II. DRINKING WATER AND SANITATION

A. INTRODUCTION

1. General comments

In light of the region's epidemiological indicators, mortality rates are closely related to infectious diseases that, to a large degree, depend on the quality of water consumed and on available access to adequate sanitation services. This situation turns critical during disasters so this sector must concentrate post-disaster activities on the rehabilitation of the services that might constitute sources of epidemics, paying special attention to water quality, sanitary removal of excreta, and to management of solid waste.

The search for solutions to restoring water supply must take into account each potential resource, its capacity, its proximity to a drainage system, and all potential causes of chemical contamination.

Under normal circumstances, inadequate human waste treatment methods negatively affect the health of the population. In cases of disaster, removal and treatment of human waste acquires increased relevance in avoiding the transmission of infectious diseases, and constitutes a public health priority.

Damage in this sector depends not only on the intensity of the disaster, but also on vulnerability, a special characteristic of each component of the entire system. To put it differently, a disaster of a given magnitude and type may cause very different damage to different systems, or to different components of one system. The vulnerability of systems basically depends on four factors: its geographical location, quality of engineering design, quality of construction (including technology, equipment, and materials used): and quality of operation and maintenance of the facilities.

Most components in water and sanitation systems require proper operation and systematic maintenance over time; their absence would make the systems less resistant to damage and would hinder repairs when a disaster occurs. In turn, good operating and maintenance require effective organization, with workshops, spare parts, and drainage layout plans, which significantly help to size, assess, and repair more quickly and at a lower cost any damage produced by a disaster. Hence, operating and maintenance departments of affected systems will be a key source of information for the assessment team's work.

B. ASSESSMENT PROCEDURE

The assessment process requires, as a prerequisite, the definition of the area affected by the disaster. The water and sanitation specialist must determine what institutions are involved in the water and sanitation sector, and each one's role in its operation. The water and sanitation sector requires a multi-disciplinary and holistic approach to the dialectic relationships among its component elements. At the same time, each service or sub sector (water supply, sanitary sewage disposal, and solid waste collection and disposal) requires special assessment procedures. The assessment team must obtain information on the individual policies to be applied in each of the sub sectors, as well as each one's degree of development. On the technical level, the assessment team should collect basic information and existing detailed maps of the affected systems, since they will be essential for the evaluations and verifications to be carried out in the field. Thus, after the assessment is concluded, it should be possible for the water and sanitation specialist to prepare a table showing the most accurate and summarized information on damage and losses to the subsystems, as indicated in the following table.

Table 3-1
Damage and losses in the water and sanitation sector
(In thousands of dollars)

Component	Damage			Sector		Effect on the balance of payments
	Total	Direct	Indirect	Public	Private	
Total						
Water supply systems						
Urban systems						
Infrastructure						
Rehabilitation expenses						
Diminished utility revenue						
Higher production costs						
Rural systems						
Infrastructure						
Rehabilitation expenses						
Waste water disposal systems						
Infrastructure						
Rehabilitation expenses						
Diminished utility income						
Higher production costs						
Rural systems						
Infrastructure						
Rehabilitation expenses						
Wells and latrines						
Solid waste systems						
Rehabilitation expenses						
Diminished utility revenue						

C. INFORMATION REQUIREMENTS

The water and sanitation specialist should strive to obtain all available information on the subjects listed below, as a basis for the assessment to be undertaken.

a) Drinking water supply systems

- Organization of the entire water supply sub sector: service provider utilities, municipalities, regulatory and governing bodies;
- Water supply service coverage levels (urban and rural) that prevailed before the disaster;
- Breakdown of the population served by collective and individual systems (such as collective water systems, individual wells, multi-family systems);
- Identification of the urban and rural systems affected by the disaster;
- Determination of whether the disaster affected the water supply treatment process, which would involve additional requirements for chemicals / reagents or additional equipment;
- Characteristics of the systems affected by the disaster:
    - Population served before the disaster (number of domestic connections, average levels of water consumption, etc.);
    - Water supply rates, subsidies in existence, billing collection effectiveness, etc.;
    - Water production of the systems before the disaster;
    - Water production capacity available after the disaster; and
    - Estimates of the time required for the rehabilitation of all affected systems.
- Blueprints of all affected systems
- Characteristics of damage sustained by all affected systems:
    - Description of damage sustained by different equipment/components of the affected systems;
    - Construction techniques and materials used in the systems' components; and
    - Accessibility to different components in the affected systems.
- Temporary organization of the water and sanitation service provider utilities, to meet the population's needs until full services are re-established.
- Identification of measures undertaken to rehabilitate systems.
- Costs of materials, construction, equipment, chemicals/reagents and other inputs required for the rehabilitation and reconstruction of systems.

b) Waste water disposal systems

- Organization of the sewage disposal sub sector: service provider utility, municipalities, etc.
- Coverage levels of the urban and rural sewage disposal and sanitation systems prevailing before the disaster.
- Breakdown of the population served by collective and individual systems (latrines and septic tanks)
- Identification of urban and rural systems affected by the disaster.
- Characteristics of the systems affected by the disaster:
    - Population served before the disaster (number of domestic connections, etc.)
    - Sewage disposal rates, subsidies, billing collection effectiveness, and their possible link to billing for the potable water service.

