

Integrated Risk Management to Protect Drinking Water and Sanitation Services Facing Natural Disasters

Thematic Overview Paper 21
By: DIEDE and AIDIS

Thematic Overview Papers



Integrated Risk Management to Protect Drinking Water and Sanitation Services Facing Natural Disasters

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International Division for Sanitary Engineering and
Environmental Health during Emergencies and Disasters (DIEDE)
Inter-American Association of Sanitary and Environmental
Engineering (AIDIS)

Reviewed by: Claudio Osorio (UNICEF) and Jan Teun Visscher (IRC)

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Table of Contents

Thematic Overview Papers (TOPs): an effective way to TOP up your knowledge		3
1	Introduction.....	5
1.1	Acknowledgements.....	6
2	Importance of drinking water and sanitation services in post-disaster conditions	7
2.1	The social dimension of drinking water and sanitation services.....	7
2.2	Drinking water services in post-disaster conditions.....	7
2.3	Increased number of disasters and their impact.....	9
2.4	Social development may be set back by years or decades.....	11
2.5	Disasters may cause enormous economic and financial loss	11
2.6	Physical infrastructure is often severely damaged	12
2.7	Environmental damages of disasters vary considerably	13
3	Risk management as a sustainable social planning and development tool..	14
3.1	The vicious circle of poverty, vulnerability, and disasters.....	15
3.2	Challenges to the inclusion of integrated risk management in resource planning and allocation	16
3.3	Current practice not supportive of risk management.....	16
3.4	Lack of management and control of contamination / environmental degradation	17
3.5	Short lived memory about disasters and their impact.....	17
3.6	Planning as a tool for risk and disaster management.....	18
4	Integrated risk management in water and sanitation systems.....	19
4.1	Conceptual framework for integrated risk management.....	19
4.2	Acceptability of risk	20
4.3	Risk and vulnerability analysis (RVA)	20
4.4	Vulnerability of water and sanitation systems.....	24
4.5	Impact of disasters on water and sanitation systems	28
5	Disaster prevention and risk management in drinking water and sanitation systems: a shared responsibility.....	34
5.1	Governmental, planning, environmental, and municipal authorities	34
5.2	Governing and regulating authorities of water and sanitation services	35
5.3	Service providers	36
5.4	Donor, finance, and other funding organisations.....	37
5.5	Universities, technical institutes, and professional bodies.....	38
5.6	Communities	38
6	Case studies / best practices	39
7	TOP books, articles, papers	43
8	TOP websites	46

9	TOP courses, institutions and research centres	47
10	TOP contacts	49
11	TOP quiz	50
12	About IRC	54

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1 Introduction

The increasing impact of natural disasters on communities, cities, and regions in the last 10 years has received special attention from multilateral agencies. They have concluded that the same factors which cause many countries to remain underdeveloped also contribute to an even greater vulnerability when faced with disasters. Overcoming this situation implies changing the traditional approach of reacting to major emergencies that result from disasters to a more integrated and preventive approach. This involves identifying in advance the nature and scale of potential threats to essential structures that support a country's productivity and its population's well-being, and acting appropriately on this information.

This effort is beginning to produce results in some developing countries that have, for instance, updated seismic resistance codes, which govern the ability of buildings to withstand earthquakes, and insisted that many State macro projects identify the scale of risks and practise risk intervention. However, it is still a challenge to anticipate disasters and to take adequate preventive and mitigating measures that ensure that they do not worsen precarious conditions of poverty and development.

Studies of hundreds of disasters worldwide have identified drinking water and sanitation services as fundamental for rapid recovery by an affected community. The absence of these services in the aftermath of a disaster generates or increases levels of poverty and impacts on public health, productivity, development, quality of life, and the environment. These studies clearly indicate that continuity of drinking water and sanitation services is critical in post-disaster conditions, since they are essential factors for rapid social and productive recovery.

Integrated risk management applied to drinking water and sanitation services is becoming an important strategy in preventive management, and is beginning to show significant results in timely anticipation of potential disasters, by facilitating proactive actions to face foreseeable threats and to mitigate the impact that natural events have on water and sanitation infrastructure. By 'integrated risk management', we mean a strategic and proactive approach to anticipating, assessing, preventing and managing risk.

This document was prepared as a guide for professionals, agencies, and authorities in the health, drinking water and sanitation sectors, to enrich perspectives and to provide updated information on alternatives for strategic interventions to combat risks inherent in drinking water and sanitation services.

Although this document brings together the thoughts, experiences and comments of various Latin American experts to indicate the best route to break the vicious circle of poverty, vulnerability, disasters and increased poverty in Latin American and Caribbean countries, it is also valuable for professionals working in other parts of the world. We invite those professionals to share with us cases and examples from their region.

1.1 Acknowledgements

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2 Importance of drinking water and sanitation services in post-disaster conditions

2.1 The social dimension of drinking water and sanitation services

Continuous and reliable access to drinking water and sanitation services is one of the most important elements for quality of life and the possibility of development. Civilizations have survived many centuries without electricity, vehicles, telephones and many other services that seem indispensable today, but they have never survived without water. Water is an important factor for social continuity, and has been so in relation to all the different civilizations that have inhabited the planet.

The close relationship between poverty and lack of water and sanitation systems is undeniable. The United Nations General Assembly has recognised its importance by setting a target to “halve, by 2015, the proportion of people without sustainable access to safe drinking water and sanitation”, as a requirement for achieving three of the UN’s Millennium Development Goals (MDGs) - eradicating extreme poverty and hunger, reducing child mortality, and ensuring environmental sustainability.

It can therefore be said that the absence of drinking water and sanitation systems has a cross-cutting impact on the dynamics of any society, region or country, through their impact on critical areas such as public health, productivity and development, quality of life and the environment.

2.2 Drinking water services in post-disaster conditions

Natural disasters are characterised by the great impact they have on roads, buildings, schools, hospitals and airports, as well as on vital services such as water, electricity, fuel and communications. When an emergency occurs, it underlines the importance of drinking water and sanitation services, turning them into indispensable and strategic factors in minimising the impact of the emergency on the community, and in restoring socioeconomic dynamics. Some of the key activities that require water are:

- *Human consumption*: 15 litres per person per day to cover basic needs.¹
- *Fire control*: earthquakes may generate fires that end up producing more damage than the earthquake itself.²

¹ Sphere Project, 2000. *Carta Humanitaria y Normas Mínimas de Respuesta Humanitaria en Casos de Desastres*. (Humanitarian Charter and Minimum Standards in Responding to Disasters). www.sphereproject.org

² Photos and data about the San Francisco fire, originated by the 1906 earthquake, can be found in: Applied Technology Council (1992). *A Model Methodology for Assessment of Seismic Vulnerability and Impact of Disruption of Water Supply Systems*. Washington D.C., USA.

- *Cleaning and removal of excreta*: water is required to clean up the great amount of rubbish and filth generated by disasters, and to prevent the appearance of contagious and gastrointestinal diseases in the affected population.
- *Restarting productive and economic activities, etc.*: a prolonged interruption of water and sanitation services affects production of goods and services, disrupts business, and encourages businesses to move to other areas, increasing local unemployment.
- *Attention to those with sicknesses and injuries* resulting from the disaster.

Table 1. Importance of drinking water and sanitation services for the socioeconomic dynamics of a community, region, or country

Dimension	Impact on society due to lack of drinking water and sanitation services	Urgent water and sanitation needs in emergency conditions
Public health and human consumption	<p>Exposure to water-transmitted diseases</p> <p>Problems in personal hygiene</p> <p>Inadequate disposal of wastewater</p> <p>High child mortality from malnutrition caused by diarrhoea</p> <p>Lower life expectancy</p>	<p>Guarantee water supply of at least 15 lt/ person/day to cover people's basic needs, including 5 lt/p/day of drinking water</p> <p>Provide urgent supplies to hospitals, prisons and public buildings</p> <p>Where sewerage systems exist, adequately dispose of excreta from shelters and temporary buildings</p>
The environment	<p>Deterioration of aquifers due to uncontrolled use of water and contamination with wastewater</p>	<p>Clean up the large amount of rubbish and filth generated by the disaster</p> <p>Facilitate activities to repair infrastructure to avoid contamination, infestation of pests, etc.</p>
Quality of life	<p>Time and energy (often by women and children) to fetch water, which they could otherwise use for education or productive labour</p> <p>Time and cost of energy to boil water</p> <p>High incidence of waterborne and poor sanitation related disease</p>	<p>Ensure that people do not get sick from drinking unclean water or have to spend a long time collecting it</p> <p>Facilitate recovery of other vital services (electricity, fuel and communications), which often require water for repairs and maintenance</p>
Productivity and development	<p>Businesses requiring water for production cannot operate</p> <p>Long periods of water rationing may even lead to bankruptcies and capital flight</p> <p>High cost of health treatment and health infrastructure uses scarce resources</p> <p>Loss of working days and loss of income</p> <p>Reduction in productivity</p> <p>Foreign investment made less attractive</p> <p>Tourism industry negatively affected</p>	<p>Fight fires which may create more damage than the original disaster</p> <p>Quickly reactivate economic and productive activities</p> <p>Reduce problems in the tourism sector</p>

2.3 Increased number of disasters and their impact

With the growing number of natural disasters (see Figure 2), one of the greatest challenges is to reduce their impact. This is even more so in developing countries where disasters often are an important factor that worsen already-serious conditions of poverty and underdevelopment. Institutional weaknesses, unregulated urbanisation, persistence of poverty, degradation of the environment, and climatic change all lead to an increase in the severity of the impact of catastrophic events in developing countries. Experience of past disasters shows that they usually have longer lasting impacts on countries and communities with lower income, thus generating a vicious circle of poverty, underdevelopment, vulnerability and disaster, as represented in Figure 1.

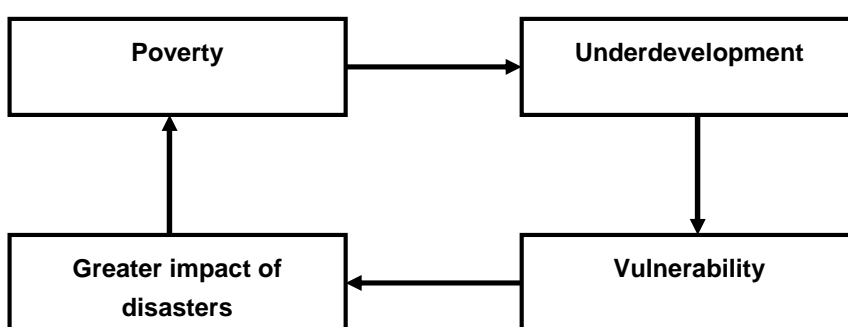


Figure 1. Vicious circle of poverty and disaster

“In 2003 alone, over 70,000 people perished in some 700 disasters that affected 600 million men, women and children and caused US\$ 65 billion (EUR 47 billion) in damages. Global trends show that disasters will increase because of human activities and more people – in particular the poor – will be affected as they grow more vulnerable. Over three-quarters of the 100 largest cities in the world are situated in locations exposed to potential serious natural hazards.”³

Some regions in the World are more prone to the occurrence of large-intensity natural events which may turn into disasters because of the unbalanced way in which mankind interacts with its environment. Large areas of Latin America and the Caribbean face dangerous natural events every year, including earthquakes, hurricanes, landslides, flooding, volcanic eruptions, tsunamis and droughts. Many of these events become disasters largely because of people’s mismanagement of their natural surroundings, and their failure to take preventive and mitigating measures to address the foreseeable effects.

