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Programme Planning and Operations Division

MANUAL FOR ESTIMATING THE SOCIO-ECONOMIC EFFECTS OF NATURAL DISASTERS

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FOREWORD

Natural disasters have a major impact on living conditions and economic development. In the industrialized countries, tremendous losses are sustained to the capital stock, while losses of life are usually very low because there are effective forecasting and warning systems. In the developing countries, on the other hand, disasters always result in heavy loss of life because there are no organization, prevention and evacuation systems. The impact on economic development is usually considerable, although capital stock losses may be less.

Based on statistics and additional estimates made by the ECLAC secretariat over the past 20 years, natural disasters can be said to have cost the Latin American and Caribbean region, in an average year, more than 6,000 lives and over US$ 1.5 billion in economic losses.[1] This amounts to a large proportion of the population, generally the lower-income population, and is a major setback for governments' development efforts.

It is essential to design and implement planning and prevention schemes and measures to help reduce such losses and to have the means of determining, after each disaster, the amount and type of damage sustained, as a the basis for rehabilitation and reconstruction efforts.

The second of these needs is hampered by the absence in the existing literature, of a comprehensive, uniform methodology for evaluating the socio-economic effects of disasters. However, the ECLAC secretariat, starting from some concepts advanced by UNDRO in the 1970s[2] and drawing on its own evaluation and monitoring experience already mentioned, has developed an evaluation tool for determining both the sectoral and the overall effects of a disaster as a guide for post-disaster rehabilitation and reconstruction processes.

This Manual describes that methodology. It is aimed at the professional whose job it is to evaluate the socio-economic impact of disasters in situations —which tend to be the norm in Latin America and the Caribbean— where little reliable quantitative information is available.

It has been prepared by compiling and systematizing the experience gained by numerous ECLAC secretariat staff and by some experts and consultants outside ECLAC. As a result, it draws on actual experience of the natural disasters that have occurred in the region in the past two decades.

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[1] See J. Roberto Jovel, "Natural disasters and their economic and social impact", CEPAL Review, No. 38 (LC/G.1570-P), Santiago, Chile, August 1989.
[2] See Office of the United Nations Disaster Relief Coordinator (UNDRO), Disaster Prevention and Mitigation: Compendium of Current Knowledge. Economic Aspects, Volume 7, New York, 1979.

prevention in Latin America and the Caribbean". The intention is to gradually expand it by adding chapters on sectors or issues not originally covered or by elaborating on and revising chapters and sections of the original.

INTRODUCTION

Natural disasters, which are a frequent occurrence in Latin America, have a major impact on countries' social, economic and political situation. Barely a month passes without some part of the world being afflicted by floods, earthquakes, volcanic eruptions, accidents, massive fires, droughts, famines or some other major disaster. Such phenomena cause massive loss of life, directly or indirectly affect large sectors of the population and wreak major economic damage.

However, research shows that natural disasters cause more devastation in developing countries and that they hit the most disadvantaged population groups hardest. Over the years, the developed countries have devised various ways of protecting themselves from the consequences of disasters by anticipating their risks through prevention and planning measures. Few such measures have been taken in the developing countries, however, where a large proportion of the population lives in precarious conditions, crowded together in flimsy, unprotected dwellings on hillsides subject to landslides or on low land susceptible to massive flooding.

The geographical location and natural characteristics of Latin America and the Caribbean expose the region to frequent natural disasters. Although these disasters may vary in intensity, they usually entail loss of life and damage to socio-economic infrastructures. They also have a serious and persistent impact on the functioning of national economies.[3]

When a disaster occurs, along with the first emergency measures taken by the government and the community concerned, various national and international agencies offer relief, aid and assistance and are often even designated to coordinate the external cooperation received. However, this support, though important, represents only part of the total cost of the necessary process of post-disaster recovery. As a result, one of the most pressing tasks for the country concerned is to make an early, reliable preliminary assessment of the damage.

When a disaster has occurred and while the emergency is still at its height, it is absolutely essential to identify and quantify its effects as accurately as possible as a minimum guide for designing rehabilitation and reconstruction programmes and for identifying the international cooperation that will have to be channeled to the affected country for it to undertake such programmes. While the Office of the United Nations Disaster Relief Coordinator (UNDRO) deploys its programmes during the emergency or immediately after the disaster, ECLAC has often, particularly since the early 1970s, assisted affected governments in the subsequent task of evaluating the disaster's direct and indirect effects and its impact on the main macroeconomic variables. The experience gained over the past two decades in evaluating the socio-economic effects of dozens of natural disasters of varying magnitude and intensity[4] convinced the ECLAC authorities that

[3] See J. Roberto Jovel, op. cit.
[4] See at the end of this Manual the list of documents produced on this issue by ECLAC since 1972.

it would be both advisable and desirable to conceptualize and standardize their findings in order to produce a manual or guide for general use in such situations.

The result was this Manual, which focuses on evaluating the socio-economic effects of disasters, classifying them as direct, indirect and secondary, and therefore omits any detailed description of the physical characteristics of the disaster itself or any mention of the emergency activities carried out immediately after it.

The emphasis is thus on the conceptual and methodological aspects of estimating the damage caused by a disaster both to capital stocks and to goods and services production flows, as well as its temporary effects on the behaviour of the principal macroeconomic aggregates. The hope is that the Manual will prove a useful tool for formulating short- and medium-term rehabilitation and reconstruction plans and programmes to be implemented once a disaster's emergency phase is over.

Its purpose, therefore, is to assist individuals and institutions involved in the identification and quantification of damage caused by a natural disaster, by providing a uniform, coherent methodology derived both from ECLAC experience and from the conceptual definitions originally advanced by UNDRO in this field.[5]

In addition to the objectives mentioned in the preceding paragraphs, it is hoped that the use of this Manual will yield the information needed to identify the social or economic sectors or geographical regions which, having borne the brunt of the disaster, must be given priority in the rehabilitation and reconstruction process. It is also hoped that it will make it easier to determine whether the affected country has sufficient capacity for this or whether and to what extent international cooperation will be needed and, in the latter case, what form such cooperation should take.

The evaluation must of course be carried out during the emergency phase. However, since the authorities will be understandably preoccupied with providing relief to the population, it will not be easy to obtain the information needed to evaluate the magnitude of the direct damage, still less the indirect and secondary effects.[6] As a result, unsubstantiated and frequently conflicting figures will often be reported. It is therefore advisable to wait until the relevant authorities have completed a substantial part of their emergency activities, so that the evaluation does not interfere with or jeopardize relief efforts. However, it is important not to wait so long that the results of the evaluation come too late to be of any use for guiding the rehabilitation and reconstruction process.

The various evaluation exercises carried out thus far cover issues in different orders and sequences, but all of them ultimately cover essentially the same aspects, subject of course to variations determined by the type and geographical scope of the disaster. They usually start by assessing the size of the affected population and how it has been affected. They then differentiate between the effects of the disaster on the "social sectors":

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[5] UNDRO, op. cit.

[6] For a definition of these and other related concepts, see part 1: Methodological and conceptual aspects, of this Manual.

education; health and housing; community services; and, lastly, on economic sectors. The breakdown which different evaluation exercises presented for economic sectors has depended on the scope of the disaster but also on the availability of information. An overall assessment has also been included, sometimes at the beginning but more often at the end of the corresponding document, comprising a recapitulation of the damage and an estimate of the disaster's impact on the behaviour of the main economic indicators during a period normally lasting one to two years after the disaster's occurrence but depending on the nature of the damage, sometimes lasting as much as five years.

Generally speaking, the Manual describes the methodology for those sectors or areas considered most relevant. As a result, it is not exhaustive but it is hoped that the definitions and calculation methods it presents and the information sources it suggests will provide the necessary basis for extending the evaluation process to sectors or areas not explicitly mentioned in it, for instance, tourism, mining, etc.

Based on the above considerations, the Manual is organized into five parts. The first covers general methodological and conceptual aspects; the second deals with estimating the effects of the disaster on social sectors (population, housing, health and education); the third describes its effects on the service infrastructure (drinking water and sewerage, transport and communications, electricity and power); the fourth covers damage to production sectors (agriculture, industry and trade); and, lastly, the fifth presents the methodology for aggregating direct and indirect damage and for measuring the disaster's impact on the main macroeconomic aggregates.

MANUAL FOR ESTIMATING THE SOCIOECONOMIC EFFECTS OF NATURAL DISASTERS

Part One:
METHODOLOGICAL AND CONCEPTUAL ASPECTS

INDEX

I. TYPES OF DISASTERS AND THEIR SUBSEQUENT PHASES

There are many types and kinds of disasters. Disasters are generally violent or unexpected occurrences, often accompanied by considerable loss of life, which cause a society, or part of it, suffering and distress, temporary disruption of normal life, substantial material damage and difficulties for the functioning of society and the economy.[1]

Thus defined, disasters can be divided into two main groups according to their origin: natural disasters and man-made disasters. The main natural phenomena, by descending order of frequency at the global level over a recent 20-year period, are as follows: floods; typhoons, hurricanes and cyclones; earthquakes; tornadoes; gales and thunderstorms; snowstorms; heat waves and cold waves; volcanic eruptions; mud slides and landslides; rainstorms; avalanches; tidal waves; fogs, frosts; droughts; and earth, sand and dust storms.

The commonest man-made disasters are those caused by explosions, fires, air crashes and collisions, land and water transport, and collapses of dams and dikes. There is also a growing list of "quasi-natural" disasters, such as air pollution and deforestation, and "social" disasters, such as epidemics, famines, pogroms, massacres, terrorist acts and wars. Most of these fall outside the scope of this Manual, which focuses mainly on the first group —natural disasters. Tables 1 and 2 show the most frequent economic and social effects by type of natural disaster.

Natural phenomena of meteorological and geological origin frequently cause disasters in the countries of Latin America and the Caribbean. On the one hand, tropical storms sweep the Caribbean each year and similar events affect countries situated in the tropical belt of the Pacific coast. Changes in air currents over the Pacific alter the sea's characteristics and cause floods and droughts on the Pacific slope of the continent. On the other hand, the presence of the "ring of fire" along the continent's Pacific coast and other lines of contact between tectonic plates cause frequent, intense earthquakes and volcanic eruptions in the region.[2]

It is customary to divide the post-disaster period into different phases, the most common division being the following: a) the emergency phase; b) the rehabilitation and recovery phase, also called the transitional phase; and c) the reconstruction phase.

The emergency phase is the period in which action is taken to save lives. It includes such activities as search and rescue, evacuation, first aid, building of shelters, emergency relief and medical assistance, temporary restoration of transport and communications networks, preliminary repairs to critical public utilities and a preliminary census of the victims and a record of the damage to public and private property.

The rehabilitation or transitional phase covers all activities designed to restore the situation in affected areas and communities to normal. It includes the temporary repair of dwellings and

[1] There are also natural disasters —droughts— which may go on for a long time before society feels their effects.
[2] J. Roberto Jovel, op. cit.

buildings, transport infrastructures and public utilities. It is also the phase in which the problem of the emotional and psychological recovery of the inhabitants of regions affected by the disaster must be tackled. Getting people back to work, creating new jobs, providing credit and financial resources and launching immediate projects to deal with the aftermath of the disaster are some of the most helpful recovery measures for victims and affected communities.

Lastly, the reconstruction phase covers all activities related to the reordering of the physical environment so that resources can be allocated according to the new social priorities arising from the effects of the disaster.

From the standpoint of this Manual, although the analyst must carry out his evaluation work primarily during the emergency phase, his calculations and conclusions must essentially serve the needs of the rehabilitation and reconstruction phases.

Table 1
EFFECTS OF NATURAL DISASTERS ON LAND SURFACE, STRUCTURE AND AGRICULTURE

Types of Disaster	Effects on land surface	Effects on structures	Effects on agriculture
Earthquakes	Tremors and fissures	Damages buildings, roads, dams, and bridges	None
	Landslides	Buries Structures; dams rivers, causing localized flooding	Some localized losses in affected areas.
	Liquefaction of soils	Damages buildings which sink	None
	Underground collapses	May damage buildings; rupture underground conducts and cables; alter course of underground streams.	Temporary losses of irrigation
	Avalanches	Damages buildings, roads, dams and bridges	Localized crop and timber losses
Hurricanes, typhoons (cyclones)	High winds	Damages buildings, power lines, towers	Loss of trees; damage to standing crops, especially grains.
	Flooding (from rain)	Damages buildings, bridges, causes mud slides and landslides	Damage to standing crops, especially tubers; erosion
	Flooding (storms)	Damages buildings, roads and bridges	Extensive damage to crops and irrigation systems; leaves salt deposits and contaminates soil and wells; causes erosion
Droughts	Dry soils	No major damage	Kills crops and trees
	Windstorms	Minor damage	Erosion and minor tree damage
	Desertification	No major damage	Covers land with sand; alters cropping patterns; kills trees; increases scrub growth.
Floods	Erosion	Undercuts and foundations	Destroys crops; changes cropping patterns
	Soil saturation and landslides	Buries buildings and damages other structures	Localized crop and timber losses
	Silting	No major effect	Improves soil
Tsunamis	Flooding	Destroys or damages buildings, bridges, irrigation systems; contaminates soil and wells	Localized destruction of crops; leaves salt deposits; destroys trees along shoreline
Volcanic Eruption	Eruption	Destroys or damages buildings and other structures	Extensive defoliation near eruption; deforestation
		Damages and buries buildings; sets fires	Buries crops and renders land unusable; starts forest fires
		No major effect	Destroys crops; makes land temporarily unusable; causes pollution; kills trees
		Damages buildings, dams and bridges	Little or no effect

Source: Adapted from Frederick C. Cuny, Disasters and development, Oxford University Press, New York, 1983.

Table 2
MORE IMMEDIATE SOCIAL AND ECONOMIC CONSEQUENCES OF A NATURAL DISASTER

Type of disaster	Short-term migrations	Permanent migration	Loss of housing	Loss of industrial trial production	Loss of business production	Loss of crops	Damage to infra-structure	Disruption of marketing systems	Disruption of transport systems	Disruption of communications	Panic	Break-down of social order
Earthquake			x	x	x		x	x	x	x		x
Cyclone			x	x	x	x	x	x		x		x
Flood	x		x	x	x	x	x		x	x		
Tsunami			x	x	x	x	x			x		
Volcanic eruption	x		x			x		x				
Fire	x		x	x	x	x	x			x	x	x
Drought/ famine	x	x				x						

Source: Adapted from Frederick C. Cuny, Disasters and development, Oxford University Press, New York, 1983.

II. GENERAL METHODOLOGICAL CONSIDERATIONS

The chapters that follow detail the methodology and the information sources recommended for each sector and for assessing a disaster's overall impact. This chapter enunciates some general criteria applicable to these issues.

The evaluation must begin with an exhaustive compilation of quantitative information and of any background information that will permit an assessment both of the conditions prevailing before the disaster and of the scope and magnitude of the damage and secondary effects. It will be necessary to consult governmental sources and professional associations (engineers' or architects' associations), chambers of commerce and industry, farmers' associations and experts of international agencies or bilateral missions who happen to be in the country at the time.

The reliability of the information obtained from the above sources will have to be verified in situ. Such verification, which of necessity will sometimes be limited to spot checks, will determine both the number of affected units and the magnitude and extent of the damage, using appropriate evaluation criteria as indicated in the following paragraphs.

It must not be forgotten that the evaluation exercise for which this Manual is intended is an essential tool for the adoption of decisions on the direction and priorities of rehabilitation and reconstruction plans and programmes. As a result, the various options must be properly weighed in order to balance the need for accurate estimates with the need to expedite the evaluation so that programmes can be launched as soon as possible. At the least, the results should give an accurate idea of the magnitude of the disaster's effects and of its geographical and sectoral impact: more precise calculations can always be made at a later stage when specific investment projects have to be drawn up.

III. CLASSIFICATION AND DEFINITION OF DAMAGE AND EFFECTS

Natural disasters do not only have readily perceptible effects, such as those caused by earthquakes, storms and floods. They also have consequences that develop slowly or appear only long after the event, for instance, crop destruction by pests arriving in the wake of the disaster or shortages of essential products arising several months after it.

This Manual describes and suggests a way of classifying the damage and effects brought about by natural disasters, applying two criteria: the methodology to be followed should permit a full assessment of the disaster's socio-economic impact at the time it occurs, and also of its subsequent effects; and it should be appropriate to the various levels (sectors and regions) at which an evaluation is required.

Bearing in mind that any set of definitions is governed to a large extent by convention, since there are cases that fall on the borderline between two concepts, the definitions used in this Manual are based, for the most part, on agreed elements deriving from the various evaluation exercises carried out to date.

In schematic terms, the effects of a natural disaster have been classified as follows: effects on property (direct damage); effects on goods and services production flows (indirect damage); and effects on the behaviour of the main macroeconomic aggregates (secondary effects). The first effects more or less coincide with the disaster or occur within hours of it, while the others occur over a period of time which practical experience has shown to be as much as five years, depending on the magnitude of the disaster.

If a rapid damage assessment is to be made, the damage caused by direct effects is relatively easy to identify and evaluate. The opposite is true of damage caused by indirect effects, as these arise at different intervals after the disaster and are therefore more difficult to identify rapidly. Most indirect effects do not show up in a rapid assessment and, while it may be possible to identify them when damage is assessed, they cannot always be measured in monetary terms.

Another point to be made here is that the first two categories of effects (direct and indirect damage) can be combined, with the necessary exceptions since one concerns property and the other concerns production flows, to ascertain the overall magnitude of the damage. Secondary effects, on the other hand, are considered to measure the impact from a different point of view . They measure the disaster's effects on the functioning of the economy, and the resulting macroeconomic imbalances. As a result, they cannot be added to the other two categories without causing duplication.

Wherever possible, the starting point for damage estimates should be physical units (number, square meters of built-up land, hectares, tons, etc.). This will make it easier to adopt the valuation criteria most appropriate to each case. We shall now describe more precisely the kinds of damage to be included in each of these three categories of effects.

A. DIRECT DAMAGE

Direct damage is all damage sustained by immovable assets and inventories (of finished and semi-finished products, raw materials, other materials and spare parts).[3] It essentially involves damage to property occurring more or less simultaneously with the disaster itself and comprises, inter alia, total or partial destruction of physical infrastructure, buildings, installations, machinery, equipment, means of transport and storage and furniture, and damage to cropland, irrigation works and dams. In the particular case of agriculture, the destruction of crops ready for harvesting must also be valued and included as direct damage.

It has also been customary to include as "direct damage" the estimated cost of demolishing and clearing areas where there has been destruction, since this comes under the budget for repairs and reconstruction and is easy to factor into the cost per square meter of construction work.

As will be seen in the sections on individual sectors, for calculation purposes it is appropriate to distinguish between: i) damage to the public sector and ii) damage to the private sector; and between: i) repairs;[4] ii) structures that have been totally destroyed; iii) equipment; and iv) inventories. Where possible, it is also very useful, in quantifying direct damage, to estimate what goods will have to be imported in order to restore or replace damaged or destroyed assets.

B. INDIRECT DAMAGE

This is basically damage to the flows of goods that cease to be produced or the services that cease to be provided during a period of time beginning almost immediately after the disaster and possibly extending into the rehabilitation and reconstruction phase, which has been set at a maximum of five years although the greatest losses occur in the first two years. Any calculation of its effects should, in any case, extend to the period needed to restore all or part of production capacity.

Indirect damage is caused by direct damage to production capacity and social and economic infrastructure.

Indirect damage also includes the costs or increased costs of providing services as a result of the disaster, and losses of income as a result of the impossibility or difficulty of

[3] Businessmen or business owners also tend to treat as losses those affecting realizable assets, such as unpaid liabilities which cannot be collected because the corresponding documentation has been destroyed. However, it seems inadvisable from the macroeconomic standpoint to include these losses as direct damage since, if the liability is not collected, it would be accounted as an inter-sectoral transfer of income and its inclusion as direct damage would result in duplication in the accounts.

[4] In practice, sectoral evaluators often value repairs as a percentage of the replacement value of the partially destroyed asset. Although this method is expeditious, an attempt must be made to improve it by using estimation techniques that reflect more closely the actual value of the repairs.

providing such services (which will, in turn, be reflected in the secondary effects). Some examples of indirect damage are losses of future harvests as a result of flooding of farmland;[5] losses of industrial output as a result of damage to factories or lack of raw materials; increased transport costs because of the need to use alternative routes or means of transport that are longer or cost more; loss of income for service companies because of the interruption of services; loss of taxes because of reduced economic activity; etc. These all constitute indirect damage for the sectors concerned and are also computed as secondary effects when an attempt is made to measure the disaster's effects on the principal macroeconomic aggregates.

The evaluator must be alert to the possibility that the indirect effects of a disaster may yield society net benefits instead of damage, costs or losses. Indirect effects sometimes yield major, quantifiable benefits which must be deducted from the overall estimates of the damage.[6]

Disasters also have major indirect effects that are difficult to identify and impossible to quantify. These are effects which cause "intangible" damage (or benefits) such as human suffering, insecurity, feelings of pride or aversion at the way in which the authorities have dealt with the consequences of the disaster, solidarity, altruistic involvement, effects on national security and many other similar factors which have an impact on well-being and quality of life. The analyst will not have time to try to put a monetary value on these important effects of disasters, but he must be aware that a comprehensive assessment of the effects of a disaster should include an evaluation or at least a thorough discussion of intangible damage or benefits that have a major impact on living conditions or standards.

Lastly, disasters have indirect effects which could be measured in monetary terms were it not for the time pressures on the analyst. These include opportunities lost because of the impact of the disaster on the structure and functioning of economic activities; distributive and redistribution effects; environmental changes; losses of human capital in the person of the victims; etc.

To sum up, disasters have one or more of the following kinds of indirect effects which are measurable in monetary terms:

i) Increased overheads in the sector as a result of the destruction of physical infrastructure or inventories by direct effects, or losses of production and income; for instance, losses of non-storable or perishable products which were not marketed; additional costs to the health system of reconstituting an appreciable quantity of statistics (health centres clinical records).

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[5] However, if the disaster destroys crops that are about to be harvested, this loss should be treated as direct damage, as shall be seen in the chapter on the agricultural sector in Part 2 of the Manual.

[6] For instance, prolonged, widespread flooding in a South American country made fertile a large amount of land on the shoreline which prior to the disaster had not been suitable for cultivation. This land was sown by the owners and the net benefits expected from the first harvest were deducted, as an indirect benefit, from the estimate of the damage.

ii) Production or service cuts as a result of the total or partial interruption of activities; for instance, the damage caused by the loss of an entire semester of instruction in the formal education system; the cost of failing to meet export contracts; etc.

iii) Additional costs in the sector because of the need to use alternative means of production or provision of services; for instance, increased costs because of having to use diversions and build emergency roads.

iv) Cost increases as a result of the reorientation or reallocation of budgets.

v) Loss of income as a result of non-provision of services; for instance, income lost by public utilities such as electric companies because they cannot charge for normal service that has not been supplied; loss of income for employees who have lost their jobs or must work part-time.

vi) Additional costs of dealing with new situations arising from a disaster; for instance, the cost of a health campaign to prevent epidemics.

vii) Production or income losses caused by a chain reaction similar to that occurring in a recession. Such losses may occur "upstream" or "downstream"; for instance, the destruction of an industry can cut back the activities of suppliers who have no alternative markets or customers who have no other suppliers.

viii) Costs or benefits deriving from external factors, in other words, from any indirect repercussion or side-effect of the disaster whose costs (or benefits) are absorbed by third parties not directly hit by (or benefiting from) it. This concept is excessively broad, for it includes effects such as the benefit of training brigades and workers in the emergency, certain costs of environmental pollution, increased traffic congestion and other similar repercussions of a disaster. The analyst must consider only those external factors that significantly modify the quantification of the damage.

Since not all kinds of effects are mutually exclusive, the analyst must be careful to avoid duplicate accounting in identifying and evaluating them. For instance, if he computes effects on the production side he must not compute them again on the income side; if he identifies the effects of reallocating budgetary resources to cover the costs of the rehabilitation phase, he must not then factor in as an indirect cost the expenditures financed by that reallocation, etc.

As a result, it will be essential to estimate indirect damage in close consultation with the relevant authorities or with experts. For instance, it will be necessary to determine how long it will take to restore services, how much output has been lost, what further costs will have to be incurred in order to provide services and what corresponding reductions will occur in factor incomes. It will also be necessary to analyze the performance record of service companies in order to estimate what their losses might be during the rehabilitation phase, and the prices and returns that lost agricultural and industrial output would have brought in. This Manual provides a step-by-step procedure for making these estimates in each of the sectors considered.

Because the concept outlined above is very broad, it would be advisable to delimit it so that the evaluator does not spend his time on laborious calculations which, taken as a whole, are not significant; for instance, estimates of the disaster's intangible effects on people's productive capacities, or the indirect effects of the approach taken to the emergency process or even the effects of certain drastic economic measures that may have been taken as part of that process. The evaluation must measure only the most important indirect effects, which could also be called primary or first-hand effects.

Combining the two categories of damage just described gives an idea of the overall material losses attributable to the disaster.

C. SECONDARY EFFECTS

Secondary effects reflect the disaster's impact on the behaviour of the main macroeconomic variables. Their measurement complements the measurement of direct and indirect damage, since it is carried out from a different standpoint. Secondary effects reflect the impact of direct and indirect damage and must not be added to it. Although it makes absolute sense to quantify these effects for the economy as a whole, it is essential that sectoral evaluators provide, on the basis of their specialized knowledge, the information the overall evaluator needs to integrate these effects into the main economic aggregates.

It also makes sense to present a disaster's secondary effects in such way as to allow to predict how each of the variables evaluated would have behaved if the disaster had not occurred. This is where we must start in order to determine the extent to which the disaster has frustrated the goals that would have been reached and the extent to which the deterioration in the main variables is affecting the country's ability to tackle the rehabilitation and reconstruction phases, making it necessary to obtain further international cooperation.

The disaster's main secondary effects are those which have an impact on the level and growth rate of the overall and sectoral gross domestic product; on the balance of trade, because of projected changes in exports, tourism and services and also in imports and payments for external services, etc.; on the level of indebtedness and of foreign reserves; and on public finances and gross investment. Depending on the nature of the disaster, it is also usually relevant to estimate the secondary effects on inflation, employment levels and household incomes.

Domestic product can be reduced by the anticipated decline in the output of sectors that have sustained damage and, at the same time, increased by a surge in activity as a result of reconstruction efforts. In some cases, exports shrink because of reduced output, or import requirements increase to meet internal demand, and this has an impact on the trade balance and the balance of payments. Public sector spending will increase to meet the needs of the emergency and rehabilitation phases, and tax revenues may shrink because reduced output and fewer exports mean the levying of fewer taxes or even the abolition of certain taxes to ease the pressure on sectors seriously affected by the disaster. This, in turn, can increase the fiscal deficit.

At the same time, prices of goods may go up because of shortages created by the disaster or because of speculation, thereby adding to inflationary pressures. Moreover, depending on the economic situation predicted before the disaster and if the latter was sufficiently large-scale and serious, it is possible that the country's international reserves or its ability to meet its external commitments will be threatened.

Secondary effects also include the decline in the living conditions of the affected population as a result of difficulties in gaining access to its sources of supply, reduced availability of essential services and, above all, loss of sources of employment and resulting loss of income. Although a reduction in quality of life cannot be measured in monetary terms, it is possible to quantify the secondary effects of a disaster on a population as a result of the loss of income caused by the partial, temporary or total interruption of its activities.

To facilitate the calculation of total secondary effects, sectoral evaluators will have to make estimates of foreseeable losses of output (of goods or services) during the time it will take to rehabilitate croplands, production equipment or physical and social infrastructure. They will also have to obtain information enabling them to evaluate the impact on the other aggregates mentioned (employment, income, exports, imports, gross investment, taxation, etc.). Lastly, as background, they will have to estimate what trends could have been predicted in the sector, given recent trends in its behaviour, before the disaster occurred.

The period of time for which secondary effects are to be projected will have to be flexible, according to the magnitude of the disaster. Experience has shown that, normally, a "reasonable time" would be the rest of the year in which the disaster occurs (short term), plus one or two years or, in exceptional cases, five years (medium term).

Part 5 of the Manual deals with this issue at greater length. However, the following are some methodological aspects common to estimates of some of the most important aggregates.

a) Gross domestic product. Loss of production of goods and services per sector as a result of the disaster and during the rehabilitation period must be measured by the overall or macroeconomic evaluator, using the information provided by sectoral evaluators. Data are needed that make it possible to estimate at constant prices the GDP lost, particularly the volume of the reductions in GDP predicted for the period it will take to repair the damage to production capacity. The sectoral evaluator will also have to estimate what trends in GDP could have been expected in his sector in the year in which the disaster occurred had the latter not taken place. This estimate will provide the basis for projecting losses by comparing results "before" and "after" the disaster.

b) Net investment. Losses of capital stock, calculated as direct damage, will not be reflected in gross investment for the year, since the destroyed assets were in existence before that year. As assets are gradually restored and depending on available resources and the country's capacity for building engineering works, gross investment for the following year will have to be increased. In any case, the magnitude of this variable in the disaster year will reflect two kinds of effects: i) ongoing projects which are suspended because of the disaster; and ii) inventory losses. Data on these effects and an assessment of sectoral investment requirements to repair the damage during the next five years[7] will have to be provided by the corresponding sectoral evaluator for use by the overall evaluator.

c) Balance of payments. The macroeconomic evaluator will have to calculate the balance-of-payments current account during the disaster year on the basis of sectoral reports for the following main headings: i) reduced exports of goods and services (if the country has experienced losses which inhibit its tourist activity or affect its shipping fleet or the production capacity of firms that export services such as engineering, etc.); ii) increased imports essential during the rehabilitation phase (fuel, food to replace lost harvests). For the following years (which may range between two and five), imports related to the reconstruction process would have to be estimated by sectoral evaluators on the basis of the imported component of each of the main headings; iii) donations in cash or in kind received because of the emergency; and iv) a possible reduction in interest payments on the external debt under emergency agreements concluded with creditors. To complete the picture of the disaster's effects on the balance-of-payments current account, compensation paid to the country under policies concluded with foreign insurers must be treated as a credit.

The balance-of-payments capital account will have to be estimated basically according to the medium- and long-term external financing requirements for the priority investment projects that will form part of the reconstruction process during the five years following the disaster[8] and also according to the additional external financing that may be needed because of the possible deterioration of the current account balance deduced from the above projections.

d) Public finances. This is another macroeconomic aggregate that will have to be quantified, since it usually fluctuates significantly during the disaster year and the years immediately following it. The following possible secondary effects will have to be included: i) lower tax revenues because of the drop in production of goods and services, loss of earnings and reduced consumer spending, and reduced earnings for public service companies; ii) increased current expenditures because of the emergency, especially to meet the needs of the affected population and repair damaged public services; and iii) increased investment spending for the reconstruction phase. The macroeconomic evaluator will have to try to reconcile possibly conflicting information from different sources. He will then estimate the deficit in the Government's accounts for the disaster year and subsequent years

[7] Or another period whose duration can be established by the sectoral evaluator and the macroeconomic evaluator as the most appropriate for completing reconstruction.