  - Wastewater treatment levels of the systems before the disaster.
  - Treatment capacity remaining after the disaster.
  - Estimate of time required to rehabilitate affected systems.
- Characteristics of damage to the affected systems.
  - Description of damage to different equipment/components of the affected systems.
  - Construction techniques and materials used in the systems' components.
  - Accessibility to components of the affected systems.
- Temporary organization of the water and sanitation service provider utilities, to meet the population's needs until services are re-established.
- Identification of measures required for the rehabilitation of systems.
- Costs of materials, construction, equipment, chemicals/reagents and other inputs needed for the rehabilitation and reconstruction of systems.

c) <u>Solid waste collection and disposal</u>

- Description of existing local utility for the collection, processing, and final disposal of solid domestic waste.
- Characteristics of damage to the service's assets (trucks, access roads to towns and dumps, etc.)
- Geographical coverage and beneficiaries of these services before the disaster.
- Identification of measures required for the rehabilitation of affected systems
- Costs of materials, construction, equipment, chemicals/reagents and other inputs needed for the rehabilitation and reconstruction of systems.

D. SOURCES OF INFORMATION

The water and sanitation specialist should enlist the assistance of all institutions that may have basic information required for the assessment of damage and losses in the sector. Examples of these institutions are listed heretofore.

- Governing bodies, regulatory institutions, and water and sanitation services provider utilities.
- Water and sanitation service provider utilities, whether national, state, municipal, private, mixed, or self-managed by the community itself.
- Annual reports of the water and sanitation service utility companies.
- Municipalities responsible for operating and maintaining water and sanitation systems and services.
- National or departmental associations of municipalities.
- Ministry of health, housing or public works, when they have jurisdiction over the water and sanitation sector.
- Local water and sanitation systems' management boards.
- Non-Governmental Organizations (NGOs) that usually construct rural water systems (CARE, Save the Children, OXFAM, Catholic Relief Services, etc.) and then transfer the systems to be self-managed by the community itself.

- National Chapters of the Inter-American Association of Sanitary and Environmental Engineering (AIDIS).
- UNDP, UNICEF and PAHO/WHO reports on the state and coverage of water and sanitation services, normally issued once every 10 years.

E. DESCRIPTION OF DAMAGE

a) <u>Direct damages</u>

The water supply and sanitation specialist should be able to describe all direct damages sustained by the systems comprising the sector, as described below.

Drinking water supply systems. Damage to the following components must be ascertained:

- Damage to infrastructure and equipment of *urban* systems, preferably broken down by component.
- Damage to infrastructure and equipment of *rural* systems, preferably broken down by component.
- Loss of stocks (chemicals, stored water, spare parts, other assets)

Wastewater disposal systems. Information on damage to the following system components must be obtained.

- Damage to infrastructure and equipment of *urban* systems, preferably broken down by component.
- Damage to infrastructure and equipment of *rural* systems, preferably broken down by component.
- Loss of stocks (chemicals, spare parts, equipment, etc).

Solid waste disposal systems. In this case, the following information on damage should be obtained:

- Damage to infrastructure and equipment
- Damage to access routes to facilities or dumps for final waste disposal
- Impact on waste disposal dumps

b) <u>Indirect losses</u>

Here again, the water and sanitation specialist should obtain all relevant information that would enable the estimation of indirect losses in the three sub sectors.

Drinking water supply systems. The following data would be required:

- Activities related to rehabilitation (distribution of water by tanker truck or other means, purchase of equipment and machinery, repairs, changes in water treatment processes, use of materials and inputs kept in stock ready for rehabilitation efforts, personnel overtime);
- Reductions in potable water output (as it relates to intake, treatment, storage, or distribution facilities);
- Reduction of operational costs due to the partial functioning of systems;
- Increase in potable water production costs;
- Losses due to income not received (water not billed, suspension of service, etc.); and
- Insurances available.

Waste Water Disposal systems. The following information will be essential for the estimation of indirect losses:

- Activities related to rehabilitation (network inspection work, acquisition of equipment and machinery, repairs, etc.);
- Reduction in waste-water treatment capacity;
- Increases in waste-water treatment costs;
- Losses due to income not received, and
- Insurances available.

Solid waste disposal systems

- Losses due to income not received
- Decrease in solid waste collection and disposal costs
- Insurances available.

F. QUANTIFICATION OF DAMAGE AND LOSSES

1. Direct damages

In order to facilitate their quantification, it is suggested that damages be grouped in accordance with the following components:

- Identification of damage by systems,
    - Potable water supply systems
    - Waste-water disposal systems
    - Solid waste disposal systems

- Within each city and individual system, damage should be grouped by component or subsystem; for example, for the potable water supply system of a city:
    - Water intake facilities: intake A, intake B, etc.;

- Pumping stations: Station 1, Station 2, etc.
- Water treatment plants: plant 1, plant 2, etc.
- Main lines to storage tanks;
- Storage tanks: tank A, tank B, etc.;
- Distribution networks, and
- Other components, to be defined in each case.

The total damage to the potable water system of each city may then be obtained by a summation of the individual component damages.

A list of damage sustained by each sub-sector (water supply, waste-water disposal, and solid waste disposal) should be prepared, broken down into their materials, equipment, or facilities of the same kind. A procedure similar to the one described below could be adopted:

- A summary description for each damaged component should be made, describing its main components, the type of damage, and the approximate amount of work or material affected, in appropriate measurement units. For each damaged component the following should be indicated:
  - Type of work and/or materials required;
  - Unit construction prices at replacement value, (UP);
  - The cost of repairs should be estimated as a percentage (R%) of the unit reconstruction price described above.