³ UN/ISDR (2004). *Living With Risk: A Hundred Positive Examples of How People are Making The World Safer*. <http://www.unisdr.org/eng/media-room/press-release/2004/PR-200404-LwR.doc>

“The number of people at risk has been growing at a rate of 70 to 80 million per year. Over 90% of population growth occurs in developing countries, among people with the lowest income and greatest exposure to disasters.”⁴ (Figure 2)

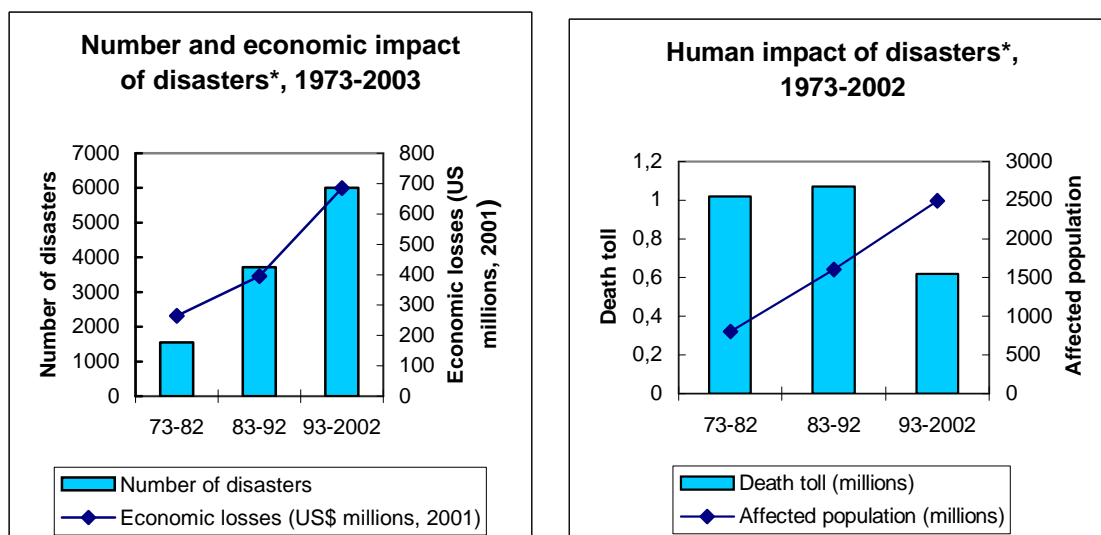


Figure 2. Increase in number of disasters and economic and human impact 1973-2002

Source: UN/ISDR (2004). *Living with risk. A global review of disaster reduction initiatives*. Geneva, Switzerland (<http://www.unisdr.org>). EM-DAT: The OFDA/CRED International Disaster Database (<http://www.em-dat.net>), Universite Catholique de Louvain, Brussels, Belgium, 2004.

*Note: includes droughts, earthquakes, epidemics, extreme temperature, famines, floods, industrial accidents, insect infestation, miscellaneous accidents, land/debris-slides, transport accidents, volcanoes, wave surges, wildfires and windstorms.

A disaster can cause a great increase in infectious diseases. Hurricane Mitch⁵ resulted in 1,400 cases of cholera in Guatemala within one month of its occurrence. Nevertheless, despite an increasing occurrence of disasters, the human death toll has dropped in recent years. This may be the result of better response strategies.

In any country, natural or man-caused disasters may entail serious consequences and these are worse if risk management is inadequate. An important difference exists between smaller scale (local) disasters, which have a much lower impact on the organisational and institutional framework of a country, and disasters affecting large parts of a country or region. Paragraphs 2.4 through 2.7 outline some possible consequences of disasters.

⁴ UN/ISDR (2004). *Living with Risk - a global review of disaster reduction initiatives*

⁵ Adapted from: *Muy Interesante*. No. 43. September/October 1999. Madrid, Spain. Pages 61 and 62.

2.4 Social development may be set back by years or decades

Disasters represent one of the greatest causes of negative social changes in a population. A natural event with a great impact, such as Hurricane Mitch, may delay development for years or decades, completely changing institutional investment programmes, increasing the level of poverty, reducing access to health or educational services, etc. The 2004 Indian Ocean (Sumatra-Andaman) undersea earthquake on December 26, 2004, triggered a series of devastating tsunamis, inundating coastal communities across South and Southeast Asia, killing an estimated 229,866 people and destroying homes, infrastructure and livelihoods and severely damaging development prospects.

Another clear example was the El Niño event, which had a global impact (Table 2).

Table 2. Global impact of the El Niño event 1997-1998⁶

Region	Deaths	Affected	Displaced
Africa	13,325	8,900,000	1,357,500
Asia	5,648	41,246,053	2,544,900
Asia-Pacific	1,316	66,810,105	143,984
Central and South America	858	864,856	363,500
<i>Global Total</i>	<i>21,706</i>	<i>117,862,114</i>	<i>4,819,884</i>

Adapted from: World Meteorological Organization (1999). *The 1997-1998 El Niño Event: A Scientific and Technical Retrospective*. Geneva, Switzerland.

<http://www.crid.or.cr/digitalizacion/pdf/eng/doc12124/doc12124.htm>

2.5 Disasters may cause enormous economic and financial loss

Financial and economic losses as a consequence of disasters may be of enormous proportions, sometimes delaying the development of entire countries for years. Table 3 shows a summary of those impacts in Latin America and the Caribbean. The financial impact of Mitch Hurricane in Honduras in 1998 was equivalent to 81.6% of its Gross Domestic Product (GDP).

Table 3. Economic impact of recent major natural disasters in Latin America & the Caribbean⁷

Country	Year	Disaster	Losses as % of GDP
Bolivia	1982	Flood	19.80
Perú	1983	Flood/Drought	5.96
Paraguay	1983	Flood	1.36
México	1985	Earthquake	2.18

⁶ Adapted from: PAHO (2000). *Crónicas de Desastres: Fenómeno El Niño 1997-1998. (Chronicles of Disasters: El Niño Event 1997-1998)* Washington, USA. (www.paho.org/spanish/ped/pedhome.htm)

⁷ Adapted from: Keipi, K. y Taylor, J. (2002). *Planificación y Protección Financiera para Sobrevivir Desastres*. Banco Interamericano de Desarrollo, Depto. de Desarrollo Sostenible, División de Medio Ambiente. Washington, D.C., USA. Número de referencia 658.155 K282-dc21

Country	Year	Disaster	Losses as % of GDP
Chile	1985	Earthquake	9.10
Argentina	1985	Flood	1.48
Barbados	1987	Hurricane	6.86
Jamaica	1988	Hurricane	28.21
Costa Rica	1991	Earthquake	8.87
Honduras	1993	Hurricane/Flood	3.39
Nicaragua	1994	Drought	8.74
Honduras	1998	Hurricane	81.60 ⁸
El Salvador	2001	Earthquake	9.5 ⁹

A natural disaster may have severe consequences for the short term and long term functioning of water supply and sanitation systems. The effects may be enormous, although there is not yet an instrument to quantify them. They begin with an increase in waterborne disease causing an increase in morbidity and premature deaths, which are costly and in turn affect economic activity. They also negatively affect society as a whole, including industry and tourism, causing high economic losses.

2.6 Physical infrastructure is often severely damaged

Disasters can severely damage physical infrastructure such as roads, bridges, houses, pipelines, electricity, fuel supplies, communications etc. The degree of damage depends on the nature and scale of the disaster, and on the level of risk mitigation applied in the affected country. This requires careful planning and the application of appropriate building codes, updated based on lessons learned from previous disasters and adhered to in practice. Unfortunately, in most developing countries, infrastructural planning is not well established and building codes do not exist, are not demanding enough or are not respected. Poverty worsens this situation through use of low-quality materials, lack of professional design, poor supervision of construction and the use of high risk areas such as steep hills around towns.

The earthquakes that hit El Salvador between January and February 2001, for example, damaged 169,932 houses, 19 hospitals, 75 health units, and 12 health facilities. Damage was also reported to 63 rural water supply systems, 24,200 family wells, and 81,300 latrines¹⁰. This infrastructure all needs to be repaired or rebuilt as quickly as possible, to ensure that society can regain its normal functioning.

⁸ CEPAL (1999). *Centroamérica: Evaluación de los daños causados por el huracán Mitch en 1998*. LC/MEX/L.375. México.

⁹ CEPAL (2001). *The Earthquake of January 13 in El Salvador: Socioeconomic and Environmental Impact*. Página 82. LC/México/L.457. México.

¹⁰ PAHO/WHO (2002). *Terremotos en El Salvador 2001 – Crónicas de Desastres (Chronicles of Disasters: Earthquakes in El Salvador 2001)*. Washington, D.C., USA.

2.7 Environmental damages of disasters vary considerably

Damage to the environment varies depending on the type of natural disaster. The consequences for water supply and sanitation systems may also vary considerably as illustrated by the following:

- An earthquake may cause landslides, soil liquefaction, soil uplifting or sinking, tsunamis, etc. and may change the environment with long-term consequences. The earthquake of Limón, Costa Rica, in 1991 produced many landslides in the Talamanca Mountains. It was estimated that forest regrowth by natural means will take more than 50 years.¹¹
- A forest fire may destroy enormous areas and change run-off patterns in water catchment areas. In Brazil, the 1998 drought generated a fire that affected 9,255 square kilometres in the State of Roraima.
- Hurricanes and flooding may produce landslides, aquifer contamination, erosion, dragging of sediment to lower areas, changes in riverbeds, overflowing, etc. Many of these phenomena may have a direct effect on water supply and sanitation services.
- A volcanic eruption may force people to abandon an area for some time, damage catchment areas and cause landslides. The eruption of the Vulcan Nevado del Ruiz in Tolima, Colombia in 1985 caused the complete destruction of the municipality of Armero causing some 25,000 victims.
(http://es.wikipedia.org/wiki/Tragedia_de_Armero).

Even developed countries are not immune to mistakes in preparedness and reaction to disasters. In 2005, when Hurricane Katrina passed over the eastern side of New Orleans in the USA, civil engineering failures and lack of preparedness resulted in a huge disaster. Levees built in the 1920s were not sufficient to protect a city of much higher population from the worst scenarios, and had not been sufficiently strengthened. They crumbled in the face of a huge water surge, resulting in the flooding of 80% of the city, causing more than 1,000 deaths and destroying and damaging homes, businesses, and property. The response to the disaster was widely criticised inside the USA as slow and inadequate, and the failure of preventive measures were said to be “the worst engineering disaster in US history”. It was notable that even in this highly developed country, the poor and marginalised were worst affected. The official death toll in Louisiana was put at 1,464.¹² According to the Centers for Disease Control and Prevention (CDC), five people died from bacterial infections from drinking polluted water.

¹¹ Picado, Luís (1994). *La experiencia de AyA en la atención del Terremoto XVII Congreso Centroamericano de Ingeniería Sanitaria y Ambiental*. Managua, Nicaragua.

¹² Louisiana Department of Health and Hospitals [Reports of Missing and Deceased](#). April 18, 2006.

3 Risk management as a sustainable social planning and development tool

"While many people are aware of the terrible impact of disasters throughout the world, few realise that this is a problem that we can do something about..."

Kofi A. Annan

UN/ISDR. 2004. "Living with Risk: A global review of disaster reduction initiatives".

http://www.unisdr.org/eng/about_isdr/bd-lwr-2004-eng.htm

Risk management should be one of the first considerations in the development planning of any community or country. Even though little can be done to modify the occurrence or magnitude of extreme natural events, a better knowledge of the way in which they happen, their probability, the possible zones affected, and the probable behaviour of infrastructure when they strike make it possible to prevent or mitigate the damage they may cause.

Increased attention for risk management is very important because of the growing interest in the water and sanitation sector as a result of Millennium Development Goals set by world leaders from 189 countries. Adequate planning and risk management is required to reduce the risk that investment related to support for the MDGs may be severely affected by disasters.

Risk management was presented in the context of water security at the 4th World Water Forum in Mexico (2006) where it was said that, "water security is a concept that has at least two different, yet interrelated notions all driven by a vision to protect and care for humanity. First, climate change and climate variability are influencing the incidence of extreme natural events (e.g. droughts, floods, tornadoes, hurricanes, etc). The poor are the hardest hit by these events. There is then an urgent need of providing efficient water storage and risk management infrastructure in the developing world and so finding ways to cope with uncertainty and risk by developing both structural and non-structural measures is of vital importance."

http://www.worldwaterforum4.org.mx/home/cuartowwf04_01.asp?resp=05

The importance of risk management is underscored by leading global organisations such as the World Water Council and the Global Water Partnership as well as by many individual experts. The key question is how risk mitigation can be put into practice as there are many impediments. The most important difficulties include:

- The poverty trap which makes it difficult to break the vicious circle that is sustained by disasters
- Difficulties in integrating risk mitigation into planning and resource allocation
- Low interest in environmental management
- Short collective memories about disasters and their impacts.

Integrated approach: the prevailing standard in Latin America and the Caribbean has been to respond to emergencies, instead of preventing or mitigating them, acting upon factors that create or intensify vulnerability in the face of catastrophic events. It is at this point that integrated risk management ... starts to play a fundamental role. It includes preventive and mitigating measures, combined with financial protection measures, which must be coordinated by the public and private sectors. Therefore, it is critical that each country develop a coherent strategy or plan to handle the risk of disasters, involving the ministry of treasury and planning, sectorial ministries, local governments, the business sector, and civil society in general. With regard to “ex-post facto” measures, it will also be necessary to have a structured response plan in the face of an emergency. The provision of effective mechanisms for financial protection “ex ante” is essential, because it expedites funds availability when they are mostly needed, thus reducing the financial load “ex post facto” of recuperation and reconstruction as a result of a natural disaster.

Adapted from: Keipi, K. and Taylor, J. (2002). *Planificación y Protección Financiera para Sobrevivir Desastres*. Banco Interamericano de Desarrollo, Depto. de Desarrollo Sostenible, División de Medio Ambiente. Washington, D.C., USA. Reference number 658.155 K282-dc21.