[8] See previous footnote.

in order to determine the financial requirements the public sector will have to face during that period.

e) Prices and inflation. Although it is not always feasible or necessary to measure the overall inflation levels existing before and after a disaster, assessments should at least be made, on the basis of sectoral reports, of the effect that supply restrictions resulting from the destruction of harvests, manufactures, marketing channels, transport networks, etc. may have on the price of certain goods and services which, in such cases, will be supplied by alternative means.[9] The influence of these variables on the overall level of inflation and on relative prices will have to be estimated and included as a secondary effect of the disaster.

f) Employment. Sectoral estimates have to be made in order to assess the overall effects on employment levels as a result of: i) the destruction of productive capacity or social infrastructure; and ii) new demands for manpower during the emergency and the rehabilitation process.

Lastly, the experience of evaluations made by both national and international institutions over the past two decades points to the existence of certain relationships between the type of disaster and the kind of damage sustained, the main ones being:[10]

- natural disasters of meteorological origin —such as floods, hurricanes and droughts— usually affect a wider geographical area than those of geological origin;

- because of population density, the number of victims resulting from natural disasters of geological origin —such as earthquakes— is likely to be higher than in the case of disasters caused by meteorological phenomena;

- losses of capital stock in the physical and social infrastructure caused by earthquakes are usually much higher than those caused by floods;

- production losses and other indirect damage, on the other hand, are likely to be much higher in the case of floods and droughts; and

- when a geological phenomenon gives rise to floods or mud flows, production losses and other indirect losses are generally much higher than in other kinds of geological disasters.

The following general effects are common to all types of natural disaster:

- a variable number of victims;

[9] In some cases, the effect may even be to reduce prices, if the substitute product that is imported or obtained from another source is bought at a lower price.

[10] J. Roberto Jovel, op. cit.

- a substantial reduction in the availability of housing and health and education facilities and a corresponding increase in already high underemployment and unemployment rates;

- temporary interruptions of water supply and sanitation services, electricity, transport and communications;

- temporary shortages of food and raw materials for agricultural and industrial production;

- regardless of the damage sustained, the activities that can be expected to recover fastest are small commercial businesses and personal services;

- in countries with predominantly dual structures, the problem of disaster-related loss of employment is more serious and more lasting in the modern sector than in traditional sectors, and is worse in industry than in agriculture, commerce or services;

- in the recovery and reconstruction phases, the structure of employment changes as activities related to housing construction and public works increase;

- a reduction in the volume of exports and an increase in imports can normally be expected; and

- public finances will also evolve towards a deficit situation, since increases in all kinds of social spending, the reallocation of spending over time and increases in investment will generally be accompanied by lower tax revenues and other fiscal income.

Although the direct and indirect losses described are considerable, the social effects of natural disasters are usually more significant.

IV. CRITERIA FOR EVALUATING DAMAGE

The experience gained in this area advises against any attempt to use a single concept of costs and prices for evaluating damage. However, as a general rule of thumb, the prices and costs most relevant to each situation must be estimated. Accordingly, damage will be estimated on the basis of the costs and prices prevailing as close as possible to the moment at which the disaster occurred, the purpose being to establish, to the extent possible, a single baseline in time for the calculation of all damage and to avoid including in the calculation any inflationary or deflationary effects that might be caused by the disaster.

However, it is advisable to value at equivalent replacement cost totally destroyed capital stock or buildings earmarked for demolition. This involves taking into account the functional equivalence of the destroyed capital asset, in other words, the cost of replacing it with other stock offering similar operating characteristics. This is a standard approach for avoiding the over-valuation that is likely to occur if the destroyed stock or equipment is simply replaced by the latest version of it (incorporating technological innovations) available on the market. In any case, once the corresponding replacement value has been established, it will have to be adjusted for depreciation (based on the average working life and age of the goods). This will give the value of the direct loss or damage. However, it is advisable that the amounts included in the final evaluation should refer to the replacement value of the destroyed assets, since these are the amounts that the economy will have to pay and that will therefore affect its financial, foreign exchange and budgetary requirements, among others. It is clear from this that, in many cases, the value of the actual damage sustained by the destroyed property will not be the same as the amount the country needs to rehabilitate or rebuild it.

The evaluator will often have to take a decision that falls between two extremes, for instance, between the value per square meter of destroyed sub-standard housing and the kind of permanent housing that the country will provide for the people who used to live there (which would clearly mean a qualitative improvement in the kind of housing), or between the value of near-obsolescent machinery destroyed in a textile industry and the cost of its replacement, which will obviously be different because it will incorporate a considerable amount of technological change. This does not mean that the value of the most sophisticated equipment will always have to be taken into account; the replacement chosen will be the one functionally closest to the destroyed equipment and the one whose purchase and financing is considered feasible.

Given the acute inflation that have affected most countries of the region, book value will generally not be taken into account as an approximate indicator of the market value of goods or assets. Indirect damage to flows of goods or services will be evaluated at producer or market prices, as appropriate. (This issue is dealt with in detail in Part 3.)

Costs and prices will be evaluated in "real terms" (use of productive resources, goods and services); in other words, the damage assessment will not include an estimate of financing costs. Such costs relate to: commissions, interest, discounts, insurance and reinsurance, subsidies and all the internal or external post-disaster systems of free, paid or subsidized financing. (As a result, the costs or prices of the real economy are treated as paid "in cash".) Transfers within the economy will also not be costs (or benefits) of the disaster, since they are transactions which do not use resources or produce goods and services.

In a rapid damage assessment, it seems unlikely that most sectors will be able to evaluate damage (pre- and post-disaster) in terms of social costs. In any case, we recommend weighing the appropriateness of using, in some situations, the approach characteristic of evaluations of social costs.

Calculations of direct and indirect damage will have to be made in the national currency of the country affected by the disaster. However, it is often essential to then convert these figures into United States dollars, using an appropriate exchange rate, to permit comparisons and a better grasp of their magnitude internationally. The prices of exports or of articles that must be imported will have to be expressed directly in dollars.

V. INFORMATION SOURCES

One common effect of natural disasters is that they obstruct normal information sources, especially if a country's capital city or other political and administrative centres have been severely hit. Many public buildings will have been evacuated and some of their functions will be carried out in various other places. Civil servants and technical staff will be working in the field or will have joined special commissions to coordinate planning or relief activities, with the result that a number of customary sources of information will be inaccessible.

The analyst must quickly evaluate his possible information sources, which in all likelihood will be dispersed. For instance, he will obtain population data from the national statistical office, but if the office cannot provide them he will have to turn to specialized centres or institutes; he will probably obtain background information on disaster victims from units of the ministries of health, government or the interior, information on damage to schools from departments such as the ministry of education or construction offices in charge of building educational establishments, and so on for each of his needs. Moreover, in many cases he will not be able to obtain information from a central office but only in the places affected by the disaster.

In the vast majority of cases, the analyst will have to make an independent assessment of the damage or review assessments already made by the authorities or by relief agencies. He will have only a short time to do this, in the circumstances characteristic of an emergency situation. Accordingly, the most advisable techniques for obtaining information would be the following:

A. STRATEGIC INFORMATION SOURCES

Regardless of whether emergency and rehabilitation efforts have been organized on a centralized or a decentralized basis, the evaluator will have to first locate a network of national bodies, national and international agencies, research centres and "key" people who can provide the necessary information and have sufficient authority to request and obtain documents and reports on the disaster. Despite time pressures, the evaluator must use for his evaluation only documented facts and data, his own observations or those obtained from oral reports, or summaries of the situation prepared by various sources. There will almost certainly be no way for him to judge the validity and reliability of this information, or to reconcile conflicting opinions or information, other than to rely on these strategic information sources.

B. ANALYSIS OF PRESS COVERAGE

Starting on the day of the disaster, the press will publish written information that the analyst may find very useful. Press clippings must be sorted into categories that are easy to handle. The press archive will be kept up to date and may prove vitally important for four aspects of the evaluation process: i) as a reference source for identifying people who could become strategic information sources and for locating useful documents; ii) as an independent yardstick for verifying the consistency and coherence of the official and unofficial information available to the evaluator; iii) to draw attention to areas and types of damage not covered by existing analyses; and iv) to provide data and figures that supplement the information obtained from other sources.[11]

C. CARTOGRAPHY

Maps are an essential tool and the evaluator must try to obtain them at the outset. Maps made after the disaster and giving information on its effects are particularly useful. However, even if they exist, such maps are usually difficult to obtain since they are being constantly updated. Moreover, in most cases even basic maps are not available in institutions and the evaluator will often have to search for them.

D. RECONNAISSANCE MISSIONS

These may be by land, sea or air. If, as often happens, the evaluator is able to make only one reconnaissance, it should be scheduled to enable him to first evaluate in his office the information sources already available to him. The reconnaissance mission will then gather additional information unavailable from those sources. In isolated or inaccessible areas, reconnaissance missions will often be the only feasible way of obtaining information. Local reconnaissance will always be useful for the evaluator, because it will provide a way for him to evaluate the quality of the information sources to be used throughout the damage assessment process, it will enable him to classify the effects of the disaster by order of magnitude on the basis of his own findings and, lastly, it is the only opportunity he will have to detect major damage not mentioned in any other documented source.[12]

E. SURVEYS

In-depth surveys are the best method of obtaining data for the rehabilitation and reconstruction phases. When the object is a rapid damage assessment —an activity normally carried out towards the end of the emergency phase— such surveys do not yet exist. There are three kinds of surveys that may be very useful, however: i) those made by

[11] The evaluator will have to take due care to identify, and treat with the necessary circumspection, information provided by the sensationalist press.

[12] This often happens in the evaluation of damage to social sectors and the affected population. However, it is valid for all sectors. For instance, when the damage caused by a recent earthquake was evaluated, much of it centered on the destruction of several kilometres of oil pipeline. The aerial reconnaissance mission, however, detected major damage to agriculture as a result of landslides, an aspect not considered initially.

departments or agencies who carry out rapid damage assessments involving, for instance, a visual inspection of the number and state of damaged or ruined dwellings or a survey of specific aspects of the damage, such as victims and morbidity structure, by a health area division; ii) more comprehensive surveys using more systematic procedures and providing comparable, valid data on the pre-disaster situation, such as employment and unemployment surveys in the main cities. These instruments are very valuable in several areas of the damage assessment process and are analyzed below as an integral part of the analysis of secondary data; and iii) the rapid assessment surveys that the evaluator (or his team) may make, especially during reconnaissance missions. These must be made whenever there are no better sources of information.[13]

F. ANALYSIS OF SECONDARY DATA

This involves the analysis and use of publications, documents and reports containing background information provided by various institutions or individuals. For the evaluator, the data are "secondary" in the sense that he does not have to produce them himself, but their importance is usually fundamental. Whatever the methodology used for evaluating damage, the evaluation must reflect values that contrast a post-disaster situation with a pre-disaster one. This is the best alternative available to the evaluator for ascertaining the relevant values and the situation prior to the disaster. Moreover, information on the pre-disaster situation will be the starting point for evaluating the effects of the disaster. Without it, an accurate assessment of the damage will be impossible.

In the case of natural disasters, reliable, valid data both on the physical characteristics of the affected territory and on its population (size, distribution, density, economic, cultural and ethnic characteristics, etc.) must be obtained. When the evaluation is being made for government institutions or international agencies, the evaluator should wherever possible use official sources or documents giving data based on those sources, with figures published by the competent agencies.

Population, housing and sectoral (agriculture and livestock, manufacturing, mining, etc.) censuses are particularly useful, as are statistical yearbooks, journals of statistics and census departments, publications of research centres operating within the country and surveys made by official bodies, university centres and other centres of recognized expertise. In the period immediately following the disaster, documents will be scarce and of the kind described above: partial surveys made by public departments and international

[13] An overland reconnaissance mission drove through a dozen or 50 small villages of the South American plateau on which there was no information about the population affected or the homes damaged by an earthquake. The evaluator made the following rapid assessment: i) he established a three-tier scale of damage to dwellings: "ruined", "severely damaged" and "damaged but habitable"; ii) in each village, estimating a distance of 50 to 60 meters, he "surveyed", by slowly driving past them a line of dwellings in the centre of the village and two lines of streets, at two different cardinal points, chosen at random towards the outskirts of the village, estimating the number of damaged dwellings and classifying the damage in the corresponding categories; iii) in addition he inspected any major "buildings", such as churches, schools and public offices. At a later stage, he combined this information with population census data to estimate the size of the affected population and the damage caused to homes and buildings in the villages.

agencies and internal reports prepared by the institutions most involved in the emergency and rehabilitation phases.

G. LONG-DISTANCE INTERPERSONAL COMMUNICATION

The evaluator often has no choice but to use telephone, radio or telegraph to obtain information about remote, inaccessible disaster-stricken areas. Since one of the first activities after the disaster is the restoration of communications, one of these channels is very likely to be in operation. In any event, the evaluator must request very precise data through these channels and then carefully evaluate the information he obtains by comparing it with information available independently from other sources.

H. AERIAL PHOTOGRAPHY

Aerial photography, if available, can be of considerable assistance. However, it is easy to exaggerate its importance. Experience has shown that photographs taken in isolation and unsystematically by non-specialized staff will yield little information of any use to the evaluator. The opposite is true when aerial photography forms part of a system of aerial photometry, since in this case the evaluator will have all the information he needs to correctly interpret the nature and magnitude of much of the damage. In such cases, the investigator should make his estimates and calculations in close cooperation with staff specialized in the analysis of aerial photometry.

I. REMOTE SENSING IMAGES

Images obtained by remote sensors mounted on aircraft or satellites are a new technique for collecting data that could potentially assist in rapid damage assessment. Remote sensing is able to provide complete resolutions over wide areas in a very short time. However, it has two serious drawbacks: the cost of installing these systems for use in disaster evaluation is too high for most developing countries; and remote sensing images do not permit evaluation of aspects essential for a rapid assessment. For example, a building may look intact from the air and be scheduled for demolition because of internal structural damage: damage to underground pipes and conduits or internal damage to industrial and commercial establishments also cannot be detected.

However, the use of remote sensing images could prove invaluable in the pre-disaster stage, especially for planning, early warning systems and vulnerability profiles. It could also prove useful in the reconstruction phase, when the mass of information gathered by sensors can be rigorously analyzed.

MANUAL FOR ESTIMATING THE SOCIOECONOMIC EFFECTS OF NATURAL DISASTERS

Second part

SOCIAL SECTORS

I. POPULATION AFFECTED

The quantitative expression of the number, attributes and characteristics of the victims, together with the presentation of the circumstances in which they occurred, must be central to the evaluation process. One of the first tasks for the analyst is, therefore, to estimate the population and geographic area affected in order to be able to determine the number of victims and the situation of the survivors. The population is the subject on which all the effects of the disaster, both quantifiable and intangible, converge. Moreover, that estimate is essential for the overall appreciation of the effects of the disaster and for the evaluation of damage in the diverse sectors (agriculture, health, housing, etc.). That calculation constitutes an independent criterion against which the consistence and coherence of all other estimates can be evaluated and, most importantly, constitutes the first step in the orientation of national and international efforts to overcome the emergency and in the establishment of priorities in the rehabilitation and reconstruction plans and programmes.

In order to determine the size and characteristics of the population affected, the analyst should first decide the limits of the impacted territory, estimate the number of persons, characterize them and, if possible, formulate appraisals of their situation after the disaster, all of which will help to draw an overall idea of the intangible damage (or benefits) affecting living conditions or levels. Large discrepancies both in the concept and measurement of the affected population occur frequently, so that analysts will nearly always have to make their own estimates. For that reason, they should begin their work on the basis of a broad view of the territory and of the population affected, sharpening the focus later on. (See chart 1).

The most frequently used source of data will be the latest population and housing censuses, or official or academic publications based on that data. Population must then be projected to the time of the disaster. The longer in the past the date of the last census, the more difficult will it be to make the estimate. In any case, the option taken will depend on the time available, the precision required and the quality of the available information. It is probable that, given the need for a rapid appreciation, the official version of available censuses or surveys will simply be accepted, specially if, in the disaster area, relevant post-census demographic events have not occurred (such as important migratory movements, opening of colonization zones, etc.). This is to be recommended specially when the original data is less than three years old; to the contrary, when it is necessary or inevitable to estimate and project the characteristics of the population, global figures should be used initially, which will then be adjusted through detailed, sectoral or derived projections.[1]

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[1] In this regard, the analyst should be familiar with the techniques for projections in smaller areas which have recently become the fashion. Moreover, electronic data processing and the capacity of small computers have made the diffusion of small area data possible, as occurs for instance in the programme for Latin America and the Caribbean of the Recovery of Census Data for Small Areas by Microcomputer (REDATAM), developed by the Latin American Centre of Demography (CELADE).

With respect to the methodology to be used to estimate the affected population, for purposes of rapid evaluations, the analyst should begin with official estimates, expect occasionally, and then extrapolate. There are two techniques for this, specially for short periods, as follows:

i) A situation in which the registry of vital facts (births, deaths, migrations) is relatively complete and the information is available and opportune.

Pd = Po + (N-D) + (I-E)

In which:

Pd = population on the day of the disaster
Po = last official population estimate
N = births between o and d
D = deaths between o and d
I = immigrations between o and d
E = emigrations between o and d

This method is recommended when not many administrative units have been affected, because the calculation must be performed for each, separately.

ii) Estimate for mathematical procedure.

Pd = Po (1 + r)t

In which:

r = annual growth rate of the population
t = extrapolation time

Example: the zone affected by a disaster on September 21, 1989, had a population of 3 650 000 persons, according to the last census of June 10, 1985, and an annual growth rate estimated at 1.2%. The estimate of the affected population on the day of the disaster would be the following:

Pd = 3 650 000 x (1 + 0.012)(4 103/365)
Pd = 3 650 000 x (1.012)4.28
Pd = 3 650 000 x 1.052
Pd = 3 839 800

See UNDRO, Disaster Prevention and Mitigation, Vol. 12, Social and Sociological Aspects, United Nations, New York, 1986.

The rate "r" is of geometric growth (also called "compound interest) and must also often be calculated by the analyst. To that end, the information for two recent official estimates must be used. Suppose a disaster during 1988. The analyst has found official data for the years 84 (Po) and 86 (Pt) for the territory of the population affected. The rate of growth can be estimated as follows, to be subsequently adjusted as necessary, if relevant demographic events have occurred.

Let P_o = 5 670 inhabitants (in 1984)
P_t = 5 825 inhabitants (in 1986)
t = 2 years

with $P_t = P_o (1 + r)^t$

$$\text{so that } r = \frac{(P_t)^{1/2}}{P_o} - 1$$

With the values of this example:

$$r = \frac{(5\,825)^{1/2}}{5\,670} - 1 = 1.36\% \text{ annually}$$

A concrete experience of this problem is presented here. In the case of a recent earthquake in a Central American country, given contradictory versions of the size of the territory and of the population affected, the analysts made estimates by following these steps:

i) They marked in a political-administrative map, the entire territory in which people "felt" the earthquake (the broadest concept). On the Mercalli scale of corrected intensity, this is the equivalent of II intensity or more;

ii) Then, they reduced the territory marked to those areas which reported victims or damage, making official partial data compatible with extra-official sources, those obtained from a complete analysis of the press from the day of the disaster and the estimates raised from field visits to the devastated zones;

iii) Some of the areas thus marked were inaccessible, held very little population, or data about them from the last census were very unreliable; the areas within these zones with slight damage were eliminated and conjectural estimates for the other zones were included (this is an inevitable adjustment, given the time available to complete the evaluation of damage); and

iv) On the basis of census information, the lowest level of political-administrative unit for which population data exist was chosen, the territory was defined and the necessary adjustments and projections were made to arrive at the definitive estimate of the population affected by the earthquake.

In another similar experience, an earthquake which affected an area and population of the high and relatively inaccessible Andean mountain country posed the need to make estimates of the population most severely affected by the disaster and their location. This task was made more difficult by the fact that the zone was rural and its population dispersed; it proved impossible to find maps which showed the current situation in terms of population. The Cartography Service solved this last problem by supplying material which made it possible to locate the small mountain localities with sufficient precision.

With this and other information relative to material loss and number of affected persons, the analysts were able to estimate damage levels and the population damaged in the hamlets, towns and cities accessible by land. Investigative parties sent to nearby places, mainly in order to confront the reliability and validity of the figures, also made it possible to classify the proportion of the population severely affected in those places. Although it was not practical to enter extensive zones nearer the epicenter, the evidence observed in the concentrated population settlements indicated a graduation, rough but clear, according to which the damage was less, the greater the distance from the epicenter.

With the figures from the towns as a reference, two circles were drawn around the epicenter. The radius of the first was provided by the severely affected town furthest from the epicenter. The second circle obtained its radius from the furthest town in which the seismic wave was felt. Knowing the characteristics of the construction of rural dwellings, it was possible to estimate the number and location of the most severely affected population between among those who live within the first circle. The urban and rural population affected was estimated on the basis of those living within the second circle.

The terms "victim" and "affected person" will be used as synonymous in this manual, , although in other contexts the term "victim" includes the dead and injured and "affected person" is limited to those who suffered material and economic losses. Primary victims and homeless persons are those in the population segment affected by the direct effects of the disaster and includes the dead, injured and crippled (the primary trauma victims) and those who suffered material loss, including those accruing from production and income losses, as a direct and immediate consequence of the disaster. (See Chart 3). This segment of the population is that found within the territory affected in the moment in which the disaster occurs.

The primary victims are not all cases of trauma, given that, depending on the type of disaster and its intensity, its direct effects may cause material damage which leave the victims helpless. Many of these can be attended in emergency field shelters, although others will require a more lengthy period of recuperation and rehabilitation. More definitive, large-scale shelters, clearly different from those erected for the emergency, are established to attend these families. Those moved to these institutionalized shelters may represent an important segment of the affected population. If these are maintained beyond the emergency phase itself, the analyst should record the costs of maintaining those shelters as damage. It is advisable to separate maintenance costs from those involved in infrastructure.

The latter costs involve the damage which may be caused by using schools, churches and other buildings suitable to serve as institutionalized shelters. Moreover, if this type of damage to infrastructure is considerable, it is more correct to record it as cost or indirect damage in the sector affected. For example, is the institutionalized shelters are located in schools, those costs should be included in the indirect damage of the education sector.

Those population segments which suffer the indirect effects of the disaster are secondary and tertiary victims. The difference between these two groups is that the secondary victims are found within the boundaries of the affected territory (or very near it) and the tertiary victims are found outside or far from it.

The calculation of the costs, losses or damage arising from the indirect effects of the disaster and sustained by secondary and tertiary victims should usually be recorded in sector evaluations. The merchants of the affected area and those involved in trading activities related to the crops who lose income as a result of the effects of the disaster, in a way similar to a recession, are examples of secondary victims. Examples of the indirect effects which affect tertiary victims are the benefits which they cease to receive as a result of the reallocation of public funds in function of emergency activities.

In disasters which occur over a prolonged period of time, such as droughts and floods, secondary and tertiary victims also tend to make use of institutionalized shelters. It is worthwhile recording these victims separately, by indirect effect, because these constitute indicators of situations which could lead to considerable internal migration. When people must remain in the shelters for a long time, another type of loss or costs arises. These are related to production and income losses (not detected by sector evaluations). When estimating this factor, the analyst should record them, subtracting the cost of maintaining the families in the shelters, in order to avoid recording them twice.

The direct effects which produced primary victims with trauma are recorded by the evaluation of damage in the health and housing sectors. The indirect costs, arising from lowered incomes, should be recorded in the evaluations of the productive sectors. Therefore, it is only necessary to estimate here the damage produced, in monetary terms, by a disaster which is permanent, as in the case of loss of lives, for society and there is no opportunity for substitution or recovery.

The most notable immediate effect on the population affected by a disaster is the deterioration of their living conditions. The physical environment changes, impoverishing and affecting other dimensions: the network of social contacts, work relationships, communications, culture and recreation is changed; personal security and confidence in the system of life are threatened; normal access to education, health and food services are interrupted; and the loss of homes and household goods deteriorates accustomed living conditions. That deterioration, which impacts the entire affected population, has greatest impact on the primary victims and must be recorded as one of the most significant direct costs of the disaster, even though it will not be easy to quantify it in a rapid evaluation of the damage.

Among the non-quantifiable indirect effects which impact the population affected are, for example, the psychological damage and societal change, the solidarity and disinterest shown with regard to the disaster, the desperation of those who do not receive aid, and many other intangible costs and benefits of this sort.

Disasters also have psychological impact. Episodes of depression, anguish, fatigue, nervousness, irritability, loss of appetite, altered sleep patterns and psycho-somatic symptoms such as diarrhea, headaches, etc., during the emergency phase and even afterwards, have been observed and measured. Psychiatric interpretations of the effects of a disaster lead to the affirmation that damage of this sort may be significant both in the short terms and even over longer periods of time. However, at the same time, sociological research undertaken in this regard reveal that, although disasters produce noteworthy stressed reactions, the population affected does not develop dysfunctional behaviours; deep pathologies are not the norm; and psychological damage disappears or recovery is made rapidly. Research into these matters continues and it is probable that, within a reasonable time, it will be possible to estimate this type of damage and incorporate it into evaluation processes.

The response mechanisms of the affected population do not support the so common and popularized catastrophic version of reality. In general, it is observed that there is no irrational reaction of generalized panic. The population tends to act positively and episode of sacking and pillaging and social disorganization occur infrequently. Manifestations of solidarity and support are the rule rather than the exception. In view of this, it is recommended in this manual that the analyst not anticipate a probable cost to be attributed to social disorganization, as a specific dimension of the damage suffered by the population affected.

Few events better reveal the inequalities in a society than the destruction produced by a natural disaster, specially in developing countries. The devastation suffered by those who are poorest is so disproportional that the causal direction becomes evident: one is vulnerable because one is poor. It frequently occurs then that societal change, occasionally significant, occurs after natural disasters. Cases have been studied and documented in which the effects of hurricanes and storms have detonated a situation which eventually led to the independence of nations in Asia; of the successive governments of African countries which have fallen from power over the "question" of aid during a long and cruel drought; and the cases of other countries which were beset by relatively long periods of social and political instability, sparked initially by the demands of the victim population. Even more that the intangible effects and psychological impact, the causes of societal change cannot be identified precisely, nor measured, by a first, rapid appreciation of damage.

Chart 2 indicates the way in which costs attributable to affects suffered by primary, secondary and tertiary victims can be displayed, using the limited concept of affected population. Together with the description of the characteristics of the primary victims with trauma and the circumstances in which they occurred or could have been avoided, it is worthwhile to complement the respective text with a summary chart. A possible version of one of these is found in Chart 3.

Chart 1

NETWORK OF INFORMATION NEEDS

POPULATION AFFECTED

- Affected
  - Survivors
    - Non-Victims
    - Victims
      - Injured and helpless
      - Material damage

Specific dimensions

Territory affected. Political-administrative divisions.

Population. By area; rural/urban residence.

Number of victims or primary homeless persons.

Persons in shelters. Number of families and costs.

Injured and helpless. Medical classification, urban/rural residence; age, sex; ethnic classification; work category.

Deaths. Grouped by age groups; rural/urban residence; sex; ethnic classification, educational level; work category

Victims or secondary homeless persons

Costs by attributable sector: public or private

Dimensions of better information

Territory affected: sex; age groups; educational levels, ethnic classification; number of families and homes; housing. Distribution by state or condition of home; population econimcally active: working, unemployed, type of work, occupational category; popluation economically inactive, available information on income; all of this data, by political-administrative division within the effected territory.

Country: national totals recommended for the affected territory for recovery ends.

Non-quantifiable effects.

Chart 2
DAMAGE TO THE ECONOMY ATTRIBUTABLE TO THE AFFECTED POPULATION

(in millions of dollars)

Victims, homeless	Total	Direct	Indirect
A. PRIMARY VICTIMS	12.2	11.9	0.3
1. Trauma victims	6.5	6.5	-
Disposition, treatment and recovery	3.4	3.4	-
Losses of production and income	3.1	3.1	-
2. In shelters	5.7	5.4	0.3
Family transport and maintenance	2.6	2.6	-
Additional family production and income losses	1.9	1.6	0.3
Infrastructural damage	1.2	1.2	-
B. SECONDARY AND TERTIARY VICTIMS	2.0	-	2.0
Transport and maintenance	0.9	-	0.9
Additional family losses	1.1	-	1.1
TOTALS	14.2	11.9	2.3

Chart 3
PRIMARY VICTIMS WITH TRAUMA, BY REGION

Description	Total	Territory affected Region 1	 Region 2
1. Deaths	4 403	584	3 819
2. Injured	14 176	1 592	12 584
Light	13 192	1 204	11 988
Severe	984	388	596
3. Crippled	3 602	614	2 988
Recoverable	2 959	512	2 367
Partial permanent	330	16	314
Permanent	313	6	307
TOTAL PRIMARY VICTIMS	22 181	2 790	19 391
Sex			
Deaths			
Women	2 970	397	2 573
Men	1 433	187	1 246
Injured and crippled			
Women	10 902	1 436	9 466
Men	6 876	770	6 106
Age			
Deaths			
Younger than 5 years	893	147	746
Between 15 and 65	2 027	246	1 781
Older then 50 years	976	129	847
Injured and crippled			
Younger than 5 years	3 031	429	2 601
Between 15 and 65 years	10 451	1 146	9 305
Older than 50 years	1 683	344	1 339
Rural/urban residence			
Deaths			
Rural	1 261	237	1 024
Urban	3 142	347	2 795
Injured and crippled			
Rural	6 093	685	5 418
Urban	11 675	1 521	10 154

II. THE HOUSING SECTOR

Social sectors are, generally, those most seriously affected by natural phenomena. According to the definition adopted for this manual, these are basically the housing, health and education sectors. The damage usually sustained by infrastructure, equipment and furnishings can generally only be repaired in the mid term. Moreover, the appraisal of destroyed assets must nearly always be performed in terms of replacement costs (which implicitly include the improvement of equipment and inputs, specially in the case of housing). In the case of repairs, on the other hand, the appraisal figure will be much closer to the market value of the asset in question.