- The estimate of the percentage (R%) to which facilities, materials, or equipment may be damaged should be obtained directly from the service provider utility, or on the basis of a weighted estimate that would take into consideration the following: whether the work, material, or equipment can be repaired or partially reconstructed or whether, because of the magnitude of the damage, it must be totally reconstructed or replaced; if there is a chance damage can be repaired, the cost of the damage should be estimated as a percentage (R%) of the total cost of said work (part of a work, material, or equipment); if the work has to be totally rebuilt or replaced, R should be taken to be 100%.

- Estimation of R% could be based on estimates by corresponding personnel from the utility that is responsible for each system, and/or from other sources, but the final figures adopted should be the one arrived at by the water and sanitation specialist in the assessment team on the basis of information he/she collected during the field mission.

In addition to the previous costs, demolition, dismantling and removal of debris must be taken into consideration. For this purpose, the following is proposed:

- For each system component (identified in accordance with the above described recommendations), a definition must be made of whether reconstruction or repair will be required or not prior to demolition or dismantling and extraction of debris. Should this is the case, an indication should be made of the approximate amount of work or material to be demolished and removed, in the appropriate unit of measurement, which as far as possible should be the same unit as the one used to quantify the damage to this item;

- A description should be made of the work or main activities considered to be part of "demolition (or dismantling) and removal of debris", for each item, adopting a single unit price for each item.

- The degree of difficulty and costs involved in the different works and materials should be taken into consideration. As an example, differences should be made between the "demolition" of a reinforced concrete storage facility and the simple "dismantling" of asbestos cement pipes, whose joints can be much easier to take apart and where, moreover, the material could be partially recovered and re-utilized.

- If an accurate estimate of prices under this heading is not possible, a criteria similar to the one indicated in the previous point should be adopted, where the cost of "demolition and removal of debris" should be expressed as D% of the unit price. However, D% should not have to be equal for the different items in view of differing degrees of difficulty of demolition or removal as indicated above.

- If part of the material can be recovered as a result of demolition or dismantling, whether for reutilization by the same utility, or for sale, its remaining value should be estimated as a percentage (V%) of the unit price of said material when new. These results should be deducted from the cost of "demolition, dismantling and removal of debris".

If the disaster directly affects the warehouses or other storage facilities where spare parts, chemicals, reagents, water tanks are kept, this must be taken into consideration. The water and sanitation specialist should consider all available sources to ascertain the amount and unit prices of the materials under reference.

In general, unit prices to be used in damage assessment can be obtained from recent feasibility studies or unit price lists normally used by the utility that provides the affected services. In this case, the date when the lists were made should be ascertained, so that, when necessary, adjustments for inflation can be made. The unit prices to be used can also be based on estimated unit prices derived from direct surveys or suitable local sources, or "comparative unit prices" available for the region that can be used for comparisons with the two previous points, and used instead of them, when necessary.

No matter where the list or estimate of unit prices used is obtained, it should include: the labor content and the percentage of domestic and imported materials as a percentage of total unit prices. The latter will enable to distinguish the total amount of direct damage, the value of imports, and their corresponding effect on the balance of payments.

Water supply, wastewater disposal, and storm drainage systems include a wide array of types of facilities, materials, and equipment. The cost of some of these facilities may easily be estimated on the basis of unit prices lists. Such is the case, for example, of water pipes, whose unit price can be expressed in lineal meters either for the purchase of the pipe or for their complete installation. On the other hand, there are other types of facilities (potable water treatment plants, for example) that include various components having different sources, technology, and price. In their case, costs should be estimated on the basis of a global price for the facility.

2. Indirect losses

Indirect effects of disasters usually last throughout the entire rehabilitation and reconstruction period or until facilities return to normal operation. These effects include the water supply utilities´ fall in income due to reduced billings (as they supply less water) and to increased water losses in the pipeline system due to as yet non repaired direct damages; and higher operational costs for the utility to ensure the temporary provision of water supply, which may last over a variable time period depending on reconstruction delays. In addition, the negative impact on health should be included. An agreement should be reached with the health sector specialist in order to avoid duplications or omissions in this regard.

a) Drinking water supply systems

i. Rehabilitation of normal operation activities. Depending on its magnitude, a natural disaster may affect very large geographical areas that might include cities of various sizes, towns, and rural areas. The random nature of the disaster itself and the variability of situations arising might require a broad range of activities for the rehabilitation of services, involving costs that should be included as indirect damage (in addition to the repairs of direct damage). These rehabilitation activities include:

- Pipeline repairs, using plastic patches or jackets, provisional by-pass pipelines, and also works to divert flow away from holes in order to avoid losses of water in damaged pipe networks, by means of valves and pipes, etc.;
- Use of existing stocks or reserves of equipment, materials, chemicals, and reagents.
- Increased chlorine concentration in already chlorinated water. Temporary functioning of chlorination facilities for untreated water, and for storage tanks. Preventive chlorination in deep and shallow wells, in both urban and rural areas.
- Use of other existing potable water sources such as, for example, the deep wells of private factories, businesses, or sports facilities, etc. This includes water connections to the network, the supply of power to pumping equipment, etc.
- Temporary conversion of existing water storage facilities – such as swimming pools, factory and business storage tanks, etc. In addition, the utilization of fiberglass and plastic tanks, to store and distribute drinking water to the population.
- Temporary utilization of tanker trucks, trucks carrying large water containers, etc. in order to deliver drinking water to the population.
- Activities required to establish, when necessary and possible, temporary rationing of drinking water in the network.

