

No ☐ Yes ☐ Open ☐ Closed ☐

Is tank and/or contents secured against unauthorized users? (check one) YES ☐ NO ☐

Describe any visual indications of damage:	Describe needs pertaining to damage:

Any Other Comments:

Damage and Needs Assessment Forms (WATER SUPPLY)

DATE: ______ – ______ – ______
dd mm yy

J-5 Transmission Lines

Name of Surveyor ______________________ Function/Title ______________________

From: ______________ To: ______________ Diagram No.: ______________

Length (m): __________ Diameter: (mm): __________ Type: __________ Nominal Pressure: __________

No. of stream crossings: ______________ No. of crossings damaged: ______________

Access:
Truck ☐ 4WD-Jeep ☐ Car ☐ Foot ☐ Boat ☐ Air ☐ No Access ☐

Describe damage to lines:

Location	Damages	Access	Urgent Action

Damage and Needs Assessment Forms (WATER SUPPLY)

DATE: ______ - ______ - ______
dd mm yy

J-6	Treatment Plant

Name of Surveyor ____________________ Function/Title ____________________

Name of Treatment Plant ____________________

Name of Plant Supervisor ____________________ Tel: ____________________

Name of Plant Operator ____________________ Tel: ____________________

Access:

Truck ☐ 4WD-Jeep ☐ Car ☐ Foot ☐ Boat ☐ Air ☐ No Access ☐

Main Treatment Process

Coagulation/Floculation	
Rapid sand filter	
Slow sand filter	

Roughing filter	
Disinfection	
Reservoirs	

Other, please indicate: ____________________

Is Treatment Plant operating normally? (check one) YES ☐ NO ☐

Capacity before disaster: ______ l/s Capacity after disaster: ______ l/s

Flow at entrance to plant before disaster: ______ l/s Flow at entrance to plant after disaster: ______ l/s

Describe turbidity/appearance of:

Incoming water	Treated water

Power Supply

	Yes	No
Mains	(kVA)	

	Yes	No
Standby	(kVA)	

Damage and Needs Assessment Forms (WATER SUPPLY)

DATE: ______ - ______ - ______
dd mm yy

J-6	Treatment Plant (continued)

Describe damages to power supply:

Mains	
Transformer	
Standby	
Controls	

Describe needs pertaining to damages to power supply:

Describe general condition of treatment plant:

Describe any structural damage:

Describe needs pertaining to structural damage:

Describe condition of laboratory:

Damage and Needs Assessment Forms (WATER SUPPLY)

DATE: ____ – ____ – ____
dd mm yy

J-6	**Treatment Plant (continued)**

Describe any damages to equipment (air valves, piping, pressure tanks, dosing equipment, flow and level recorders, pressure gauges, washouts, etc.)

Equipment damaged	Needs

Indicate what chemicals are available and/or needed

Chemicals or reagents	Quantity Available	Quantity Needed

Any Other Comments:

Damage and Needs Assessment Forms (WATER SUPPLY)

DATE: ____ – ____ – ____
dd mm yy

J-7	**Pumping and Booster Station**

Name of Surveyor: ______________________ Function/Title ______________________

Name of Water Source: ______________________ Area: ______________________

Access:

Truck ☐ 4WD-Jeep ☐ Car ☐ Foot ☐ Boat ☐ Air ☐ No Access ☐

Pumps	Type of pump(s)				Pump specifications				
	Submersible	Ram Pump	Multi-stage	Other	Volts	Amps	Cycles (Hz)	Speed (RPM)	Brand Name
1									
2									
3									
4									
5									

Power Supply

	Yes	No		Yes	No
Mains	(kVA)		Standby	(kVA)	

Describe Damages to Power Supply

Mains	
Standby	
Transformer	
Controls	

Describe any structural damage:	Describe needs pertaining to structural damage:

Describe any damages to equipment (pumps, valves, air valves, washouts, surge tanks, piping, flow recorders, pressure gauges, etc.)

Damage and Needs Assessment Forms (WATER SUPPLY)

DATE: ____ – ____ – ____
dd mm yy

J-7	**Pumping and Booster Station (continued)**

Equipment damaged	Needs

Any Other Comments:

Summary

DATE: ____ - ____ - ____
dd mm yy

J-8 **Water Supply Compilation Sheet**

Name of Surveyor ______________________ Function/Title ______________________

Community	% of Capacity Remaining	Urgent Needs < 1 week	Medium-Term Needs > 1 week

Damage and Needs Assessment Forms (SEWERAGE)

DATE: ____ – ____ – ____
dd mm yy

J-9 Distribution System

Name of Surveyor: ____________ Function/Title: ____________

Name of Water Source: ____________ Area: ____________ Population served: ____________