3.1 The vicious circle of poverty, vulnerability, and disasters

An in-depth analysis of the impact suffered by the economies of developing countries due to disasters shows a vicious circle of poverty, vulnerability, disasters, financial damage, and increasing poverty.

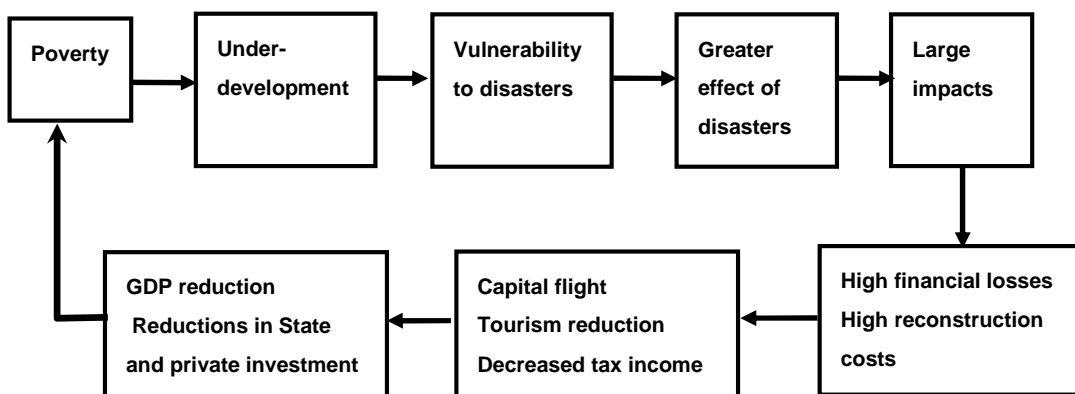


Figure 3. Vicious circle of poverty, vulnerability, and disasters

Integrated risk management in development planning is the instrument that can make it possible to turn this vicious circle into a virtuous circle. By investing in a planned way in prevention and mitigation, societies will be less vulnerable, and financial, social, environmental and other damages caused by disasters will be reduced, as will rehabilitation and reconstruction costs. All of this will lead to a gradual reduction in poverty, and an improvement in the quality of life. This approach is already having an important effect in changing this vicious circle in a number of countries, including Costa Rica, Nicaragua, Ecuador, Colombia, Honduras and Bolivia.

3.2 Challenges to the inclusion of integrated risk management in resource planning and allocation

In developing countries, there is constant competition for scarce resources between many urgent needs, and from causes that are politically more profitable and those that generate more visible results in the short term. Difficulties in obtaining funding for risk management include:

- Results are not usually obvious in the short term, and are not always tangible for the community
- Actions to improve a system do not guarantee that it will not fail in the face of a large-scale disaster
- Technical experts are often unable to 'sell' the results of their studies to decision-makers who can finance implementation
- The general public and decision-makers are not aware of the benefits of risk management.

3.3 Current practice not supportive of risk management

The pressure of population growth and migration on land-use forces many families to settle in high-risk zones, or in areas that should be protected. For instance, the serious effects of the flood in Jimaní, in the Dominican Republic, at the beginning of 2004, were partially due to the fact that the population was living on a dry riverbed that flooded following heavy rainfall.



Photo 1. Settlers around pipeline Medellín, Colombia

Lack of urban planning may result in areas around pipelines being invaded by displaced poor people (illegal settlers), some displaced as a result of previous natural disasters, others to escape from hunger and misery or violence.

Choosing a location near the pipeline guarantees them access to water in an illegal and technically inadvisable way, which may cause major leakages. Malfunctioning systems lead to considerable economic losses for the water company and for the community at large.

The use of recent technologies such as Geographic Information Systems (GIS) has allowed municipalities and other institutions in charge of planning to begin to prepare master plans for land use, in which populations, schools, hospitals, lodging houses,

industries and others are located in zones of minimum risk. For example, the National Risk Prevention and Emergency Response Commission of Costa Rica (CNE), in May 2006, distributed digital maps of vulnerability and threats to all municipalities in the country. This information is available on:

http://www.cne.go.cr/Atlas%20de%20Amenazas/atlas_de_amenazas/atlasde.htm

3.4 Lack of management and control of contamination / environmental degradation

Poor management of the environment, the growing contamination of aquifers, rivers, and lakes with debris and wastewater, and soil degradation and erosion have several negative consequences.

- They put existing water sources at risk and increase the possibilities of landslides etc
- They increase the need for and cost of water treatment
- They make it increasingly necessary to select more remote sources of water, thus increasing construction, operation and maintenance costs, as well as a system's vulnerability, since longer pipelines are more likely to be affected by natural events and often pass through areas with difficult geographical conditions.



Photo 2. Accumulated debris at the small lake of Tizcapa in Managua, Nicaragua. Note the people walking on the "island" of garbage. Source: Arturo Rodríguez, 2003.

3.5 Short lived memory about disasters and their impact

There is a tendency to forget previous disasters and the damage they caused. People often do not learn from past mistakes, and do not seem to look for locations with lower risks, perhaps because of lack of options. It is common to see human settlements, particularly those where very poor people live, in zones previously affected by landslides or floods, or that have been officially declared high-risk areas. They may aggravate the situation by constructing their own water supply systems in an illegal and technical

inappropriate manner, thus increasing the danger of landslides due to soil instability, water leakage and wastewater disposal.

3.6 Planning as a tool for risk and disaster management

Overcoming the vicious circle presented at the beginning of this chapter will require the participation of a variety of social forces. It is not enough for technicians from municipalities and planning authorities to be aware of the problem and to have a clear idea of its dimensions. In particular, it is necessary to raise the awareness of political authorities and to get them involved, since they decide on large infrastructure projects and determine relevant macro policies and legislative frameworks. It is also necessary to stimulate awareness amongst the public, since politicians need the backing of the population.

Breaking the vicious circle requires social and financial development strategies, led by high-level national staff in each country. The water and sanitation (W&S) sector must share the lead in developing policies and new laws that make it possible to create the virtuous circle for integrated risk management and disaster prevention as shown in Figure 4.

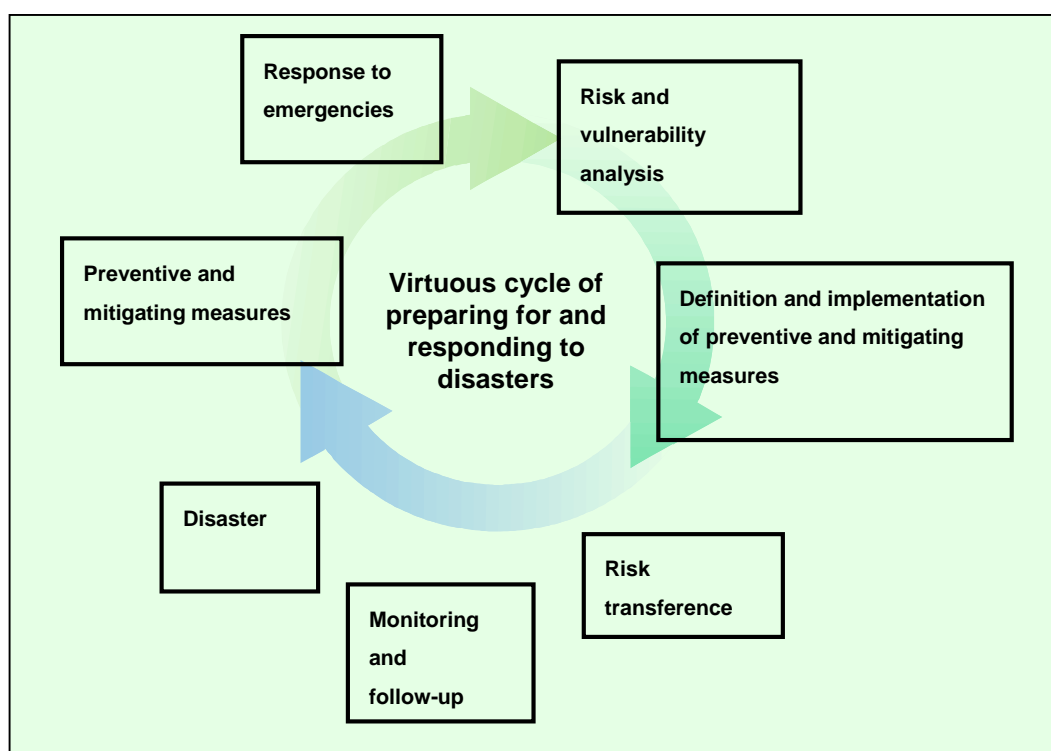


Figure 4. Virtuous cycle to prevent, mitigate and prepare for disasters

4 Integrated risk management in water and sanitation systems

As we have seen, clean water and effective sanitation are vital for society. This implies that it is crucial to guarantee the security in terms of the continuity, reliability and quality of service delivery. Undue interruptions will impact the social, environmental and financial situation of the population.

Sources of water are generally several kilometres from the locations where the water is consumed and systems often stretch over large areas. This can imply a considerable risk of potential damage by natural disasters in disaster prone areas.

Assuring the reliability of W&S services requires proper identification of risks through the development of risk scenarios, the implementation of rational preventive measures and the development of emergency plans. Another essential aspect is the active monitoring and evaluation of these measures.

4.1 Conceptual framework for integrated risk management

The reliability of W&S services requires integrated management of the risks that may threaten the services. This includes:

- Risk prevention, ensuring that at least a strategic part of the system remains intact or can be quickly repaired in case of a disaster
- Risk mitigation to keep the damage low
- Risk transfer to for example insurance companies to keep the 'economic' damage within manageable proportions.

These approaches are illustrated Figure 5.

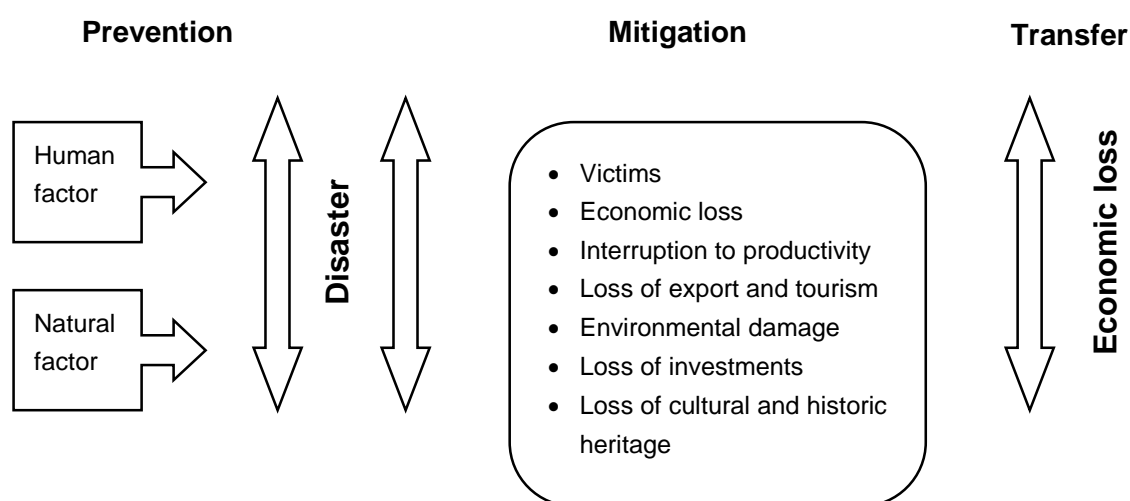


Figure 5. Integrated risk management strategy

4.2 Acceptability of risk

Risks are inherent in any economic or productive activity carried out by human beings, and W&S services are no exception. It is therefore necessary for providers of W&S services to define *acceptable levels of risk* that they are prepared and able to take while operating a system.

Risks will need to be assessed in relation to a range of potential problems, including the duration of service breakdown (days without water supply services), economic loss, victims, environmental damage, or damage to the operator's image. These factors are called *vulnerability factors*.

The criteria used to rate vulnerability factors need to be defined through a consensus between technical specialists, the water provider and relevant authorities. Establishing the level of acceptability for each factor is fundamental to effective risk management, since these criteria will define the required level of reliability for each of the system components and treatment and distribution processes.

The question to pose is: "*What level of interference in service provision are we willing to accept as a consequence of damage to the system?*" The answer to this question based on a good understanding of the potential size of the impact of a disaster will allow the initiation of a systematic process of risk management that includes the following steps¹³:

- Identify and analyse risk scenarios
- Weight and prioritise the scenarios
- Define and implement prevention and mitigation measures
- Transfer part of the risk to insurance companies
- Provide monitoring and follow-up

The Vulnerability Mitigation Works performed on the Orosi Water Supply System in Costa Rica, mentioned in Chapter 5, are a good example of the application of this process.