- Increasing water pressure in the network in order to avoid contamination of the potable water (which might turn out to be essential, even if leakage of water increase).
- Preparation and delivery of instructions to the population on preventive measures for the use of water (boiling it, for example), rationing timetables, tanker truck routes, water distribution points, etc.
- Costs for the population to acquire/purchase water by other means (increased costs, health problems).

ii. Cost estimation of rehabilitation activities. There exist a very wide range of possible rehabilitation activities in the sub-sector, in view of the many existing cases of natural disasters, and the wide range of regional or local situations. In order to undertake an estimation of the cost of these activities, the problem must be simplified by grouping together these costs into a limited number of items:

Increases in wages and salaries. This item includes any increases in costs of professional, technical, administrative, and manual labor personnel employed in rehabilitation operations, over and above the normal payroll levels. They may be estimated as follows, bearing in mind that the affected utility company would already have some estimates on the matter:

- Prepare a simplified list of personnel categories employed in this type work, indicating their unit cost in each category (person-months, person-days, as applicable);
- Estimate the "number of person-units" in each category that will be required for the rehabilitation operations during the entire period they are expected to last; and
- Multiply these values and add the subtotals to obtain total losses.

Estimated costs of works and repairs. This point includes an estimated budget of any costs not included under the previous item. It should include all materials, transport, fuel, etc. that may be used in works and repairs. From the total value of equipment, machinery, pipe, and valves installed on a temporary basis, only a fraction is to be included in these estimates; they would involve an estimated amortization (r%) whose value will depend on the use made of such elements during the rehabilitation. In order to carry out these costs estimates, a list of the main material works performed should be made, including: a summarized description of each work or other materials costs; the approximate volume of each work, materials or item; the unit price of each one; and any overhead expenses and profits (when appropriate).

Estimated cost for the utilization of water sources or intake works not belonging to the public water supply utility. The temporary use of water sources and intake systems that do not belong to the Potable Water Service involves expenses that have to be paid in accordance with special agreements to be reached between the parties.

Use of tanker trucks for drinking water distribution. Tanker trucks may deliver water in order to alleviate problems in those areas that the public network cannot reach as a result of the disaster. To estimate its cost, the following points should be taken into consideration: the different water carrying capacity of trucks engaged to deliver water, and the corresponding rates per trip.

iii. Reductions in drinking water production. The volume of water tapped from different sources for treatment and delivery to the public may decrease due to the disaster. This can be due to different direct damages arising from the disaster, such as:

- A decrease in water availability due to drought;
- A pollution of water resources; and/or
- Damage to intake facilities, machinery, or pumping equipment, etc.

iv. Reductions in the transport capacity of drinking water systems. Damage to main pipelines that convey drinking water to cities or intermediate facilities (such as treatment plants, pumping stations, storage reservoirs, etc.) may affect the system's overall delivery capacity. Damage to secondary pipelines or to distribution networks may partially affect drinking water conduction and distribution capacity. Damage to domestic connections and or interior networks of buildings, houses, factories, markets, etc. may locally affect the delivery capacity of drinking water. Damage to pumping plants may also affect the system's total or partial water conveyance capacity.

v. Reductions in the regulation and storage capacity of drinking water systems. Any reduction in water regulation capacity diminishes the ability of a system to supply the varying demands over time, affect maximum demands and cause losses of non-stored waters. This item includes any damages to the regulation and/or storage reservoir of a system and affects water supply as a whole; damage to secondary reservoirs; and damage to minor, industrial, commercial, or domestic reservoirs.

vi. Reductions in drinking water demands. The consumption of drinking water in affected cities and towns could drop or even be eliminated by damages such as the ones indicated above, or due to the fact that the population has been displaced elsewhere. A combination of such situations might result in a diminished availability of drinking water, lower pressure in the system and even a reduced sanitary quality of the water, thereby forcing the population to boil water before its direct consumption. Drinking water demand may also drop even without direct damage to the potable water supply system, when a disaster damages houses that then stop consuming. Obviously, a fall in supply and demand would lead to decreased utility billings and lower revenues.

vii. Increase in water production costs. These increases would mainly be due to: increases in the production cost per cubic meter of water (that may partially or totally affect the supply) due, for example, to an increase in the elevation of existing water intake points; higher operational costs of water resource intake points used to temporarily replace the ones normally used; an increase in the daily volume of production of water to compensate for abnormal losses in either the main pipelines or in the distribution networks; higher power and other input costs; and combinations of the above.

viii. Losses of income not received (water not billed, temporary suspension of supply, etc.). In order to estimate the amount of lesser billings (or the probable reduction in water sold to consumers in cities and towns located in the disaster area) the main factors governing the decrease in volume of water supplied through the system must be weighed.

ix. Impacts on the health of the population (because water services are not provided in sufficient quantity or with adequate quality and continuity). The impact on health, particularly on children and the elder, can have highly varied consequences. These impacts should be analyzed under the health sector.