1. Introduction

a) Definition, conceptual and institutional aspects

In this section, the methodology for evaluating damage to housing caused by a natural disaster is described. The term dwelling means every building destined to sheltering persons or families for purposes of habitation. Only that damage caused to "dwellings" will be analyzed and not that caused to what has been traditionally called the "housing sector", which includes urban infrastructure and equipment, nor does it include the industrial and commercial sectors, dedicated to construction materials and processes. The damage to those elements is dealt with in Part Three: Infrastructure; and Part Four: Economic Sectors (Chapter II Industry and Trade) of this manual.

The deterioration or destruction of dwellings has general implications for the economy and the living conditions of the population, so that, in the analysis of these factors, it will be necessary to keep interrelations with other economic activities and social sectors in mind. Thus, expenditures in housing construction contribute to the overall formation of fixed capital in the economy. In the same way, variations in the housing construction rate have direct impact on the creation of jobs, as well as in the industrial areas related to construction. Given this interrelation, damage to the housing inventory will be relevant, in general, to the activities of the Ministries of Economy and Finance, and of Planning, and to the corresponding sector agency (Ministry or Institute of Housing and Urban Affairs), as a factor in the evaluation of the disaster, and also within policy design for the subsequent reinitiating of the economic development process.

Action in the area of housing is an important aspect of social development policies. Through that policy, governments attempt to satisfy the housing needs of the entire population (either recovering from current deficits or those caused by natural disasters). The evaluation of housing needs and the execution of action geared to satisfy those needs come within the sphere of interest and are the responsibility of central government bodies (Ministry or Institute of Housing and Urban Affairs), of regional governments or agencies and the municipalities.

The evaluation of the damage to housing and the projection of reconstruction possibilities will make it possible, on the one hand, to determine their impact on employment and on the capacity of the industrial and commercial sector to provide the inputs necessary for the construction and repair of damaged dwellings. The Ministries of Work and of Industry and Trade are responsible for these matters.

The evaluation of damage to housing will generate, in short, basic information for both national and international aid organisms participating in sector reconstruction activities.

b) Evaluation methodology and application

Experience has taught that the evaluator will have approximately one or two weeks of notice prior to the visit to the disaster zone and, usually little more than one week in the affected zone, itself, in order to gather data and prepare a report. During the period prior to the visit, the evaluator should gather relevant information on the housing conditions in the disaster zone and prepare specific lists of institutions and persons with whom it will be necessary to establish contact. The evaluation process will lead to the elaboration of indicators which can be summarized in a matrix (see Chart 1).

The "dwelling unit" or "housing unit" is the simplest unit for quantifying sector damage. The information obtained during field visits and that supplied by agencies which act during the emergency are usually expressed in terms of that unit. The statistical information codified in units such as "square meters constructed" can be converted into "housing units" by using an estimate of the average dwelling size, obtained from statistical information or on-site inspection.

In the same way, home furnishings and equipment, which are usually found dispersed throughout the statistics, can be estimated in terms of average composition and value, per "dwelling", or by type of dwelling, as required by local conditions.

In order to satisfy the information needs indicated in Chart 1, the following steps should be taken, nearly simultaneously, given the scant time available:

i) Delimitation of the area affected by the disaster;
ii) Evaluation of the situation prior to the disaster
iii) Identification of direct effects/damage
iv) Measurement of direct effects/damage
v) Appraisal/costs of direct effects/damage
vi) Identification of indirect effects/damage;
vii) Measurement of indirect effects/damage;
viii) Appraisal/costs of indirect effects/damage
ix) Identification of secondary effects
x) Evaluation of secondary effects;
xi) Formulation of commentary on the main damage to housing and its relation to the housing typology and the physical and socioeconomic context of the affected area;
xii) Gathering of information about the main reconstruction works/projects, their duration and possible budgets; and
xiii) Identification of those sector areas which need support for implementing reconstruction works.

c) <u>Delimitation of the affected area</u>

One of the initial tasks is to delimit the affected area in which evaluation activities will be concentrated. In this regard, the following information should be gathered:

- location and ways of access to the affected area:
- identification of the political and administrative bodies responsible for emergency and reconstruction activities in each region;
- identification of the organisms and sources of information about the economic and social indicators of the affected zone;
- programme of in-depth field trips.

Taking into account the available sources of statistical information, the administrative competencies of public organisms and the environmental characteristics of the country, it is considered necessary to identify: the total area affected by the natural disaster, the political and administrative divisions of the affected area (example: districts, provinces, departments, states, or regions affected); and the natural regions involved (example: forest, plains, coast, highlands, etc.).

As far as possible, the affected area should be marked on a map or plot of the country, indicating, as necessary, the political and geographical divisions mentioned above.

To gather information about the size and characteristics of the affected area, recourse may be had to the national organism (or regional and local organisms) responsible for civil defense or emergency tasks; the entity responsible for the housing sector and other central government agencies, municipalities and regional governments; together with information in the press; and that provided by non-governmental organisms and individuals who work in the affected zone.

Given the diversity of sources to be used, it will be necessary to cross verify them and, inevitably, to carry out on-site inspections as a complementary measure.

d) <u>Evaluation of the situation prior to the disaster</u>

Knowledge of the housing situation in the zone prior to the disaster will serve as the starting point for the evaluation and help avoid common errors, such as over-estimating damage. In this regard, efforts to gather the following minimum information are considered important:

i) Number of dwellings in the affected zone, classified as: urban/rural; self-owned/collective; and public or private property.

ii) Quality of the dwellings in the affected zone, classified by: permanent and semi-permanent. (See the definition of these categories below.) If this information cannot be obtained directly, it can be estimated on the basis of other data which describe:

- construction materials used (paper, cardboard, waste materials, brick, wood, adobe, etc.);
- the condition of the dwelling (good, very good, fair, poor, etc.);

- the type of dwelling (hut, trailer, house, etc.).

This classification must be made on the basis of the appraisal of the local physical and socioeconomic conditions, as well as of the predominant type of dwelling in the area.

iii) Average dwelling size:

If these data are not available directly, they can be estimated on the basis of the following information:

- average number of inhabitants per dwelling
- average cost of affected dwelling, divided by the cost per square meter constructed.

iv) Description of the main construction techniques and materials used in the affected zone.

Information should also be gathered with respect to:

i) Number of dwellings in the affected zone: classified by: one-family/multi-family use and by a scale of construction costs. (See the definition of these categories below.)

ii) Number of inhabitants in the affected zone and number of inhabitants per dwelling.

iii) Typical furnishings of the average dwelling (defined as that which represents the majority of dwellings in the affected zone) or according to typologies which correspond to the categories indicated below.

iv) Construction, furnishings and equipment costs:

- at current market prices
- at factor costs (market prices, excluding indirect taxes).

Costs should be expressed in national currencies. In the event that some costs are expressed in other currencies (American dollars, German marks, French francs, etc.), prices should be converted to national currencies, using an exchange rate to be determined with the corresponding Central Bank or the financial and economic authority of the country.

e) <u>Information sources</u>

Information on the country and/or the zone affected by the disaster, with respect to housing conditions, can be found in:

i) <u>National sources</u>

- Censuses and periodic surveys:

Population and housing censuses
Statistical bulletins/annuals
Property registers/listings
Periodic surveys in the housing and construction sectors
Construction permits/licenses
Consumer price lists

- Data obtained directly from organizations, such as:
  National Statistical Institute/agency
  Ministry/Institute of housing and urban affairs
  Ministry/Institute of planning
  Chamber of Construction
  Schools/associations/federations of architects and engineers
  Banks which finance housing
  Municipal governments
  Regional governments: state/department/province
  Academic and research institutes related to: architecture, demographics, social sciences.

ii) Other sources

- Construction/commercial/industrial sector companies
- Chambers of commerce and of industry
- Newspapers: property listings
- Realtors
- Insurance companies.

iii) International sources

- United Nations annuals or statistical compendia:
  Statistical Yearbook for Latin America and the Caribbean (ECLAC);
  Compendium of Human Settlements Statistics (New York);
  Construction Statistics Year Book (New York).

- Data obtained directly from organizations such as:
  Latin American Demographics Centre (CELADE), Chile);
  Economic Commission for Latin America and the Caribbean (ECLAC, Chile);
  United Nations Centre for Human Settlements (CNUAH, Kenya); and
  United Nations Statistics Office (New York).

2. **Direct damage or effects**

a) Direct effects, according type of disaster

As noted, direct effects are mainly those related to loss of capital or property. Natural phenomena cause direct damage to housing, causing partial or total destruction. Earthquakes tend to produce structural damage (in rafters, columns, paved areas, bearing walls, etc.) and non-structural damage (light walls, installations, non-structural roofs, furnishings, equipment, etc.) in dwellings, due to the additional loads to which those elements are subjected by the earth's movements. Damage is also produced by permanent deformations of land (settling, slides, etc.) used for housing.

High intensity winds, associated with storms and hurricanes, also bring additional loads to bear on buildings, affecting both structural and non-structural elements. In this case, however, the foundations and underground elements will suffer little or no damage. Other phenomena, such as floods, land slides and volcanic eruptions, tend to act in ways similar to those described above, bringing additional loads to bear on buildings, deteriorating or destroying their components, deforming the land on which they rest, or making them useless because wind or water have deposited extraneous material in them (mud, ash, debris, etc.).

Damage to structural elements is usually worse than other types of damage, often making it necessary to demolish or abandon the building . Non-structural damage, although more visible, can often be repaired or only requires the replacement of some element which does not affect the building as a whole. Faults in the land may make it necessary to abandon the building or to execute stabilization works.

b) Classification of dwellings

Given the brief time available to the evaluator, it is very difficult to generate detailed inventories of all damaged houses, so that it is necessary to extrapolate conclusions from the inspection of representative samples of damaged dwellings (not necessarily statistically valid). For this type of evaluation, it seems best to classify dwellings as described in Chart 2.

As can be seen in Chart 2, the minimum consolidated information required is that relative to self-owned and collective housing; urban and rural; private and public. A typology of housing by construction type and cost will only be important in order to obtain a more exact calculation of the cost of the damage and must only be employed in those cases in which the differences among these typologies, together with the number of damaged dwellings, make separate accounting necessary. According to this criterion, and as justified in each particular case, the evaluator may employ other housing typologies, based on the predominant materials used in construction (wood, earth, concrete, etc.) or by building type (individual, up to four floors, etc.).

The definitions of the categories and typologies indicated in Charts 2 and 3 are:

Urban dwelling: that located in urban settlements, according to the definition used in the country under study. (Examples: in Peru, all settlements with more than 100 dwellings are urban; in Venezuela, all settlements with more than 2 500 inhabitants are urban).

Rural dwelling: that located in rural settlements, under the same conditions as the previous definition.

Public sector dwelling: includes all dwellings which are the property of the central government, regional and local governments, and State companies.

Private sector dwelling: includes all dwellings which are the property of individuals and private companies.

Particular dwelling: includes units such as houses, apartments, huts, tents, etc., in which each unit houses a family or home. These may be either individual one-family units or buildings with various units (multi-family).

Collective dwelling: this category includes boarding houses, hotels, motels, boarding schools, convents and other establishments used for purposes of collective habitation.

Permanent: that which, according to the materials and quality of the building, can be considered as a dwelling for permanent use and which provides adequate protection from the environment.

Semi-permanent dwelling: includes units such as tents, huts, marginal dwellings, mobile dwellings, etc., made of non-durable materials and which do not provide adequate dwelling quality.

According to the prevalent conditions in each case, dwellings can be grouped according to cost levels, as a means of classifying by social strata or income levels. For example:

i) expensive dwelling (building valued at more than US$15 000);

ii) mid-range dwelling (building valued at between US$5 000 and US$15 000);

iii) low cost building (building valued at less than US$5 000).

c) Dwelling components liable to suffer damage.

A natural disaster can destroy the basic components of a dwelling either partially or totally. In order to calculate damage with a certain degree of precision, it will be necessary to itemize the characteristics of the components of a dwelling and their cost. Those components and the types of damage they suffer are as follows:

i) Building

↴ Structural elements (Rafters, columns, paved areas, bearing walls, foundations, etc.).

?? Damage which may possibly be repaired:
Type of damage: cracks, deformation, partial destruction
Forms of repair: repair of the element, repair with additional reinforcement

?? Damage beyond repair
Type of damage: cracks, deformation, total destruction

Action: replacement of the element and additional reinforcement, abandonment and replacement of the building.

↴ Non-structural elements (partitions, interior installations, doors, windows, non-structural roofs, floors)

?? Damage which may possibly be repaired:
Type of damage: cracks, deformation, partial destruction
Forms of repair: repair of the element, repair with additional

?? Damage beyond repair
Type of damage: cracks, deformation, total destruction
Action: replacement of the element and additional reinforcement.

ii) Furnishings. For the purposes of this evaluation, furnishings include: furniture (tables, chairs, beds, etc.), kitchen and table utensils, clothing and other linen goods; domestic machinery and equipment (stove, washers, heaters, radios, etc.), and other items (ornaments, books, games, etc,).

It will be very difficult, in the brief time available, to evaluate which of these elements can be repaired and the degree (percentage) of damage they have suffered, so the evaluator should define two or three degrees of destruction for all furnishings, based on the inspection of the damage, to be applied to the dwelling or model dwelling.

For example, 100% of furnishings destroyed;
50% of furnishings destroyed; or
25% of furnishings destroyed.

iii). Equipment. Some dwellings, both one-family and multi-family units, have equipment, apart from the usual interior installations (sanitary, electrical): for example, installations for air conditioning, electrical generators, pumps for drinking water or for the removal of sewage, incinerators and other mechanisms for the removal of solid wastes, elevators, security equipment, central heating, recreational equipment (swimming pool, etc.), irrigation systems, etc. Much of this equipment is heavily used under certain conditions (high income areas in tropical cities), although the number of dwellings so equipped in the countries of the region is relatively small. The evaluator will find it necessary to adopt one of the following criteria for identifying damage to equipment:

- assume and describe a set of "basic equipment" for all affected dwellings, or

- assume and describe a set of "basic equipment" for a certain number or typology of affected dwellings (this will be the more common case).

As in the case of furnishings, it will be difficult to make a detailed inventory of deteriorated or destroyed units, if they are numerous. In that case, it is recommended that the evaluator define two or three categories of damage to be applied to the typical equipment of a dwelling, or the units of individual equipment which it seems reasonable to appraise.

For example:

- damage which requires extensive repair;

- damage which requires minor repairs;

- total replacement of the equipment.

iv) Other aspects to be considered in the identification of damage to housing

Other direct damage. Other works than those already mentioned must be performed so that the repaired or replaced dwelling will be the equivalent to that which existed previously. These should be appraised as direct damage and include the reconnection of public services (drinking water, sewage services, gas, electricity), demolition works and the removal of debris or other materials accumulated in the damaged dwelling.

Imported components. The evaluator should identify, list separately and appraise the content of imported materials and products in the dwelling or model dwelling.

The identification of imported elements which have been damaged or those which must be replaced with imported goods, is of great relevance given the impact of this factor on reconstruction activities and periods, as well as on the country's balance of payments. Depending on the natural conditions and the industrial development of the country, these may include such varied products and materials as: wood, cement, construction iron, sanitary and electrical accessories, panels for roofing and walls (P.C.V., fibre glass, asbestos-cement, etc.) and all kinds of furnishings and housing equipment.

d) Appraisal of damage

i) Building, furnishings, equipment and reconnection of services. Some ways of appraising damage to housing are presented here, which, in all cases, have incorporated the criterion that a dwelling, or element of a dwelling, must be obtained which is functionally equivalent to that in place prior to the disaster, except in those cases in which what existed before was of very low quality, in which case the reconstruction process must involve a positive qualitative change.

Certainly, the costs reported in this appraisal will not coincide with the real (depreciated) value of the destroyed goods, because it must also include, within the total price, the financial costs to be met in obtaining the resources necessary to provide a housing solution equivalent to that which existed prior to the disaster, with the exception mentioned above.

Chart 3 displays the possible ways of estimating the magnitude of the damage on the basis of the "quantities" of labour, materials/accessories and equipment which it will be necessary to use in reparation or replacement works, which themselves are to be appraised by eventually applying the corresponding unit prices.

The exercise indicated in the Chart will only be important in those cases which involve partial reparation or replacement of housing. In cases of total replacement, it may be more useful to use universal units, such as "square meter constructed", instead of executing the burdensome exercise of calculating labour, materials and equipment separately. Moreover, it is not necessary to have recourse to the detail provided in Chart 3, if universal measurement units already exist which incorporate the labour, materials and equipment values which constitute them.

ii) Partial or total demolition of destroyed dwellings. Natural disasters may cause damage to dwellings which make them unsafe, thus requiring partial or total demolition, prior to replacement. It is advisable to estimate demolition works on the basis of the "housing unit" or a percentage of it (for example: the number of units to be 10% demolished; the number to be 25% demolished), thus making it possible to correlate these magnitudes with the appraisal of direct damage already mentioned.

Another form of assessment would be through the calculation of "square meters" of housing (buildings) to be demolished, which would have to be codified as "housing units" by applying an "average dwelling area".

Dwellings to be partially or totally demolished should be grouped in the same typologies employed by the evaluator for the appraisal of the direct effects, as already explained.

iii) Removal of debris and material. The works to remove debris and the material deposited during the disaster (mud, ash, solids, etc.) may be grouped in two categories, which should be appraised separately:

- the removal of debris during the period immediately after the disaster, for the purpose of saving lives and property, clearing ways of access and for transport, etc., which should be calculated within the total costs of the emergency and, therefore, should not be included among the figures for direct damages contemplated in this manual as housing costs; and

- the removal of debris of destroyed or demolished dwellings in order to begin reparation or replacement works. Those costs are to be added to the figures for direct damage to housing.

As in the case of demolition works, it is acceptable to estimate an "average volume" of debris or material to be removed (expressed in cubic meters) for each typology of dwelling selected in the specific situation to be evaluated.

f) Appraisal of direct damages or effects

i) General criterion. The unit prices to be applied to the "quantities" of the kinds of damage listed in Chart 3 (for building, furnishings, equipment and reconnections), together with those related to the units of demolition and removal of debris, should correspond to current prices at the time of the disaster. They should be current market prices under normal conditions; that is, excluding possible distortions due to the speculative or inflationary situation generated by the disaster itself. Those prices should include all necessary costs (administrative, financial, etc.) for incorporating inputs (labour, material or equipment) into reparation and replacement works, or tasks involved in the reconnection of services, or the demolition and removal of debris.

Prices of imported materials and equipment should be determined in a way similar to that employed above, according to the information provided by suppliers. If this is not possible, CIF prices (which include transport and insurance to destination) are to be obtained, to which the necessary domestic costs of incorporating the input into the repair or replacement work should be added.

ii) Buildings, furnishings, equipment and reconnections to services. Charts 4, 5 and 6 present possible ways of facing the task of quantifying damage to housing, with regard to buildings, furnishings, equipment and the reconnection of services. They should only be used in cases involving the partial replacement of housing, because, when total replacement is necessary, universal units are to be preferred. For this reason, it is also recommended that estimates be made on the basis of damage to the "average dwelling" or for each type of dwelling deemed necessary, depending on the concrete situation.

As noted above, it will not be necessary to enter into all the detail indicated in the Charts, if universal measurement units are used, together with unit prices which incorporate the labour, materials and equipment which constitute them. In the case of total dwelling replacement, it may be more useful to use universal units, such as "square meter constructed", as indicated above.

iii) Partial or total demolition of destroyed dwellings. Unit costs for demolition vary greatly, depending on type of dwelling, the materials employed in their construction and their location. In order to simplify the evaluation, it is recommended that global unit costs be estimated for the appraisal units described above. If this proves difficult, it will be necessary to estimate costs on the basis of the basic inputs to be used in demolition works; labour, equipment, and some materials (such as explosives).

Information about demolition costs can be obtained from the sources indicated below, as well as from companies in that type of work.

iv) Removal of debris and material. For debris removal, the most easily obtained price is that for a cubic meter. By multiplying this by the average volume per dwelling, the unit cost per dwelling will be obtained (according to the diverse types of dwelling selected). The evaluator must be sure that the unit prices to be applied or calculated include all the costs of labour and equipment necessary for the removal, transport and final deposit of the debris or material deposited during the disaster. The information on costs for the removal of the debris or material deposited during the disaster can be obtained from the sources indicated above or directly from companies specializing in demolition work, earth moving and transport of materials and aggregates.

g) Sources of information

Generally, information on the magnitude of damage will be obtained from organizations which operate in the affected zone and by on-sight evaluator inspections. Construction prices can be obtained from sector organizations or directly from suppliers.

i) Sources of information on the magnitude of the damage. The main source is the reports of organizations responding to the emergency, press reports, graphic material (area photographs, photographic records, films) and the reports or records of the evaluator's on-sight inspections.

That data and other information obtained directly from organizations at work in the affected area, such as those of international aid: multilateral, bilateral, non-governmental (including the churches); from the central government: the civil defense agency, the Ministry/Institute of Planning; from municipal and regional governments; from non-governmental aid agencies: churches, non-governmental research and technical support agencies; sector institutes; and insurance companies.

ii) Sources of information on unit prices. These data can normally be obtained from periodical bulletins reporting construction sector prices, the documentation for contract bids for housing construction, reports on unit prices for housing prepared by the relevant governmental organisms, the price lists of suppliers of materials and equipment, indexes of price and salary variations, reports on diverse prices in the trade, construction and industrial sectors, and the press.

This type of information can also be obtained from domestic and international suppliers of material and equipment, chambers of construction, industry and commerce, national statistics institutes/agencies, the Ministry/Institute of Housing and Urban Affairs, Colleges/associations/federations of architects and engineers, academic and research institutes, construction companies and the press.

3. Indirect effects

a) General observations

Together with the loss of capital and property involved in the destruction of housing (direct effects), there are other indirect effects of the disaster, related to:

i) the necessary costs involved in obtaining dwellings equivalent to those in existence prior to the disaster (together with those costs already considered as arising from the direct effects).

ii) Other costs or losses (in the production of goods and services or income) to the family or the nation arising from the direct damage caused to housing. In coherence with the general criterion for this manual, the costs considered in this category will include only those incurred after the emergency stage.

For the purpose of calculating them in categories similar to those employed for direct effects, it is recommended that indirect effects be classified as: urban and rural; public and private.

A basic criterion for the identification of indirect effects is that they should be easy to express as costs and to add to direct effects, in order to calculate the total damage caused by the disaster. Although the damage to housing has other additional effects on economic and social conditions within the country, these may be considered as "secondary" effects and are treated below.

In Chart 7, the indirect effects to be taken into account are presented.

b) Assessment and appraisal of indirect effects.

i) Stabilizing the ground and protection of dwellings. In some cases, repair and replacement works, the reconnection of services, demolition and debris removal must be complemented by other works to ensure the quality of the repaired dwellings under normal conditions and a minimum of protection in the event of another disaster. This category includes works to stabilize the ground affected by settling or sliding (earthquakes, land slides, etc.) or those undertaken to provide protection against flooding.

The typologies and costs of stabilization and housing protection works are too varied to be classified, so that the analyst should determine the main works required in each situation and, insofar as possible, express them in terms of a generalized "housing unit" or, if this is not possible, for the total number of dwellings which will be affected by this type of work. It will be very useful for the evaluator to break down stabilization and protection works into their basic components of labour, materials and equipment, making it easier to obtain unit prices.

Information on costs for land stabilization and housing protection works can be obtained from the same sources mentioned above in the section on direct effects.

ii) Relocation of housing occupants and uninhabitable settlements. All costs arising from the need to relocate the inhabitants of housing damaged by the disaster to new or provisional places of residence, together with the relocation of families and settlements located in dangerous localities or those vulnerable to new disasters are included in this section. For the purposes of this manual, movements undertaken in the emergency stage are not taken into account. The analyst should establish a degree of certainty that the relocation activities being evaluated are feasible to be performed, prior to their inclusion in the calculation of damage. To this end, the five UNDRO requisites for evaluating the possible success of a relocation should be applied:

- the consent of the community affected;
- the availability of safe land, at a cost which the community (or the State) can bear;
- the proximity to sources of employment or social services;
- the provision of services and facilities for the construction and financing of housing;
- the existence of services and facilities for the construction and financing of housing.

Costs to be considered in this section include the cost of transportation to the new or provisional place of residence; the costs of preparing the land to be occupied temporarily or permanently, both those destined to physical preparation (including services for drinking water and disinfecting) and those involved in the purchase or rent of the land to be used; when this involves the provision of temporary (non-emergency) dwellings, that cost is included here; and also the administrative, legal, financial, etc. costs implicit in this activity.

To perform the appraisal, it is best to take the family (understood here as the occupants of a damaged dwelling) as the basic unit of measurement. The calculation of costs per family will make it possible to add them to the other direct and indirect damage already accounted for. Some costs, such as those for transportation, will be easier to calculate per "person", but they can be converted into costs per family by applying an estimate of average family size for the zone or country under study. The necessary data can be obtained from public or private companies which specialize in the transportation of persons and cargo. The evaluator should verify the information about transportation with the data obtained for the specific evaluation of that sector (See the Chapter on the transportation sector in Part Three of this Manual).

The costs involved in the preparation of land are very diverse and difficult to typify. They may involve works such as: the opening of access roads, surveying and laying out plots, leveling and preparing land, and the installation of basic services (latrines, water spigots, etc.). The evaluator should select the most relevant activities to be undertaken to attend to one family and apply the corresponding unit costs. Those costs, together with those for provisional housing (which are not the emergency shelters) may be obtained from the same sources mentioned in the previous section, as well as from those mentioned earlier.

iii) <u>Additional transportation needs of displaced families to their centres of work, education, etc.</u> Families displaced to localities far from their original place of residence may incur additional transportation expenses as they travel to their habitual places of work and services. Such expenses are usually assumed directly by the families; however, it may happen that the public sector will occasionally cover part or all of them. As in the case of "relocation", it will be best to take the "family" as the unit of measurement. To arrive at that level of aggregation, the evaluator should estimate the average <u>additional daily transportation expense</u> for each member of a family representative of all the families affected in this way. Individual expenses will be accumulated to yield the average expense per family.

The additional daily expense per family is then multiplied by the number of days estimated before the situation returns to normal, thus yielding the total cost for transportation. Transportation costs can be obtained from the same sources indicated in section ii) above.

iv) Loss of income from rent not paid to the owners of damaged dwellings. The inventory of dwellings in a country generates income for the owners which is the value of the rent paid for those units, when they are rented. Those same income flows should be attributed to dwellings occupied by their owners in order to reflect the loss of comfort (damage) they suffered as a result of the damage to their dwellings.

When a certain number of dwellings are totally or partially destroyed, the (real or attributed) flow of income arising from the use (or rental) of those dwellings ceases. Given that precise identification the number of cases in which this occurs as a result of the disaster may be very difficult, the evaluator should presume that income is lost only in the case of dwellings which have been totally destroyed or rendered uninhabitable. The value of the indirect damage calculated in this section will be equal to the amount of the "lost contribution to the national economy of the income attributed to housing", which is considered as a secondary effect (See section 4).

The corresponding loss of housing income is obtained by multiplying the number of totally destroyed dwellings by the average value of the rent for those same dwellings. In order to make that value uniform with that to be estimated for secondary effects, the average rent used will be that employed by the economic authorities in national surveys (which is usually that used in surveys of household expenses).

v) Lost public sector income from unpaid taxes on damaged dwellings. In normal circumstances, the inventory of housing in a country generates income for the public sector (central or local governments), in the form of land taxes. In some countries, however, a large percentage of that inventory is not adequately registered and, therefore, does not produce tax revenue.

When a certain number of dwellings are totally or partially destroyed, they may cease to generate tax revenue, thus reducing public sector income from that area. In order to estimate that public sector loss, the evaluator should first determine that the number of destroyed dwellings, subject to taxation, and the amount of tax revenue in question are significantly great to justify their calculation and inclusion in the list of damage.

The value of this type of indirect damage will also be important in the calculation of secondary effects on the gross domestic product and public sector finances (See the following section 4 and Part Five of this Manual).

The loss to the public sector arising from uncollected tax revenue is equal to the amount of tax paid per average dwelling (dwelling representative of the destroyed dwellings), multiplied by the number of dwellings totally destroyed which had been subject to taxation prior to the disaster.

4. Secondary effects

Together with the direct and indirect effects described in earlier sections, the destruction of housing produces several secondary effects on the economic and social conditions of the affected population and the country, as a whole, which become apparent some time after the disaster. As is known, those effects are not added to the direct and indirect effects. For the purposes of this evaluation, a qualitative or, perhaps, a quantitative assessment of the impact of the disaster on diverse indicators of the economic and social conditions in the country affected should be made, so that the evaluator may study and integrate them.

This section indicates several particularly relevant secondary effects arising from the destruction of housing, such as:

i) loss of income, which would normally be generated by or imputed to housing rental;
ii) variations in housing sector employment rates;
iii) effects on the balance of payments;
iv) effects on the public sector;
v) effects on inflation.

a) Loss of housing rental income to the national economy

The inventory of dwellings in a country generates an income equivalent to the product of the number of dwellings, multiplied by the value of the rent actually paid, plus that imputed to owner-occupied dwellings. When a certain number of dwellings disappears, having been destroyed by a natural disaster, the income normally generated by the corresponding activity (housing rentals) will be affected (See Part Three of this Manual).

The corresponding loss of rental income is obtained by multiplying the number of dwelling totally destroyed by the value of the average rent imputed to those dwellings.

b) Variations in housing sector employment rates

A disaster may affect housing sector employment rates in the following ways:

i) Increase employment in reconstruction works;
ii) Reduce employment due to the temporary closure of conventional construction activities at the time of the disaster;
iii) Create employment in emergency activities.

In this section, only the evaluation of variations in the number of jobs will be addressed, because the costs of the job positions created are dealt with in the appraisal of repair/replacement works (case i) or emergency works (case iii). Experience shows that the loss of jobs due to the closure of housing construction (case ii) is normally slight and, therefore, may be excluded, if the evaluator so determines.

Given that, due to factors not directly related to the disaster, reconstruction works may extend into the mid- and long-terms, it is recommended that the impact on employment be studied "only" in the short term; that is, during the year or two, at most, after the disaster.