4.3 Risk and vulnerability analysis (RVA)

Integrated risk management requires a methodology which permits rational and systematic analysis of risks and the definition and implementation of measures to ensure the desired reliability of W&S services to a community. This section outlines the basic steps that virtually all methodologies use to deal with a chain of sub-processes such as W&S services.

Figure 6 presents the issues involved in Risk and Vulnerability Management, each of which is explained in detail in this section.

¹³ If one regards integrated risk management as an administrative system, similar to those defined in the ISO 9000 or ISO 14000 standards, it is necessary to add two further steps – 'communicate the plan' and 'carry out an administrative review'.

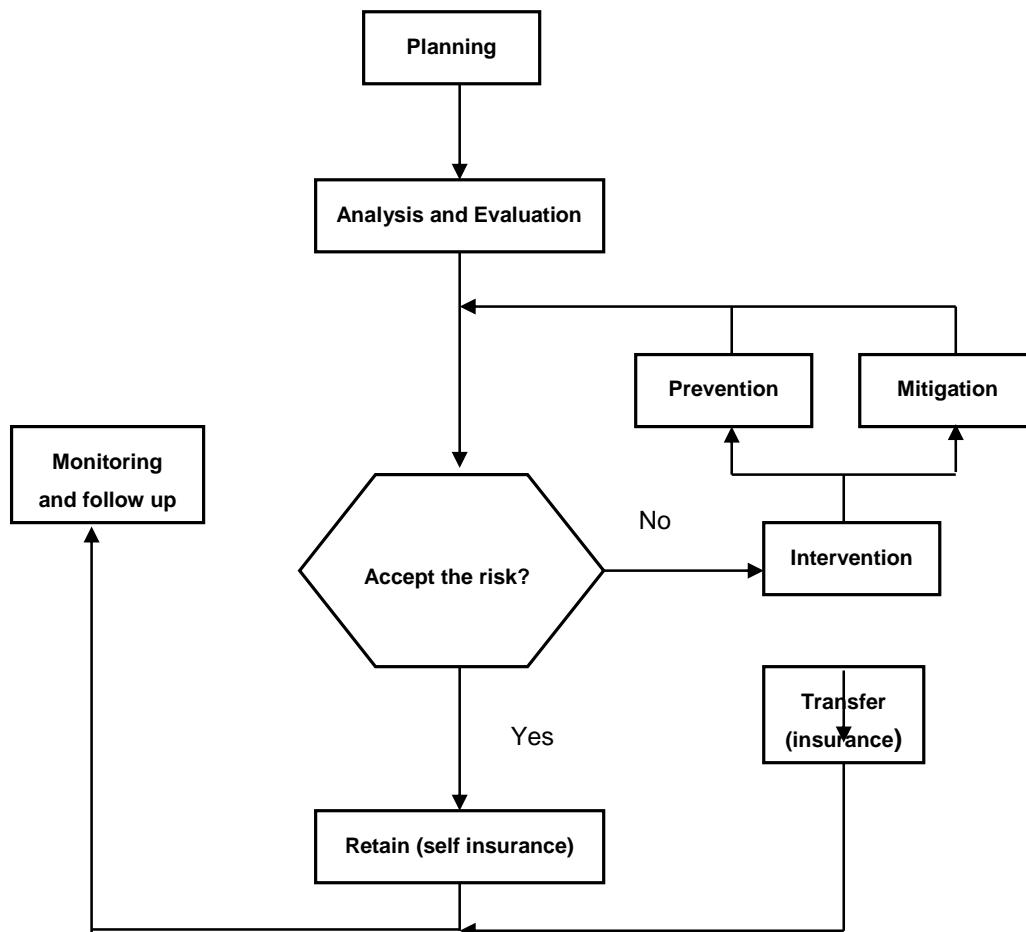


Figure 6. Risk and vulnerability analysis procedures

4.3.1 Planning

Planning involves the definition of the scope of work to be done, the related time frame, the persons or organisations that are involved, and the resources that are necessary to do it. The definition of acceptable risk is also determined in the planning stage.

Although the entire infrastructure which supports the provision of water supply services is almost indispensable, it is common to focus on that part of the infrastructure which has presented most problems or incidents in the past. Another important issue to take into account is the identification of the core components of the system that are needed to provide at least a minimum level of service in case of an emergency. If resource limitations dictate, it may be necessary to begin with an analysis of the main intake(s) and transport network, which may be especially vulnerable because of its location and local conditions.

A similar analysis can later be carried out for other parts of the system such as the treatment plant, storage tanks and distribution networks.

This phase needs to be carried out with technical staff involved in the system as their knowledge and experience are very important for the assessment. It is also important to have access to maps and any technical studies that are available about the system, particularly those that have already looked at some of the risks.

4.3.2 Risk analysis and evaluation

This stage consists of identifying and evaluating the magnitude of the most important risks, as well as the impact that the realisation of these risks could have on the service provider. This involves identification of risk in terms of combinations of threats (probable adverse events) and impacts (consequences).

The risks that may affect the W&S system must be identified and ranked in descending order in terms of their *magnitude of damage* or impact on services, thus obtaining a *risk map* or *risk profile* for the system or installation being analysed. This analysis needs to involve the staff responsible for operating the system.

Subsequently a *vulnerability diagnosis* has to be carried out to identify vulnerable and critical components in the system. This diagnosis:

- Is normally applied to entire systems
- Can be undertaken by representatives of a water and sanitation institution with little or no external assistance
- Should conclusively define the elements that need to be secure, but not necessarily all the vulnerable ones
- Produces primarily qualitative results
- Can be carried out with available or easily obtainable information
- Can be done in a short time
- Is relatively inexpensive
- Forms the basis to develop scenarios that require emergency and contingency plans
- Forms the basis to define prevention and mitigation activities
- Identifies components or threats that require vulnerability studies.

A vulnerability diagnosis can also be carried out when a project is being planned. This will help to identify whether more detailed analysis is needed, special measures need to be taken, special materials need to be used or the project should be redesigned.

The vulnerability diagnosis will determine elements which should receive intervention to reduce their vulnerability, through infrastructure reinforcement. It will also establish if a more in-depth *vulnerability study* is needed of vital components of the system that are exposed to threats, have known weaknesses or are critical, because their failure interrupts system performance or can cause great damage. The vulnerability study:

- Normally requires specialists, coordinated by staff of the service provider
- Should conclusively identify vulnerabilities and proposed strengthening mechanisms
- Provides mostly quantitative results

-
- Often requires additional information to be obtained
 - Takes more time and is more costly than a vulnerability diagnosis
 - Recommends prevention and mitigation activities in existing or proposed future systems.

Together the vulnerability diagnosis and vulnerability study allows service providers or those responsible for governance to:

- Define or redefine equipment and infrastructure maintenance policies
- Improve monitoring and additional care for crucial structures and equipment
- Establish new prevention and mitigation measures
- Reinforce and protect structures in agreement with the most up-to-date seismic resistance standards
- Purchase specific spare parts and accessories with long delivery times
- Define policies for risk transfer to third parties (insurance companies)
- Create a contingency fund (self-insurance).

4.3.3 Intervention

Intervention measures are defined for those risks which require them, based on their level of impact on W&S services provision. It is necessary to evaluate a range of intervention alternatives in order to select those with the best combination of technical, economic, and political viability. There are two basic types of intervention to manage risks:

- **Preventive measures** are measures designed and implemented before the occurrence of a negative event to reduce the causes which can lead to loss, reducing the probabilities of their occurrence. Such measures include engineering works as well as administrative and legislative measures. Urban, environmental, and soil use planning are good examples.
- **Protection and mitigation measures** are administrative and technical measures taken and implemented before the occurrence of a negative event, intended to reduce its impact and associated effects on society and the environment. These measures are not aimed directly at the negative event, but are rather intended to limit its consequences. Emergency and contingency plans fall in this category.

Once intervention measures have been defined, it is necessary to assign resources, responsibilities, time frames and follow-up measures, thus creating a *risk management plan* for the process, business, or service.

This stage also includes *recovery activities*, initiated once the emergencies and contingencies that have affected different processes in the W&S system have been overcome; consisting basically of all the activities aimed at the rehabilitation and reconstruction of the system. In the recovery phase, it is vital to have new resources immediately available, which should be guaranteed by adequate risk transfer measures.

4.3.4 Risk transfer

It is impossible to totally eliminate all risks to a system, while the characteristics of some risks make intervention impossible due to their nature and associated technical, economic, or political difficulties.

To avoid the risk that potential damage from these risks is not repaired, it may be necessary to transfer risks at least partially by means of insurance policies. This involves a specialist company determining a price to charge to assume responsibility for certain risks in a facility. The company guarantees an immediate financial flow needed to implement mitigation, contingency, and recovery measures which allow the system to be brought back to normal operation conditions. Transferring risks to third parties permits the establishment of an equilibrium between operating services, risk administration, and the availability of resources when confronted by natural disasters,

Another approach to managing such risks is *self-insurance*, the retention of resources that can be used if damage occurs. This can be adopted when insurance costs are very high or when the risk is well understood and can be managed with internal resources.

4.3.5 Monitoring and follow-up

Once a risk management plan has been defined, it is necessary to create a monitoring and follow-up plan in order to audit the implementation and effectiveness of intervention measures. It is important to document the results of this step to identify behaviour or early warnings that will assist in decision making. Workshops should be held periodically to evaluate results of monitoring and pinpoint any other signal or behaviour which technicians and systems operators can use to identify abnormalities.

Given that risks are dynamic and change over time, analyses of risk and vulnerability should be cyclical, with their periodicity determined by the characteristics of each system. As in all administrative systems, the key to success is to seek continual improvement which guarantees ever greater service continuity, even after a disaster.

4.4 Vulnerability of water and sanitation systems

Vulnerability is almost an inherent property of W&S systems, since their geographic spread makes them especially vulnerable to natural phenomena. This underlines even more strongly the need to adequately manage risk, adopting early interventions when negative events occur. Conditions which increase the vulnerability of W&S systems include:

1. **Geographical spread:** W&S systems usually cover large areas, due to the remoteness of high-quality and high-quantity sources of water and the location of people in difficult-to-access terrain, so that the systems that serve them are prone to natural and human-caused risks.

-
2. **Necessity of locating system components in high-risk areas:** some system components must, by their nature, be located in high-risk zones. For example, surface water intakes may be located in or near river beds whose water levels may rise while storage tanks may be located on high ground more prone to landslides. This exposure affects not only the structures of W&S systems, but also access routes to reach these structures, making recovery more difficult after an adverse event.

Damage caused by the Bañaderos River to the pipeline which serves the Bahía de Tela Tourism Project and the new Tela Regional Hospital in Atlántida, Honduras. Reconstruction without a detailed study of the causes of this damage might result in re-creating the original vulnerabilities, leading to a repeat of the impact on social and economic life and on tourism.



Photo 3. Damage caused by the Bañaderos river – Honduras.

3. **Demographic pressure in high-risk areas:** it is increasingly common to see poor people who have been displaced by hunger, poverty, or conflict relocate legally or illegally in high-risk areas. They may adopt various measures to bring water to their homes, increasing the risks not only to the area where they live but to entire cities. This situation is especially problematic when pipelines are located on steep slopes where there are higher risks of landslides.
4. **Variable characteristics of system components:** W&S system components have highly variable characteristics, making it possible for the same phenomenon to affect them in different ways. For example, pipelines can flex during an earthquake, but anchor blocks and concrete structures are rigid and tend to remain in place, at least during the first moments of the earthquake. Since they are normally the weakest elements in the overall structure, the pipelines are often the elements that break when the earth moves.
5. **Dependence on other systems:** some W&S system components depend for their continued functioning on other systems such as electricity, highways, and communications. Table 4 presents a summary of the different effects which W&S services provision can suffer as a result of damage to these other systems.