b) <u>Waste-water disposal systems</u>

i. Indirect losses in wastewater disposal and in storm drainage systems.[1] Three main types of indirect losses may be sustained by these systems:

Increase in health risk levels and declines in quality of life. Apart from the fall in the level of hygiene that may result from the lack of sufficient drinking water, the lack of (sanitary or storm) drainage may bring about significant health risks to the population, due to a combination of several factors:

- Wastewater disposal systems cannot be used in those areas that do not have a potable water supply, because water is essential to flush away excreta and wastewater.
- Breaks and blockages in the sewage disposal network will likely result in waste water flow to the surface of streets, increasing the risk of disease and epidemics either by direct contamination or by the action of vectors.
- Any problems at wastewater treatment plants might provoke greater pollution of the water resources into which effluents are discharged.
- There exists the risk of flooding by rainwater caused by heavy precipitation when rainwater drains are damaged.

Rehabilitation works and activities. A wide array of activities is needed to rehabilitate the system; they include pipe repairs; the placement of provisional pipelines or drains; and the digging of drainage ditches, etc. They should also include maneuvers involving valves, gates, and other facilities to divert flows from waste water or rainwater pumping plants, and pumping stations to raise waste water that has flooded plants, chambers or ditches. The costs of maneuvers and rehabilitation works of any kind for sewers should be estimated in the same fashion as indicated for the case of drinking water supply.

Decreased income from wastewater billings. How the disaster affects billings for wastewater disposal services shall depend on how billing is normally done in the affected cities. In those cases where the charge for the wastewater disposal service is computed as a percentage of water

[1] There exist cases where a combined use is made of the same system to evacuate both waste water and storm runoff. In other cities, separate systems exist.

supply billings, the estimation of losses should be undertaken using the following formulae:

I_t = total decreased water supply billings in the city.
a% = percentage (%) overcharge in water supply bills included to pay for the waste water disposal service;
s% = percentage of population having both water supply and waste water system in relation to the total population having water supply connection.

Hence, the decrease in wastewater disposal services billing will be obtained as:

$$\triangle f_a = I_t \text{ x } (a\%) \text{ x } (S\%).$$

However, there could also be an <u>additional</u> group of population that cannot make use of the wastewater disposal service because it is broken. This additional loss might be estimated as an additional percentage (Z%) to the one indicated above, in the following manner:

$$\triangle f'_a = (Z\%) \text{ x (Normal billing for waste water disposal service)}$$

When the cost for use of the wastewater disposal service is a flat rate for connection to the system, the loss in billings can be estimated by applying a percentage to the overall billing for the city.

Given:

Fa = total monthly billing for waste water disposal service for the entire city
$F_a/30$ = average daily billing
g% = estimated billing percentage not charged due to the disaster
p = length of the period during which irregular or no service is provided, in days

Then:

$$\triangle f_a = (g\%) \text{ x } p \text{ x } (F_a/30)\text{, in US\$/period}$$

In cases where no charge is made for wastewater disposal service, there would not of course occur any decrease in the utility's income.

G. MACROECONOMIC EFFECTS

All items, information, background, and procedures necessary to undertake the assessment of the Water Supply and Sanitation sector effects on the in the country's macro-economic performance are described herein.

1. Effects on Gross Domestic Product

a) Lower production

This item refers to the lower production of water that occurs from the time the disaster occurs, and to the lower production forecast during the rehabilitation period, until normal production capacity is restored. The reduction in production should be estimated as the reduced volume of water billed to the users, and also as a possible increase in the cost to provide the services. These would occur because usually there are volumes of water produced that do not reach the consumers due to leaks in networks or other reasons. It is suggested that this calculation be undertaken using the diminished revenues due to lower billings that occur between the time of the disaster until the point in time when things are expected to return to normal.

Depending on the scale and characteristics of the previously identified direct damages, and on the capacity of the corresponding water-supply utilities (financial, and repair and reconstruction work) capacities, an estimate can be made of the time needed to achieve normal supply and billings.

Bearing this in mind, a table should be prepared that would include the following data:

- Reduced drinking water volumes billed each month to the users, since the disaster occurred and through forthcoming months;
- Any variations in average rates to the public for the volume of drinking water delivered;
- The resulting decrease in monthly revenue, determined from the difference in billings in the pre- and post disaster situations;
- Any variation in costs because the population has to acquire water by other means;
- Should the disaster affect several utilities, or cities, separate tables should be made for each case.

b) Expected performance of the sector, under no disaster conditions

The macroeconomics specialist might have available this background information for the entire country and, if possible, for the affected area. Normally only estimates are available on the volumes of water tapped, treated, or lost through network leaks in the cities of Latin America and the Caribbean. Therefore, it might be more practical to estimate the sector's GDP based on the volumes of water billed to consumers. Therefore, it is recommended that the water and sanitation specialist, in close cooperation with the macroeconomics specialist:

- Analyze national accounts and consult all institutions having overall responsibility for the sector in order to obtain, where possible, data on changes in GDP for the previous five years, together with a forecast by the responsible officials on the sector's expected performance for the current year had the disaster not occurred; and
- Analyze any changes in the sector's strategies that would enable the recovery of the service

affected by the disaster and to continue its development processes.

2. Effects on gross investment

Under this heading, the main types of effects on a number of issues are to be determined.

a) **Projects under execution and other expected investments that must be suspended or postponed, or whose funds must be reassigned to meet disaster-related needs**.