Access:
Truck ☐ 4WD-Jeep ☐ Car ☐ Foot ☐ Boat ☐ Air ☐ No Access ☐

Location	Pipe		Nature of Damage	Access
	Size	Type		

DATE: ______ - ______ - ______
dd mm yy

J-10	**Sewage Treatment Plant**

Name of Surveyor ____________________ Function/Title ____________________

Name of Treatment Plant ____________________

Name of Plant Supervisor ____________________ Tel: ____________________

Name of Plant Operator ____________________ Tel: ____________________

Access:

Truck ☐ 4WD-Jeep ☐ Car ☐ Foot ☐ Boat ☐ Air ☐ No Access ☐

Main Treatment Process

Ponds	
Trickling filters	
Activated sludge	

Oxidation ditch	
Extended aeration	
Anaerobic digestion	

Other, please indicate: ____________________

Is Treatment Plant operating normally? (check one) YES ☐ NO ☐

Capacity before disaster: ____________ l/s Capacity after disaster: ____________ l/s

Flow at entrance to plant before disaster: ____________ l/s Flow at entrance to plant after disaster: ____________ l/s

Describe turbidity/appearance of:

Incoming residual water	Treated residual water

Power Supply

	Yes	No
Mains	(kVA)	
Standby	(kVA)	

Damage and Needs Assessment Forms (SEWERAGE)

DATE: ______ - ______ - ______
dd mm yy

J-10	**Sewage Treatment Plant (continued)**

Describe damages to power supply:

Mains	
Standby	
Transformer	
Controls	

Describe needs pertaining to damages to power supply:

Describe general condition of treatment plant:

Describe any structural damage:	**Describe needs pertaining to structural damage:**

Describe condition of laboratory:

Damage and Needs Assessment Forms (SEWERAGE)

DATE: ______-______-______
dd mm yy

J-10 **Sewage Treatment Plant (continued)**

Describe any **damages** to equipment (blowers, pumps, valves, piping, pressure tanks, dosing equipment, flow recorders, skimmers, grit removers, laboratory, etc.)

Equipment damaged	Needs

Indicate what chemicals are available and/or needed

Chemical or reagent	Quantity Available	Quantity Needed

Any Other Comments:

Damage and Needs Assessment Forms (SEWERAGE)

DATE: ____ - ____ - ____
dd mm yy

J-11	Sewer Systems

Name of Surveyor: ______________ Function/Title: ______________

Location: ______________

Access:
Truck ☐ 4WD-Jeep ☐ Car ☐ Foot ☐ Boat ☐ Air ☐ No Access ☐

Location	Pipe		Nature of Damage	Access
	Size	Type		

Damage and Needs Assessment Forms (SEWERAGE)

DATE: ____ – ____ – ____
dd mm yy

J-12	**Sewerage Compilation Sheet**

Name of Surveyor ______________________ Function/Title ______________________

Community	% of Capacity Remaining	Urgent Needs < 1 week	Medium-Term Needs > 1 week

Glossary

Hazard – An external risk factor: the latent danger that a natural or man-made phenomenon may adversely affect people, assets, or the environment.

Mitigation – A set of measures to reduce or neutralize the impact of natural hazards by reducing social, functional, or physical vulnerability.

Preparedness – The organization, education, and training of the population and all relevant institutions to facilitate effective control, early warning, evacuation, rescue, relief and assistance operations in the event of a disaster or emergency.

Prevention – The elimination or reduction of the likelihood that natural events may endanger human beings, their goods, their social assets, or their environment.

Reconstruction – A set of activities aimed at achieving the medium- and long-term recovery of the components and structures that have been affected by a disaster or emergency.

Rehabilitation – A set of measures aimed at restoring normal living conditions through the repair and reestablishment of vital services interrupted or degraded by a disaster or emergency.

Risk – The likelihood of damage to a given element or component with an intrinsic degree of vulnerability as the result of an adverse event of specific intensity.

Simulation – A drill or other exercise aimed at testing and reinforcing the capacity of an organization or community to withstand the impact of an adverse event, including its decision-making capacity in real time.

State of Alert – The time between the recognition that an adverse event is likely to affect a given population or system, and the actual event itself. A state of alert is normally declared officially by a relevant authority.

Vulnerability – An internal risk factor affecting a population, infrastructure, or system exposed to a given hazard. While the likelihood of being affected by the phenomenon increases as a function of its intensity, which cannot be controlled, it is also a function of the degree of vulnerability, which can be reduced through prevention and mitigation efforts.

Selected Reference Material

The following reference material may be obtained from the Regional Disaster Information Center for Latin America and the Caribbean (CRID) by writing to the following address: Apdo. Postal 3745, San José 1000, Costa Rica, or crid@crid.or.cr. The material is also available in full text at the CRID's Web site (www.crid.or.cr).

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Program on Emergency Preparedness and Disaster Relief

Pan American Health Organization
Regional Office of the
World Health Organization

In 1976, the Pan American Health Organization created this Program in response to a call by the Member Countries to establish a technical unit to strengthen health sector disaster preparedness, response and mitigation activities.