Increases in employment can be estimated on the basis of the investment made in reconstruction works during the year following the disaster, dividing it by the investment necessary to create one job in the country under study (it is worth noting that research has shown that, in Latin America and the Caribbean, between US$ 3 000 and US$ 7 000 of investment in "conventional" housing construction are needed to create a job/year);

Jobs lost due to the closure of works (if deemed necessary): the final cost (finished) of the works paralyzed by the disaster should be calculated and divided by the investment necessary to create a job while the conventional works are paralyzed.

c) Effects on the balance of payments

The destruction of housing and subsequent reparation and replacement works may have significant impact on the county's volumes of imports and exports of goods and services. Some of the flows of goods and services and of capital, which may occur between the country and abroad and which may affect the balance of payments, are discussed here.

i) Imports of materials, inputs and equipment for the reparation and replacement of housing. The need for additional imports, as a result of the disaster, should be calculated. The appraisal of additional imports should be based on the calculations made for the quantification and appraisal of the imports component of the direct damage (See the previous section).

ii) Cash income from loans and donations for emergency and reconstruction works. Those values can be estimated on the basis of the costs of the emergency phase and the foreign currency component estimated for reconstruction projects.

iii) Cash income for the payment of secondary insurance on damaged housing. In the case of housing, the total amounts arising from secondary insurance may be very small; however, the evaluator should ascertain the facts before proceeding with the evaluation.

iv) Income loss from exports not realized, because national production of housing materials and components (example: cement, iron, hardware, etc.) normally geared for export will be employed during the transition process to cover reconstruction needs.

d) Effects on the public sector.

The destruction of housing and subsequent reconstruction works may have significant impact on the finances of the public sector. Here, only two of the most relevant aspects of this issue should be taken into account:

i) Increased public sector expense/investment: needed for reconstruction works in the housing sector. This greater expense can be calculated on the basis of the costs estimated for reconstruction projects.

ii) Reduced public sector income arising from lower tax revenues from dwellings totally destroyed. These values can be calculated on the basis of what was indicated above.

e) Effects on inflation

Normally, during the evaluation period, it will be possible to make only a very rough estimate of the impact of the destruction of housing and the demand for construction materials on the prices of those products. To this end, the evaluator can be guided, to a degree, by comparing prices prior to the disaster with those in effect during the evaluation itself. Future trends for the period deemed relevant for the calculation of secondary effects must be evaluated jointly with the macroeconomist and the evaluator of the industrial sector, who will indicate current stocks of materials and the country's capacity to produce and distribute them.

A general recommendation for sector evaluators, specially those of the housing sector, is that they work closely with the macroeconomist to obtain the necessary information and harmonize criteria for the calculation of the flows mentioned above.

5. Reconstruction period and works

a) General observations

The purpose of including this section in the chapter on housing is to present a description of the special characteristics of the housing under analysis and its surroundings in the disaster zone which are believed to have been determinant of the magnitude and type of damage caused to those dwellings. The analysis of these characteristics will make it possible for the evaluator to put forward general recommendations for the execution of reconstruction works, including measures geared to prevent or mitigate the impact of a future occurrence of natural phenomena of similar intensity. Finally, it is recommended that an estimated calendar of activities and expenses for reconstruction works be included in this chapter, in order to guide government and other aid organization activities.

The most common types of dwelling in the affected zone and the impact produced in them by the disaster (structural and non-structural) should be described. The construction materials most commonly used in the area, their quality, their behaviour during the disaster, and their adequacy to the most common construction typologies should also be included. Finally, the placement of the dwellings and the physical characteristics of their surroundings (soils, geology, topography, etc.) which may have affected housing resistance to the disaster should be indicated. A brief list of recommendations about the most relevant aspects of the reconstruction process is included here, as follows:

i) Technical characteristics of housing repair, the processes to be applied and the materials to be used. The same for the construction of new housing.

ii) The placement or relocation of housing according to the characteristics of the surroundings. Need for preparatory works, if it is impossible to relocate dwellings situated in vulnerable places.

iii) Economic and input supply aspects of reconstruction works.

iv) Organizational and institutional questions related to the execution of reconstruction works (community participation, technical assistance, training, institutional coordination, etc.).

List of research projects and technical cooperation activities designed to develop these recommendations in greater depth and support reconstruction works. These projects should address four main issues: construction and repair techniques; costs and materials; institutional organization and coordination; and housing location.

List of reconstruction/rehabilitation projects, in which the amounts of investment needed should be indicated, together with possible sources of financing: national resources and foreign loans or donations.

b) Programming reconstruction works.

Programming reconstruction and its corresponding budget in order to generate an hypothesis about the amounts and time periods during which investments should be made for reconstruction works, together with estimates of their impact on public sector finances and its institutional capacity to execute those works.

The following aspects should be taken into account in the programming of reconstruction works:

i) existence of economic resources and normal execution periods for the allocation and utilization of those resources;

ii) institutional and organizational capacity for reconstruction works, taking into account the role to be played by the public sector, the private sector and civic organizations;

iii) the supply of inputs for reconstruction works, including human resources, materials and equipment, and considering that, in some cases, it will be necessary to import them;

iv) the time needed to design, plan and organize reconstruction activities; and

v) climatic and physical aspects (for example, the length of the rainy season which would hinder reconstruction works or the time deemed necessary for a flooded zone to drain and become apt for the realization of reconstruction works).

The evaluator should obtain information about the aspects mentioned above from public and private sector organizations, as well as from direct observation during the evaluation. This information will make it possible to programme the number of housing units and the amount of investment in housing in terms of annual periods for the entire reconstruction period, or for a period agreed upon, according to the programming needs of the country under study.

Chart 1
SUMMARY OF EFFECTS ON THE HOUSING SECTOR

Effects of the disaster	**Cost (Millions of monetary value)**				**Reconstruction or reparation period (months)**
	Total 1/	Public 2/	Private	Rural Urban	
a) Direct effects: (i+ii)					
i. Reparation					
ii. Replacement					
Imported component 3/					
b) Indirect effects:					
c) Sub Total (a+b)					
d) Secondary effects:					

1/ Total cost corresponds to the sum of costs for the urban and rural categories, which will be equal to the sum of public and private costs.

2/ The number of publicly owned dwellings is usually not significant. Nevertheless, it has been retained as a separate category for the sake of coherence with the global classification of damage, which separates public from private damage.

3/ The imported component refers both to repairs and replacements; they should not, then, be added together.

Chart 2
CLASSIFICATION OF HOUSING

Category	Typology of privately owned dwellings			Collective dwellings 1/
	Total number of dwellings	By type of construction	By cost	
By location				
Urban				
Rural				
Total 2/				
By ownership				
Public				
Private				
Total 2/				

1/ Experience indicates that the great majority of collective dwellings should be considered to be permanent and have similar construction costs, within each category.

2/ The total number of urban and rural dwellings is equal to the total of public and private sector dwellings.

Chart 3

UNITS FOR MEASURING THE REPAIR OR REPLACEMENT OF HOUSING COMPONENTS (INCLUDES INPUTS)

Components	Labour	Materials (includes accessories and equipment)		Equipment used for repairs and replacements	
	Domestic	Domestic	Imported	Domestic	Imported
Unit of measurement	Days or man/hours by:	Quantity of materials (cement, pipe, wire, doors, windows, etc.) or furnishings and equipment by:		Days or machine/hours by:	

Component	Unit
Structure	
Repairs: Foundations	Lineal meter of average section (e.g. 0.06 x 0.7 m foundation)
Rafters/columns	Average unit (e.g. 2.5 x 0.4 x 0.3 m column) lineal meter of average section (e.g. 0.4 x 0.3), m^2 surface, m^3.
Floors/walls	Average unit (e.g. 2.2 x 4 x 0.3 m wall) average thickness (e.g. 0.15), m^3
Repair and reinforcement	Same as above, but including reinforcement works
Replacement (irreparable damage):	
Land preparation 1	M^2 (includes excavation, plotting, etc.)
Foundations	M^3
Rafters/columns	M^3, average unit (3 m metal rafter)
Floors/walls	M^3, average thickness (e.g. 0.15) m^3
Non-structural elements	
Repairs: Partitions/dry wall	M^2
Water/sewage	Water hook-up,[2] sewage hook-up, lineal meter exterior sewage (includes accessories)
Electricity	Electrical inlets/outlets[3] (includes accessories)
Roofs	(non-structural) m^2
Carpentry	Number (doors, windows, etc.)
Repair and reinforcement	Same as above, but including reinforcement works
Replacement	Same as above (including all tasks from surveying to conclusion)
Furnishings	
Partial replacement Minor	Inventory of furnishings destroyed in average dwellings with minor damage (approx. 25% destruction)
Partial replacement Major	Inventory of furnishings destroyed in average dwellings with major damage (approx. 50% destruction)
	Inventory of furnishings in average dwelling totally destroyed
Equipment	
Repairs Minor	Inventory of repair work on equipment units with minor damage (25% destruction)
Major	Inventory of repair work on equipment units with major damage (50% destruction)
Replacement	Inventory of equipment units to be replaced (totally destroyed)
Other	
Reconnection to services	Number of reconnections

1 Does not include demolition, removal of debris, etc.
2 Each hook-up for sanitary units (e.g. garden spigot, kitchen faucet, etc.) Includes average materials per dwelling (pipe, accessory unions, sanitary apparatus, etc.)
3 Each electrical inlet or outlet (e.g. sockets, lamp outlet). Includes average materials for each dwelling (wire, tubing, lamps, etc).

Chart 4
LABOUR INPUT FOR REPAIR OF DAMAGED DWELLINGS

Description	Units (example)	Quantity	Domestic Unit Price	Totals
<u>Structures</u>				
Repairs (with or without reinforcement)				
✍ Foundations	Man/days			
✍ Rafters/columns	"			
✍ Floors/walls	"			
Replacements (irreparable damage)				
✍ Land preparation	"			
✍ Foundations	"			
✍ Rafters/columns	"			
✍ Floors/walls	"			
<u>Non-structural elements</u>				
Repairs (with or without reinforcement)				
✍ Partitions/dry wall	"			
✍ Water/sewage	"			
✍ Electricity	"			
✍ Roofs	"			
✍ Carpentry (doors, windows, etc.)	"			
Replacements (irreparable damage)				
✍ Partitions/dry wall				
✍ Water/sewage				
✍ Electricity				
✍ Roofs				
✍ Carpentry (doors, windows, etc.)				
<u>Furnishings</u>				
Replacements (minor: approx. 25%, major: approx. 50%, total)				
<u>Equipment</u>				
Repairs (minor: approx. 25%, major: approx. 50%, total)				
Replacement				
<u>Other</u>				
Reconnection to services				
Total				

Chart 5
MATERIALS INPUTS FOR REPAIR OF DAMAGED DWELLINGS

Description	Units (example)	Domestic
Structures		
Repairs (with or without reinforcement)		
- Foundations	m^3 concrete	
- Rafters/columns	m^3 concrete	
- Floors/walls	m^3 concrete	
Replacements (irreparable damage)		
- Land preparation	-	
- Foundations	m^3 concrete	
- Rafters/columns	m^3 concrete	
- Floors/walls	m^3 concrete	
Non-structural elements		
Repairs (with or without reinforcement)		
- Partitions/dry wall	m^2 stucco plus paint	
- Water/sewage	Number of sewage hook-ups	
- Electricity	Number: electrical inlets/outlets	
- Roofs	m^2 clay tile (including trusses)	
- Carpentry (doors, windows, etc.)	Number: doors and windows	
Furnishings		
Replacements (minor: approx. 25%, major: approx. 50%, total)	Inventory of damage	
Equipment		
Repairs (minor: approx. 25%, major: approx. 50%, total)	Inventory of damage	
Replacement	Number of units destroyed	
Other		
Reconnection to services	Number	
Total		

Chart 6
EQUIPMENT USED IN THE REPAIR OF DAMAGED DWELLINGS

Description	Units (example)		Domestic		
		Quantity	Unit price	Totals	Quantity
Structures					
Repairs (with or without reinforcement)					
✍ Foundations	Mixer/hours				
✍ Rafters/columns	Mixer/hours - crane – vibrator				
✍ Floors/walls	Mixer/hours - crane – vibrator				
Replacements (irreparable damage)					
✍ Land preparation	Mixer/hours				
✍ Foundations	Mixer/hours				
✍ Rafters/columns	Mixer/hours - crane – vibrator				
✍ Floors/walls	Mixer/hours - crane - vibrator				
Non-structural elements					
Repairs (with or without reinforcement)					
✍ Partitions/dry wall	"				
✍ Water/sewage	"				
✍ Electricity	"				
✍ Roofs	"				
✍ Carpentry (doors, windows, etc.)	"				
Replacements (irreparable damage)					
✍ Partitions/dry wall	Crane/hours				
✍ Water/sewage	"				
✍ Electricity	"				
✍ Roofs	"				
✍ Carpentry (doors, windows, etc.)	"				
Furnishings					
Replacements (minor: approx. 25% , major: approx. 50%, total)	"				
Equipment					
Repairs (minor: approx. 25%, major: approx. 50%, total)	"				
Replacement					
Other					
Reconnection to services					
Total					

Chart 7
INDIRECT EFFECTS ON THE HOUSING SECTOR

Description	Total 1/	Cost per category			
		Urban	Rural	Public	Private
Stabilization, housing protection					
Relocation of settlements					
Additional transportation					
Rental income lost					
Public sector income lost					
TOTAL					

1/ The total cost corresponds to the sum of the costs for urban and rural categories, which will be equal to the sum of public and private sector costs.

Note: When determining costs, market prices, current at the time of the disaster, are used.

III. THE HEALTH SECTOR

1. Introduction

Natural disasters create extraordinary demands on the health sector, which are more difficult to meet when those phenomena have caused direct damage to sector infrastructure itself, as is usually the case, limiting its physical capacity and making human resources to meet those demands less available.

After the disaster, this sector assumes two basic functions: reception, treatment and recovery of primary trauma victims who suffered the direct impact of the disaster --that is, preventing the appearance or propagation of secondary effects harmful to public health. The approach to primary victims has been developed in chapter I of Part Two, Affected Population. Another important segment of primary victim costs are allocated to the emergency phase. Consequently, any cost attributable to the reception, treatment and recovery of primary trauma victims, not included in the emergency phase nor in the section on the affected population, should be dealt with in the evaluation of damage to the health sector, as explained in this section.

With respect to the function of preventing the propagation of the secondary impact of disasters on public health, unfounded rumors and the urgency with which massive international medical aid is moved to devastated areas have contributed to spreading the belief that epidemic outbreaks, transmitted by infected water, vectors or direct contact, are the nearly inevitable sequel to a disaster. Real experience, happily, has not confirmed those fears. In fact, there is nearly no immediate danger of epidemic outbreak due to causes attributable to a disaster. Some time after the disaster, the use of adequate techniques of epidemic control, based on commonly accepted procedures, allows for identifying and isolating the risk of infectious diseases and preventing potential epidemic outbreaks. In fact, in the recent history of natural disasters, not one case is known in which massive immunizations have been necessary, due to the disaster in question.[2]/

The belief that widespread treatment of trauma continues for a long time is also false. It has been observed that, in all cases, care of injuries and wounds, specially important in certain types of disasters, lasts for a surprisingly brief period of time. The relationships between epidemiological risk and demand for care, by injury and type of disaster, are summarized in Chart 1, in which it is clear that this problematic neatly belongs to the emergency stage.

2. Direct and indirect effects and damage

a) Direct and indirect effects

i) Direct damage typically stems from the effects of the disaster on health system infrastructure. The main categories usually are: i) national health network hospitals, health centres, consultancies, dispensaries and rural and urban health posts; i) private sector rural and urban

[2]/ F. Cuny, Disasters and Development, Oxford University Press, New York, 1983.

hospitals and clinics; iii) medical or auxiliary equipment and medical instruments; iv) furnishings, and v) inventories, specially medicine.

ii) Direct effects which cause damage to health and sanitation infrastructure. Particularly significant is the destruction or partial damage to: i) the sources, collection works, transmission systems, distribution networks and energy plants which supply and regulate the drinking water supply systems and water for other public uses; ii) sewage, excreta, liquid and solid waste disposal systems; iii) rural and urban, public and private wells; iv) connections to dwellings; v) latrines; vi) cisterns; vii) wind mills; viii) other lesser systems for the production and collection of drinking water and for the disposal of solid and liquid waste. (Many of these categories are included in Paragraph B, in the evaluation of drinking water and sewage, so the analyst must be careful to avoid duplicating calculations.)

iii) Direct effects which cause deaths, wounds, injuries and crippling in the population affected by the disaster. The health sector is responsible for the reception, treatment and recovery of these primary trauma victims of the disaster. Conventionally, the costs related to primary victims are considered direct damage to the sector.

b) Indirect effects

The decrease in the volume of services "normally" lent must be included in this category, together with the additional costs involved in the care of homeless persons. More is said on this matter below.

Indirect damage is, of its nature, very diverse. The following types are noteworthy:

- Major risk of the propagation of infectious-contagious diseases and adverse impact on health.
- Higher costs --public and private-- for hospital, ambulatory and health care.

- Reduced well being and deteriorated living conditions for the affected population, due to, the lack or rationing of drinking water and water for other uses.

3. Methodology and sources of information for the evaluation

a) Direct damage

For the estimate of direct damage to sanitary and health infrastructure, the same general procedure used for the housing sector should be followed. That is, on the basis of the adjusted data with respect to the number and size of damaged or destroyed hospitals, health posts, etc., current information about the value of a square meter, constructed or repaired as the case may be, should be obtained. Previously, a list of the different categories of affected buildings and health installations should be prepared, including their location and the relative seriousness of the damage they suffered.

Then, each work should be classified by specific identification, including its type, the predominant material and unit prices of its construction, complete replacement or repair. In cases of repair, the respective cost should be estimated as a percentage of the relevant unit cost, on the basis of the analyst's own judgment as to whether or not the installation needs repair or partial reconstruction. As was the case for housing, all demolition, debris removal and land clearance costs should be included as <u>direct</u> sector costs.

Given the relative importance of medical equipment and other installations in the total value of hospital establishments and health posts and given the difficulty of estimating the value of the impact of the disaster on them rapidly, unit cost per hospital-bed has been the mechanism most frequently used in this type of evaluation, to which a quantity is added (often of a value similar to the first figure), thus accounting for medical equipment and furnishings (when both have been totally destroyed), or percentages of both, when repairs are called for.

Direct damage also includes the transportation, treatment and recovery of trauma victims, when these activities last longer than the emergency period itself. From the medical point of view, the classification of wounded and injured in function of the gravity of the injuries and the possibilities of recovery are specially important. In the case of disasters which cause a relatively high number of victims, individual attention is not possible. This situation is defined by the initial study and "triage" classification of victims, performed by medical or paramedical personnel at the moment of search and rescue. That appraisal is essential, if optimum use of available health resources is to be achieved, because it describes and typifies the victims, making it possible, as well, to estimate treatment and recovery costs for the wounded, injured and crippled.

Given that, to date, a uniform, effective classification does not exist, some services use the organs affected, as a grouping criterion; others, the severity of the trauma.

The evaluator may face two situations when appraising costs attributable to the health sector within this category. One is that primary trauma victims are few and the normal emergency and treatment services of the devastated area or those nearby are sufficient to attend all cases, without undue trouble. In this situation --given that information will generally be centralized-- the evaluator should not find it difficult to estimate incremental costs: additional visits, increased hospitalization costs, long treatment periods, additional petitions for medicine and drugs, appraisal of additional medical and paramedical hours, transportation costs stemming from the transport of victims or of old patients released early, etc.

The other situation is that in which the number of primary victims is sufficiently high to alter the normal conditions of first aid and hospital care, both within and outside the devastated zone. Given the difficulties in estimating costs, two conventions are accepted in this case: i) conjectural adjustments are not made for injured persons who are not registered in the national and private care systems, and ii) the total costs of the hospital system are estimated on the basis of the care of primary victims. In other words, the increase is determined by those total system costs which arise from the transport, treatment and recovery of trauma victims from the devastated zones or nearby. The accuracy of the appraisal will, therefore, depend essentially on the validity and reliability of the "triage" process. If available records are reliable, the evaluator will not experience significant difficulties in estimating costs. Otherwise, they should be estimated on the basis of the following items, related to higher costs arising from: expansion of reception and treatment areas; in-patient residence in treatment and recovery areas; intra-hospital patient treatment and recovery; out-patient treatment and recovery, if significant; medical, paramedical and auxiliary personnel; evacuations of new and old patients. Transportation costs; treatment of those sent home early; mobile units and health care visits to homes.

These cost components can be estimated in aggregate form for the whole hospital system, both public and private areas, which have attended primary victims of the disaster. If care is paid for in some places, the value of those services replaces the preceding procedure. Finally, it is probable that victim follow-up and their personal records will be maintained centrally by the Ministries of Health or by the Government.

It must be repeated that costs are to be estimated, free of possible duplications arising from actions undertaken during the emergency phase or from the costs attributed to the affected population in the relevant section. In the same way, it is necessary to insist that, if the evaluator has not recorded the costs involved in the transportation, treatment and recovery of primary victims for these two concepts, it will be necessary to add the cost items indicated in that section to those presented in this chapter.

b) Indirect damage

i) Additional costs arising from environmental sanitation and epidemiological control and vigilance. The information the evaluator will use to estimate the costs involved in avoiding or controlling the propagation of the public health impact of the disaster is dealt with in this category. Although it is probable that in national health systems, in normal times, the functions of environmental and epidemiological sanitation (in some places, health, medical care, and sanitation) operate as separate departments, it is also usually the case that, faced with an emergency, they will coordinate their efforts, including those geared to face indirect effects. For this reason, that integration has been presumed in the presentation of sector cost categories which follows here.

In general, epidemiological sanitation action after a disaster is geared to: achieve adequate levels in the quality and quantity of drinking water and water for other uses; maintain systems for the disposal of excreta, liquid and solid waste; avoid epidemic outbreaks and that the disaster stimulate the propagation of latent diseases. With regard to epidemic outbreaks, the evaluator should distinguish those triggered by the disaster itself, before proceeding to make an accurate estimate of costs.

Two lists designed to identify and classify the additional costs incurred (or to be incurred) in sanitation or epidemiological action are presented. The first classifies costs by actions typically undertaken in the post-disaster stage. The second identifies and classifies items or sets of expenses. Evaluators will probably discover that the information has been classified in one or the other of these ways. In any case, they will be useful for the confrontation of the validity and reliability of the available information, or for drawing up their own cost table.

ii) Costs by sanitation and epidemiological action:

- Production, treatment and distribution of drinking water;

- production, treatment and distribution of water for washing, cooking, irrigation, urban, industrial and agricultural use;

- removal of contaminants in water, land and air;

- functioning of the system for the disposal of excreta, liquid and solid waste;

- public health education about the manipulation of food and domestic cleanliness;

- sanitary control of domestic and international humanitarian aid, perishable foods and provisions;

- vector control;

- control and destruction of new focus of vector reproduction;

- control of flies and mosquitoes;

- disinfecting;

- mass immunizations;

- selective immunizations;

- continued immunization programme;

- disposal of corpses and burial of animal carcasses;

- epidemiological vigilance;

- epidemiological vigilance in clinics and in the community;

- quarantine, isolation and treatment of the first cases;

- reduction of overcrowding in precarious dwellings, and

- domestic sanitary control.

iii) Other items of indirect costs. Increase in health system personnel occupied in response to the disaster: hospital and first aid care, epidemiological vigilance, laboratories, environmental sanitation and vector control.

Provision, storage and distribution of medicine, vaccinations and drugs for preventive and curative purposes in response to the disaster. Cost of imported medicine.

Logistical costs of immunization programmes.

Use of equipment to control vectors and for environmental sanitation action.

Transportation.

Appraisal of community participation. Use of special brigades in sanitation and epidemiological vigilance actions.

Cost of public information through diverse means of communication.

Special training needs.

If there is an epidemic outbreak, the administrative, technical and treatment costs to contain it.

The first step for the evaluator is to identify the costs of sanitation and epidemiological vigilance of the kind mentioned here. The second and more difficult step is to estimate the effects of the disaster which may be considered to be its sequel. This difficulty is greatest in the area of epidemiological vigilance, one of the functions of which is the collection and interpretation of data to determine the risk (or existence) of outbreaks or foci of contagious disease. It is often argued that a disaster does not "produce" contagious disease; it simply changes the environmental conditions in such a way that latent diseases erupt. When changes in the incidence of diseases are detected, the only way of knowing, with any degree of precision, if the increase in any of them is attributable to the disaster, is through the existence of reliable records for those same diseases prior to the disaster and careful analysis of trends in previous years,[3]/. For this reason, the evaluator should meet with specialized personnel to learn about that type of situation and decide to what degree those costs should be attributed to the disaster.

In other words, even when the etiology (causes of diseases) remains unclear, health services incur in considerable additional costs (such as those mentioned in the lists above) which are the consequence of the disaster and should be recorded as indirect effects.

iv) Additional indirect health care operating costs. The destruction or incapacitation of public and private hospital and first aid infrastructure, together with the occurrence of deaths, wounds, injuries and inability among medical and paramedical personnel as a result of the

[3] For example, in a Central American country, a very high incidence of measles and gastroenteritis were detected after an earthquake. Careful analysis of the trend in the occurrence of those diseases in previous years revealed that high incidence was common at that time of year and could not be attributed to the disaster, without further research.

disaster produces effects which imply additional operating costs for the national and private health systems, such as:

Lower income. The absence of qualified personnel or the destruction of infrastructure may reduce income from the paid services of the national public system and private clinics and hospitals. The evaluator should determine that lower income from ambulatory, surgical and hospital services, using of pre-disaster indicators. Those calculations can be simplified by using the pre-established indexes of income and costs of hospital programmes.

Services not lent. Similarly, the cost of the free or subsidized services not lent by the national public health system must be appraised. Two techniques are suggested to facilitate rapid evaluation: to estimate the number of ambulatory cases not attended, surgical interventions not performed and hospital care not given, appraising them at average market prices, or if that information is not available (or when the destruction or incapacitation of infrastructure is considerable), to appraise "lost remuneration" for absent medical, paramedical and auxiliary personnel. The average daily remuneration for each of these categories is multiplied by the total number of days of services not lent and by the daily number of absent personnel in each category of health personnel.

Higher service costs. A record of the higher costs incurred for health services as a result of the disaster by both the national and private systems. This should include the cost for replacement personnel (estimated as described in the previous paragraph), for relocating centres for ambulatory care, for evacuations and reinforcement of infrastructure, for transportation, public information costs, for medicine and instrument imports, etc. These are obtained by considering that the use of resources to respond to the effects of the disaster have a cost arising from "care not given" through normal activities and resource use. For this reason, the evaluator may occasionally find it useful to estimate them from the point of view of the needs which those resources have ceased to satisfy, in order to respond to the needs created by the disaster.

Suspended aid programmes. In many countries, the national health services act as executive agencies and distributors for social aid programmes (distribution of milk, family aid programmes, loans for medical expenses, etc.), which are usually interrupted by a disaster. As that interruption is usually only temporary, often without serious consequences or loss to the beneficiaries, the evaluator should estimate the costs generated by this factor. If beneficiaries suffer net losses during the entire time programmes are suspended, they should be appraised according to estimated market costs. The same holds true for the greater costs of accelerating the normal provision of those benefits.

The registry of higher costs for the operation of health services as indirect costs is often questioned, because doing so is to estimate costs for services not lent, when it is often the case that many of them could perfectly well be lent later, without grave prejudice to the probable beneficiaries. If the evaluator or the office responsible for those services could develop a selection system for separating the hypothetically urgent and necessary services from those which could wait, the calculation would be considerably more refined. However, this will not be possible in a rapid appraisal and, in the calculation, all services not lent must be considered necessary and be regarded as a net loss to the well being of the beneficiary population.

v) Higher costs of preferential attention for vulnerable groups. Although disaster type changes the nature of vulnerable groups, natural disasters nearly always have disproportionate impact on children younger than five years old and the elderly. At the same time, after the disaster, pregnant women and the malnourished population are high risk categories, specially with regard to infectious-contagious diseases. It is, therefore, common that specific health actions are undertaken after the disaster to protect those four groups. Special health action is also usually taken with regard to other groups, depending on the type of disaster; for example, small farmer and precarious farm families, in the event of flooding or long droughts. The higher costs involved in these special actions, taken in function of vulnerable groups, should be estimated and recorded as indirect costs.

vi) Higher public and private costs arising from higher rates of illness. Increases in rates of illness for reasons attributable to the disaster, once verified by the epidemiological health service authorities and by the evaluators themselves, involve higher costs: those incurred by the national and private health systems and those which must be faced by the victims themselves. To estimate these costs, the evaluator, on the basis of a rapid appraisal, may face situations in which there are few cases; to perform the estimate, it would be most useful to record the additional public and private costs incurred, by "beginning with cases to arrive at costs". When there are many cases and these are widely dispersed, the first step is to verify the two types of cost records attributable to the disaster: a) the treatment of the first cases (quarantine, isolation, etc.) and b) higher sector costs arising from the provision of services (described above as one of the additional sector operating costs). If one or both of these categories registers costs, the evaluator should separate those corresponding to unusually high rates of illness, according to the diseases identified, from those corresponding to higher costs for other reasons. In this way, duplications arising from the allocation of costs to unusually high rates of illness are eliminated. The effects of the latter situation are assigned to unusually high rates of illness and should be estimated in terms of their real costs or of the alternative cost of resource use. The separate costs found in existing records, together with these last costs arising from unusually high rates of illness, within both the public and private systems, constitute the total institutional cost attributable to this phenomenon.

However, the unusually high rates of illness attributed to the disaster impose costs on persons, arising from loss of income, together with the cost of medical visits and medicine bought by patients who became ill for reasons related to the disaster. The evaluator should estimate those losses and add them to the institutional costs arising from unusually high rates of illness. To this end, it is necessary to develop conjectures with respect to the group of cases which have contracted a given disease and its distribution over large age groups or some other relevant characteristic. As can be seen, in this context, the notion of group refers to all those who contracted a given disease. In order to calculate unperceived income, an average value is assigned which is multiplied by the proportion of the economically active population, among those over 15 years of age and, then, by the estimated number of days of inactivity. In order to estimate higher costs for medical visits and medicine, an average value for a visit, the proportion of patients who make those visits and the typical treatment should be defined with specialists. Those values, together with unperceived income, visits, and medicine at market prices are only applied to that part of the population which has been defined as ill due to causes attributed to the disaster. If treatment has significantly different costs by age, that fact should be taken into account.

4. Illustration of the calculation of direct and indirect damage

Chart 2 presents an example in which health sector costs arising from a hypothetical disaster are summarized. In the Chart, it can be seen that several cost concepts admit greater detail, depending on the relative importance the different concepts assume.

In case of an absolute lack of information, the following tables and charts may serve as useful points of reference for the evaluator. Chart 3 presents the most effective prevention and control measures for the infectious diseases most likely to appear after natural disasters. Chart 4 presents a matrix of effects on sanitation or environmental health, by type of natural disaster; finally, Chart 5 shows variations in the occurrence rate of diarrhea in response to sanitation actions.