This information should be summarized in a table identifying the main projects affected and the investment envisaged for each one. Finally, an estimate is to be made of the expected reductions in investment for each project as a result of the disaster, in the current and in following years.

b) **Losses of stock**

A table must be prepared showing losses of stock, such as water stored in reservoirs and/or in storage tanks, chemicals and reagents for the treatment of water, as well as losses of materials and spare parts stored and/or available in facilities that were under construction.

c) **Financial requirements to repair or reconstruction**

The background to develop this item will mainly come from the direct damage lists and assessment, providing total and itemized costs for the damage. Based on that information, a table comprising the following information can be prepared:

- A list of affected works, broken down by systems, subsystems (and main facilities), and indicating the overall cost of the damage to each one. This list should separately identify works in the different cities, different companies (if there is more than one company responsible for the service in the same city) and should separate urban and rural areas; and
- An investments forecast for the following years in order to repair said damages.

The forecast on investments should reflect the relative urgency of the respective works, the companies and the country's engineering capacity, and possible sources of financing. Special regard should be given to weighting, on the one hand, the national project execution capacity and its relation to the new construction demands and, on the other hand, the domestic capacity to supply the inputs required for reconstruction. In this last aspect the extraordinary demand generated as a result of reconstruction after the disaster should be compared to the normal domestic manufacturing capacity *vis a vis* importation.

The water and sanitation specialist should make special reference to the requirements and capacity limitations foreseen during reconstruction and damage repair and (as time and information limitations permit) make appropriate recommendations.

3. Effect on the balance of payments

The water and sanitation specialist should provide basic information on indirect losses so that the macroeconomics specialist may calculate the effects of the disaster on the balance of payments´ current account. The following information should be included:

a) Decreased exports of goods and services

Since drinking water is very rarely exported, this item would not normally be taken into consideration. However, if an affected country normally exports engineering services related to the sector, the increased internal demand for them determined by the disaster might reduce or eliminate the export capacity for said services over a period of time. The value of this reduced export of services should be expressed as follows:

M$s = decreased value of exports of services, in a given period
MsO = decreased value of exports of services, in the year of the disaster
Ms1 = idem for the year following the disaster
Ms2 = idem for the second year following the disaster

Therefore: M$s = (MsO + Ms1 + Ms2)

b) Increased imports

In order to estimate the value of this item, imports required for rehabilitation and reconstruction of direct damages should be taken into consideration. Such imports may be obtained from the summation of the imported components of direct damage estimates made previously.

To estimate increased imports, the following procedure might be used:

Given:

Idd = increased imports as a result of direct damage
Idd0 = idem, during the year of the disaster
Idd1 = idem, during the year following the disaster
Idd2 = idem, during the second year (etc.) following the disaster (as applicable)

Thus: Idd = Idd0 + Idd1 + Idd2

c) Donations

This item includes donations in kind, equipment, materials, and machinery received in the sector as international assistance. Although these donations will probably occur in the period immediately after the disaster (year 0), there should be an indication of whether donations are expected in the following years.

d) Reductions in interest payments

In cases where a reduction in the payment of interests has been granted by creditors, due note should be made of it under the year in which it occurs.

e) Insurance and re-insurance

With increasing frequency, both assets and revenues of the water and sanitation sector are domestically insured against disaster risks. Should that be the case, estimates must be made of insurance payments due after the disaster, as well as the expected amounts of reinsurance to be received from abroad, since these will have an effect on the country's balance of payment.

4. Effects on public finances

A disaster might disrupt public finances in several ways that are described below.

a) Decline in tax revenues due to lower production of goods and services

If water and sanitation billings are subject to taxation and if, as a result of the disaster, utility revenues decline, the corresponding fiscal or municipal revenue will also decline. In order to estimate these declines in tax revenue, due consideration should be given to the following:

- Declines in revenues due to decreased billing and water losses;
- Information on the percentage (p %) and value of said taxes as may be estimated by the utilities;
- The value of lower taxes may be estimated as follows:

  Mi = Mi0 + Mi1 + Mi2 = lower tax revenue in years 0, 1, and 2.

b) Decline in public utility revenues

Lower billings due to a decreased supply of drinking water, as indicated above, results in decreased revenues for the affected utilities.

Thus:

Mf = Mf0 + Mf1 + Mf2 = Lower billing for years 0, 1 and 2.

c) Increased outlays for reconstruction and damage repair

Information required to estimate this effect on public finances should be obtained from tables included in the previous example on gross investment.

Let Mgi = higher outlays in reconstruction investment,
$Mgi = Mgi0 + Mgi1 + Mgi2$ = idem, year 0 + year 1 + year 2

5. Effects on prices and inflation

Damage caused by the disaster may have a bearing on changes in the prices of water and construction materials required to repair damages in the sector. This would depend on several factors, including the magnitude of the disaster and the amount of damage caused.

a) Possible change in the price of water

There exist several reasons why the cost of water may vary as a result of a disaster. Among them:

- Water production costs may vary due to the need to change the place or type of water resource intake, the type or types of treatment plants, the conveyance or elevation of the water, or a draw down in groundwater levels.
- If the resulting difference in costs compared to those before the disaster is absorbed by the utility through subsidies, there should be no effect on the price to the public.