Since then, the Program's main objective has been to support the health sector to strengthen their national disaster preparedness programs and its interaction with all the sectors involved in disaster preparedness. This support has been channeled to the countries of Latin America and the Caribbean in three principal areas:

In **disaster preparedness**, in addition to constant promotion of a strong health disaster preparedness program, PAHO regular activities include training (through hundreds of courses and workshops) and the preparation and distribution of training materials (books, slides and videos).

Disaster mitigation is just as important. An investment in disaster preparedness can be rendered useless if hospitals or health centers cannot withstand the impact of a disaster and collapse at exactly the moment they are most needed. PAHO promotes and supports the inclusion of disaster mitigation in natural disaster reduction programs and legislation.

In **disaster response**, PAHO works with the affected countries to identify and assess damages and needs, carry out epidemiological surveillance, monitor drinking water, and mobilize international relief, and manage humanitarian supplies. PAHO has established the Voluntary Emergency Relief Fund that collects money to support post-disaster activities.

The Program also has several special technical projects: Disaster Mitigation in Hospitals and Drinking Water Systems; Humanitarian Supply Management System; Use of the Internet for Disasters and Emergencies; and the Regional Disaster Information Center (CRID).

Offices of the Program on Emergency Preparedness (information updated in August 2002).

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SUMA

¿What is SUMA?

At the beginning of the 1990s, the countries of Latin America and the Caribbean pooled their efforts, with the support of the Pan American Health Organization (PAHO), the government of the Netherlands and the Colombian Red Cross, to develop SUMA—the Humanitarian Supply Management System.

SUMA is an information management tool that helps governments improve the management of humanitarian assistance and ensure efficiency and transparency in the reception and distribution of relief supplies. SUMA also helps disaster managers to provide donors and humanitarian agencies with the information they need to guarantee accountability.

¿What does SUMA do?

- It streamlines the identification, sorting and classification of arriving humanitarian supplies.
- It helps to assign different priorities to the incoming supplies based on the needs of the affected population.
- It consolidates all the information about incoming shipments and existing stocks into a single database.
- It provides a clear picture of the circulation of donated supplies from the point of arrival until they get to the final beneficiaries.
- It eases and encourages the preparation of reports and exchange of information among all stakeholders (governments, NGOs, donors, etc.).

¿Who handles SUMA?

SUMA trains national teams and promotes self-sufficiency by ensuring that countries can manage humanitarian assistance employing their own resources. The national teams comprise volunteers from health agencies, civil defense or emergency committees, the armed forces, the local Ministry of Foreign Affairs, customs, the Red Cross, NGOs and other bodies. Over 2,000 volunteers have already been trained in Latin America and the Caribbean.

SUMA—Towards a Global Standard for Humanitarian Supply Management

SUMA is accepted throughout Latin America and the Caribbean as *the* standard in the management of relief supplies. The countries of the Region are now exporting the model to other parts of the world that have requested assistance and training in the use of the SUMA System to meet their disaster management needs.

For more information please contact:

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or visit their website: www.disaster.info.desastres.net/SUMA/

Regional Disaster Information Center (CRID)

Disaster management is, above all, the management of information. The goal of CRID is to provide the countries of Latin America and the Caribbean with access to the best disaster information sources and resources available so that users can make well-informed decisions when managing disasters and trying to prevent or reduce their impact.

CRID enjoys the support of six organizations and agencies[1]. Its objectives are:

- To improve the compilation, processing, and dissemination of disaster information.
- To strengthen local and national capacity in setting up and maintaining disaster information centers.
- To promote the use of information technologies.
- To support the development of the Regional Disaster Information System.

Services Provided by CRID

CRID provides the following services:

- The ability to conduct bibliographic searches over the Internet, on CD-ROMs, or by contacting the Center directly.
- The publication and distribution of specialized bibliographies and reviews of the literature *(Bibliodes).*
- Direct access over the Internet to a wide collection of full-text documents on disasters and disaster reduction in general and in the Region.
- Distribution of publications and training material.
- Mass distribution of public and technical information.
- Technical advice and training on how to set up and manage disaster information centers.
- CRID promotes and supports the consolidation of a Regional Disaster Information System for Latin America and the Caribbean through technical support for national and local information centers, the development of a unified methodology and tools, and the establishment of uniform information services.

For more information please visit: www.crid.or.cr

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CRID, the best source of disaster information
in Latin America and the Caribbean

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[1] The Pan-American Health Organization / Regional Office of the World Health Organization (PAHO/WHO), the United Nations International Strategy for Disaster Reduction (UNISDR), the National Risk Prevention and Emergency Response Commission of Costa Rica (CNE), the International Federation of Red Cross and Red Crescent Societies (IFRC), the Center for the Prevention of Natural Disasters in Central America (CEPREDENAC), and the Regional Office for Emergencies of Médecins Sans Frontières (MSF).