Table 4. Possible effects on W&S systems of damage to other systems. (Adapted from: Applied Technology Council, 1992)¹⁴

Failing system	Impact of effect which failure produces on a W&S system
Electrical supply	Interruption of pumping station and wells Treatment plants breakdown Control centre malfunctions Light fails in facilities
Sewage systems	Delays caused by conflicting demands for machinery and workers Possible drinking water contamination from absorption of faecal material Problems with repairing leakages
Roads and highways	Difficulty in reaching remote infrastructure Delays caused by conflicting demands for machinery and workers Ruptures in pipes attached to collapsed bridges
Telecommunications	Control system malfunctions Delays to repairs
Railroads	Delays in recovery work due to difficulties in obtaining materials, machines, and workers
Natural gas	Delays caused by conflicting demands for machinery and workers

6. **Inflexible designs:** most systems are designed to function under specific conditions, which may change substantially in or after a disaster. Treatment plants, for instance, may cease to operate because the quantity and quality of water entering the plant may change radically during droughts, landslides, or when volcanic ash falls in the watershed. Systems sometimes do not have alternate sources or interconnections that allow them to function partially if some elements cease to operate. Systems with a single supply source, a single storage tank, or a distribution network without interconnections are more vulnerable.
7. **Water quality:** if the water source contains bacteriological contamination, water treatment is essential, making the system more vulnerable than in the case of groundwater systems that are bacteriologically safe but may require removal of iron, manganese or other substances. Failure of treatment in these latter cases is not directly life-threatening.
8. **Necessity of continuous operation:** unlike other operations which can cease operation temporarily without causing major problems for populations, W&S systems need to function continuously, 24 hours per day, 365 days per year. Furthermore, water supply is critical for effective response after a disaster has occurred.
9. **Difficulty of accessing components:** certain components are remote or buried, making it difficult to inspect them during normal or emergency conditions, creating obstacles for the implementation of prevention and mitigation measures and delaying system rehabilitation and the re-establishment of services.

¹⁴ Adapted from: Applied Technology Council (1992). *A Model Methodology for Assessment of Seismic Vulnerability and Impact of Disruption of Water Supply Systems*. ATC-25-1.

10. **Lack of prevention and mitigation measures:** this condition is not inherent in W&S systems, but the effects of natural phenomena are often not considered during the conceptualisation, design, construction, operation and maintenance of systems in developing countries, where the tendency has been to confront the results of disasters only after they have occurred. Even in these cases, there are often no emergency plans, or adequate transfer of risk has not been undertaken to manage service providers' costs or losses.
11. **Invisibility of intervention measures:** investments in risk prevention and mitigation tend to disappear from the minds of the community and responsible authorities since their effects are only in evidence (if at all) in an emergency, which means that there is little pressure to provide them when budget decisions are made. Confronted with obvious vulnerabilities, and taking into account the great impact that failures in W&S services can have in a community, it is obvious that adequate risk management is necessary. Table 5 presents critical elements of the type of management that is required.

Table 5. Key elements in risk management

Before the event: risk prevention and reduction				After the event: recovery	
<i>Risk identification</i>	<i>Mitigation and prevention</i>	<i>Risk transfer</i>	<i>Preparation</i>	<i>Emergency response</i>	<i>Recovery and reconstruction</i>
Evaluation of natural threats (frequency, magnitude, location)	Structural and non-structural mitigation work	Insurance and re-insurance of public infrastructure and private goods	Monitoring, early warning and communications systems	Humanitarian aid	Re-establishment of services and damaged critical infrastructure
Evaluation of vulnerability (population and resources threatened)	Territorial dispositions and construction and maintenance codes	Existing financial market instruments (bonds for catastrophes and other situations)	Shelters and evacuation plans	Cleanup, temporary repairs, and re-establishment of services	Macroeconomic and budgetary management (stabilisation, protection of social expenses)
Risk evaluation (threats and vulnerability)	Economic incentives to promote mitigation measures	Development of new instruments	Response plans (public services companies); emergency response networks (local and national)	Damage evaluation	Restoration of affected sectors (exportation, tourism, agriculture, other)

Before the event: risk prevention and reduction				After the event: recovery	
<i>Risk identification</i>	<i>Mitigation and prevention</i>	<i>Risk transfer</i>	<i>Preparation</i>	<i>Emergency response</i>	<i>Recovery and reconstruction</i>
Monitoring of natural threats and development of forecasts (GIS, cartographic, and study of hypothetical situations)	Education, training, and consciousness raising about risks and their prevention	Decentralisation, concessions or privatisation of public services with regulation about security (energy, water, transport, other)	Disaster funds (national or local), contingency credits	Resource mobilisation for recovery (public, multilateral, insurance, other)	Incorporation of disaster mitigation components in reconstruction activities
Creation and strengthening of national prevention and disaster response systems: These systems form an integrated inter sectorial network of institutions which respond to all of the previously mentioned phases of risk reduction and disaster recovery. Assistance is necessary in the areas of regulation and planning, including reform of judicial and normative frameworks, coordination mechanisms, strengthening of participating institutions, national action plans, prevention policies and institutional development.					

Table adapted from: BID (2000). *El Desafío de los Desastres Naturales en América Latina y El Caribe: Plan de Acción del BID*. Washington, D.C., USA, Interamerican Development Bank. Department of Sustainable Development.

In the specific case of water and sanitation systems, risk management should assure that:

- The majority of systems or components are evaluated and, if necessary, strengthened so that they will not be affected by light or medium intensity adverse events
- Vital components remain functioning, even if only partially, after high-intensity phenomena
- Minimum production and water quality is maintained, to permit the basic supply of safe water for a population to be maintained
- Basic disposal of wastewater continues to be carried out, especially that of hospitals, shelters and other sites of population concentration
- Systems or components damaged by a disaster can be rapidly re-established, decreasing the vulnerability that allowed them to be damaged
- Water and sanitation services providers have their own funds, or can access to such funds through insurance and assistance, which allow them to respond quickly and repair their systems in case of disaster.

4.5 Impact of disasters on water and sanitation systems

The occurrence of high-intensity natural phenomena, such as disasters, together with the vulnerability of water and sanitation systems, has both direct and indirect impacts on services. The Economic Commission for Latin America and the Caribbean (CEPAL)¹⁵

¹⁵ CEPAL (2003). *Manual para la evaluación socioeconómica y ambiental de los Desastres*. (Manual for the evaluation of socioeconomic and environmental impact of disasters) <http://www.cepis.ops-oms.org/bvsade/cd/e/publicaciones/CEPAL/index.html>

states that when carrying out a socioeconomic and environmental evaluation of damage to W&S systems caused by a disaster, one should consider:

- **Direct damage:**
 - Damage to infrastructure and urban and rural system equipment
 - Loss of reserves (chemicals, stored water, replacement parts, and other resources).

- **Indirect damage:**
 - Reduction in the quantity of drinking water
 - Possible cost reduction (less water may have to be provided because the systems are only partly functioning)
 - However, the production costs of water may increase considerably because of water source problems in post disaster conditions
 - Income loss (water not billed for, service suspension, etc.)
 - Complications involving insurance
 - Recovery activities
 - Distribution of water by tankers and other means
 - Equipment and machinery acquisition
 - Repairs
 - Changes in water treatment processes (drinking water and wastewater)
 - Use of materials and supplies held in stock for recovery purposes
 - Overtime pay.

In the following pages, we discuss some of the effects that water and sanitation can suffer as the result of natural disasters.

4.5.1 Physical infrastructure

A water or sewage system is generally composed of many components that differ in location, material, resistance, state and function. A disaster can affect each component in a different way.

The estimated cost of recovery and reconstruction of the water and sewage systems of Honduras, El Salvador, and Nicaragua after Hurricane Mitch in 1998, has been estimated at more than US\$ 250 million (EUR 182 million).

The effect of Mitch on Honduras was devastating. A total of 1,683 water supply systems were damaged (among them, 115 water systems covering the country's 130 biggest populations and 1,318 rural water supply systems), 16 deep wells, and 3,130 manual pumps, affecting a population of approximately 4.37 million people. In total, 75% of the population lost access to drinking water. Before Mitch, drinking water coverage was estimated at 85%; after the hurricane, only 10% of the population had access to water through the water supply system. The damage to the sewerage systems was so serious

that in some cases, domestic wastewater was spilling out of manholes and flowing in the streets.¹⁶

Table 6 summarises possible effects of a natural disaster on the infrastructure of a W&S system, including the watershed and water which feeds the system or receives waste.

Table 6. Possible effects of natural disasters on a water and sanitation system

Disaster and Component	Possible damage
Earthquakes	
Water sources	Watershed landslides and deforestation; increased river bed sedimentation; damming or diversions of channels; hydro geological changes; structural damage in intakes, wells, etc.
Heavy structures (sedimentation and other tanks, plants)	Structural damage from differential settling; soil liquefaction; movement of faults; broken input and output tubes due to concentration of shear forces; structural fissures and cracks in water containment structures causing leaks and losses.
Pumping stations	Damage to electrical systems, either from general service interruption or in the system's own electrical components; structural damage to equipment and operating facilities.
Pipes (for drinking water and sewage)	Breakage in tubes or accessories; joint failure; flattening or flexing of tubes caused by earthquakes and soil deformation.
Other	Fallen chlorine cylinders and gas leaks; landslides and access road obstruction; interruption of communication and telemetry services.
Landslides	
Water sources	Partial or total obstruction of river beds, eventually causing mudslides which can move or destroy intakes; increased channel sedimentation.
Heavy structures (sedimentation and other tanks, plants)	Structural damage from falling materials if the landslide passes over the structure, or failure of foundations if it occurs below the structure.
Pipes (for drinking water and sewage)	Deformation or dragging of pipes, causing leaks which can increase the magnitude of the landslide.
Other	Obstruction of access roads.
Flooding	
Water sources	River bed diversions; increased sedimentation; contamination of groundwater by overloaded aquifers.
Elements near river beds (intakes, sedimentation tanks, sewers, oxygenation lakes, others)	Destruction, dragging, or burial by flooding; floating of structures which are empty at the time of the flood.
Treatment plants	Settling due to loss of soil resistance caused by saturation; damage to electrical equipment and facilities from short circuits and other damage caused by submersion; total interruption of plant operation due to submergence and the entry of large amounts of sediment in its components; destruction of stored

¹⁶ PAHO (no date). *Impact of Hurricane Mitch on Central America*. www.paho.org/spanish/ped/pedmitch.htm

Disaster and Component	Possible damage
	chemicals that should be kept dry.
Pipes (for drinking water and sewage)	Breakage and dragging of pipes located in bridges, special elevated pipeline support structures, and river margins.
Hurricanes	
Water sources, heavy structures, and pipelines	Hurricanes generally cause flooding and landslides, with the attendant damages mentioned previously. They can also provoke strong watershed deforestation.
Elevated tanks	Fallen or detached tanks and other structures as a result of strong winds.
Other	Damage to other infrastructure exposed to high winds (detached roofs, broken glass, fallen objects, etc.).
Volcanic eruptions	
Water sources	Increased sedimentation and acidification of water due to ash falls .
Elements near lava and mud flows	Destruction or dragging by lava or mud flows, if the eruption occurs on a snowy peak, of the components which are near the flows.
Other	Obstruction of intakes; pipelines and roofless structures from ash falls; damage to unpainted metallic structures from acid rain; structural damage from falling pyroclastic material; damage to electromechanical equipment by ash.
Drought	
Water sources	Drastic decrease of the available water quantity
Distribution pipelines	Leaks and contamination of the distribution network. When rationing is implemented, the network empties, which allows the entry of contaminants in broken or open points. When water returns to the system, air trapped in pipelines generates leaks when it attempts to escape.

In the case of the El Niño phenomenon in Ecuador in 1997-1998, the water and sanitation sector suffered losses of approximately US\$ 5.6 million (EUR 4 million) due to direct damages and US\$ 11.6 (EUR 8.4 million) million due to indirect damages.¹⁷

The history of the damage to W&S systems in Ecuador indicates:

“The supplies of water, as well as sewage and rainfall runoff disposals were severely affected by rains, avalanches and swelling rivers. The damage was made worse by the fact that systems had been inadequately maintained.

Water supplies to many urban communities were affected by the disaster due to sediments in open channels, breakages in pipelines and damages to the distribution network. In other cases, both shallow and deep wells which supplied water to the network were flooded. In some areas, the water supply was interrupted for weeks, and in at least two cases the re-establishment of water services took months.

In addition, the quality of water fell due not only to an increase in turbidity but also to the absence of sufficient chlorination. Sewage systems in urban coastal areas were severely damaged to the point that they did not work and even generated discharges of wastewater in unexpected locations. Some treatment ponds were flooded by rising waters, but the

¹⁷ Source: Comisión Económica para América Latina y el Caribe-CEPAL (1998). *Ecuador: Evaluación de los efectos socioeconómicos del Fenómeno El Niño en 1997-1998* LC/R 822/Rev. July 1998

underwater outlets did not suffer greatly. In some rural zones, floods devastated latrines and septic trenches; in other cases latrines overflowed and this in addition to filtration from these damaged facilities caused contamination of water supply sources.”¹⁸

4.5.2 Finances

A water institution can suffer a range of financial effects from a disaster, especially if it has not taken steps to transfer risk. The principal financial effects are related to activities to deal with emergencies and unforeseen events, as well as with system recovery. These activities are described at the beginning of section 4.5 in the list identified by CEPAL.