Increased operating costs for health care are outstanding among the indirect costs. Those greater costs should be noted in terms of one or several of the following concepts: lower income due to paid, free or subsidized services not lent; higher costs for health care; and interruption of aid programmes. A minimum of data, consisting mainly in indexes used for hospital planning and programming which are usually computed by health services and take the form of summary ratios (examples: equipment per bed; doctors per paramedic; etc.) is necessary to perform these estimates. With respect to higher operating costs and lower income, the standard costs or budgets, pre-determined figures for costs or income which will serve as a norm against which operational efficiency can be evaluated will be specially useful. When lacking a classification system for recording the greater operational costs caused by disasters, the evaluator should design categories of health care costs. A flexible and practical classification will be that which divides costs by ambulatory, hospital and surgical attention, and which can be applied to both public and private health systems. It is also important that the calculations allow for estimating damaged or utilized imported components.

The greatest difficulty lies in determining the units of cost or income to be applied in public and private systems. In paid systems, the notion of average market value should be applied; when this is difficult to estimate, the indicators for hospital programming mentioned above should be used. (See Chart 6)

Chart 6 presents an example in which lower income from health care due to a disaster has been estimated for paid systems, both public and private. Most of the criteria already mentioned were employed in the calculations. The classification of lower income for ambulatory care, hospitalizations and surgery was chosen, assimilating all other possible cases to those categories.

The complexity of the health system was simplified to three categories, in the case of the national health system, and to two in the private system. Average values obtained from hospital programming (value of visits, income per bed, daily cost of operating theatre) were used as unit costs (or of income) in order to determine lower income. In the case of surgery, whose standard or programming indicators are usually expressed in theatre hours, an adjustment was made to simplify the calculations. The indexes which serve as unit costs are usually estimated centrally in the departments of hospital planning and programming of the Ministries of Health. Otherwise, evaluators should make their own estimates.

The other columns of the Chart summarize various calculations. The Trends column presents the estimate of the number of doctor's visits, and days of bed and operating theatre use which would have taken place throughout the health system, up to the date indicated, if the disaster had not occurred. That estimate should be based on sources within the health planning system or, otherwise, on the evaluator's own extrapolations. The Real Estimate column contains the extrapolation of the probable number of units of care performed after the disaster. For both calculations, the relevant universe is formed exclusively by the paid, public and private, health units, whose income was significantly reduced by factors attributable to the disaster. Other health units do not affect this calculation. The final columns are self explanatory.

Estimates of the free or subsidized services lent within the national health system are made in similar fashion to those explained above for calculating the costs of lower income. First, it must be determined if the cost units are similar to those utilized in the previous calculation. Differences in the quality of health services may produce significant variations in unit costs. For example, hospitalization only in collective wards and operating theatres with less sophisticated equipment may entail considerable relative reductions in unit costs. In order to avoid duplications, the evaluator should discard amounts paid in subsidies.

In the estimate of higher costs for the provision of services, the evaluator should separate those attributable to the disaster from those which are not. After the disaster, curative attention usually involves higher costs. On the one hand, the same human resources and equipment, temporarily idle after the disaster, are often used to reestablish normal pre-disaster health care. In this case, the costs attributable to the disaster are only those which are additional and necessary for the restoration of the normal provision of services and generally constitute insignificant losses. Costs will be greater to the degree that it is necessary to substitute or contract human resources and equipment in order to restore services deteriorated by the effects of the disaster. Those higher costs are recorded while those elements are in use, according to contract costs, or otherwise, according to alternative costs for the use of those resources.

A concrete example of the calculation of costs for unusually high rates of illness attributable to a disaster: intermittent rains for more than four months in a Latin American country produced some of the country's worst coastal flooding. A team to evaluate the damage caused by the disaster began work before the rains had fully stopped. The sector evaluator had very little time and it was known that the direct damage to first aid and hospital infrastructure, together with damage to the sanitary system, was considerable but difficult to evaluate in the prevailing climatic conditions. In those circumstances, one of his/her first activities was to decide on the allocation of costs for unusually high rates of illness, given that such continuous and prolonged flooding made it probable that those costs would be incurred.

Regional sanitation specialists maintained simple, although fairly complete, records in their systems of epidemiological water quality, entomological and nutritional vigilance. Together with the evaluator, they examined recent trends and made comparisons with earlier periods. From this analysis, it was clear that there were no signs of unusually high rates of illness caused by the floods. Moreover, in recent weeks, the overall illness rate had begun to drop notably, as is seen in Figure 1, one of the many records analyzed which indicated the same trend. As well, in spite of the situation of reduced health care services, higher costs had apparently not been incurred as a result of increased demand for doctor's visits and hospitalizations.

Naturally, regional sanitation specialists feared the moment when the water would go down and had planned detailed sanitation and epidemiological control and vigilance actions for that period. As the rainy season was nearing its end, the evaluator recorded the higher costs of that necessary campaign, which derived exclusively from the disaster. The evaluator estimated the cost of the campaign to be around 2 million dollars, covering mass immunizations, medicine, material for the control of sanitary aspects, insecticides, the cost of contracting and training additional brigades of medical and sanitary personnel, and did not allocate costs for unusually high rates of illness.

What no one anticipated was that the rainy "season" did not end as it had in earlier years; heavy rains continued, although with intermittent openings, for another six months. At the end of that period and when the water went down, the evaluator team was called in again to rapidly appraise the damage.

In terms of sector damage, the situation had changed significantly, generally for the worse. The sanitation campaign had not really begun because the waters had not gone down and it had been necessary to implement alternate procedures, as circumstances required and potential problems were anticipated. Moreover, direct damage to health and sanitation infrastructure had more than doubled.

The higher institutional and private costs for unusually high rates of illness were among the most significant instances of indirect damage, according to the evaluator. In spite of adequate public health action, certain gastrointestinal, respiratory and skin diseases amply surpassed their historical levels, due to effects attributable to the prolonged period of flooding. As well, there were significant outbreaks of two diseases, transmitted by vectors and thought to have been eradicated, in several areas.

This experience taught valuable lessons. Among the most important are the awareness of the difficulties involved in a rapid appraisal while the phenomenon is still occurring; the danger of anticipating costs, giving an erroneous impression of near certainty; and finally, the complexity of allocating costs for unusually high rates of illness in this type of evaluation.

FIGURE 1
RATE OF ILLNESS

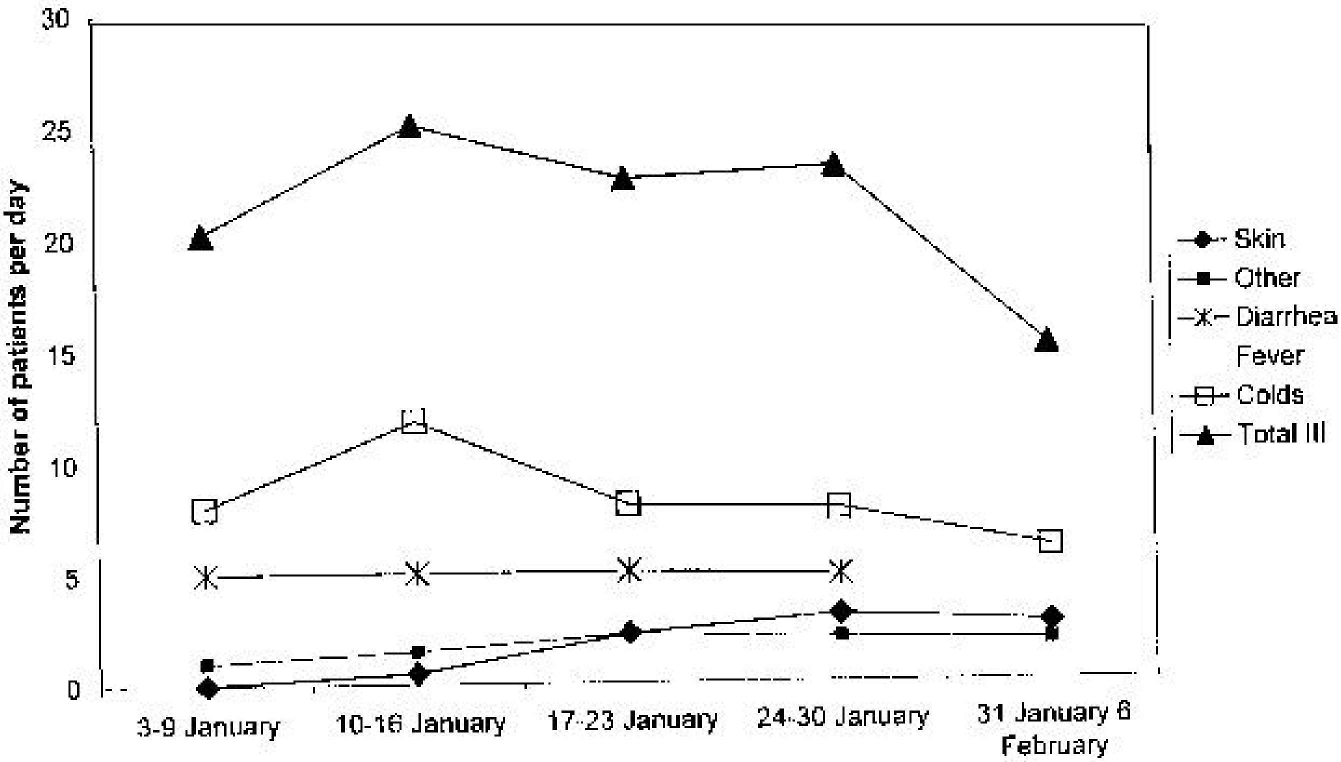

Chart 1
EPIDEMIOLOGICAL RISK AND CARE REQUIRED BY INJURIES BY TYPE OF NATURAL DISASTER

Disaster	Immediate epidemiological risk	Secondary epidemiological risk	Care needs injuries	Period required for attention of injuries
Earthquakes	None	None	High	First 72 hours
Floods	Transmissible by water a/	Transmissible by water and vectors b/	Low	First 72 hours
Droughts/famine	(By malnutrition)	In the malnourished c/	Little-none	First 72 hours
Hurricanes, cyclones	None	Transmissible by water and vectors	Moderate	First 48 hours
Tornadoes	None	None	Moderate	First 72 hours
Tsunamis	None	Transmissible by water (except cholera and vectors)	Low	First 72 hours
Avalanches	None	None	Low	First 72 hours

Source: Adapted from K. Western, The Epidemiology of Natural and Man-made Disasters: the State of the Art, as it appears in C. Cuny, Disaster and Development, Oxford University Press, New York, 1983, Tables 2-2 and 2-3, p.47.

a/ Diseases transmitted by water: typhus, typhoid fever, poisoning by fecal contamination, cholera, schistosomiasis, leptospirosis.

b/ Diseases transmitted by vectors: typhus transmitted by lice, smallpox, malaria, viral encephalitis, recurrent fever.

c/ Malnourishment increases vulnerability to all kinds of disease, specially measles and diarrhea, which are transmitted by direct or indirect interpersonal contact. Skin infections, hepatitis, convulsive cough, diphtheria, influenza and tuberculosis belong to these categories.

Chart 2
EXAMPLE OF SUMMARY PRESENTATION OF HEALTH SECTOR DAMAGE
(in millions)

Concept	Cost			Sector affected		Component	
	Total	Direct	Indirect	Public	Private	Domestic	Imported
1. Damage to health infrastructure	175.5	173.5	-	142.9	30.6	85.7	87.8
National system	142.9	142.9	-	142.9	-	70.6	72.3
Private system	30.6	30.6	-		30.6	15.1	15.5
2. Damage to sanitary infrastructure	87.4	87.4	-	73.9	13.5	60.3	27.1
3. Disposition, treatment and recovery of primary trauma victims	56.1	56.1	-	44.0	12.1	48.5	7.6
4. Sanitation programme	78.3	-	78.3	78.3	-	66.9	11.4
5. Epidemiological vigilance and control	64.0	-	64.0	58.4	5.6	40.8	23.2
6. Higher costs for hospital, ambulatory and First Aid care	29.3	-	29.3	22.8	6.5	19.6	9.7
7. Higher institutional and private costs due to higher than normal death rates	40.9	-	40.9	18.4	22.5	37.1	3.8
8. Programme for vulnerable groups	26.2	-	26.2	26.2	-	23.2	3.0
9. Lower incomes for water companies and similar	30.8	-	30.8	19.7	11.1	30.8	-
10. Water supply and sanitation action via alternative methods	49.7	-	49.7	28.9	2038	39.4	10.3
11. Secondary urban, agricultural, and industrial effects of rationing	22.1	-	22.1	-	22.1	14.2	7.9
TOTAL	658.3	317	341.3	513.5	144.8	466.5	191.8

Chart 3
TRANSMISSIBLE DISEASES WHICH MAY APPEAR AFTER DISASTERS AND THE MOST EFFECTIVE METHODS FOR PREVENTING AND CONTROLLING THEM

Disease	Public health measure
	Transmissible by water or food
Typhus or typhoid fever	Adequate disposal of fecal matter and urine
Food poisoning	Drinking water for consumption and washing
Contamination of sewage	Cleanliness in food preparation
Cholera	Control of flies and pestilence
Schistosomiasis	Epidemiological vigilance
Leptospirosis	Isolation and treatment of initial cases (typhus and paratyphoid fevers, cholera).
	Mass immunization (typhoid fevers, cholera).
	Inter-person contagion
Via contact	
Shigellosis	Reduction of overcrowding
Non-specific diarrhea	Personal hygiene and in food preparation
Streptococcic skin infections	Public health educational programmes
Mange	Treatment of clinical cases.
Infectious hepatitis	Immunization (infectious) hepatitis
Via respiratory system	
Measles	Adequate levels of immunization prior to the disaster
Convulsive cough	Reduction of overcrowding
Diphtheria	Epidemiological vigilance in clinics and the community.
Influenza	Isolation of cases detected.
Tuberculosis	Selective immunization (e.g. children and measles).
	Continued immunization of children (diphtheria, convulsive cough, tetanus)
	Transmissible by vectors
Louse-borne typhus	Disinfecting (except malaria and encephalitis)
Disease borne by rodent fly	Vector control
Recurrent fever	Isolation and treatment (isolation is not necessary for malaria)
Malaria (mosquito)	

Source: Karl Western, The Epidemiology of Natural and Man-made Disasters: The State of the Art, London School of Hygiene and Tropical Medicine, as it appears in Frederick C. Cuny, Disaster and Development, Oxford University Press, 1983, p. 48.

Chart 4
MATRIX OF IMPACT ON ENVIRONMENTAL SANITATION. BY TYPE OF NATURAL DISASTER

Area	Most frequent impact	Earthquakes	Hurricanes	Floods	Tsunamis
Drinking water supply and disposal of liquid waste	Damage to public works	x	x	x	-
	Conduit and pipe line breaks	x	o	o	-
	Energy failures	x	x	o	o
	Contamination (biological or chemical)	o	x	x	o
	Insufficient personnel	x	o	o	-
	System overload	-	x	x	-
	Scarcity of equipment and replacement parts	x	x	x	o
Management and disposal of solid waste	Damage to public works	x	o	o	-
	Interruption of transportation	x	x	x	o
	Scarcity of equipment	x	x	x	o
	Insufficient personnel	x	x	x	o
	Water, land and air pollution	x	x	x	o
Food manipulation	Damage to places where food is managed	x	x	o	-
	Transportation failures	x	x	o	o
	Energy failures	x	x	o	o
	Flooding of places where food is managed	-	x	x	x
	Contamination and spoiling of emergency rations	o	x	x	o
Vector control	Proliferation of vector reproduction sites	x	x	x	x
	Increased human-vector contact	x	x	x	
	Destruction of existing control programmes	x	x	x	x
			x	x	
Domestic sanitation	Damage to sanitary systems	x	x	x	x
	Contamination of food and water	o	o	x	o
	Destruction or malfunction of electrical, water or sewage services	x	x	x	o
	Overcrowding	-	-	-	-

Source: A guide to Emergency Health Management after Disaster, Pan-American Health Organization, 1981, as it appears in Office of the United Nations Disaster Relief Coordinator, Preparedness Aspect, vol. 11 of Disaster Prevention and Mitigation, United Nations, 1984, p. 60.

x Possible severe impact
o Possible less severe impact
- Possible minor or null

Chart 5
DRINKING WATER AND SANITATION INTERVENTIONS AND VARIATIONS IN DEATH RATES FROM DIARRHEA

Improvements in:	Number of:	Reduction of death rate in diarrhea research. By the mean (%)
Quantity of drinking water	9	18
Quality of drinking water	17	25
Quantity and quality of drinking water	8	37
Excreta disposal	10	22

Source: Adapted from S.A. Esrey, R.G. Feacham and J.M. Hughes. "Interventions for the control of diarrhoeal diseases among young children: Improving water supplies and excreta disposal facilities". Bulletin of the World Health Organization, vol. 63, N° 4, 1985.

Chart 6
INDIRECT COSTS ARISING FROM LOWER INCOME FOR SERVICES

		Trend	Real Estimate	Difference	Lower Income
		Ambulatory care			
	Price of visit				
National system					
Clinics	40	43 200	32 300	10 900	436 000
Centres	53	34 560	25 480	9 080	481 240
Hospitals	61	15 930	12 655	3 275	199 775
					1 117 015
Private system					
Rural	44	6 375	5 200		51 700
Urban	62	11 540	9 268		140 864
			Lower income from ambulatory care		1 309 579
		Hospitalization			
	Price bed/day				
National system					
Centres	452	52 728	34 209	18 519	8 370 588
Hospitals	568	63 747	48 384	15 363	8 726 184
					17 096 772
Private system					
Rural	394	8 304	6 930	1 374	541 356
Urban	590	29 970	22 685	7 285	4 298 150
					4 839 506
			Lower income from hospital care		21 936 278
		Surgery			
	Price operating theatre/day				
National system					
Centres	15 700	621	407	214	3 359 800
Hospitals	16 950	810	594	216	3 661 200
Private system					
Rural	11 800	162	105	57	672 600
Urban	17 100	602	510	92	1 573 200
					2 245 800
			Lower income from surgery care		9 266 800
			TOTAL LOWER INCOME		35 512 657

IV. EDUCATION SECTOR

1. Introduction

a) Definition, conceptual and institutional aspects

This section presents a methodology for evaluating damage caused to the physical infrastructure and equipment of the education sector. By physical infrastructure is meant all those buildings used for normal and adult education (class rooms, laboratories, workshops, etc.) and auxiliary installations (sanitary services, general services, libraries, etc.). For the purposes of this manual, other installations linked to scientific and educational activities, such as museums, archives and public libraries, are also considered within this sector. Installations which are an integral part of other productive or social sectors, such as libraries and training class rooms in hospitals or in manufacturing industries are not included here. Likewise, the buildings already accounted for in other sectors, such as housing for teaching or administrative personnel, are not included here.

The education sector fulfills the main function of ensuring the formation of human resources and the promotion of scientific and cultural activities which contribute to the social and economic development of countries. In this context, the capacity and quality of educational infrastructure are decisive in the achievement of steady progress in the sector.

The responsibility for creating norms and maintaining statistical registers of educational institutions lies mainly with central government bodies (Ministry of Education, Agency for Educational Constructions, etc.) or in regional and local government (Municipalities). The ownership, operation and maintenance of educational institutions in Latin America and the Caribbean is both public and private, varying in composition from country to country and level to level (primary, secondary, university, etc.).

Specially in rural or low income urban areas, some schools fulfill additional functions, such as serving as centres for community and cultural activities. In other cases, the opposite situation prevails and public installations (churches, community centres, etc.) are used for educational activities.

Although statistical information evaluating the relative importance of the construction of educational buildings, within total construction sector activity --as normally defined in the national accounts--, is not available, it is generally recognized that it is not as significant as housing construction or other civil engineering works.

It is equally important to mention that schools are usually used as emergency or temporary shelters after the occurrence of natural disasters which damage housing extensively. For that reason, it may be that the national "civil defense" systems also possess detailed information about the inventory of schools (or about education, in general) in a given country.

Museums, libraries and archives in Latin America and the Caribbean are mainly public property and are generally found in urban areas; however, there are a few cases in which they are private property or are located in rural zones. The number of museums, libraries and archives in the region is relatively small, so that it is easy to identify and characterize them individually.

What has been said indicates that the evaluation of damage in the education sector is mainly of interest to the authorities responsible for its planning and administration, although it is also of interest to central planning and civil defense organisms.

b) Evaluation methodology and its application

The methodology to be used in the evaluation of education sector damage is very similar to that applied in the housing sector. Therefore, this chapter makes frequent reference to that sector.

As is true for the other sectors dealt with in this manual, the process of evaluation of this sector should make it possible to quantify indicators, which should be summarized in the matrix presented in Chart 1.

The heterogeneity of education sector equipment considered in this manual (schools, adult educational centres, museums, archives and public libraries) makes it necessary to apply a small number of indicators or units of damage assessment, so as to produce results compatible with the type of information managed by the corresponding planning or sector administration organisms. For example, in simple terms, schools consist of the following elements: class rooms; other teaching spaces (laboratories, work shops, etc.); spaces not dedicated to teaching (administration, hall ways, libraries, etc.) and paved and sports areas. However, educational statistics are generally presented only in terms of the number of class rooms, square meters constructed (total or only those dedicated to teaching), or the number of students enrolled (total or by shifts).

The diversity of schools also makes it difficult to compile detailed statistical records of furnishings and equipment. As in the housing sector, their composition and average value should be estimated for each construction unit selected (square meter constructed or average class room).

Museums, libraries and archives are too diverse to allow for reduction to standardized units of measurement. The same holds true for furnishings, equipment and inventories of printed scientific and artistic works. In that case, it will be necessary to define units of measurement and assign them independent values for each installation. Works of art or of historical value, whose monetary value is more difficult to express, present an additional problem, when they have been totally destroyed.

As in the case of housing, it is recommended that the following steps be taken --nearly simultaneously, given the brief time available-- to evaluate the education sector:

i) Definition of the area affected by the disaster;
ii) evaluation of the situation prior to the disaster;
iii) identification of direct damage/effects;
iv) assessment of direct damage/effects;
v) appraisal/costs of direct damage/effects;
vi) identification of indirect damage/effects;
vii) assessment of indirect damage/effects;
viii) appraisal/assessment of indirect damage/effects;

ix) identification of secondary effects;

x) evaluation of secondary effects;

xi) preparation of comments on the main damage to educational installations, their typology and physical and socioeconomic context;

xii) preparation of comments on reconstruction works/projects, their duration and possible budget; and

xiii) identification of those sector areas which need aid for reconstruction works.

c) Definition of the area affected by the disaster

It is recommended that the same steps as those indicated for the housing sector be followed. The entities responsible for the educational and cultural development sectors should also be consulted.

d) Evaluation of the situation prior to the disaster

The evaluation of the condition of education sector equipment prior to the disaster requires the following minimum information:

i) Schools (schools, centres for adult training and Universities):

- Number of teaching establishments in the affected zone, classified by: urban-rural and privately or publicly owned;
- Number of class rooms and students (total and/or by shift) by educational establishment;
- The quality (construction) of existing teaching establishments. This may be estimated on the basis of data, such as:
- construction materials used (brick, adobe, wood, concrete, etc.);
- the age of the building, and
- the condition of the building (very good, fair, poor, etc.)

ii) Museums, libraries and archives

- number of installations in the affected zone, classified by: urban-rural and privately or publicly owned;
- nature of the collections (content) in those installations (see classification in Section 2) and number of works or volumes;
- average area (or "volume" if the type of building justifies it) of the installations.

Other data must also be gathered with respect to:

- number of teaching establishments, classified by educational level: pre-school and primary, secondary, University and other categories of adult education;
- typical furnishings and equipment of teaching establishments or according to diverse categories of establishments, such as those indicated in the preceding paragraph;

- inventories of the furnishings and equipment of museums, libraries and archives;
- construction, furnishings and equipment costs:
- at current market prices;
- at factor cost (market prices, excluding indirect taxes) (see "Housing Sector", Part Two, Chapter II, for criteria to be applied in the determination of costs).

e) Sources of information

Information about conditions in the education sector in the country and/or the zone affected by the disaster is usually found in the same sources as for the housing sector. Other particularly important sources for the education sector are:

- the Ministry of Education;
- public institutions (Councils, Centres, Institutes, Committees, etc.) responsible for the construction and administration of teaching establishments;
- public institutions responsible for the coordination of University and adult education;
- religious and private entities which administer educational centres;
- insurance companies, specially in the case of museums, libraries and archives;
- periodic censuses of the education sector;
- statistical annuals of the United Nations Organization for Education, Science and Culture (UNESCO);
- UNESCO statistical summary (annual publication).

2. Direct damage or effects

a) Introduction

As defined for this manual, direct effects refer basically to loss of capital or property. In the education sector, this includes the partial or total destruction of buildings, furnishings, equipment and the material, works or printed volumes (in the case of museums, libraries and archives) in the buildings affected.

The way in which these elements suffer damage in different types of natural disasters is very similar to that which affects the housing sector; therefore, that matter will not be repeated in this section.

b) Classification of sector equipment

i) Teaching establishments.

Because the brief time available for evaluating damage makes detailed inspection of all teaching establishments difficult, the evaluator should attempt to study the greatest number of representative cases possible and extrapolate those findings to the universe of damaged units. Unfortunately, countries do not have uniform construction typologies for teaching establishments, with the possible exception of public schools. Other teaching establishments are generally of diverse design and construction quality, there being many cases in which they are residential buildings or were constructed for other purposes and have been adapted subsequently to serve as teaching establishments.

If the magnitude of the damage and restrictions on inspections within the affected zone make it necessary to establish "typologies" of teaching establishments, they may be defined on the basis of educational levels, most commonly used construction materials and the quality or condition of the buildings (in the latter case, building age could be used). The application of the first criterion is based on the assumption that teaching establishments of the same educational level will have similar "areas" or "spaces" for teaching, non-teaching and recreational activities. The building materials employed will serve to determine the unit cost of construction and the quality of the construction will allow for making very sweeping distinctions between that damage arising from obsolescence or poor maintenance and that which is properly due to the natural disaster.

The norms which regulate the construction and operation of teaching establishments vary considerably from country to country within the region. By way of example, it is worth noting that the requirements for space, both for primary and secondary schools, oscillate between:[4]

- ?? Total surface built = 6 (Argentina) to 1.2 (Paraguay)
- ?? Class room area = 1.5 (Uruguay, Peru) to 0.9 (Guyana, Haiti)

The ranges for spatial norms for other educational installations are similar:[5]

?? Administrative spaces:	0.85 (Argentina) to	0.5 (Bolivia)
?? Laboratories:	3.8 (Ecuador) to	1.2 (Dominican Republic)
?? Technical-manual workshops	5 (Peru) to	1.2 (Uruguay)
?? Art workshops	6 (Paraguay) to	1.5 (Uruguay-Peru)
?? Industrial workshops	9 (Guyana) to	4.5 (Guatemala)
?? Libraries	4.32 (Brazil) to	0.15 (Bolivia)
?? Music rooms	2.7 (Paraguay) to	1.2 (Argentina)

The spatial norms stipulated (although not always applied) by the countries of the region are usually differentiated by school level and locality (urban or rural). If necessary, the evaluator should obtain the norms applicable to the installations in the zone affected by the disaster and verify their validity (or the deviations which may exist, in fact) with regard to local conditions, basing his/her conclusions on direct inspection and interviews with the authorities and those responsible for those educational installations.

As mentioned above, the spaces and equipment used in adult and University educational installations are so varied that it is very difficult to define average dimensions for general application. For that reason, it will be necessary to evaluate case by case, or define certain typologies on the basis of evaluator observations. The norms and factors presented above may serve

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[4] expressed in squares meters per student

[5] See "Construccones escolares :Criterios y normas utilizados en América Latina y el Caribe," UNESCO, Santiago, Chile 1983

as the basis for evaluator conformation of the typologies of the adult and University installations to be inspected.

ii) Libraries, museums and archives. This type of installation will usually be identified and studied individually, due to the specificity of their function and architectonic design. Some definitions which may assist the evaluator in the identification and/or classification of these units, in a manner compatible with the available information in the country or the international sources of information, are the following:

- ?? National libraries: those responsible for the acquisition and preservation of copies of all the publications printed in the country and which function as "depositories", usually elaborating a national bibliography.

- ?? Specialized libraries: those which are part of an association, official service, research centre, or other organism whose collections basically cover a discipline or particular branch of science or culture (excluding school and University libraries or those located in industrial and commercial institutions).

- ?? Public libraries: those at the service of the community, specially at regional or local levels.

Museums are usually defined as permanent non-profit institutions, at the service of society and its development, open to the public, which perform research into the material testimony of human history and environment, displayed for the purposes of study, education, and enjoyment. The International Council of Museums (ICOM) and UNESCO classify museums according to the predominant nature of their expositions and collections: of art; archaeology and history; history and natural science; science and technology; ethnography and anthropology; specialized collections (in an area not covered by the preceding categories); regional; general and others. Moreover, this category also includes historical monuments and protected archaeological sites, together with zoos and botanical gardens, aquariums and natural reserve parks.

Archives are defined as every institution, the main function of which is the preservation of archives (conventional documents, cartographic documents, audiovisual, microcopy and other materials) and the organization of those collections for use by persons other than the members of the institution. For statistical purposes, archives may be classified according to the main content of their collections, as indicated at the beginning of this paragraph.

On the basis of what has been indicated, education sector information can be summarized within the framework provided by Charts 2 and 3; that is, the evaluator should gather the information which will make it possible to fill in those Charts. In the case of teaching establishments, "individual record cards" for each establishment, containing the minimum information required by Chart 2, should be prepared.

c) Damaged equipment

In order to calculate damage to education sector installations with a certain degree of precision, it will be necessary to open them into their basic components: buildings, furnishings, equipment and inventories of works or collections.

i) Buildings, furnishings and equipment. These components may have been totally or partially destroyed, depending on the intensity of the natural phenomenon. The description of those components and the types of damage they may suffer are similar to those of the housing sector. The evaluator may refer to the appropriate chapter for further information on this matter.

It is necessary to clarify that, in the case of the education sector, all those instruments, implements and equipment used in the development of the main function of the institution under study (for example, in teaching establishments, laboratory equipment and manual workshops, sports installations, etc.), or which are necessary for the processing or direct use of the works stored there (for example, in libraries, museums and archives, micro-film viewers, computers, projectors, etc.) are considered under the heading "furnishings". This type of unit has usually been inventoried on an individual basis.

In contrast to the components mentioned above, "equipment" refers to those installations which are additional to the normal interior installations (water, sewage, etc.) and which are complementary elements to the building itself (elevators, security, air conditioning, internal communications systems, etc.).

ii) Inventory of materials, works and collections. It may occur that some installations of the education sector contain important inventories of materials (paper, chemical products, etc.) in fulfillment of their functions and which, due to their cost or volume, should be considered in the evaluation of damages.

It will, moreover, be necessary to quantify and appraise the inventories of works and collections found in certain buildings. This appraisal will include the books contained in a library, the works of art, displays and pieces which constitute a museum's collection, the documentation of an archive, etc.