Information on these matters should be provided by the utility that provides the water service. However, it is unlikely that so soon after the disaster there may exist any reasonable certainty in connection with some of these issues, and therefore any estimation on future prices should have to be done based on possible trends. If, as a result of the factors indicated above, the cost increases, the relationship between the new cost per cubic meter and the previous cost, or the expected variation in the new price to the public, should be indicated.

b) Possible effects on construction materials prices

Construction material prices may rise because demand will increase not only in this sector, but to repair damages in other sectors as well. Therefore, the assessment team as a whole should analyze the situation concerning a possible increase in construction material prices.

From the point of view of the water and sanitation sector, it would be useful to have an estimate of the increased demand for the main materials that will be involved in repair and reconstruction during the years following the disaster; an idea of the domestic production capacity and its relation to the increased demand, and the capacity to import said materials. In addition, consideration should be given to possible price controls adopted by the government.

H. OTHER EFFECTS

1. Possible effects on employment

As in the case of the energy sector, due to the growing use of technology and equipment, the water and sanitation sector employs a limited amount of personnel for the operation of its networks. Therefore, the effect that a disaster may have on employment and personal income in this sector is likely to be very limited. In fact, personal income of utility enterprises may actually increase during the rehabilitation period due to the payment of overtime.

The water and sanitation specialist should work in close cooperation with the employment specialist of the assessment team in order to arrive at the overall effects that the disaster may have on employment and income, ensuring that figures for the water and sanitation sector are duly included and not duplicated in the latter’s global estimates.

In any case, the following paragraphs describe possible effects on employment for the sector.

a) Effects due to replacement of facilities and infrastructure

Since availability of drinking water is essential to the population, destroyed facilities and other infrastructure must be replaced as quickly as possible. The technology and design of the new facilities might require a different number or type of personnel for purposes of operation and maintenance. Any differences in employment arising from technological changes must be duly estimated noted.

b) Effects occurring during reconstruction and repair

Employment requirements during the emergency phase fall outside the scope of the assessment described in this handbook. However, any of the following possible impacts on employment occurring during the reconstruction process should be indicated:

- Employment levels might remain unchanged when other projects and works are cancelled;
- There might occur an increase in employment, due to reconstruction and rehabilitation work demands, and should there not occur any reduction in normal projects and activities.
- There might be a mixed situation, when only some – but not all – development projects scheduled before the disaster are postponed.

The possibility of effects on employment will depend on the government’s and the drinking water utilities´ decisions in this regard. And therefore, the water and sanitation specialist should approach these institutions to obtain the required information to estimate any variations in employment foreseen for years 0, 1, and 2 (if reconstruction works require more time, more years must be added).

The level of employment required and the time period used for the estimations under this item must coincide with those used in the item on reconstruction investment requirements.

2. Differential effects on women

Any damages to the drinking water supply in the rural and marginal urban areas have a differential effect on women since they are the ones that, within a family, are entrusted with collection of water for domestic consumption where no domestic water connections are available.

Whenever a shallow well or a spring were polluted or silted and thus rendered useless to supply the drinking water needs of the family, and alternative sources located farther away from the family dwelling, women have to increase their time and effort for water collection. This fact increases women's productive workload.

As described in detail under the appropriate section on the differential impact of disasters on women, under Section Five of this handbook, special field surveys should enable the determination of the increase in reproductive work for women in this item. The water and sanitation specialist should work in close cooperation with the gender specialist in order to arrive at a figure for these increased workloads on women.

3. Impacts on the environment

Any change in availability or quality in the water resource used by the drinking water supply system constitutes an environmental modification that has negative effects on people's health and well being. The same is true of sanitation problems caused by disruption of wastewater disposal and solid waste management systems. While the chapter on environmental matters in Section Five deals with these issues, the estimation of costs involved falls within the purview of the water and sanitation specialist which should co-ordinate with environment specialist in order to assure, on the one hand, that all the relevant information is effectively obtained, and on the other, that double accounting is not permitted.

APPENDIX XVIII

ESTIMATING LOSSES IN THE DRINKING WATER AND SANITATION SECTOR CAUSED BY THE JANUARY 13, 2001, EARTHQUAKE IN EL SALVADOR [2]

On January 13, 2001, an earthquake that registered 7.6 on the Richter scale struck El Salvador. Its epicenter was located off the Pacific coast, approximately 100 kilometers southeast of the city of San Miguel. The quake was felt throughout El Salvador and in some neighboring countries, but the regions suffering the greatest damage were the Departments of Usulutan, La Paz and San Vicente.

The earthquake, which was followed by numerous and powerful aftershocks, imposed a significant toll on the poorest segments of the population, especially on housing, basic services, education, and access to healthcare. All productive sectors and the country's basic infrastructure were affected.

Most of the information required for evaluating the water and sanitation sector was provided by the Administracion Nacional de Acueductos y Alcantarillados (ANDA), the Pan American Health Organization/World Health Organization, and the Ministry for Public Health and Social Services.

1. Drinking water and sanitation

Prior to the earthquake, El Salvador supplied potable water to 86.8% of the urban population (2,951,565 inhabitants) and to 25.3% of its rural residents (830,130 inhabitants). Sanitation services were available to 85.9% of urban residents (2,727,160 inhabitants) and to 50.3% of the rural population[3][4].