In Piura, Peru, the sanitary services provider GRAU S.A. reported the following economic effects produced by El Niño phenomenon of 1997 -1998:

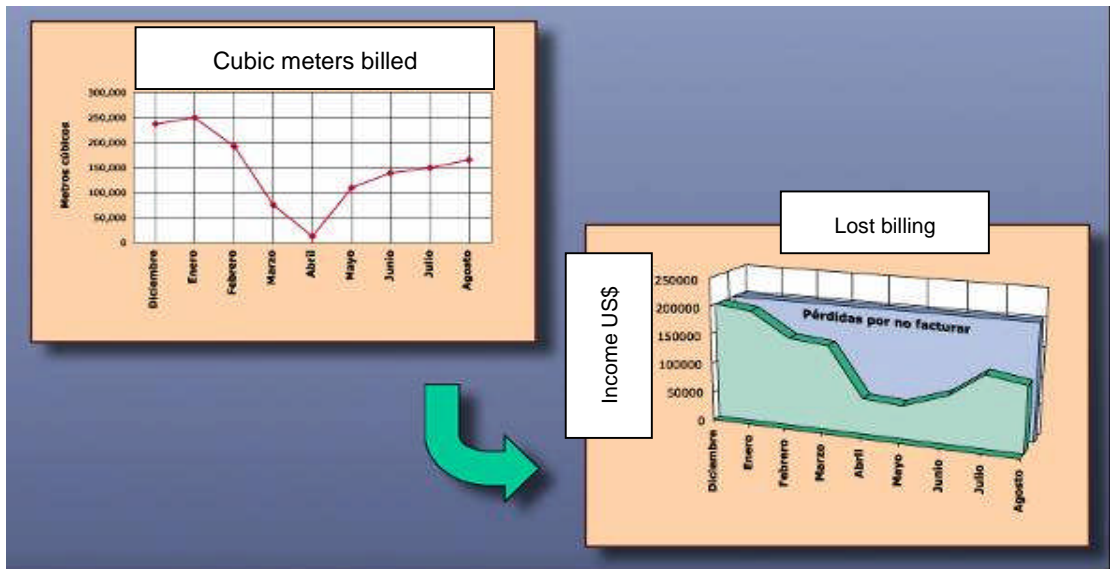
“The major non-physical impact was to worsen the company’s precarious financial situation.

The service obviously has an operating cost which should be covered by user fees to insure continuity and development. However, there was a chronic problem with balancing costs and income due to a large percentage of unac counted for water and a high rate of overdue payments. Before and during the El Niño phenomenon the population understandably changed its economic activities to meet new priorities caused by the need to protect housing and store food; this attitude weakened peoples’ ability and desire to pay water bills.

The organisation could not rise above this situation, since it was necessary to protect its facilities, and to incur increased operating costs to continue offering a basic service that was directly related to public health. On the other hand, when several supply pipelines failed, billing fell accordingly, making the gap between income and expenses even greater”¹⁹

¹⁸ Organización Panamericana de la Salud (2000). *Crónicas de DESASTRES: Fenómeno El Niño 1997-1998*.

¹⁹ EPS GRAU S.A. (1998). *El Fenómeno El Niño 1998 y su Efecto en los Servicios Básicos de Saneamiento en el Departamento de Piura. Perú*. www.cepis.org.pe/bvsade/cd/videos/grau.htm



Adapted from: OPS/OMS. Presentation on *Mitigación de Desastres en Sistemas de Agua Potable y Saneamiento* <http://www.cepis.ops-oms.org>

Figure 7. Decline in billing and income reported by an Ecuadorian provider of sanitation services during the El Niño of 1997-1998

5 Disaster prevention and risk management in drinking water and sanitation systems: a shared responsibility

A large range of actors are involved in the planning, design, construction, operation and maintenance of water supply and sanitation systems. They include service operators (public, private, or mixed), local authorities, governing and regulating entities, financial and support organisations, NGOs, the community, universities, and sanitary and environmental engineering professional associations. Many of these organisations also play an important role in meeting the challenge to change to a new paradigm of active anticipation of potential disasters, rather than from the conventional reactive approach after the event.

It is encouraging to see that the change towards disaster prevention and risk mitigation is already taking place in several countries of Central and South America. This change is of great importance because it may cost 10 or even 20 times more to remedy the results of emergencies and disasters than to prevent them.

This makes it very important to help actors to adopt roles and activities in relation to disaster prevention and risk mitigation. This section presents these roles and stresses the overall responsibility of the government to ensure that proper action is taken. The information presented in this section is based on a number of publications listed in Sections 6 and 7 of this document.

5.1 Governmental, planning, environmental, and municipal authorities

Governmental, planning, environmental and municipal authorities are responsible for land use, use of natural resources and planning development. They have a fundamental responsibility to achieve a balanced use of secure sources of water, to design systems which transport water from these sources, to define safe zones for population settlements, and to support rural water conduits.

National and regional government agencies should:

- Create soil use and geotechnical maps, and make them known to the community, municipal authorities, and universities
- Define medium- and long-term planning which clearly specifies the zones in which services expansion will be required
- Define the watersheds that will supply water in the medium and long term and define measures to protect these sources
- Work with operators to identify risks, create their own risk maps, and define prevention and mitigation measures
- Draw up plans to make physical and financial resources speedily available to assist service operators in recovering following a disaster and in rebuilding infrastructure
- Facilitate the use of Geographical Information Systems for the study of risks and responses to risks by authorities, small municipalities and the community in general

-
- Provide technical and financial resources to rural systems to contribute to their modernisation and to their ability to make contingency plans for emergency situations.
 - Promote decentralisation of responsibility for drinking water and sanitation systems.

It is important to take account of the increased popularity of decentralisation of W&S services provision as a part of state modernisation. This basically consists of ceding the responsibility for service provision to specialised operators – public, private, or mixed – through concessions, in order to improve efficiency and coverage.

Even though this strategy has had impressive results in some cases, where there is lack of effectiveness by the regulating entity, or an inability to pay for services in communities, it is difficult to balance operating costs and revenue from bills, making even modest investments towards risk management difficult.

Organisations promoting decentralisation must create strategies to generate enough income to finance preventive actions for the most serious risks identified in drinking water and sanitation systems, since it can cost 10 or 20 times more to respond to emergencies and disasters, than to prevent them. The strategy of transferring operations of some public services and their risks does not necessarily imply transferring responsibility for maintaining security and continuity of services. It is the duty of oversight agencies, NGOs, and community organisations to assure this security and continuity, and to demand that the state assists by going beyond simply awarding concessions to third parties.

Municipal governments should:

- Develop maps of land use regulations, defining areas deemed as unsuitable for schools, hospitals, human settlements, industries, etc.
- Provide advice to community emergency committees and sponsor training, simulated exercises for evacuation and similar measures
- Raise awareness in schools, community action boards (CABs) and other community organisations about the importance of risk management measures, disseminate important findings from risk studies in their areas, and support community-generated risk management
- Monitor contingency measures adopted to overcome emergencies and ensure that they are not regarded as definitive, so that the initial risk conditions for the population do not remain static or increase
- Statistically quantify the frequency of negative events and disasters and their impact on the population and W&S systems, so that the benefits of investment in risk management strategies can be demonstrated to decision-makers.

5.2 Governing and regulating authorities of water and sanitation services

Governing and regulating authorities that oversee the definition of norms and operating conditions and balance the interests of the community, the government, and services

providers, have a fundamental and strategic role, given the far-reaching importance of the W&S sector. These institutions should:

- Include in norms for design and construction, criteria related to the analysis of risk and vulnerability, as well as for disaster prevention and mitigation
- Update norms based on lessons learned from large-scale negative events and disasters
- Define clear policies and programmes for monitoring and following up on current norms
- Assign necessary and sufficient resources to control compliance with norms
- Create incentives to encourage service providers to implement measures against risks
- Facilitate the interchange of experiences and advice among service providers
- Specify in concession contracts for W&S services an obligation to provide integrated risk management, indicating minimum levels of service quality that should be provided in emergency and disaster situations
- Specify norms for water quality and minimum service conditions provided to populations in emergency conditions

5.3 Service providers

Water and sanitation service providers are the main agencies active in this area. They should:

- Determine corporate risk policies specifying methodologies, resources, criteria and procedures they will use to manage risk
- Undertake risk and vulnerability analyses and define risk maps for the system
- Produce risk management plans which specify the intervention measures they will implement when dealing with events that pose the main risks to the system
- Take advice when creating risk maps and specifying intervention measures and learn from the knowledge, experience and information of municipal, environmental, and planning authorities, as well as NGOs and other organisations
- Take risks into account when designing, constructing and operating systems
- Update protocols and routines used in the operation, and preventive and predictive maintenance of the system, taking into account risk management and ensuring that programmed actions are strictly carried out
- Avoid reconstructing structures damaged by negative events or disasters in such a way that this repeats or reconstructs the vulnerabilities they had before the event
- Design emergency and contingency plans to confront possible disasters and carry out simulated exercises to prepare for them
- Evaluate effects of and reactions to all negative events or emergencies in a detailed manner, and specify measures to prevent or mitigate their repetition
- Maintain records of the lessons learned in emergencies and disasters, in order to not repeat previous mistakes
- Systematically train administrative and operations staff in integrated risk management
- Assign sufficient resources to emergencies and contingencies and define high-priority procedures

- Clearly explain the criteria for transferring risk to third parties to facilitate recovery and minimise the impact of catastrophic events on the community
- Consider the construction of contingency structures and redundant systems in medium-sized and large cities, in order to make systems more flexible and to mitigate possible impacts of social or natural disasters on the community
- Maintain an up-to-date inventory of the technical characteristics of the various networks which provide services, including information about their age, materials, location, number of failures, causes of failures and useful life, since this information is a vital element for planning the possible relocation of system elements
- Purchase reserve stocks of pipes, accessories, and equipment which is likely to be affected by natural disasters that cannot be prevented or mitigated effectively, and which must be imported or manufactured on a customised basis
- Contract specialist firms to carry out geotechnical assessments and studies of structural deficiencies, seismic resistance, flood zones, future watershed use and water sources, to be used in future reconstruction or in remodelling projects.

The photo shows the reconstruction of a rural system which was affected by a mud slide. The new pipeline was placed 'provisionally', but remains in place several months later, and is much more vulnerable than the original pipeline.



Source: Arturo Rodríguez, 2003.

Photo 4. Reconstructing vulnerability in a rural system

5.4 Donor, finance, and other funding organisations

Donor, finance and other funding organisations, such as solidarity NGOs, have a strategic role, and their views are respected by operators as well as regulating agencies. They should:

- Demand that risk and vulnerability analysis from natural and human-caused disasters be included within the analysis of a project's environmental impact
- Make credits and interest rates conditional upon taking risk management into account in the planning, construction, and operation of the project being financed
- Redefine policies for the reconstruction of systems affected by disasters, in order to avoid the reconstruction of vulnerabilities in systems under the same conditions of risk that existed before the disaster.

5.5 Universities, technical institutes, and professional bodies

Centres of learning such as professional training institutions have a key role in developing and disseminating conceptual changes to risk management. These institutions should:

- Include risk management in the curricula of professions related to W&S services
- Publicise and make available existing information on the subject, through theses, publications, conferences, etc.
- Provide incentives for investigation and consultancies for service providers in these areas
- Advise and train community organisations.

5.6 Communities

When responsibility for public structures is assumed by a community, it often also adopts the associated risks. People in the community should:

- Inform themselves in detail about the risks and vulnerabilities that they are exposed to, and prepare effective measures for risk intervention, with support from state agencies
- Organise themselves to confront possible disasters through the formation of emergency brigades and evacuation plans
- Organise water committees to help them reduce the vulnerability of their systems and to respond effectively in case of a disaster
- Participate in the formation and integration of 'popular knowledge' in rural populations with 'technical knowledge' about risk management. Both are important in the planning and design of W&S systems.

6 Case studies / best practices

Orosi Water Supply System, Costa Rica²⁰

The Orosi Water Supply System belongs to the Costa Rican Water and Sewage Institution (the Instituto Costarricense de Acueductos y Alcantarillados, or "AyA"). It was constructed in 1987 at a cost of US\$ 53 million (EUR 38 million), and is the most important system of the Institution. It serves approximately 40% of the population of San José, the capital of Costa Rica. The pipelines pass through zones that are exposed to various risks, including earthquakes, landslides, erosion, river flooding, and structural threats of the pipelines themselves. The system has been reinforced in a sustained process beginning in 1994 to reduce its vulnerability to these threats, at a cost of US\$ 1.5 million (EUR 1 million), while the cost of an eventual collapse of the system is estimated at US\$ 7.3 million (EUR 5.3 million).