Those elements may have been damaged by a natural phenomenon and may have been totally or partially destroyed. In the case of the former elements (materials), they can usually be easily obtained in the market and, therefore, their replacement cost can be obtained or calculated rapidly. However, the situation is different in the case of inventories of documents, objects or works which are part of library, museum or archival collections. First, they may be difficult (or impossible) to repair, restore or replace, as in the case of unique or irreplaceable works. Moreover, it may be very difficult to appraise objects of subjective value or which are not traded openly on the market, as is the case of works of art or of historical value.

It is nearly impossible to establish general criteria for the appraisal of inventories of materials, works and collections; therefore, the evaluator will be forced to make a case by case analysis of the affected installations, with recourse to the information provided by specialists, appraisal agencies, insurance companies, etc.

iii) Other aspects to be considered in the identification of direct damage to education sector equipment.

Other direct damage. As in the case of "housing", in addition to the necessary replacement or rehabilitation work on the buildings, furnishings, equipment and inventories so that the installation (school, museum, library, etc.) repaired or replaced will be "equivalent" to that which existed previously, the appraisal of which will be considered within the direct damage, such as the reconnection of public services (drinking water, sewage, gas, electricity, telecommunications, etc.), demolition works and the removal of debris and other accumulated materials (mud, water, etc).

Imported component. The evaluator should identify, list separately and appraise the imported materials and products which will be used in the repair or replacement of damaged installations. For greater clarity in this regard, see the "housing sector".

d) Assessment of damage

i) Buildings, furnishings, equipment and inventories. The basic criterion to be applied in the assessment of damage is that their quantification, as a basis for their subsequent repair or replacement, must lead to the production of an installation (school, University, museum, etc.) or element of an installation which will be functionally (in the case of furnishings, equipment, etc.) and intrinsically (in the case of documents, publications, etc.) equivalent to that which existed prior to the disaster. Works of art or irreplaceable works should be appraised at their value at the moment of the disaster as a net loss.

Chart 4 shows possible ways of quantifying the magnitude of the damage suffered by education sector installations globally. In this case, due to the diverse typology and variety of the installations involved, it does not seem worthwhile (or possible in the limited time available for the evaluation) to make a detailed cost analysis on the basis of the quantification of inputs (labour, materials, equipment) for each element of each installation. However, evaluators should have recourse to that type of analysis when they deem it appropriate. In that case, charts similar to those used for the housing sector may be useful.

ii) Partial or total demolition. As explained above, damage to education sector installations may make their partial or total demolition necessary, as a preparatory step for repair or replacement works. The quantification of demolition works should be performed in global terms; that is, per square meter constructed, which, if necessary, may be converted into volume (thus using measuring units easily made compatible with the assessment of debris removal) or construction units (class rooms, workshops, etc.), if they can be normalized and are sufficiently numerous to justify that type of treatment.

iii) Debris removal. As indicated for the housing sector, in this section only "the removal of debris or of material deposited during the disaster (mud, ash, etc.) necessary to begin repair or replacement works" will be considered. Activities which are part of the emergency phase are not included.

e) Assessment of direct damage or effects

i) General criterion. The unit prices to be applied to the "quantities" of direct damage --as indicated in Chart 4-- correspond to those valid at the time of the disaster. They should be market prices, under normal conditions; that is, excluding possible distortions arising from speculative or inflationary situations generated by the disaster itself. The prices used should include all necessary costs (administrative, financial, etc.) so that inputs (labour, material or equipment, if it is decided to assess in such detail) be incorporated into the repair or replacement works; or so that the unit measured (m2 built, furnishings unit, etc.) constitute an integral part of the finished work.

Prices of imported material and equipment are to be determined in the same way, according to information provided by suppliers. Otherwise, CIF prices should be obtained (which include transport and insurance to destination), to which those domestic costs, which are necessary so that the input be incorporated into the repair or replacement work, should be added.

ii) Building, furnishings, equipment and reconnection to services. For ease in calculation, the ideal situation would be a set of homogeneous buildings, in which all square meters constructed would have the same intrinsic characteristics and, therefore, the same value. Given that this is not the situation, in the education sector, there are two ways or methods of assessment available: assume an average value per unit of building, based on the relative weight (evaluation) and average value of each type of space (class rooms, sanitary services, administrative spaces, etc.); or allocate a value to each type of space and, then, add up the total for the whole building. Experience has shown that the first method is the more commonly used, in spite of its being less precise, given the time limitations on this type of evaluation.

In the case of museums, libraries and archives, it is difficult to provide parameters for construction costs, given the diversity of the typology; therefore, the evaluator should evaluate those costs on the basis of field observations.

Certain generalizations can be made for teaching establishments, based on the circumstances in each case. For example, costs for school buildings may range between US$ 150 and US$ 250 per m2, according to local conditions and the types of space involved. If more detailed types of spaces is desired, tables of relative costs should be elaborated, taking into account the construction materials to be used, the interior installations, open spaces, etc. Chart 5, "Building cost coefficients in school buildings", contains an example, which is presented as a point of reference only.

The criteria to be applied in the assessment of furnishings are similar to those indicated for buildings. Given that the assessment will be based on a percentage of the furnishings damaged, it will be necessary to estimate the average value of the total furnishings, which may be made per installation or part thereof. Once again, in the case of museums, libraries and archives, it will be necessary to assess on a case by case basis. For school establishments, a certain level of generalization may be possible, if the situation permits. An example of relative furnishings costs is presented in Chart 6. The coefficients were calculated on the basis of furnishings costs for an average class room (it must be noted that what this manual refers to as furnishings is known, in educational literature, as "equipment").

For the assessment of equipment, reconnections to services, and the demolition and removal of debris, specific analyses for each case will be necessary, in general, along the lines indicated for the housing sector.

3. Indirect effects

a) General observations

Together with capital and property losses due to the destruction of education sector installations, there are other effects, classified as indirect, related to:

i) the costs (beyond the direct costs discussed above) necessary to obtain an installation equivalent to that which existed before the disaster;

ii) the damage suffered by educational installations after the disaster, as a result of action taken in direct relation to the disaster (for example, prolonged use of school establishments as temporary shelters, storage centres or administrative offices);

iii) other losses to the income flows of institutions or the nation arising from the suspension or reduction of services lent, as a result of the direct damage sustained by education sector installations.

Indirect effects should be expressed as costs and added to the direct effects, in order to calculate total damage. In the same way, they should be classified as urban, rural, public, and private.

Chart 7 displays those indirect effects which should normally be considered in damage evaluations.

b) Assessment and appraisal of indirect effects

i) Stabilization of land and protection of buildings. These indirect effects refer to costs arising from works undertaken in addition to the reconstruction or repair of buildings, which are necessary to ensure the quality and permanence of the restored buildings.

As was the case for housing, this category includes land stabilization works, the construction of additional flood protection structures, etc. The criteria for quantification and assessment to be applied are similar to those utilized in the housing sector; therefore, the evaluator may refer to the appropriate section for further information in this regard.

ii) Relocation of sector installations. In this section, costs arising from the relocation of education sector installations, currently situated in dangerous surroundings or those vulnerable to future disasters, are included. In the case of the education sector, these costs refer basically to moving furnishings and stockpiles; the costs of preparing the land to be occupied; the cost of the land and all administrative, legal financial, etc. costs necessary to undertake the actions indicated above. It is necessary to repeat that, in this section, the costs of the construction of new buildings (even though in different locations) are not considered, given that they are covered among the direct effects. One extremely rare exception will arise in those cases in which costs for building construction in another location are so different with respect to reconstruction costs on the original site that the calculation of the difference as an additional indirect cost is justified.

It is recommended that the installation (school, library, museum etc.) be taken as the basic unit of measurement; however, if deemed necessary, costs may be presented in terms of the capacity of the installation in question (for example, cost per student or per school space).

For the assessment and appraisal of these indirect effects, the same criteria as those used for the housing sector should be applied.

iii) Damage caused by ulterior use of education sector installations. As indicated above, education sector installations, specially school installations which resisted the effects of the natural disaster, are occasionally and temporarily used as family shelters, materials and equipment depositories, or as administrative offices. Experience has shown that this use of school establishments often causes significant damage to interior installations, non-structural elements and the furnishings of the affected installations.

Much of this damage may be evident at the time of the evaluation mission; however, other damage will only come to light over time. The evaluator faces the task of estimating the quantity of damage which will have been done by the end of the provisional occupation of the installations and, then, of assessing them.

The methodology to be applied in the measurement and assessment of this damage is similar to that used for the calculation of direct damage, with regard to the repair or replacement of the affected installations.

iv) Additional transportation needs. This cost category will be applied mainly to teaching establishments. These costs arise from the additional transportation expenses incurred by students and teaching personnel when traveling to provisional or relocated teaching establishments. Those costs are usually assumed by families (private cost); however, it may happen that the public sector will cover part or all of them (public cost). It is recommended that the student or individual be taken as the unit of measurement. The evaluator will thus be able to estimate the average additional daily cost per person (or student, etc.) and, then, add it, if necessary, to the cost per school establishment. The daily additional expense per person is multiplied by the number of days estimated for the return to a normal situation. If it is foreseen that these additional expenses are going to assume a more permanent character, the evaluator will establish a time limit for the sum of these costs (one or two years), assuming that, after that period, transportation costs will reflect other socioeconomic variables, as well as with those related to the disaster itself.

v) Loss of income to institutions due to the interruption or reduction of their services. Education sector installations play the basic role of promoting education and culture, to which end they operate as service-lending institutions. In many cases, they receive net income which makes them operationally similar to any other commercial institution offering services. In other cases, operating costs are assumed by the public sector. Thus, for example, teaching establishments will collect monthly fees from students or, will otherwise finance operating costs; museums will charge entry fees and, in some cases, archives and libraries will do the same.

When a natural disaster occurs, it may happen that, due to the damage suffered by education sector installations, or for other reasons of diverse nature (for example, the alternative use of installations), those establishments temporarily cease to operate, thus interrupting the services and, therefore, their income flows. The most practical, although not the most precise, way of expressing that absence of income is through the calculation of the salaries of those who work in those establishments and who,
if they become unemployed, will reflect the damage of ceasing to offer those services and, if they remain employed, will indicate the cost lost, because the service is not actually provided.

To estimate this cost, the evaluator should determine the average salary of personnel who work in institutions which have ceased to provide services and multiply that amount by the number of affected persons and the number of days the interruption of those services is expected to last.

vi) Loss of public sector income from unpaid taxes or fees related to the income of affected institutions. It may happen that some education sector institutions, specially those of the private sector, generate State income by paying taxes (training centres, private museums, etc.) or by transferring part of their incomes (public museums and archives, etc.).

When some education sector institutions are totally or partially destroyed and cease to operate, they may also cease paying taxes or making transfers to the central government.

In order to estimate those losses, the evaluator should calculate the amount of taxes the affected installations would pay during the period for which it is expected that they will be inoperative or for the period during which the government has granted them tax exemptions, if such is the case. It seems important to note that this factor will only be significant when direct damage is also of great magnitude; therefore, the evaluator should judge its relative importance within overall damage and, consequently, the amount of work (or time) which he/she should dedicate to its accurate evaluation.

The appraisal of the indirect damage calculated in this section will also be an important factor in the calculation of the secondary effects on the gross domestic product and public sector finances, always subject to the considerations of magnitude mentioned in the previous paragraph.

vii) Other additional operating costs. Finally, it may happen that education sector institutions may incur additional expenses in their efforts to maintain the normal provision of services in the face of irregular external conditions. An example of this situation is when schools are forced to work night shifts or during vacation periods, implying additional expenses for the consumption of energy or payment of overtime and benefits for teaching and administrative personnel.

As indicated elsewhere, the evaluator should decide whether the volume of this type of damage justifies assessment and appraisal and the investment of time which its estimate would require.

The total appraisal of those indirect effects should take into account the volume of additional inputs required under irregular operating conditions, their unit costs, and the time that irregular situation is expected to last.

4. Secondary effects

The destruction of education sector installations produces secondary effects on the economic and social conditions of the affected population and country which become evident some time after the disaster. Those effects should not be added to the direct and indirect effects.

Some particularly relevant secondary effects of the destruction of education sector installations are presented below:

i) Lost contribution to the national economy of income or production generated by the education sector;
ii) Variations in employment rates;
iii) Impact on the balance of payments;
iv) Impact on the public sector; and
v) Impact on inflation.

a) Lost contribution to the national economy of income or production generated by the education sector

Education sector institutions generate income (as expressed in the national accounts) which is normally included in the personal services sector.

To calculate it, institutions may be classified as: private for profit, non-profit, and public institutions. It is acceptable to measure income in terms of the "production" of those institutions, which, in the case of private profit-oriented institutions, means applying a methodology similar to that used for industrial establishments, according to the recommendations of national accounts systems.

Given difficulties in measuring the production of education sector institutions directly, the common practice of assessing it in relation to its inputs is recommended. This is done by taking estimated quantities of both primary and intermediate inputs, multiplying them by estimated unit prices and the time period the suspension of services is expected to last.

The evaluator should take care to avoid calculating interruptions of normal working hours (or periods) which are already being (or will be) provided for in extraordinary operational periods (prolonged school year, night shifts in other installations) as secondary effects.

b) Variations in employment rates

A disaster may affect the employment rate in the education sector, leaving the personnel of the affected institutions unemployed for long periods.

This section is limited to the evaluation of variations in the number of work positions available , given that the costs of lost positions were considered as a factor in lost earnings, under indirect effects.

c) Impact on the balance of payments

The destruction of education sector installations and subsequent repair and reconstruction works may have considerable impact on the country's volumes of imports and exports. Some of the possible flows of goods and services and of capital between the country and abroad, which may affect the balance of payments, are the following:

i) Imports of materials, components and equipment for the repair and reconstruction of buildings and equipment. The additional imports required, as a result of the disaster, should be quantified. That appraisal should be based on the calculations made for the quantification and appraisal of the imports component of the direct damage.

ii) Foreign exchange income from loans and donations for emergency and reconstruction works. This can be estimated on the basis of the costs of the emergency and the foreign currency component estimated for reconstruction projects.

iii) Foreign exchange income from reinsurance payments for damaged installations, and their inventories of works of art, collections, etc. In the case of buildings, total income from reinsurance payments may be very small; however, the situation may be very different in the case of historically valuable objects and collections, for which the amounts may be very high.

iv) Foreign exchange losses from suspended exports, because national production of materials, components and equipment for education sector installations (example: cement, iron, hardware, furnishings, etc.), normally exported, will be used to cover reconstruction needs during the transition period.

d) Impact on the public sector

The destruction of education sector installations and the subsequent repair and reconstruction works may have considerable impact on public sector finances. In this section, only two of the most relevant aspects will be discussed:

i) Increased public sector outlay/investment: required for the implementation of reconstruction works in the education sector. This greater outlay can be calculated on the basis of the costs estimated for reconstruction projects.

ii) Lower public sector income due to reduced taxes collected or reduced transfers from totally or partially destroyed installations. Those values can be calculated as indicated earlier in this section.

e) Impact on inflation

Normally, only a very rough estimate of the effects of the destruction of education sector installations and the need for reconstruction materials, on the prices of those products, can be made during the evaluation period. To that end, the evaluator can derive certain guidance by comparing prices prior to the disaster with those prevalent at the time of the evaluation. Future trends for the period considered relevant for the calculation of secondary effects must be evaluated jointly with the macroeconomist and the evaluator of the industrial sector, who will provide indications about the current availability of materials and the national capacity to produce and distribute them.

A general recommendation for all sector evaluators is that they work very closely with the macroeconomist in order to obtain needed information and to establish uniform criteria for the calculation of the flows indicated above.

5. Reconstruction period and works

a) General recommendations

The purpose of including this section is to present a description of the special characteristics of education sector installations and their surroundings, within the disaster zone, which are believed to have been determinant in the magnitude and form of the damage suffered. The analysis of those characteristics will allow the analyst to make general recommendations for reconstruction works, including measures designed to prevent or mitigate the effects of new natural phenomena of similar intensity. Finally, the inclusion in this chapter of an estimated calendar of activities and expenses for reconstruction activities is recommended, in order to guide the endeavours of the government and other aid organizations.

The most common types of sector buildings (specially school buildings) in the affected zone and their weaknesses (structural and non-structural) resulting from the disaster are to be described. The construction materials most commonly used in the zone, their behaviour at the time of the disaster and their adequacy for the most common construction typologies should also be included. Finally, the placement of installations and their physical surroundings (soils, topography, etc.), which may have affected their capacity to resist natural phenomena, should be indicated. A brief list of recommendations about the most relevant aspects of the reconstruction process should be included in this section:

i) Technical characteristics of building repair, the processes to be applied and the types of materials to be used. The same, with respect to the construction of new buildings and connected installations.

ii) The location or relocation of buildings in accordance with the characteristics of their surroundings. The need for ground preparation if it is impossible to relocate housing situated in vulnerable places.

iii) Economic matters and inputs supply for reconstruction works.

iv) Organizational and institutional issues related to the execution of reconstruction works (community participation, technical support, training, institutional coordination, etc.).

v) List of projects for executing research and technical cooperation activities for the purpose of developing the above recommendations in greater depth and to support reconstruction works. Those projects should take five aspects into account: construction and repair techniques; costs and materials; institutional organization and coordination; location of buildings; and promotion of local economic activity.

vi) List of reconstruction/rehabilitation projects, in which the required amounts of investment are to be indicated, together with possible sources of financing: national resources and foreign loans and donations.

b) Programming reconstruction works

The purpose of the programming of reconstruction works and their corresponding outlays is to present an hypothesis of the amounts and periods in which investments should be made, as well as estimating their impact on public sector finances and that sector's institutional capacity to execute those works.

The following aspects should be taken into account in the programming of reconstruction works:

i) the availability of economic resources and normal execution periods for the allocation and use of those resources;

ii) institutional and organizational capacity for reconstruction works, taking into account the role to be played by the public and private sectors and civic organizations;

iii) the supply of inputs for reconstruction works, including human resources, material and equipment, and in the awareness that, in some cases, these must be imported;

iv) the time needed for the design, planning and organization of reconstruction activities;

v) climatic and physical aspects (for example, the length of the rainy season which would impede reconstruction works, or the time needed to allow for the drainage of flood waters before reconstruction works can be undertaken), or aspects of sector planning (for example, periods of school vacations).

Evaluators should obtain information on these matters from public and private sector organizations, as well as from their own field observations during the evaluation. This information will allow for programming investment amounts for the education sector, in annual periods, for the entire reconstruction period, or for the period agreed upon according to the programming needs of the country under study.

Chart 1
SUMMARY OF EFFECTS ON THE EDUCATION SECTOR

Effects of the disaster	Costs (Millions of monetary units) Total1/	Public	Private	Rural	Urban	Reconstruction or repair period (months)
a) Direct effects (i+ii)						
i. - Repairs						
ii. - Replacement						
- Imported component 2/						
b) Indirect effects						
c) Sub Total (a+b)						
d) Secondary effects						

1/ The total cost results from to the sum of the costs for urban and rural categories, which will be equal to the sum of public and private costs.
2/ The imported component refers both to repairs and replacements and, therefore, should not be added together.

Chart 2
CLASSIFICATION OF TEACHING ESTABLISHMENTS

Description 1/		School Pre-school/Primary	School Secondary	Universities	Other
Number of establishments:2/					
- Total					
- Rural					
- Urban					
- Public					
- Private					
Average capacity:					
- N° class rooms per establishment					
- N° students per:					
- establishment					
- shift					
Average area constructed:					
- Per total establishment					
- Per class room					
Furnishings:	- Good				
	- Fair				
	- Poor				
Equipment:	- Good				
	- Fair				

- Poor

Building: - Good
- Fair
- Poor

1/ Individual information cards can be prepared for each teaching establishment, containing the minimum information indicated in this column, as well as the name and location of each school.

2/ The total number of rural and urban establishments will be equal to the total number of public and private establishments.

Chart 3
INFORMATION CARD FOR LIBRARIES, MUSEUMS AND ARCHIVES

1.	Description	(museum, library or archive)
2.	Name:	
3.	Location:	(city, region, etc. and rural or urban)
4.	Type of ownership:	(public or private)
5.	Type of installation:	
	- (Library:	national, specialized, public)
	- - (Museum:	art; archaeology and history; history and natural sciences; science and technology; ethnography and anthropology; specialized (indicate type); regional and general)
	- (Archives:	conventional; cartographic; audiovisual; microcopy and other)
6.	Building:	
	a)	Total area constructed (and height for non-conventional buildings)
	b)	Average age of the principal buildings
	c)	Building condition (good, fair, poor)
7.	Capacity:	(for libraries and archives: number of volumes or items. For museums: according to the type of collection)
8.	Furnishings:	Quantity and condition (good, fair, poor)
9.	Equipment:	Quantity and condition (good, fair, poor)

Chart 4
COMPONENT UNITS OF MEASUREMENT FOR EDUCATION SECTOR REPAIR OR REPLACEMENT WORKS (DIRECT DAMAGE)

Description of component	Unit of measurement
Building 1/	
- Replacement	- m2 constructed (specify ceiling height if different from 2.5 - 3 m.)
- Repair and reinforcement	- " " "
- Repairs	- " " "
Furnishings	
- Partial replacement: Minor 2/	- Inventory of furnishings with minor damage (25% destruction)
Major 2/	- Inventory of furnishings with major damage (50% destruction)
- Total replacement	- Inventory of furnishings totally destroyed
Equipment	
- Repairs Minor	- Inventory of repair work on units of equipment with minor damage (25% destruction)
Major	- Inventory of repair work on units of equipment with major damage (50% destruction)
- Replacement	- Inventory of units of equipment to be replaced (totally destroyed)
Works, objects, collections	
- Replacement	- Inventory of stock to be replaced
- Restored	-Inventory of restoration tasks
- Losses	- Inventory of works/stock impossible to restore or replace
Reconnection to services	- Number and type of reconnections
Demolition	- Cubic meter, square meter of building
Removal of debris/deposits	- Cubic meter of material to be removed

1/ Includes structure, non-structural elements and interior installations
2/ Includes possible repair tasks

Chart 5
BUILDING COST COEFFICIENTS FOR SCHOOL BUILDINGS

Type of space	Coefficient
General class rooms	0.92
Special class rooms	1.00
Laboratory	0.98
Sanitary services	2.02
General services	0.99
Library	0.98
Hallways	0.86
Administration	1.13

Chart 6
RELATIVE COSTS OF SCHOOL FURNISHINGS 1/ 2/

Diversified secondary schools		COSTS
	Laboratories	Relative costs
1.	Physics -biology	3.55
2.	Chemistry	3.33
3.	Multiple (triple)	4.88
	Workshops	Relative costs
1.	Bench and tool machine adjustment	13.27
2.	Plastic arts	5.85
3.	Carpentry	5.85
4.	Cooking and food preservation (2 *)	1.86
5.	Beauty styling (2 *)	2.03
6.	Electricity (area: 12 x 18 x 3.5 m)	5.91
7.	Electricity (12 x 18 x 3.5 m)	6.52
8.	Clothing industry (4 *)	4.57
9.	Automotive mechanics (12 x 18 x 3.5 m)	7.63
10.	Typing (3 *)	3.66
11.	Soldering and metal work (12 x 18 x 3.5 m)	7.36
	Others	Relative costs
1.	Administration (3 *)	2.66
2.	Audiovisual (4 *)	2.61
3.	Library (4 *)	2.24
4.	Storage (3 *)	1.56
5.	Porter dwelling (80 m2)	2.20
	Diversified higher secondary schools	
	Laboratories	Relative costs
1.	Clinical analysis (4 *)	6.46
2.	Biology and microbiology (4 *)	8.65
3.	Mechanized accounting (5 *)	7.26
4.	Physics (4 *)	5.52
5.	Language (4 *)	4.26
6.	Chemistry (4 *)	5.75
	Workshops	Relative costs
1.	Integral basic (12 x 24 m.)	21.49
2.	Carpentry (12 x 24 m.)	7.68
3.	Drawing (4 *)	2.34
4.	Electricity (12 x 24 x 3.5 m.)	14.11
5.	Electronic equipment and consoles Labvolt. (12 x 24 x 3.5 m.)	19.81
6.	Electromechanics (12 x 24 x 3.5 m.)	30.75
7.	Clothing industry (6 *)	6.30
8.	Machines - tools	18.00
	Workshops	Relative costs
9.	Vehicle mechanics	12.87
10.	Typing (4 *)	3.21
11.	Preparation and conservation of food products Milk/meats/fruit	32.50
	Others	Relative costs
1.	Administration (6 *)	4.23
2.	Storage (12 x 24 x 3.5 m.)	5.69
3.	Audiovisual (6 *)	0.97
4.	Library (4 *)	2.26
5.	Guard post (1 *)	0.53

1/ Revista del Centro Regional de Construcciones Escolares para América Latina y el Caribe, N° 41, September, 1976.
2/ In this manual, "furnishings" refers to what corresponds to "equipment" in school planning.
All dimensions are expressed in square meters per student. See "Construcciones escolares: Criterios y normas utilizados en América Latina y el Caribe", UNESCO, Santiago, Chile, 1983.

Chart 7
INDIRECT EFFECTS ON THE EDUCATION SECTOR

Description	Total cost 1/	Cost by category			
		Urban	Rural	Public	Private
Stabilization, protection of buildings					
Relocation of installations					
Ulterior damage/use of installations					
Additional transportation					
Institutions' income losses (public/private)					
Public sector income losses					
Other additional costs					

1/ The total cost results from the sum of the costs for the urban and rural categories, and will be equal to the sum of public and private costs.

Note: In the determination of costs, current market costs at the time of the disaster should be used.

MANUAL FOR ESTIMATING THE SOCIOECONOMIC EFFECTS OF NATURAL DISASTERS

Part Three

INFRASTRUCTURE

INDEX

This chapter addresses the effects of natural disasters on infrastructure, in a broad sense, that is, as that corresponding to basic services: drinking water and sewage, transportation and communications, and energy supply.

I. DRINKING WATER AND SEWAGE

This section begins with a description of the type of damage to drinking water and sewage infrastructure which may be caused by different types of natural disasters. Then, the direct effects likely to be caused by disasters are defined and the methodology for estimating the costs implied by that damage is presented. The same procedure is followed for indirect effects, and the chapter concludes with the corresponding explanation of secondary effects.

A. MOST PROBABLE TYPES OF DIRECT EFFECTS, BY NATURE OF DISASTER

The effects caused by a natural disaster are conditioned by the characteristics of the environment in which it occurs and even by the diverse ways a given natural phenomenon can occur, with the result that it is difficult to foresee all the damage a disaster may cause. Even so, orientation which will allow for anticipating the most probable forms of damage, in each case, as an aid to finding and identifying them, is useful.

Damage does not only depend on the disaster but also on the "capacity to resist damage", a characteristic proper to each system of installations, so that a disaster of one magnitude and form may cause very diverse types of damage.

That resistance depends basically on three factors: the quality of the engineering design; the quality of the construction (including the technology: equipment and materials employed); and the quality of the operation and maintenance of the installations.

For example, If the design of a project took into account only one source of water or drainage, the system will be much more vulnerable to damage than if there were two or more, which would allow for maintaining at least a partial supply of drinking water, thus reducing sanitary problems and avoiding the need to construct emergency supply channels.

Good construction implies greater physical resistance, both with regard to the work's normal use and to the impact of a natural disaster and, therefore, means that damage will be less.

Most components of drinking water and sanitary systems need adequate operation and systematic maintenance over time. When this has been provided, they display greater capacity to resist damage and are easier to repair after a disaster. Good operation requires, moreover, effective organization, with areas for repairing, replacement parts and maps of the distribution network, the existence of which may help identify, evaluate and repair the damage produced by a disaster more rapidly and at lower cost.

1. EARTHQUAKES

a) General effects of earthquakes

According to their intensity, earthquakes may produce faults in rock, in substrata, sinking of land surfaces, slides, land slippage and mud slides[1]; saturated soils may soften (due to vibration), reducing the weight bearing capacity of soils at the level of foundations and substructures. This set of phenomena, combined with the movement of the earth, may produce destruction or other direct damage to any part of water supply, sanitary sewage or drainage systems, located within the area affected by the quake.[2]

The magnitude and characteristics of the damage are usually related to:

i) The magnitude of the earthquake and its geographic extension;

ii) The anti-seismic design of the works, the quality of their construction, the technology employed, maintenance and condition at the time of the disaster;

iii) The quality of the land on which the works are located and the adjacent zone, as well. The possibility exists that the works themselves resist the quake but that adjacent land movements, for example, could cause damage due to the "domino" effects of the earthquake. This would also be the case if a dam were to burst, as a result of the quake, with the avalanche of water causing damage to sector works.

Most of these works, specially drinking water conduits, and sanitary and drainage sewers, are built under ground; and are subsequently covered so that they are not visible to the eye. In the event of a quake, these structures react differently than buildings and structures at ground level.

b) Ground level works

These are works, for the most part, visible, so that a visual appraisal of the damage is possible nearly from the moment of the quake itself. The quake affects these works through inertia (the greater the mass of the work, the greater the effect); the resistance of the structure depends on the ratio between its rigidity and its mass, while mass is not relevant for buried pipe lines, but rather the ground deformations produced by the tellurian event.

i) Buildings, warehouses, housing and machine sheds. Both service administration buildings, materials warehouses, technicians', guards' and operators' housing, and the diverse types of machine sheds or plants, will tend to behave in ways similar to those of similar buildings in other sectors and the damage to them should be evaluated by applying the same criteria. However, damage to machines, equipment and stored materials should be evaluated separately.

[1] Heavy rains may also produce slides, slippages, and mud slides.
[2] A list of the types of damage the different parts of these systems can sustain is included below.

ii) Tanks. In the case of water tanks, the mass of the volume of water stored may be very great and, therefore, the oscillations produced by the quake will also be very pronounced. If the tanks are elevated, there exists the additional risk that seismic vibrations may break them. "This tendency of high buildings to vibrate in resonance with the vibrations of the natural earth attains maximum intensity when these have been built on thick, loose layers of deposits"[3]. Together with the effects of the quake on tank structure, the oscillation and waves of water in storage may imply additional risk, specially when dampening plates have not been installed.

According to the quality of the design, construction and maintenance of the tanks, on the one hand, and the magnitude of the quake and the reaction of the earth, on the other, damage ranging from minor to very serious may occur, including their collapse, in which case the water spilt, if it is of considerable volume, may produce significant additional damage.

Semi-buried tanks. Semi-buried tanks[4], usually constructed of dry masonry, concrete, reinforced concrete or other materials, may suffer damage such as:

i) cracks in walls, floor, cover or joints of these elements, as well as in entry and exit points for pipe lines. Those cracks may range from easily repairable to those which imply the complete reconstruction of the tank.

ii) partial collapse of the covering, interior pillars or part of the walls or floor, which may require repairs ranging from those which are moderately significant to total reconstruction.

iii) collapse of the tank.