The above service breakdown implies an overall coverage (both urban and rural) of 60.4% for drinking water and 68.3% for sanitation. Such services are supplied by ANDA, municipal governments and the health ministry as well as local and international NGO's that are largely focused on covering demand in rural areas.

a) Drinking water supply

According to ANDA damage reports, water storage tanks and distribution systems were the components **of urban service networks** hardest hit by the quake. The extent of damage varied widely, ranging from cracked walls, weakened support structures (beams, towers), and the

[2] CEPAL, *El terremoto del 13 de Enero de 2001 en El Salvador. Impacto socioeconómico y ambiental*, Mexico, February 2001

[3] Dirección de Planificación, *Boletín estadístico Nº21*, ANDA, San Salvador , 1999

[4] OPS/OMS – UNICEF, *Evaluación global de los servicios de agua y saneamiento – Informe analítico*, San Salvador, July 2000.

settling of surface-level facilities[5].

In the San Salvador metropolitan area and other regions serviced by ANDA, varied levels of impact on flows from wells and pumping stations were reported. Meanwhile, weakened slopes and the resulting landslides led to ruptured water mains, especially near hillsides, and water supply was suspended for days or even weeks before the breaks were repaired. There were also reports of damage to electric equipment and water treatment plants, but in most cases these were repaired and service was reestablished quickly.

Unfortunately, it was not possible to obtain information in regard to the extent to which services were suspended or impaired in municipalities not covered by the ANDA system.

Thirty-two out of approximately 400 **rural drinking water systems** reported varying degrees of damage that largely consisted of the uncoupling or breaking of water mains, especially near to inclines and ravines or in areas where the land was otherwise unstable. Cases of destruction to shallow well walls required their cleaning or to locate alternate water sources. According to estimates, approximately 10,400 household shallow wells were in need of repair or reconstruction after the quake, and most of those were to be found in the countryside or in marginal urban neighborhoods.

According to data from ANDA and other relevant institutions, roughly 500,000 urban residents temporarily lost drinking water supply; that is equivalent to 15% of those normally receiving this service. In rural areas, 9.1% of service recipients or 75,626 inhabitants[6] were similarly affected.

During the emergency stage, tanker trucks were used to deliver properly chlorinated water, and portable water treatment equipment was deployed to areas where normal service had been affected. By February 8, tanker trucks had distributed 18,968 cubic meters of drinking water.

In addition to the emergency measures cited above, ANDA, municipal authorities and local water boards went to work from the moment of the quake to restore damaged networks, prioritizing those supplying urban areas as well as those rural systems for which the cost of repairs could be immediately covered by local water boards or ANDA. Work was strictly focused on restoring service as quickly as possible, so some repairs further magnified vulnerability, especially along ravines where there were reports of landslides. Some inclines that were left unstable by the quake remain highly susceptible to future tremors, human intervention and rainfall that could inflict the same or even greater damage than the original earthquake.

b) <u>Sanitation systems</u>

While ANDA reported no damage to waste water disposal facilities and municipalities have yet

[5] ANDA , *Información preliminar de agua potable y alcantarillado sanitario a nivel nacional – Ocasionado por el sismo del 13/01/2001*, San Salvador, 2001.
[6] Gerencia de Sistemas Rurales, *Informe de daños a sistemas rurales de agua potable hasta el 29/01/2001*, ANDA, San Salvador, 2001.

to publish any relevant information in this regard, it was assumed that any damage would arise during the operation of sewage systems. Depending on where sewerage lines ran, and their proximity to water mains, there was a remote possibility that potable water could have been contaminated.

Latrines, which are the main form of sanitation system in the rural sector as well as in marginal urban communities, sustained considerable damage or were totally destroyed; especially in the hardest hit areas. According to estimates based on available data on the number of rural dwellings that were destroyed and the extent of such sanitation systems in the countryside, it is estimated that approximately 63,000 latrines were damaged.

c) Solid waste disposal

Municipalities provide solid waste collection and disposal services. During the field visits it was impossible to obtain any information concerning the state of these services. COMURES (the National Council of Municipalities of El Salvador) intends to collect information on this matter sometime in the future.

2. Estimated damage and losses

Direct damages to drinking water and sanitation systems were estimated at 13.1 million dollars. Indirect losses – which involve greater expenses and fewer revenues for the sector's utilities – were estimated at 3.3 million dollars. Total damages and losses thus reached 16.3 million dollars. The international community provided one million dollars in emergency assistance. Meanwhile, the temporary suspension of service implied estimated savings of approximately 525,000 dollars in state subsidies to ANDA. See table below.

Table 1
Summary of damage and losses in the San Salvador earthquake of January 2001
(Thousands of US Dollars)

Item	Total damage	Direct Damage	Indirect losses	Impact on balance of payments
Total	16,340.0	13,062.0	3,278.0	8,500.0
1. Urban systems	8,363.0	6,200.0	2,163.0	5,000.0
- Infrastructure damage[7]		6,200.0		
- Emergency relief[8]			663.0	
- Low income			1,500.0	
2. Rural systems	7,977.0	6,862.0	1,215.0	3,500.0
- Damage to rural water systems		362.0		
- Emergency relief			1,215.0	
- Damage to shallow wells		500.0		
- Damage to latrines		6.000.0		

[7] Reconstruction costs include those for repairing public sector buildings damaged by the earthquake.
[8] Includes an increase in operational expenses.