In this case the investment in prevention and mitigation represents only 3% of the total construction cost and 20.5% of the direct costs of a system collapse. The indirect costs of such a collapse, including loss of human life, inconvenience to system users and substantial loss of national productivity, have not been estimated, but would almost certainly be far higher than the direct losses.

INAA-Nicaragua Regulations²¹

After Nicaragua was strongly affected by Hurricane Mitch, the vulnerability of W&S services in the country became apparent through 28 vulnerabilities studies. In response to this, the Nicaraguan Water and Sewage Institute, which regulates services in the country, has created several tools to contribute to the study of risk management of W&S systems, including the following:

- A guide to the general terms used in carrying out vulnerability analyses and emergency plans for drinking water and sanitary systems (G-05095-INAA)
- A technical guide for the reduction of vulnerability in drinking water and sanitation supply systems
- Technical guides which incorporate mitigation measures for the construction and operation of W&S systems in the face of disasters.

These guides are currently adopted as standards by the Nicaraguan Fund for Emergency Social Investment (FISE). This body finances new rural systems and makes use of the guides a condition for lending money for projects and systems.

²⁰ Based on a presentation by Arturo Rodríguez, M.Sc., during the Latin American Workshop on Vulnerability Reduction in Drinking Water Systems. Nicaragua, April 2004

²¹ Based on: *Analysis of the Drinking Water and Sanitation Sector in Nicaragua*, PAHO (not yet published)

EMAAP-Q Prevention, Quito, Ecuador²²

The Metropolitan Sanitation and Water Company of Quito (La Empresa Metropolitana de Alcantarillado y Agua Potable de Quito, or EMAAP-Q) was able to respond efficiently to problems caused by a substantial ash fall produced by the Pichincha Volcano in October, 1999, thanks to the development of risk management plans. Because of this contingency planning for critical threats to the water supply, and its experience with the Pichincha ash fall, the Company was also able to avoid suspending services in a similar event caused by the Reventador Volcano in November 2002, and continued to provide drinking water to the population.

Some of the elements included in the company's risk management plan are:

- Redesign of surface water intakes to keep out sand and ash from volcanos
- Placing covers on filters and other open structures in water treatment plants
- Obtaining mobile sludge pumps with enough capacity to remove sand and ash sediments.

Empresas Públicas de Medellín (EPPMM), Colombia²³

EPPMM is a public services company that operates water, sewage, electricity, gas and telecommunications services in Medellín, Colombia. In 1999 the company established a Risks and Insurance Unit to coordinate a corporate policy on integrated risk management, which has enabled the company to refine its work on risk prevention and mitigation, improving its standards of service quality and continuity.

This unit provides direct technical and operational assistance in risk administration for the processes and structures that allow the company to provide water and sanitation services. They prepared a Guide for Preparation of Emergency Plans.

Other successful actions include:

- Risk and vulnerability analysis exercises (risk mapping) for processes and installations, and definition of risk administration plans
- Development and implementation of emergency and contingency plans for multiple scenarios, including water contamination, chlorine leakage, and energy failure
- Periodic monitoring of pipelines to detect negative impacts of natural agents
- Preventive maintenance of civil works, pipelines, and electromagnetic equipment
- Construction of retaining structures and relocation of pipelines located in geotechnically unstable ground

²² Based on: 1. Cueva, Manuel (No date). *Gestión de riesgos en los sistemas de agua potable de Quito*. Ecuador; and 2. Organización Panamericana de la Salud [OPS] (2003). *Efectos de la erupción del volcán Reventador (2002) en los sistemas de agua y alcantarillado – Lecciones Aprendidas*. Lima, Perú. <http://www.Paho.org/desastres>
<http://www.disaster-info.net/watermitigation/e/publicaciones/Reventador/index.html>

²³ Based on: Empresas Públicas de Medellín (1999). *Administración de Riesgos*. Medellín, Colombia

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- Construction of pumping stations and the installation of valves to facilitate interconnection of water circuits for continued service provision in emergency situations.

Decree 475 of the Colombian Health Ministry²⁴

The Colombian Health Ministry issued Decree 475 in 1998, and among other aspects, it regulates the technical norms for water quality in normal and emergency conditions.

Among other things, it indicates:

- Article 50: Any individual or corporate firm that carries out designs or studies for a water supply system should include a vulnerability analysis to identify potential risks and dangers
- Article 51: Any person who provides public water services should have an emergency operating plan based on vulnerability analysis which guarantees that as soon as an emergency occurs there will be measures to be implemented immediately, especially to avoid risks to health
- Article 52: In emergency operating plans, priority shall be placed on taking into account the most probable risks detected in the vulnerability analysis.

Aguas del Illimani, La Paz, Bolivia²⁵

The water company Aguas del Illimani of La Paz, Bolivia, has detailed an Emergency Prevention Plan as part of contractual obligations acquired with the service provision concession. The plan included:

- Vulnerability assessment of the water supply systems of La Paz and El Alto cities
- Identification of the elements (problems-causes-effects) that make up the risk
- General measures to prevent emergencies
- Prioritisation of mitigation measurements identified in the 1998 Emergency Prevention Plan
- An action plan.

Preparations by the company between 1998 and 2000 mitigated the possible impact of a flood that occurred in February 2002, when La Paz was declared a disaster area because of extremely heavy rainfall which destroyed various parts of the city.

National Engineering University of Nicaragua²⁶

The National Engineering University (UNI) of Nicaragua is the main centre in the country for the professional training of engineers and future designers, constructors, and operators

²⁴ Based on the presentation of Eng. Dumar Toro during the Latin American Workshop: 'Vulnerability Reduction in Potable Water Systems'. Nicaragua, April 2004.

²⁵ Otero, María (2003). *It's urgent: Introducing risk management in the Drinking Water and Sanitation Sector*. Revista ABIS. La Paz, Bolivia.

²⁶ See <http://www.uni.edu.ni>

of drinking water systems. It is beginning to incorporate risk management in its curricula for undergraduate Civil Engineering, and the Masters Programme in Environmental Engineering. In January 2004, Arturo Rodríguez, from Costa Rica, with the support from PAHO, presented the first training course to familiarise professors and students with these subjects.

University of Honduras

A Masters Programme in Risk Administration began in 2003 at the University of Honduras, which includes modules on disaster prevention and mitigation in water and sanitation systems. This subject is also being included in the Masters Programme in Public Health, and in the Nursing Programme at the university's medical school. In the engineering schools, some teachers and students have participated in training courses given by PAHO/WHO, and some professors have included this subject in their areas of work, although the subject is not yet officially incorporated into the corresponding curricula.

7 TOP books, articles, papers

A selection of publications and articles is listed in this section. Many of them are in Spanish. For further reading in English, also review the web site:

<http://www.disaster-info.net/watermitigation/i/publications.html>.

Manual para la mitigación de desastres naturales en sistemas rurales de agua potable. (Manual on mitigation of natural disasters in rural drinking water systems)

Authors: Plaza N., Galo; Yepéz A., Hugo

Source: Quito: PAHO, 1998. 86p. maps, tab. Serie Mitigación de Desastres (Series on Disaster Mitigation)

Vulnerabilidad. El entorno social, político y económico de los desastres

(Vulnerability. The social, political, and economic context of disasters)

Authors: Piers Blaikie, Terry Cannon, Ian Davis y Ben Wisner

Source: La Red, 1995. 374p. <http://www.desenredando.org/public/libros/index.html>

Navegando entre brumas. La aplicación de los sistemas de información geográfica al análisis de riesgo en América Latina (Cruising in the mist. Application of geographic information systems to risk analyses in Latin America)

Authors: several. Editor: Andrew Maskrey

Source: La Red, 1998. 344p. <http://www.desenredando.org/public/libros/1998/index.html>

La reducción de riesgos de desastres, un desafío para el desarrollo, un informe mundial (Reducing disaster risks, A challenge for development. Global report)

Author: United Nations Development Programme (UNDP). Bureau for crisis prevention and recovery.

Source: UNDP. Bureau of crisis prevention and recovery, 146p, 2004

http://www.undp.org/bcpr/disred/documents/regions/america/2004/eird/rdrinforme_eng.pdf

Planificación y protección financiera para sobrevivir desastres

(Planning and financial protection to survive disasters)

Authors: Keipi, K. and Taylor, J.

Source: Banco Interamericano de Desarrollo, Depto. de Desarrollo Sostenible, División de Medio Ambiente. Washington. Reference number 658.155 K282-dc21.. 2002

A model methodology for assessment of seismic vulnerability and impact of disruption of water supply systems

Author: Applied Technology Council, 1992. ATC-25-1.

Facing the challenge of natural disasters in Latin America and the Caribbean: An IDB action plan

(El desafío de los desastres naturales en América Latina y el Caribe: plan de acción del BID)

Author: Inter-American Development Bank (IDB)

Source: IDB, Department of Sustainable Development. Washington, USA, 2000

Manual para la evaluación socioeconómica y ambiental de los desastres

Manual for estimating the socio-economic effects of natural disasters

Author: Economic Commission for Latin America and the Caribbean (ECLAC/CEPAL), 2003.

Source : <http://www.cepis.ops-oms.org/bvsade/cd/e/publicaciones/CEPAL/index.html>
(English: <http://www.eclac.org/publicaciones/xml/8/7818/partone.pdf>)

Minimizing earthquake damage – a guide for water utilities

Author: American Water Works Association.

Source: AWWA – Reference ISBN 0-89867-750-5, Colorado, USA.

Seismic design and retrofit of piping systems

Authors: several. Editor: American Lifelines Alliance

Source: American Society of Civil Engineers (ASCE), Federal Emergency Management Agency (FEMA), 2002.

<http://www.americanlifelinesalliance.org>

Development of guidelines to define natural hazards performance objectives for water systems (Volume I & 2)

Authors: several. Editor: American Lifelines Alliance,

<http://www.americanlifelinesalliance.org>

Source: American Society of Civil Engineers (ASCE), Federal Emergency Management Agency (FEMA), 2002.

Publications on the Internet

InfoDesastres http://www.disaster-info.net/socios_sp.htm is the doorway to Web pages of many organisations involved in risk management, with special focus on Latin America and the Caribbean. All materials are presented in their original language. Some links are:

- OPS/OMS Programa de preparativos para Emergencias. (Emergency preparedness programme) <http://www.paho.org/spanish/dd/ped/home.htm>
- CRID - Centro Regional de información para Latinoamérica y el Caribe. (Regional Information Centre for Latin America and the Caribbean.) <http://www.crid.desastres.net/crid/esp/index.html>
- EIRD - Estrategia Internacional para la Reducción de Desastres. (International Strategy for Disaster Reduction.) <http://www.eird.org/>
- CDERA - Caribbean Disaster Emergency Response Agency (only in English). <http://www.cdera.org/>
- CEPREDENAC - Centro de Coordinación de Prevención de Desastres Naturales en Centro América (Coordinating Centre for the Prevention of Natural Disasters in Central America.) <http://www.cepredenac.org/>
- Material de capacitación sobre accidentes químicos. (Teaching materials on chemical accidents.) <http://www.disaster-info.net/quimicos/index.htm>

LA Red de Estudios Sociales en Prevención de Desastres en América Latina (LA RED). (Social Studies Network for Disaster Prevention in Latin America.)

<http://www.desenredando.org/public/libros/index.html>

Initially conceived to facilitate investigation of natural disasters from a social perspective, LA RED has become an essential source for those working on disasters and risk management in Latin American and Caribbean countries. Some of its publications are:

- Educación y prevención de desastres (Education and prevention of disasters)
- Riesgo y Ciudad (Risk and the City)
- Escudriñando en los desastres a todas las escalas (Study of disasters of all magnitudes)
- Los Desastres no son naturales (Disasters are not natural)
- Gestión de riesgos ambientales urbanos (Management of urban environmental risks)

Publications by the International Federation of Red Cross (IFRC) – World report on Disasters. <http://www.ifrc.org/sp/publicat/wdr2004/>

Journals

- Estrategia internacional para la reducción de desastres. EIRD informe – América Latina y el Caribe. (International strategy for disaster reduction. EIRD Report – Latin America and the Caribbean) <http://www.eird.org>.
- Revista desastres & sociedad. (Journal on disasters & society) <http://www.desenredando.org/public/revistas/dys/index.html>

8 TOP websites

<http://www.eird.org/index-esp.html>

Estrategia Internacional para la Reducción de Desastres América Latina y el Caribe EIRD
International strategy for risk reduction in Latin America and the Caribbean

<http://www.desenredando.org/>

Social studies network in risk prevention in Latin America

<http://www.americanlifelinesalliance.org/>

American Lifelines Alliance (ALA) is a public/private project of the society funded by Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS), aimed at risk reduction in vital services.

<http://cinara.univalle.edu.co/>

Cinara is one of the most important Latin American institutes in water, water delivery infrastructure, and sewage management. They have experience in management of risks related to water systems.