Elevated tanks. Mid-sized or large elevated tanks[5] are usually made of steel or reinforced concrete.

Tanks supported by steel structures, with broad diagonal trusses, hold up well in earthquakes; their most vulnerable point is where the tubes (which form part of the support structure) enter the ground. However, diverse types of design, construction and maintenance of steel tanks, combined with diverse magnitudes of quakes and different responses from the foundation ground, may produce:

i) light damage, such as diagonal truss breakage, which can be repaired or replaced rapidly;
ii) damage to support structures and/or to the tank itself (where the water is stored), which may vary from minor to very serious, and which will most probably occur at the joint with the support structure or where water pipes enter or exit;

iii) Collapse of the tank:

The examination of the damage must be performed by a specialist in steel structures in order to determine, if the damage is severe, whether the structure can be repaired and it is worth doing, or if total reconstruction is preferable.

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[3]"Prevención y mitigación de desastres. Vo. 8. Aspectos de Saneamiento", UNDRO, 1982
[4]Regulation or storage tanks for cities and towns are included here
[5]Regulation or storage tanks for cities and towns are included here

According to the UNDRO document, mentioned above, the survival rate of elevated reinforced concrete tanks is lower than that for steel tanks and the precautions to be taken in their construction are less clearly defined. A structure of reinforced concrete will tend to hide the effects of damage much more than a steel structure, so that every trace of damage which goes beyond a superficial loss of stucco should be examined and diagnosed by a specialist, so that what seem simple cracks do not become, in a new quake, the source of a more serious problem.

A quake may produce:

i) superficial loss of stucco, easy to repair, although perhaps requiring scaffolding;

ii) damage to entrance and exit pipes or to attached elements, such as stairways or the like, which, if the structure of the tank itself is not compromised, may be repaired by work of low or mid-range difficulty;

iii) cracks in the support structure and/or in the tank, which may appear, for example, in the overlap zones of an excessive number of iron plates; where pipe enters concrete walls; at the joint of the tank with the support structure or at the base of the structure itself;

iv) tilting of the structure due to foundation failure, usually very serious in nature;

v) collapse of the tank.

Small elevated tanks. These are small elevated tanks, used for isolated houses, small groups of houses, schools, small industries, etc., constructed of a great variety of materials which include support structures of wood or metal profiles, reinforced concrete, etc.

The tank will be of corrugated or smooth iron plates, asbestos cement, fibre glass or reinforced concrete, etc.

Corrugated iron tanks collapse frequently in earthquakes, although experience shows that this occurs more due to poor maintenance than to instability.

Small elevated tanks may suffer damage in the support structure and/or in the tank, ranging from slight and easily reparable, to the collapse of the structure and/or the need to replace the tank. It is probable that part of the material of wooden structures can be recovered, as is also the case for metal structures (except parts which may have rusted).

iii) Dams and reservoirs. Only dams and reservoirs for the supply of drinking water are treated here, excluding those designed for other uses which fall beyond the scope of this chapter.

Important seismic movement may cause large waves in the reservoirs, as a result of horizontal movement, with the risk of overflows. This danger may be greater when land slides and slippage, caused by the earthquake itself, fall inside the reservoir, producing what amounts to an interior tidal wave.

The bursting of a dam may have very serious consequences. However, in this section, only the damage suffered by the dam itself and replacement costs are considered, excluding reference to the damage which the avalanche of water may produce to the works of other sectors.

Rock filled dams. These are more flexible than concrete dams and are more resistant than earth dams but the concrete or clay coverings usually used to waterproof them may be cracked by the earthquake and leaks may ensue. Damage to be considered may involve: i) minor cracks or leaks; ii) medium or severe cracks or leaks; iii) debris slides within the dam; iv) collapse of the dam.

Earth dams. These may suffer damage, during the quake, due to faults in the foundations, interior cracks, land sliding off dikes or overflows due to interior waves, or slides in the contention wall. Possible damage to be considered may involve: i) slight damage which, if it involves leaks, must be repaired rapidly to avoid larger leaks produced by erosion; ii) mid-range or severe damage; iii) debris slides within the dam, which may require dredging; iv) collapse of the dam.

Concrete dams. These can crack or suffer damage in their foundations. As in all dams, there is also the danger that waves will overflow. Damage to be considered may involve: i) cracks or slight leaks which must be repaired rapidly; ii) those which are mid-range or severe and may require emptying the dam (which may imply losing the water stored in it); iii) debris slides within the dam forming barriers; iv) collapse of the dam.

iv) Some considerations for the evaluation of damage.

?? Damage to works connected to dams, such as canals, pipe lines, pump plants, etc. (when they exist), should be evaluated separately, using the corresponding indicators or unit prices for those works.

?? The same criterion should be applied for access roads, fences, electrical lines, guard houses, etc., which may form part of the general works installation whose central feature is the dam or reservoir.[6]

?? For the evaluation of damage to the dam itself, two alternatives are available:

?? estimate it as a percentage = p% of the total value of the construction of the dam itself;

?? estimate globally each of the main sections of repair works.

c) Underground or buried works

In this section, works located underground are considered, such as:

?? all types of pipe lines and drinking water conduits, sanitary and drainage sewers, including the respective distribution networks, chambers, valves and domestic installations;

?? collectors of subterranean waters, such as wells, drains, galleries, etc.

[6]The same criterion is suggested for collectors and different plants

These works are significantly different from those above ground, given that they are mainly not in view, so that most of the damage will not be directly visible. This will make the true determination of damage much slower and laborious. In the Mexico City earthquake[7], for example, even though the most severe damage to drinking water conduits had been repaired within 15 days of the disaster, it took months to complete the needed minor repairs, while the reparation of storm and sanitary sewers was even more complex and slower.

The quake acts with inertia against constructions built above ground; in contrast, underground structures (such as pipe lines, for example) move with the ground, producing deformations which may cause damage. In industrialized countries, tubings have traditionally been made of rigid material, selected to resist water erosion (inside) or the chemical contents of the ground (outside), but not quakes, given the low risk of that phenomenon in those countries. However, long-term technological dependence has led to the use of those inadequate materials in this region with its high risk of seismic activity. Consequently, earthquakes damage rigid tubes and/or their rigid joints. This implies that less damage can be expected in relatively flexible tubing (PCV or welded steel, for example) and more damage in the more rigid tubes, such as compressed mortar, concrete, cast iron and asbestos cement, specially if they have rigid joints.

i) Impact of soil type on damage. In land fill embankments or in soft soils, the quake may produce cracks which can break the pipe lines in them. Breaks have also been observed in zones of transition in the quality of the soil, as well as where density changes in natural fills.

Softening of the soil is one of the most harmful effects of earthquakes because it lowers the soil's capacity to sustain foundations. Large part of the damage sustained by pipe lines, in flood plains or ground made up of water-saturated sand, is due to softening caused by seismic vibrations. It happened in Japan, once, that, due to seismic vibration, a zone of saturated sand became practically liquid and the tubes and chambers in it "floated", causing severe damage to those installations.

Moreover, it is worth keeping in mind that large diameter tubes, near the surface, suffer greater damage than those of less diameter, given their smaller capacity to resist "Rayleigh waves", which, having been produced by the quake, move across the surface of the land in a way similar to, although less obvious than, waves at sea.

Another zone of danger for water conduits or sewers is proximity to buildings overthrown by the quake. The breakage of pipe lines which enter or exit buildings may extend that damage to the public network to which they are connected.

ii) Usefulness of plots and maps of seismic risk, by soil quality. Given the difficulties involved in locating damage to installed pipe lines, the examination of seismic risk maps of the localities affected by the earthquake (if they exist) is recommended, because damage is more likely to have occurred in the zones more vulnerable to quakes, for example:

[7] See CEPAL, Daños causados por el movimiento telúrico en México y sus repercusiones sobre la economía del país, October, 1985

?? Areas with deep layers of "soft" soils, sand and sedimentary gravel, marshes and land fills (subsoils which do not absorb seismic vibrations as does hard rock);
?? Areas with layers of loose sand, saturated with water and others, with layers of loose soils, in which the ground may soften;
?? Faults in rock strata: pipe lines which cross those faults may suffer damage.

iii) Suggestions for finding pipe line damage.

Drinking water pipe lines. Damage to drinking water pipe lines usually produces visible leaks near the breaks in tubes or joints, although in order to determine their magnitude and extent and repair them (which is usually urgent), it will be necessary to excavate and expose the broken pipes. However, it may happen that high soil permeability around the break, or low water pressure, will hide breaks which may be discovered later, once service is restored, considering, for example:

i) New visible leaks, made evident by increased water pressure, once the breaks discovered first have been repaired;

ii) Presence of areas of the city or town which continue without water or receive it at pressures lower than normal, which may be due to damage to feeder lines for those zones, which it will be necessary to discover and repair;

iii) Detection of leaks. This may be very time consuming, specially if equipment and experience are lacking locally. Moreover, it may be difficult to discern which leaks were caused by the quake and which were in existence before;

iv) Through the use of flow monitors in the feeder lines or network, if they are available and can be installed at adequate points, to discover other leaks;

Sanitary sewer pipes. Breaks in these pipes may lead to visible leaks of sewage on the surface which may indicate a zone of damage. Here, as well, it will be necessary to expose the pipes to determine the true magnitude of the damage and effect repairs. However, given that these systems usually operate by gravity flow, and not under pressure, there may be fewer leaks visible than in drinking water lines, in which pressure may make leaks more immediately evident. As well, inspection chambers may make the ocular inspection of the flow in successive chambers possible, which will make it easier both to detect leaky stretches (by comparing the flow in successive chambers), and to detect obstructions in the pipes (by comparing sewage levels in neighboring chambers). If they are not antecedent to the quake, those obstructions may be the result of breaks due to the earthquake.

On the other hand, in areas without drinking water (due to the effects of the disaster), there will be no return flow of sewage, so that the final inspection of sewers requires the prior reestablishing of drinking water service.

Storm sewer pipes. If the disaster occurred during the rainy season, the inspection of this system will be similar to that indicated in the previous section. In contrast, if it occurred during the dry season, damage inspection may involve visual inspection, throughout drainage channels and accessible large collectors, if they exist, and the revision of smaller diameter sections from neighboring inspection chambers.

These measures, however, do not ensure that evidence of other damage, not detected previously, will not appear in the next rainy season.

iv) Quantification of damaged pipe lines. It is, at any rate, clear that the quantification of damage to pipe lines, both for drinking water and for sewage and storm sewers, requires the participation of the administration of the respective services (combining parallel location and repair of damage, because there is no sense in excavating to discover damage, without simultaneously performing the necessary repairs). For this to occur, more time than that available for an initial evaluation of damage will probably be needed.

Perhaps a system based on a preliminary selection, consisting of a sample of damaged stretches in the network, may be helpful in the generation of a very rough estimate of the pipe lines to be replaced or substituted.

v) Danger of contamination of the water in the drinking water networks. If the pipe lines of drinking water networks and those of the sanitary sewers break simultaneously, some of the sewage may mix with or enter the drinking water network. This occurs because those two networks have usually been constructed next to and near each other. Thus, breaks may occur near each other which make the entry of sewage into the drinking water network possible (specially if the volume of sewage spilled is considerable). In some cases, subterranean waters near the surface cover both systems. If the quake produces breaks and leaks in the sewer system, the phreatic layer will be contaminated. In turn, that layer may contaminate the water network through breaks or filtration into the drinking water through non-hermetically sealed joints, if there is negative pressure (less than atmospheric) in that network, due to breaks in its lower sections or the effects of water rationing.

d) Possible impact of the quake on aquifer collection

i) Risk or reductions in the amount of water collected. In zones where water is extracted from wells or deep galleries, it may occur that the earthquake will divert subterranean waters to recently opened faults, producing a reduction (and even the end) of the flow which was being collected in those installations.

ii) Risk of aquifer contamination. There is also a risk that subterranean water will be contaminated if recently opened cracks or faults mix surface water or that from latrines with the aquifer. This is a serious risk because it may render one or several collectors useless. The possibilities of recovery depend largely on chance and vary from case to case.

iii) Damage to deep wells, mid-range wells and those of large diametre, etc. Given the variety of wells in existence, damage may range from:

?? sinking of the ground adjacent to the well, with slight or severe damage;

?? collapse and total loss of the well (due, for example, to a fault which passes through the well itself and leads to its collapse, or to cave-ins which cover it);
?? slight or severe damage to pump mechanisms (pump equipment is to be evaluated separately).

iv) Damage to drip galleries or drains[8]. The quake may cause diverse types of damage, such as:

?? cracks in walls, tubes or voussoirs which form the gallery or drain, which may vary from small cracks, relatively easy to repair (if the gallery is accessible) to larger cracks which will require interior reinforcement or the replacement of the covering;

?? cave-in of part of the gallery or drain, or of some inspection wells;

?? total collapse of the gallery or drain;

?? damage to pump equipment (if it exists), which is to evaluated separately.

e) Contamination of the sources of drinking water

In the preceding section, reference was made to the risks of aquifer contamination, caused by the quake, although contamination of surface sources of drinking water, either from animal carcasses, oil spills, or industrial or toxic products in the water, is much more frequent. This may be one of the most serious effects of the earthquake, given the large scale sanitation risks it implies. In that case, it will be necessary to seek alternative sources, with extreme urgency, and construct (or utilize, if existent) new water collection and distribution works, if the case so requires.

2. FLOODING

a) General effects of flooding

Flooding occurs for several reasons, for example, heavy rains, melting, river or dam overflows, storms, tidal waves, etc. These may be very violent and cause great damage. Their magnitude will be related to:

i) the level achieved by flood waters, the violence and rapidity with which they occur and the geographical area they cover;

ii) the quality of the design and construction of the relevant works, insofar as precautions for a certain level of flooding were considered and implemented, or not;

iii) the quality of the land on which the works are located, in terms of their capacity to resist, or not, the erosion which the floods may cause, together with the quality of the land adjacent to the works, in terms of the danger of cave-ins or land slides which torrential or persistent rain may provoke.

8 Drip gallery: this is a type of collector similar to a drain, but built at greater depth and like a tunnel, with small openings in its walls so that subterranean water may enter.

b) Contamination of drinking water by flooding

Among the damage which natural disasters may produce, the most serious and grave risk, given its consequences, is large-scale contamination of drinking water. In that situation, many diseases usually associated with the lack of hygiene may assume the form of diseases of hydric origin and affect a large part of the population. Those diseases may include typhoid and cholera, where they are endemic, and bacillus and amoebic dysentery, infectious hepatitis and gastroenteritis. The grave risk of the appearance of these diseases means that methods of water treatment with chemical sterilizing agents (such as chlorine, for example) or the boiling of water for human consumption is of the greatest importance.

Contamination of drinking water and of the ground can occur in different ways:

i) Contamination of surface sources of drinking water, from animal carcasses accumulating near intakes, due to excessive opaqueness of the water, or due to the presence of different types of toxic or contaminant substances.

ii) Contamination of aquifer sources when flood levels overflow well heads and flow directly into wells and other collectors.

iii) When the levels in the rivers and bodies of water into which sanitary and storm sewers drain rise, sewage may flow back through the sewers, flooding the interiors of houses and the lower floors of buildings and the streets. In houses, this occurs via the sanitary artifacts themselves and household drains; in the streets, through inspection chambers and rain water drains. (If retention valves have been considered in the design and construction of the sewers, this type of back flow could be avoided, although that is rare in the countries of the region).

iv) If fuels become wet during the flooding, it will be more difficult to boil contaminated water, to sterilize it.

In order to evaluate the costs arising from contamination, it will be necessary to consider:

- ?? the cost of emergency or alternative collection works, and operating costs;
- ?? the cost of emergency drinking water supply for the population, for example, tank trucks and the like;
- ?? cleaning and disinfecting of contaminated drinking water sources;
- ?? cleaning of houses and streets contaminated by sewage and/or the flood itself.

c) Flood damage

i) Damage to pipe lines and connected installations. Damage to pipe lines and connected installations, such as diverse types of chambers and valves, are considered in this section. Flooding may produce damage like the following:

- ?? Erode land and, thus, expose, move or even carry pipe away;

- ?? Raise the level of aquifer waters and, consequently, float pipe and chambers, moving them out of their normal positions. That damage will only exceptionally be slight; most often it is from mid-range to severe;

- ?? Sweep away and cause total loss of pipe lines.

ii) Damage to semi-buried tanks. Tanks are usually located on high ground, so that this type of damage is rare.

Flooding may cause damage by:

- ?? Erosion of foundations, opening cracks and/or causing the partial collapse of tanks, more so if they are made of dry masonry than of reinforced concrete;

- ?? A tank, if a large percentage of it is below ground level, may float when flooding occurs in conjunction with a high phreatic level (which is very probable in certain soils, due to prolonged rains). The risk is greater if the tank is not full of water. This may cause serious partial damage or even destroy the tank.

iii) Damage to pump equipment and electrical installations.

- ?? If flooding is sufficiently high, electric motors, motorized pumps, starters or diverse types of electric control panels may be damaged by humidity.

- ?? It is also possible that low and high tension lines will fall, due to erosion at the base of the installation, causing damage to that base, --to the high and low tension lines; --to electric control panels; and --to sub-stations.

iv) Damage to intakes, dams and constructions at ground level. If the dynamic force of the flood is sufficient and devices to protect against it are lacking, erosion may occur around any sector installation in the affected area, which may be located in the path of the most violent segment of the flood and which, moreover, is below flood level.

These conditions may have special impact on constructions such as: intakes and complementary works for example, canals and water conduits, machine housings, treatment plants, etc., which should be evaluated separately.

v) Dams and reservoirs. The high risk for dams and reservoirs located in the course of a river on the rise due to flooding is evident. Dams designed and constructed to hold drinking water are vulnerable to floods, specially if they have low overflow capacity. Moreover, if the sluices and gates are insufficient, there is danger, not only of serious damage, but also of the destruction or collapse of the dam itself, with the subsequent danger of a new disaster and enormous additional losses caused by the avalanche of stored water.

3. VOLCANIC ERUPTION

a) General effects of volcanic eruptions

Volcanic eruptions can cause "serial" disasters, the effects of which may be greater than those of the eruption itself, and may include:

i) seismic effects produced by the volcano in eruption;

ii) flooding and/or avalanches of snow, earth or mud, produced by the heating of the ground and local vibrations.

iii) as well, the eruption itself may involve the eruption of ash, dust or gasses, the eruption of rock or stone and of lava. The main damage the eruption itself may cause are:

b) Drinking water contamination by volcanic eruptions

i) Contamination of surface sources of drinking water by deposits of ash, the effects of gasses or toxic substances or the death of animals near intake works or near open aqueducts.

ii) The contamination of underground waters is relatively improbable, unless the ash fall is so plentiful and/or contains extremely toxic materials, or if these enter wells (when they do not have protective covers) and the stored water becomes contaminated.

iii) Contamination may occur in filter or treatment plants, due to the fall of volcanic ash on the coagulation or decanting tanks, or on the filters, contaminating the water or making the filters inoperative due to clogging with water-borne ash;

iv) Contamination of open tanks or deposits.

c) Evaluation of damage by contamination

These types of contamination do not --usually- cause damage to the works, as such. Costs will rather involve the cleaning and washing of the filters (which can be appraised in terms of the labour involved). However, it may be necessary to replace inoperative intakes or plants temporarily. In order to evaluate the cost of the damage, it is recommended to consider, if necessary, the following:

- the cost of building emergency collector works and their operating costs;

- the cost of supplying emergency drinking water to the population (if these costs are different from those accounted for in the preceding point); and

- the cleaning and disinfecting of drinking water sources and collectors, plants, tanks and deposits, etc.

i) Damage to pipe lines, semi-buried tanks and connected installations. Lava flows, if sufficiently abundant and of sufficient erosive capacity, may cause damage even to underground installations, such as:

- drinking water pipe lines or drains. They may expose, move, carry away and/or crush pipe lines, chambers and valves;

- semi-buried tanks: partial or total destruction.

ii) Damage to ground level works and buildings. Eruptions of lava, stone or large rocks, which may be thrown great distances, may produce damage in every type of installation of these systems. Depending on the violence of the eruption, the distance of the installations from the centre and other chance factors, the damage produced may range from slight to the total destruction of any of them.

4. WIND STORMS

a) Wind storm damage

Wind storms, as such, cause damage mainly to ground level works. The risk of damage increases in direct relation to the their height and the area exposed to the wind. Damage depends on the capacity to resist wind with which they were constructed.

i) The buildings, houses, machine sheds of drinking water and sewage systems will behave in ways similar to those of other sectors and the damage they sustain should be evaluated according to the criteria indicated for the Housing Sector.

ii) Elevated tanks. If the wind is sufficiently strong, it may knock over one or more tanks and, secondarily, cause damage as a result of the abrupt emptying of the water stored in the tank (which may be several thousand m3), together with the damage produced to connecting pipe lines and nearby structures by the collapse itself.

On the other hand, if the structure itself is sufficiently resistant to the wind or the wind is insufficiently strong to knock over the tank, damage may still be caused to installations adjacent to the tank, such as, for example, access stairways, protective railings, or to the connecting pipe lines. Among the types of damage most likely to occur are those which affect:

- public drinking water storage tanks of towns and cities --which probably have the largest storage capacity--;

- the tanks of industries, markets, schools, etc., of intermediate size;

?? the generally small tanks for domestic use, when they are at the level of the house.

5. DROUGHTS

a) General effects of droughts

Droughts, unlike other natural disasters, do not occur suddenly, but rather arise from the accumulated lack or insufficiency of rain or snow during months or even years. Their main impact is related to the reduction or elimination of the sources of drinking water. Surface water courses, such as rivers and streams, will usually suffer the effects of the drought long before the aquifers, due mainly to two factors:

i) Surface waters generally flow much more rapidly than those of aquifers. This means that rain water or that coming from the melting of snow will reach the sea, via rivers, much more rapidly[9] than water underground. For this reason, river flows are much more rapidly impacted by droughts (or heavy rains), unless there are lakes or artificial reservoirs which regulate the annual level of rains and make the flow of the corresponding river steady.

ii) Aquifers have two characteristics which are very effective in lessening and delaying the impact of drought (specially when hydro-geological conditions are favourable): a large storage capacity in the pores of permeable ground (similar to water in the pores of a sponge) and the low velocity with which the water drains through them to finally reach the sea. That velocity, of a few meters a day,[10] implies that its flow is the result of the accumulation of the rains of many consecutive years and, that aquifer fluctuations, therefore, depend much less on annual levels of rain.

b) Damage produced by drought

i) Damage in surface sources of drinking water. Depending on the characteristics of the surface source(s) of drinking water and the development of the drought:

Less than normal supply flows of drinking water may occasion, depending on the drought's gravity:

?? a moderate restriction of consumption;
?? rationing, from mid-range to severe;
?? increased pumping heights in certain collectors;
?? the total loss of some sources.

ii) Contamination of drinking water sources due to factors such as:

?? reduced self-purifying capacity of rivers and streams, due to reduced flow;

[9] With a velocity of only 0.1 m/hour, for example, water in a river will go 8.64 Km/day and will take 12 days to go 100 Kms

[10] At a steady velocity, of around 1 m/day, it will take 274 years to go 100 Kms.

- ?? increased concentration of pesticides, insecticides or industrial waste, due to the same phenomenon;
- ?? contamination caused by fish killed by reduced supplies of free oxygen, for example;
- ?? contamination caused by animal carcasses near drinking water intakes;
- ?? the preceding factors may require increasing or varying the chemical additives in the water to reduce sanitary risks or opaqueness;
- ?? the need to construct (or put in operation) alternative sources of drinking water.[11]

iii) Damage to aquifer sources. Depending on the duration of the drought and local hydra-geological characteristics, there may be new demands for aquifer waters:

- ?? for emergency supplies of drinking water; and
- ?? for alternative supplies for industry and agriculture;
- ?? which may imply: a relative reduction of phreatic levels, leading to reduced well production and higher pumping heights to achieve the necessary flow.

This may involve higher operating costs for wells than previously, including a probable reduction in pump performance and even --in certain cases-- the risk of having to pay fines to the electric company for low watt power.

iv) Alternate sources of drinking water. The need to provide alternate sources of drinking water (given the reduced capacity of surface waters) may make it necessary to:

- ?? construct emergency wells and rapidly equip them to supplement the drinking water supply;
- ?? use existing wells, originally destined to other uses (industrial, sports or farming, for example), using them for the necessary supply of public drinking water;
- ?? mixed solutions, combining i) and ii).

B. METHODOLOGY FOR ESTIMATING DIRECT DAMAGE

1. INVENTORY OF DAMAGE

In order to estimate the cost of direct damage, it is recommended that an inventory be made. This involves several phases, many of which can be implemented simultaneously. They are the following:

a) Identification and reliability of the sources of information

i) Specific identification of the sources of information used, among which the following should be considered:

- ?? governmental or municipal organisms directly responsible for drinking water and sewer services, and other bodies related to the sector;

[11] In many cases, this may involve the collection of aquifer water from deep wells

- ?? professional and sector organisms and/or associations related to the issue (such as the local chapter of AIDIS, for example);
- ?? sector engineering and constancy firms;
- ?? national and international experts who may be in the country and may have information or experience in the area;
- ?? and other sources to be identified in each case.

ii) Verify and indicate the reliability of the data received in each case. Undertake field trips and verifications as necessary and possible.

iii) It is worth noting the degree of reliability and relative precision of reports on the amount of damage done to works, for the diverse estimates of damage. It is also useful to indicate what has been verified personally and what corresponds to third party information, or to rough, unconfirmed estimates, or which reports it proved impossible to verify.

<u>b) Lists of direct damage</u>

i) Separate lists by site of damage. It is suggested that damage be grouped according to the following considerations:

i) damage suffered by each city or town, and distinguish urban from the rural damage;

ii) damage by system, so that the damage suffered by each system are listed together, that is:

- a certain drinking water system;
- a certain sanitary sewer system;
- other sanitation systems;
- a certain storm sewer.

iii) Within each city and each system, group damage by plant or sub-system, for example, for the drinking water system of a city:

- collectors: collector A, collector B, etc.;
- treatment plants: plant A, plant B, etc.;
- main conduits to tanks;
- tanks: tank A, tank B, etc,;
- distribution network and
- others, specified in each case.

This will facilitate obtaining the cost of total damage to the drinking water system of each city, by adding the sub-totals thus generated.

iv) Together with each damage list, the evaluator should also indicate: --the name of the corresponding city or town; --origin(s) of the information; --reliability of the information; and --the system and sub-systems to which the damage corresponds.

c) Characteristics of damaged sub-systems

In order to ascertain the extent to which collecting data will be worthwhile, the availability of information in the official sources should be considered. If the city is large, the drinking water and sewer systems may be very large and complex and the information about them may be incomplete, even in normal times. Moreover, due to the disaster, many sector personnel will be working on emergency tasks, so that the evaluator will not find their time readily available.

In that case, it may be preferable to seek only the information strictly necessary about damaged sub-systems and not about those which continue to function normally, unless that information is useful for estimating damage or weighing indirect effects. Therefore, only the main characteristics of damaged sub-systems should be indicated.

d) Direct damage, as such

This type of damage is to be recorded by sub-systems as indicated above. Damage lists should be drawn up, grouping damage by materials, equipment or works of the same kind. It is recommended that a procedure such as the following be adopted:

i) For each type of damaged material or installation, a brief description of its main characteristics, of the type of damage and the approximate amount of installation or material affected, in adequate units of measurement, should be made.

ii) For each type of damaged installation and/or material, indicate:

- the type of installation and/or material;
- the unit price for its construction or total replacement (PU);
- the unit price for repairs, as a percentage (R%) of the preceding unit price.

Thus, the following data should be obtained for each damaged installation:

Ud = unit cost by damage = (PU) x (R%)
Ur = unit cost by replacement = (PU) x 100% = (PU)

iii) The estimate of the percentage (R%) to which certain installations, materials or equipment have been damaged, may be obtained as a weighted appraisal, considering: --whether it will be possible to repair or partially reconstruct the installation, material or equipment or if, given the extent of the damage, total reconstruction or replacement is necessary; --if it is possible to repair the damage, the cost of that damage is to be estimated as a percentage (R%) of the total cost of that installation (part of an installation, material or equipment); --if it is necessary to reconstruct or totally replace the installation, it is understood that R = 100%.

iv) The estimate of the percentages R% may be made on the basis of the appraisals of the Service personnel responsible for each system and/or other sources, although the final appraisal must be that of the mission expert.

e) Demolition, wrecking and removal of debris

Along with what has been indicated in the preceding section, demolition, wrecking and debris removal must also be considered. To that end, it is suggested that:

i) for each type of damaged installation or material (identified as recommended above), it be considered whether reconstruction or repairs will require prior demolition, wrecking and removal of debris. If such is the case, the approximate amount of the installation or material to be demolished and removed is to be indicated, in adequate units of measurement, which, insofar as possible, should be the same as that used to quantify the damage;

ii) the main works or activities considered within the "demolition (or wrecking) and removal of debris" be indicated, for each item, but as one global unit price, which includes these factors, within each item.

iii) However, it will be necessary to bear in mind the degree of difficulty and costs implied by different installations and materials. Thus, for example, it will be necessary to distinguish the "demolition" of a tank of reinforced concrete from the simple "wrecking" of asbestos cement pipe lines, whose joints will be easier to disassemble, allowing as well for the partial recovery of material.

iv) If it is not possible to make precise price estimates in this area, a criterion such as that recommended above can be used, estimating the cost of the "demolition, wrecking and removal of debris", as D% of the unit price. However, there is no reason for D% to be equal for the different items, due to the diverse degrees of difficulty involved in the demolition or wrecking indicated above.

v) If, as a result of demolition and wrecking, it is possible to recover some of the material, either for use by the company or for sale, its eventual value is to be estimated as a percentage (V%) of the unit price of that material when new. These sums may be subtracted from the cost of the "demolition, wrecking and removal of debris".

2. UNIT PRICES AND GLOBAL COSTS

a) Unit prices to be considered in the evaluation of damage.

These may be based on:

i) Those provided by studies or lists of unit prices normally used by the organisms responsible for the corresponding services and systems. It is worth indicating the date of the lists. If necessary, they must be up-dated by simple coefficients, to correct the effects of inflation and other factors;

ii) Estimated unit prices, provided by direct surveys or appropriate local sources;

iii) "Comparative unit prices", gathered for the region and which may serve to verify those mentioned in the two preceding points and may be used in their place, if deemed appropriate;

iv) Other unit price lists obtained from construction manuals, catalogues or national magazines, for example.

b) Labour and the domestic and imported component of materials prices.