<http://www.desinventar.org/desinventar.html>

An inventory system of disasters. In the public domain are databases on disasters in Colombia and other countries, as well as consulting software (DesConsultar).

<http://www.cdera.org>

A Caribbean disaster-response agency, CDERA's main focus is to provide immediate coordinated response to participating countries requesting help in the face of any catastrophic event.

<http://www.cepredenac.org>

The Central America's Centre for the Prevention of Natural Disasters has a mandate to promote reduction of natural disasters in Central America by exchanging experiences, technologies and information. It analyses common strategic subjects, and promotes and coordinates international cooperation.

9 TOP courses, institutions and research centres

Courses

Health, disasters and development. An international course for managers.

Organised by OPS/WHO, to promote acquisition of knowledge and skills to lead risk-management programme, aimed at health, disasters, and development in Latin American countries. Information: <http://www.disaster-info.net/LIDERES/>

Management, prevention and attention to disasters

Trains professionals in the development of risk-reduction skills and knowledge, and in management of disaster scenarios. Technological University of Pereira, Colombia. Information: Dr. Dr Jesús Herney Moreno Rojas; hermon@epm.net.co Telephone: (+57 6) 3215402

Risk evaluation and disaster prevention, and sanitation management in emergencies and disasters

Organised by the University of Los Andes, Colombia, this specialisation identifies, studies and assesses natural and man-caused threats, vulnerabilities and risks.

Departamento de Ingeniería Civil y Ambiental. Telephone: 3324312/14/15 Fax: 3324313 Carrera 1 No. 18A-70 (Edificio W - Piso 3) Bogotá, Colombia. spedic@uniandes.edu.co

Sanitary management of emergencies and disasters

<http://guajiros.udea.edu.co/fnsp/Documentos/Otros/ESPDesastres.pdf>

University of Antioquia (Medellín-Colombia), Facultad Nacional de Salud Pública.

Telephone 57-4 5106809, 5106802 and 5106804.

E-mail: jflorez@guajiros.udea.edu.co.

<http://www.udea.edu.co>.

Integrated risk and disaster management

An Internet higher education course from the Polytechnic University of Cataluña (UPC), through the International Center for Numerical Methods in Engineering (CIMNE) and Structures. <http://www.structuralia.com/cdl1/cvdata/curso70/info/default.asp>

Institutions / Resource Centers

Centro Nacional de Prevención de Desastres (CENAPRED)

(National Centre for Disaster Prevention), Mexico. CENAPRED was created through a Cooperation Agreement between the Mexican and Japanese governments for technology use and transfer in disaster prevention. <http://www.cenapred.unam.mx/>

Centro Regional de Sismología para América del Sur (Ceresis)

(Regional Seismology Center for South America). Lima, Perú. Ceresis is an international organisation created in 1966, through an agreement between the Peruvian government

and UNESCO (United Nations Organization for Education and Culture), to promote and help to implement seismologic studies and activities in South America, and to establish links between seismologic stations and institutions in the region, and other international seismologic centres. <http://www.ceresis.org>

Dirección General de Protección Civil y Emergencias. Ministerio del Interior de España. (Directorate for Civil Protection and Emergencies. Ministry of the Interior, Spain).

Its mission is to physically protect people and goods who are at serious collective risk of public calamity or catastrophe, in which lives and safety may be in danger.

<http://www.proteccioncivil.org/index.html>

The Directorate is linked to the Protección Civil journal, which contains important articles about prevention of and attention to emergencies and disasters.

<http://www.proteccioncivil.org/boletrevispc.htm>

10 TOP contacts

The persons mentioned in this section mostly work in Latin America. We invite those professionals working in other parts of the world to share their contact details with us.

Juan Diego Narváez Osorio. Geologist specialising in the management, prevention and attention to disasters. Advisor in risk management to the Water and Sewage Institute of Pereira (Agua y Aguas de Pereira). Tel: 57-6 3361479.

E-mail: juanchonarvaez@hotmail.com.co

Juan Carlos Giraldo Ospina. Civil Engineer specialising in Management, Prevention and Attention to Disasters. Planning Assistant Manager of the Water and Sewage Institute in Dosquebradas. SERVICIUDAD (Dosquebradas – Risaralda-Colombia). Cell phone: 310-8327840.

E-mail: jcgo@epm.net.co

Luis Carlos Martínez Medina. Civil Engineer specialising in Disaster Management and Prevention. Director of the International Investigation and Educational Center in Risk Management. Avenida Bolívar No. 7-46. Tel: (57-6) 7460401, Armenia (Quindío-Colombia).

E-mail: ciger@ugcarmen.edu.co, luisdesas@hotmail.com

Jorge Rivera Cevallos. Operations and Maintenance Manager. Quito's Water and Sewage Metropolitan Institute. Av. Mariana de Jesús e Italia. Telephone: 250 1255/250 1225 Ext. 116. Quito (Ecuador).

E-mail: jrivera@emaapq.com.ec

Jesús Herney Moreno Rojas. Professor and Director of Management, Prevention and Attention to Disasters, Technological University of Pereira UTP. Telephone: (57-6) 3215402.

E-mail: hermor@epm.net.co

Jaime Guzmán Giraldo. Geologist, expert in Geographic Information Systems analysis of risks and disasters. Experience in vulnerability studies for water and sewage systems. Pereira, Colombia. Telephone: (+57-6) 3364327.

E-mail: colombiajaigu@yahoo.com

Bernardo Caicedo. Civil Engineer PhD., Associate Professor, Department of Civil and Environmental Engineering University of Los Andes, Santa Fe de Bogotá. Expertise in seismic behaviour of underground pipes. Telephone: (+57-1 3324327 ext 2800).

E-mail: bcaicedo@uniandes.edu.co

Arturo Rodríguez Castillo. Costa Rica. Civil Engineer. M.Sc. in Hydric Resources. Private PAHO consultant in the field of Risk Management in Water and Sanitation Services. Phone (506) 253-68-67. E-mail: hidrogeotecnia@gmail.com

11 TOP quiz

1. What are the main links between poverty and water and sanitation services?
2. What are the main uses of water in emergency conditions?
3. Why is it said that human activity has contributed to an increase in the number of disasters and their impact around the world?
4. Why is it claimed that there is a vicious circle related to disasters in developing countries?
5. How can this vicious circle be converted into a virtuous circle? What are the elements of the virtuous circle?
6. Who are the principal actors involved in risk management?
7. What are the main causes of the financial losses that a water and sanitation company suffers as the result of a disaster?
8. Why are water and sanitation systems especially vulnerable to natural disasters?
9. What benefits can water companies obtain by investing in effective risk management?
10. Why should design, construction, operation, and maintenance standards of W&S systems be updated after a disaster?
11. What can financial and support organisations do to make W&S companies take risk management into account in the development of new projects?

Answers

1. What are the main links between poverty and water and sanitation services?

Poor quality or lack of drinking water and sanitation services is directly reflected in infant mortality, gastrointestinal diseases and malnutrition, which in turn affect education and the income and consumption rate of families. See Section 2.1.

2. What are the main uses of water in emergency conditions?

- Human consumption
- Care for the sick and injured
- Fire fighting
- Cleaning and disposal of excreta
- Restarting production

See Section 2.2.

3. Why is it said that human activity has contributed to an increase in the number of disasters and their impact around the world?

Human activities are generating important environmental changes, such as contamination of water, air, and soil; the greenhouse effect, which promotes global warming; the reduction of the ozone layer; deforestation and soil compaction which prevent water penetration; and so forth. All of these contribute to an increase in the number of disasters.

In addition, population growth, which occurs most strongly in the poorest countries, and the location of population and infrastructure in risk zones, makes the impact of disasters ever greater, in terms of loss of human life and property.

4. Why is it claimed that there is a vicious circle related to disasters in developing countries?

Poverty and short-sighted planning create vulnerable societies in which very little is invested in prevention and mitigation. When a disaster occurs, its impact on a society is very harsh, and the economic consequences of the disaster increase poverty, leaving the population even more vulnerable to new disasters.

See Sections 2.3 and 3.1.

5. How can this vicious circle be converted into a virtuous circle? What are the elements of the virtuous circle?

Appropriate risk management can convert the vicious circle of disasters and poverty into a virtuous circle. The cost of well-planned investments in prevention and mitigation is always less than the cost of reconstructing and rehabilitating a system after it has been affected by a disaster, and it decreases vulnerability and mitigates economic, social, and environmental impacts.

The virtuous circle should include activities before and after disasters occur. Preliminary activities should include risk identification, prevention and mitigation efforts, risk transfer measures, and preparations for the disaster, including early alert systems. Measures taken after the disaster should include emergency response efforts, and the reconstruction and rehabilitation of systems.

See Section 3.6.

6. Who are the principal actors involved in risk management?

In addition to W&S service providers (who should take the lead), other important actors include service regulators, governments, financial institutions, solidarity organisations including NGOs, universities and professional training institutes, and the general community.

See Section 5.

7. What are the main causes of the financial losses that a water and sanitation company suffers as the result of a disaster?

The main causes of financial loss are:

- Lower income as a result of not being able to produce and sell water
- Extra costs of reconstructing and rehabilitating the system
- Increased operating costs which occur when services are rationed
- Fines that the company must pay when it cannot provide services, if it is a private business that operates under a concession
- Possible legal actions if damages to the W&S system cause other damages to third parties or decreased production in other businesses.

See Section 4.5.

8. Why are water and sanitation systems especially vulnerable to natural disasters?

Because of a series of special characteristics they present:

- Large geographical spread
- Necessity of placing some components in high risk zones
- Diverse characteristics of components
- Dependence on other systems
- Inflexible design
- Difficulty in accessing some components
- Lack of prevention and mitigation measures

See Section 4.4.

9. What benefits can water companies obtain by investing in effective risk management?

Technical

- Fewer service interruptions
- Ability to plan investment in mitigation or strengthening measures

Financial

- Saving resources through preventing problems rather than reconstruction after they occur
- Reduced loss of revenue when service interruptions are avoided
- Reduced operating costs during emergencies
- Adequate administration of the transfer of risk to third parties
- Funding for new projects is facilitated

Legal

- Decreased risk of fines or legal actions as a result of loss of lives, or material, or financial losses caused by an emergency

Development

- Attraction of new industries that contribute to the region's development
- Procurement of funds by the State for new projects is facilitated
- General improvement in health, which favours increased productivity

Social

- The State can save resources that can instead be applied to improving health and educational infrastructure, as well as other vital services. Avoids negative impacts on the lives and on the physical and mental health of the population.

See Section 4.5.

10. Why should design, construction, operation, and maintenance standards of W&S systems be updated after a disaster?

A disaster usually highlights previously undetected system weaknesses which might continue to cause problems in the future if they are not dealt with. It is therefore necessary to learn from experience, and to revise design, construction, operation, and maintenance in

the light of what has been learned, so that new previous errors are not repeated in new projects.

See Section 5, especially 5.1-5.4.

11. What can financial and support organisations do to make W&S companies take risk management into account in the development of new projects?

Financial and supporting institutions should assess the viability of projects not only in financial terms, but also in terms of environmental sustainability, where this includes disaster prevention and mitigation. When this requirement is included as a condition for awarding a loan or donation, it helps to ensure that new projects will be less vulnerable to natural disasters.

See Section 5.4.

12 About IRC

IRC facilitates the sharing, promotion and use of knowledge so that governments, professionals and organisations can better support poor men, women and children in developing countries to obtain water and sanitation services they will use and maintain. It does this by improving the information and knowledge base of the sector and by strengthening sector resource centres in the South.

As a gateway to quality information, the IRC maintains a Documentation Unit and a web site with a weekly news service, and produces publications in English, French, Spanish and Portuguese both in print and electronically. It also offers training and experience-based learning activities, advisory and evaluation services, applied research and learning projects in Asia, Africa and Latin America; and conducts advocacy activities for the sector as a whole. Topics include community management, gender and equity, institutional development, integrated water resources management, school sanitation, and hygiene promotion.

IRC staff work as facilitators in helping people make their own decisions; are equal partners with sector professionals from the South; stimulate dialogue among all parties to create trust and promote change; and create a learning environment to develop better alternatives.

IRC International Water and Sanitation Centre

P.O. Box 2869

2601 CW Delft

The Netherlands

Tel. +31 (0)15 219 29 39

Fax. +31 (0)15 219 09 55

E-mail: general@irc.nl

Internet <http://www.irc.nl>



IRC International Water and Sanitation Centre

P.O. Box 2869
2601 CW Delft
The Netherlands

Telephone: +31 (0)15 2192939 Fax: +31 (0)15 2190955
E-mail: general@irc.nl Website: www.irc.nl