Whatever the sources or unit price estimates used, when drawing up the lists, it is worth considering:

i) the labour content;

ii) the percentage of domestic materials and;

iii) imported materials, as % with respect to the unit price.

This last calculation will make it possible to distinguish the value of imports and their impact on the balance of payments, within the figures for total direct damage.

c) Types of works, unit or global prices

Drinking water, sanitation and storm sewer systems embrace a wide variety of types of works, material and equipment. The cost of some of these elements is easy to estimate, on the basis of unit price lists. Such is the case, for example, for pipe lines and water conduits, the unit price for which can be expressed in terms of lineal meters, either for the pipe itself, or its installation.

In contrast, there are other types of works --such as water treatment plants-- for example, consisting of various components which may come from different sources and involve diverse technologies and prices. In that case, costs should be estimated on the basis of the total price per plant. This may be done on the basis of the following data:

i) Local information about construction costs for the plant and its current value;

ii) The use of price manuals or studies from other countries, preferably those most similar to the case under study;

iii) Use of the Manual developed by the Pan-American Sanitation Office; [12]

iv) If the plant is only partially damaged, these indications should only be applied to the relevant elements.

[12] See Water and Wastewater Cost Analysis Handbook for Latin America and the Caribbean, Pan-American Santitation Office and the International Development Bank, September, 1986.

3. APPROXIMATE COST FUNCTIONS

a) Simplified cost functions

The functions used to describe cost variations occasioned by changes in design parametres (for example, flow capacity) are usually:

$$C = ax^{b}$$

In which:

C = cost

x = design parametre, as Q (flow capacity in lt./sec.), for example.

a,b, are factors and exponents which describe the variation of the function in each case.

(This equation can be written in nearly straight lines on double logarithmic paper).

b) OPS-BID Manual of cost functions[13]

On the other hand, in the Pan-American Sanitary Bureau Manual mentioned above, a more complex function is used (which functions with the use of a computer) and which yields closer approximations.

Those functions take the form:

$$C = a + b\,x^{c} \cdot y^{d}$$

in which:

C = cost

x,y, are independent variables (for example, design parametres)

a,b,c, and d, factors and exponents which describe the variation of the function in each case.

c) Evaluation of damage to buildings

Damage to administration buildings, and to personnel and guard housing, diverse types of machine housings, etc. should by evaluated according to the criteria indicated in the chapter on "Housing".

d) Evaluation of damage to electric installation access roads

Damage to access and other kinds of road should be evaluated according to criteria indicated in the chapter on "Transportation and Communications" and those which refer to electric installations, as indicated in the relevant chapter.

[13] See again OPS-BID, Op.Cit.

4. EXAMPLES OF THE EVALUATION OF DIRECT DAMAGE

a) Example of an inventory of direct damage

Chart 1 presents an example of an inventory of direct damage suffered by a hypothetical city. In order to effect the evaluation and gather the necessary information, the following is recommended:

i) On the pages of the inventory made for the evaluation, include only the information necessary to identify the work, the equipment and/or material damaged, in such a way as to be able to indicate the corresponding unit price (U.P.).

ii) However, it may occur that additional information is required about the main characteristics of sub-systems to delimit the relative importance of the damage and evaluate indirect damage. It is recommended that such information be included separately, but annexed to the inventories.

iii) Moreover, the summary inventory itself may need additional notes, which provide, for example, more detailed information about damage to a certain work, material or equipment, or which explain the method utilized to estimate the value (R%) of each item, when necessary.

b) Example of an evaluation of direct damage

It is recommended that Chart 1, "Example of summary inventory of direct damage", be examined. That chart is the basis for the elaboration of Chart 2, which contains two additional columns: "Unit Prices" (U.P.) and "Subtotals" = (U.P.) x (R%) x (amount damaged). In order to determine unit prices, what has been indicated in earlier sections of this chapter should be taken into account.

c) Unit prices and their break down

What follows is the break down of some unit prices[14]? , by component (the % of which is supposed and approximate), which should be determined in each real case.

M.O = % of U.P., in labour

M.N = % of U.P., in domestic material

C.I = % of U.P., in imported component

G.G = % of U.P., in general and expenses and profits

i) Concrete well with a 2 Mts. interior diametre.

U.P = US$ 500/lm

[14] All of these unit prices and their components are not from a real case; they are only suppositions for the sake of giving an example.

M.O = 30 % (U.P.)

M.N = 35 % (U.P.)

C.I = 15 % (U.P.)

G.G = 20 % (U.P.)

ii) Asbestos cement pipe, with Gibault joints, type 20, installed.

	U.P. US$/lm	M.O	M.N	C.I	G.G
a) D = 100 mm	12	20%	30%	30%	20%
b) D = 150 mm	20	"	"	"	"
c) D = 200 mm	32	"	"	"	"
d) D = 250 mm	41	"	"	"	"
e) D = 300 mm	57	"	"	"	"

iii) Cast iron pipe, with socket-cord joint, installed.

D = 400 mm

U.P. = US$ 100 lm.

M.O. = 20%
M.N. = 10%
C.I. = 50%
G.G. = 20%

iv) Compressed cement pipe, installed.

	US$/lm	M.O.	M.N.	C.I.	G.G.
a) D = 175 mm	14	30%	50%	-	20%
b) D = 200 mm	18	30%	50%	-	20%
c) D = 300 mm	30	30%	50%	-	20%
d) D = 500 mm	70	30%	50%	-	20%

v) Semi-buried tank, of reinforced concrete.

Volume = 1 000 m3 (estimated at US$80/m3)

U.P. = US$ 80 000

M.O. = 25%
M.N. = 40%
C.I. = 15%
G.G. = 20%

vi) Administration of building, brick walls, with reinforced concrete pillars, rafters and floors.

U.P. = US$ 250/m2

M.O. = 20%
M.N. = 50%
C.I. = 10%
G.G. = 20%

vii) Demolition and debris removal of collapsed sections.

U.P. = US$ 20/m2

M.O. = 80%
G.G. = 20%

C. INDIRECT DAMAGE

1. DEFINITION AND GENERAL OBSERVATIONS

a) Definition of indirect damage

According to the criteria proposed in this manual, indirect damage is defined as those goods and services which it will be impossible to obtain as an effect of the direct damage caused by the disaster. These may last the entire period of time necessary for reconstruction, repair and re-establishment of normal operations of the works in question. They also include reduced drinking water company income, due to reduced billing (arising from reduced service) and losses of water, due to as yet non-repaired direct damage; and increased operating costs incurred by drinking water companies for temporary water supply activities, which will last indefinitely, depending on delays in reconstruction.

b) General observations

Indirect damage depends on the effects of direct damage impact on the functioning of systems. As well, different types of direct damage may cause the same or similar indirect damage.

2. MAIN INDIRECT DAMAGE TO DRINKING WATER SUPPLY SYSTEMS

Direct damage may have the following main effects, either separately or in combination:

i) reduced production or collection of drinking water;

ii) reduced drinking water treatment capacity;

iii) reduced capacity to channel drinking water;

iv) reduced capacity to control and store drinking water;

v) reduced drinking water consumption. All these factors may generate higher costs or reduced system income. Each of these categories is explained, as follows:

a) Reduced production or collection of drinking water

This refers to the reduction in the normal production or collection of drinking water in the intakes or collectors customarily used by the system. This may be caused by diverse types of direct damage, such as, for example:

i) reduced capacity of water sources (due to drought, for example);

ii) contamination of sources;

iii) damage suffered by works, plants, machinery or collector equipment;

iv) damage to electrical lines or in the supply-line of fuel necessary for the operation of pump machinery or collector equipment and;

v) other damage.

b) reduced drinking water treatment capacity due to damage

i) to treatment, filter, chlorinating, etc. plants;

ii) to the energy supply of those plants;

iii) to the supply of inputs;

iv) excessive water sediments, damage to sources, which make it necessary to reduce the flow treated;

v) other damage;

c) Reduced capacity to channel drinking water

i) arising from damage to pipe lines or other types of main channels which carry water to cities or to intermediate installations (such as treatment plants, pumping stations, tanks, etc.), thus affecting the overall channeling capacity of the system;

ii) damage to pipe lines or secondary channels and/or distribution networks, which partially affect the capacity to channel drinking water;

iii) damage to domestic connections and/or interior networks in buildings, houses, industries, markets, etc. which affect, locally or domestically, the capacity to channel and deliver drinking water;

iv) damage to pumping or re-pumping stations, which are necessary to the overall or partial channeling capacity of the system;

v) other damage;

d) Reduced capacity to control and/or store drinking water

Reduced regulation capacity diminishes, in turn, the capacity to deliver water, in response to variations in demand throughout the day, with greater impact during peak demand, which leads to the loss of water not stored.

i) due to damage to main regulation and/or storage tanks of a system which will affect overall water supply;

ii) damage to secondary tanks;

iii) damage to lesser tanks, be they industrial, commercial or domestic;

iv) other damage.

e) Reduced drinking water consumption

i) The consumption of drinking water in affected cities and towns may be reduced or cease as a result of the damage indicated above. It is most probable that a combination of those factors will cause a reduction in the water supply, lower pressure and even lower sanitary quality, making it necessary for the population to boil water prior to direct consumption.

ii) Consumption of drinking water may also be reduced, even if direct damage to the drinking water supply system does not occur, if the disaster has left housing damaged and unserviceable.

iii) It is evident that reduced supply and reduced consumption will mean reduced billings and lower revenue for the corresponding services.

3. HIGHER OPERATING COSTS

These higher costs will mainly be caused by:

i) increased production costs for m3 of water --affecting all or some of system water-- due to, for example:

- higher than normal pumping heights in collectors;

- higher operating costs in emergency collectors, used to (totally or partially) replace those used normally;

ii) increased daily production to compensate for abnormal losses in conduits;

iii) higher energy costs and for other inputs;

iv) combinations of the above.

In order to calculate higher water production costs, the following should be considered:

a) Case A: Only one collector

	Before the disaster	After the disaster
Average cost for production of m3, in $/m3	Mo	Ms
Average volume, produced daily, m3/day	Vo	Vs
Average daily cost, in $/day	Do=Vo x Mo	Ds=Vs x Ms

Therefore, the higher daily cost will be:

(1) d=(Ds-Do) = (Vs x Ms) - (Vo x Mo); in $/day
and the cost for a period of (p) days, which the situation will supposedly last, will yield:

(2) P=d x p, in $/period.

By way of example, suppose:

i) Before the disaster. Mo = US$ 0.02/m3
Vo = 10 000 m3/day

In which, Vo = volume for an average day for some 40 000 persons, with 250 lt/day/inhabitants

ii) After the disaster: Ms = US$ 0.035 m3
Vs = 12 000 m3/day (in this case, greater volume is supposed, in order to compensate for intermediate losses)

iii) Higher daily cost: d = Vs * Ms - Vo * Mo = US$ 220/day

iv) If the emergency situation lasts p = 30 days, the higher cost during that time will be:
p = 30 * 220 = US$ 6 600

b) Case B: Diverse collectors.

If there are several collectors, each with different production volumes and costs per m3, average costs can be obtained, as follows:

	Before the disaster	After the disaster
Cost m3, in each collector: $/m3	m1, m2, mn	M1, M2, Mr
Daily volume, per collector: m3/day	v1, v2, vn	V1, V2, Vr
Daily cost, per collector: $/day:	Vn x mn	Vr x Mr
Number of collectors	n	r
then:		
Total daily volume, m3/day	Vo= Sigma Vn	Vs= Sigma Vr
Total daily cost, $/day	Do=SigmaVnxMn	Ds= Sigma VrxMr
Average cost per m3, $/m3	Mo=Do/Vo	Ms=Ds/Vs

Therefore, the higher daily cost will be:

(3) d= (Ds-Do)= (Sigma Vn x Mn- Sigma Vr x Mr), in $/day. This equation is similar to (i) above.

and in a period of (p) days:

(4) P= d x p = (Ds-Do) x p, in $/period. Similar to (2) above.

c) Case C: Higher cost of pumping water

One of the most frequent causes of higher water production costs is the increased cost of raising water (due to factors such as those indicated above). It is worth recalling here how pumping

costs are calculated[15] (taking only electric energy into account, in this case, because other factors either have little impact or are considered elsewhere).
Calling:

Q: pump flow in lt/sec.
H: total height in meters (including loss of load)
N: total yield (wire-water) of pump equipment
k: cost of K.W.H. in $/KWH[16]?
M: elevation cost of 1 m3 to H height, in $/m3
V: volume raised per hour = 3.6 x Q, in m3/hour
Nh: number of daily pump hours
V: daily volume raised = 3.6 x Q x Nh, in m3/day
D: elevation cost per day = M x V, in $/day.

Then, the pumping cost per m3, to H height, is:

(5)
$$M = \frac{0.736 \times k}{75 \times 3.6 \times N} \times H = 0.002726 \frac{K}{N} H$$

Estimating an average yield of M = 0.68, gives:

(6) M = 0.004 x k x H, in $/m3

i) By way of example, suppose that, prior to the disaster:

H = 100 mts. (height)
k = US$ 0.05 per KWH
Q = 500 lt/sec
Nh = 20 pumping hours daily

So that, prior to the disaster (with the figures of this example):

M0 = 0.004 x K x H = 0.004 x 0.05 x 100 = 0.02 dollar/m3

V0 = 3.6 x Q = 3.6 x 500 = 1 800 m3/hour

V0 = 3.6 x Q x Nh = 3.6 x 500 x 20 = 36 000 m3/day[17]

D0 = M x V = 0.02 x 36 000 = 720/US$/day

ii) Supposing that, after the disaster, only height has changed, so that now:

[15]See Herman House: Método de diseño económico para un sistema de abastecimiento que incluye elevación del agua, Congreso Nacional de Hidráulica de México, 1976.
[16]If raised by internal combustion pump, the equivalent KWH cost is to be used here.
[17]The daily average consumption of some 120 thousand persons, approximately

Hs x 140 mts.

$$Ds = \frac{140 \times 720}{100} = \text{US\$ } 1\,008/\text{US\$/day}$$

Then, the higher daily cost will be:

d = (Ds - Do) = 1 008 - 720 = 288 US$/day

If that situation lasts p = 30 days, the higher cost, caused only by increased height, will be:

P = (Ds - D) x p = 288 x 30 = US$ 8 640 of higher cost for that period.

iii) The value P, indicated above, supposes that the yield "N" of the pumping equipment has not changed; however, in the probable event that yield is less, supposing 70% (0.07) of previous yield, will give:

$$Ms = \left(\frac{1}{0.7} \times M\right) = 1\,428 \times 0.02 = 0.0286 \text{ Dollar/m3}$$

and the higher daily cost and for the entire period will increase by the same proportion:

P' = 8 640 x 1 428 = US$ 12 338, higher cost for the period.

4. ESTIMATING OTHER EMERGENCY OPERATING COSTS

a) Emergency operating activities

Depending on its intensity, a natural disaster may cover vast zones, including cities of different size, towns and rural areas. The factor of chance, proper to the disaster, and the variety of situations which arise may require a very wide range of emergency service activities, implying costs which should be processed as indirect damage (beyond the repair of direct damage). Among this type of activity are:

i) Emergency repair of pipe lines, using patches or plastic sleeves, installing temporary by-pass pipe lines or conduits, as well as maneuvers to channel run-off, in order to avoid water loss in damaged pipe lines, using emergency valves and tubing. etc.

ii) Increased chlorine concentration in flows already being chlorinated. Installation of emergency chlorination stations for flows not previously chlorinated. Preventive chlorination of deep and shallow, urban and rural wells.

iii) Use of other available collectors of drinking water such as, for example, the deep wells of industries, commerce or sports complexes, etc. Included here are hydraulic inter-connections to the network, the energy supply for pumping equipment, etc.

iv) Preparation of available depositories as emergency drinking water tanks, such as swimming pools, industrial and commercial depositories, etc. Moreover: the use of fiber glass, plastic, etc. tanks, for storing and distributing drinking water to the population.

v) Use of tank trucks, towed cisterns, trucks with tanks loaded on flat beds, etc. to distribute drinking water to the population.

vi) Activities and maneuvers to establish rationing of the water in the network, when necessary and possible.

vii) Hydraulic maneuvers to increase pressure in the network, if necessary to avoid contamination of drinking water (sometimes indispensable, even though water losses increase, through leaks).

viii) Elaboration and delivery of instructions for the population, with regard to cautionary measures in the use of water (boiling, for example), rationing schedules, tank truck routes, distribution points, etc.

b) Estimate of emergency operating costs

The different situations created by natural disasters, together with the diversity of regional or local situations, make it possible to appreciate the wide range of emergency activities possible and the variability of their magnitude. For a rough estimate of the costs of these activities, it is necessary to simplify the problem, grouping costs in a limited number of categories:

i) Estimate of extraordinary expenses in wages and salaries. Included here are the costs for professional, technical, administrative and operating personnel occupied in emergency operations, as indicated. The procedure for this estimate is as follows:

?? make a simplified list of the categories of personnel occupied in those activities, indicating the unit cost in each category (man-hour, man-day, or man-month, as appropriate);
?? for each category, the "number of man-units" required for emergency activities, while the emergency lasts, should be estimated;
?? the values of (i) and (ii) should be multiplied and partial totals should be added together, as indicated in the following example (with supposed values and %):

(a) Personnel	(b) Category	(c) $/day/each	(d) Number man/days	(c) * (d) Sub-totals/ $
Engineers or Professionals	A	60	30	1 800
	B	50	70	3 500
Technicians	A	30	90	2 700
	B	20	120	2 400
Administrators	A	20	60	1 200
	B	15	90	1 350
	C	12	-	-
Operators	A	14	1 000	14 000
	B	12	1 200	14 400
	C	10	1 500	15 000
	S1 = Subtotal 1:			56 350
	I1 = Unforeseen = 30% x S1			16 905
	S2 = Subtotal 2:			73 255
	General expenses: (20% x S2)			14 651
	Profit (if relevant): (%U) x S2			
	T = Sum Total			87 906

This exercise should be performed separately for cities, regions or for organisms responsible for drinking water (which may embrace regions or the whole country), as proves possible and advisable in each case. They may also be separated according to who assumes the costs, be it the drinking water service, the government or some other entity.

ii) Estimate of work done on installations and emergency repairs. This section involves the preparation of an estimated budget of costs not included in the previous section; and, thus, refers to the materials, their transportation, fuel, energy, etc. used in emergency works and repairs. The equipment, machinery, pipe and valves which are installed in temporary fashion, but which can be removed after the emergency has passed, should be considered at only a percentage of their total value, which should include amortization (r%), estimated according to the use made of those elements during the emergency. To perform this cost estimate, a list of the main works undertaken should be made, including: a brief description of each work or other materials cost[18]; the approximate quantity of each work or category; the unit price of each category; general costs and profit (if relevant).

Example: In this example, supply and transportation of all materials and their installation are included.[19]

[18] This refers to costs such as energy, transportation, etc.

[19] Unit prices and % are supposed, only by way of example.

Item N°	Summary of emergency works	Unit	Quantity	Unit Price (US$)	Totals US$
	Supply and installation of pipe and valves				
1	Steel pipe D = 400 mm	lm	200	180	36 000
2	Steel pipe D = 300 mm	lm	500	130	65 000
3	Steel pipe D = 200 mm	lm	2 800	100	280 000
4	Valves D = 300	No.	2	630	1 260
5	Valves D = 200	No.	8	240	1 960
				S1 = Subtotal 384 220	
				General expenses (20%) x S1=	76 844
				Profit (0%) x S1	--
				TOTAL	461 064

Supposing that the recovery of 200 mm pipe, which cost US$ 60/lm[20], with an expected 15% rate of amortization and, thus, implying the recovery of 85% x 60 x 2 800 = 142 800.

Then: value to be recovered -142 800
Thus, the real cost of those emergency works would be: $ 318 264.

iii) Estimate of costs for use of collectors which are not public drinking water service property. The use of collectors which are not public drinking water service property involves expenses which should be faced in accordance with the appropriate agreements.
For example, a case in which the Public Service only covers electric energy costs, incurred for pumping water.

It was stated above that the cost of a m3, raised to H height, is:

M = 0.004 x k x H, in $/m3, in which k = KWH cost
H = height in meters.

If it is supposed that the collector used yields a flow: Q, in lt/sec., during : Nh = hours of pumping daily for a period of: p = days of use of this collector,

then:

V = (3.6 x Q x Nh) = volume raised daily, in m3/day

D = (3.6 x Q x Nh) x M = cost of raising water daily, in $/day

P = p x D = cost of raising water in period "p"

[20] This is the unit cost for the purchase of the pipe itself, apart from installation costs

By way of example, suppose:

Q = 50 lt/sec.
k = US$/ 0.05 per KWH
H = height of 60 mts.
Nh = 16 hours of pumping daily

Then:
M = 0.012 US$/m3
V = (3.6 x Q x Nh) = (3.6 x 50 x 16) = 2 880 m3/day
D = M x V = 0.012 x 2 880 = 34.56 US$/day

In a 30 day (p) period:

P = D x P = 34.56 x 30 = US$ 1 036.80 = cost for (p) period.

For a case in which an agreed upon price per cubic meter will be paid, suppose all factors of the previous exercise, adding only the agreed upon price for a cubic meter of water:

M = US$0.02
D = Ma x V = 0.02 x 2 880 = 57.60 $/day
P = p x Ma x V = 30 x 0.02 x 2 880 = US$ 1 728, cost for the period.

iv) Use of tank trucks for water distribution. The distribution of water by tank truck may aid areas not supplied through the public network. In order to calculate this cost, the following should be considered: diverse types of truck under contract to distribute water, to be paid a per-trip rate, according to their freight capacity. This should be done as follows:

Cl = number of type 1 trucks (id. for other types)
t1 = rate per trip for truck 1 (id. for other types)
n1 = Number of daily trips for truck 1 (id. for other types)
d1 = t1 x n1 x c1 = daily cost for type 1 trucks.
p1 = number of days in use
P1 = p1 x t1 x n1 x c1 = total cost of use of type 1 trucks.
P = p x t x n x c = total cost of use of tank trucks.

The following example supposes the use of 10 cubic meter capacity tank trucks, which make 30 Km. trips to pick up and distribute water. The cost, per cubic meter and per trip, is US$0.90; therefore, the rate is US$/9/trip. (A value which includes transportation and distribution). If the company's own trucks or municipal vehicles are used, the apparent cost may seem somewhat less. That rate does not include the cost of the water.

If n = 10 daily trips, per tank truck, are made
and there are c = 5 tank trucks working
during p = 30 days

the daily cost of transportation (to distribute some 500 cubic meters, daily) will be:

$d = c * t * n$ = S$ 450 daily

and the cost for 30 days will be:

$Ct = c * t * n * p$ = US$ 13 500

If there are other trucks with other rates, cost estimates should be made for each type and, then, those subtotals should be added together.

5. LOWER INCOME FROM REDUCED BILLING AND LOSS OF WATER

In order to estimate the amount of reduced billing (probable reduction of water sold to consumers in cities and towns included in the disaster zone), it is necessary to weigh the effect of the main factors which lead to lower water consumption through the normal supply system. Those main factors have been identified and explained in the preceding chapter.

a) Estimate of the impact of reduced production or collection of drinking water

Call:

Vo	=	Average daily volume, produced before the disaster, in m3/day;
vs	=	Average daily volume, produced after the disaster, in m3/day;
Eo	=	Monthly volume produced, before the disaster, in m3/month;
Fo	=	Monthly volume billed, before the disaster, in m3/month;
Fs	=	Monthly volume billed, after the disaster, in m3/month;

It is known that Fo usually involves a volume smaller than Eo, due to leaks in the network and unpaid consumption.

Call:

(7) R= Fo/Eo, then Fo = R x Eo (in which R is less than 1).

If the disaster had the exclusive effect of reducing water production (for example, in a drought), the new monthly billing would be approximately:

(8) Fs = R x Eo x (Vs/Vo) = Fo x Vs/Vo in m^3/month; so that the reduced monthly income will be:

Delta I = (Fo - Fs) x Mf in $/month

in which Mf = average value of m3 billed.

(9) Delta I = Fo - Fs) x Mf = Fo (1- Vs/Vo) x Mf

and lower daily income = $\frac{\text{Delta I}}{30}$

and, due to reduced production of water, in a "p" period of days, the loss of income will be:

(10) Delta Ip = $p \frac{F}{30}$ (1- Vs/Vo), in $

b) Impact of reduced treatment capacity

When treatment capacity is reduced and it is necessary to continue to consume all the water produced, the effect will not be a reduction of income, but rather diminished water quality.

If treatment capacity is the bottle neck, in the sense that only treated water can be consumed, equation (10) is to be applied, in which:

Vo = average daily volume of water treated, before the disaster
Vs = average daily volume of water treated, after the disaster.

c) Impact of reduced channeling capacity, due to damage and leaks

Water leaks caused by damage to pipe and joints imply that water is not reaching its habitual consumers, who, therefore, cannot be billed. It is known that, even before the disaster, a certain quantity of the water produced was being lost through leaks. This value should be ascertained for each city (it is usually around 25 or 30% of the water produced). The damage caused by the disaster, specially if it was an earthquake of a certain magnitude, will necessarily augment that loss.

Moreover, as noted above, only a fraction of the new loss will be apparent. In this case, the following procedure should be employed:

i) The most important leaks will probably be visible on the surface. In those cases, the breaks should be excavated and appraised.

Suppose that leaks 1,2, etc. have been discovered. For leak 1:

q1 = estimated loss for leak 1, in lt/sec.
v1 = 24 x 3.6 x q1 = volume lost daily, in m3/day
d1 = number of days during which water is lost (before damage is repaired)
r1 = v1 x d1 = 24 x 3.6 X q1 x d1 = total volume lost through leak 1, in m3.

If there are several leaks, it will be necessary to add

R = Sigma r = total volume of known water lost, during the period.

ii) Moreover, there are probably invisible leaks; these should be estimated as a percentage (j%) of the total volume produced.

Estimate of reduced revenue, resulting from the losses indicated here:

- due to identified losses. Volume "R", lost

(11) Delta I'r = R x Mf, in $

- due to losses estimated as j % of the volume produced:

(12) Delta I"r = J % x (Vs xp) x Mf, in $

d) Impact of water distributed without charge

Emergencies usually imply that a certain quantity of water is distributed to the population in ways different from the usual (tank trucks, etc.). Water distributed in this way, that is, without charge, will also have some impact on reduced billing.

Call:

ve = average daily volume, in m3/day, distributed during the emergency;
pe = number of days this is done;
Mf = average price of m3 billed

(14) Ve = ve x pe = total volume distributed during the period;

Then, reduced billing for this reason will be:

(15) Delta Ie = Ve x Mf.

e) Impact of reduced consumption due to housing having been abandoned by inhabitants and the suspension of other activities

Normal consumption of drinking water may also decrease when, as a result of the disaster, housing has been left abandoned; and/or schools, industries, businesses and other activities cease to function. That decrease will be equal to the normal consumption of those system users.

To estimate that decrease, the following procedure is recommended:

i) make a rough calculation of the percentage of housing abandoned (due to damage or other causes), with regard to total housing in the corresponding city;

ii) estimate the percentage of activities in the city which have ceased to function, based on economic sector information.

Those estimates will make it possible to weigh the percentage (W%) of reduced daily consumption.

Call:

Fo = average monthly value in US$/month, of billing for the whole city, before the disaster
Fo/30 = average daily billing
W% = percentage of total billing, before the disaster, estimated for current "non consumption" in (ZONE W)
dw = (w%) $\times \frac{Fo}{30}$, normal average daily billing in zone W.
pw = number of days the "non consumption" in zone W will last.

The, the reduced income will be:

(16) Delta Iw = pw x (w%) x $\frac{Fo}{30}$ in US$/period.

f) Summary of reduced billing income for different reasons

The preceding equations are to be joined together:

i) Due to reduced water production in collectors or treatment plants:

(10) Delta Ip = $p \times \frac{Fo}{30} \left(1 - \frac{Vs}{Vo}\right)$

ii) Due to leaks: identified and estimated:

(12):Delta I'r = R x Mf
(13): Delta I"r = (j%) x (Vs x p),

iii) Due to water distribution in alternate, emergency ways:

(15): Delta Ie = Ve x Mf

iv) The total impact of reduced income (on billing during the period) will be:

(16): Delta It = (DeltaI p + DeltaII'r +Delta I"r +Delta Ie +Delta Iw), in US$/period.

6. INDIRECT DAMAGE TO THE SANITARY AND STORM SEWER SYSTEM [21]

Three main types of indirect damage to these systems may occur:

a) Increased levels of health risks and reduced quality of life

Together with the reduced levels of hygiene implied by the lack of drinking water, the lack of sewage service may pose serious health risks for the population, given the combination of diverse factors:

i) It will not be possible to use the sewer system in areas left without drinking water, because --as is known-- water is necessary to sweep away excrement and sewage. The wastes which accumulate in those areas may be a source of contamination for the population.

ii) Breaks and clogging of the sewer system will probably bring sewage to street level, with increased risk of disease and even of epidemics, due to direct contamination or via flies and rats.

iii) Problems in sewage treatment plants may lead to increased contamination of the water courses into which they discharge.

iv) The need to establish emergency camps for those who were obliged to leave their homes generates the need to construct improvised latrines, entailing a sharp reduction in normal hygiene levels and increased risk of disease (the cost of emergency latrines, which should be addressed in the organization of the emergency phase, is not included here).

v) Risk of flooding by rain water, when rains occur while storm sewers remain unrepaired.

b) Activities and maneuvers for emergency operations

Among the many different activities to be undertaken to face the emergency, it is worth mentioning the emergency repair of pipe lines; the installation of temporary pipe lines or sewers; and the digging of drainage ditches, etc. The manipulation of valves, gates, and other installations, in order to channel run-off, for example, in drinking water or storm sewer pumping stations, as well as the installation of pumps to remove sewage from plants, chambers or flooded ditches must also be mentioned.

The costs of all kinds of emergency maneuvers and works related to sewers should be calculated in the way described above for drinking water.

c) Lower income from sewage billing

[21] In different cities, there may be joint systems, in which the same pipe lines serve as sanitary sewers an as storm sewers; or there may be separate or mixed systems

The way in which the disaster will impact billing for sewage services will depend on the way it is usually done in the affected cities.

i) When sewage billing is a percentage of the drinking water bill, the procedure should be the following:

It = lower total drinking water billing in the city, to be obtained through equation (16).

a% = percentage (%) added to the drinking water bill to pay for sewage service;

s% = percentage of population with drinking water and sewage, with respect to the total population with water.

Then, reduced sewage billing will be:

(17) Delta fa = It x (a%) x (S%).

However, there may also be other persons who cannot use their sewers, due to breaks in the system; this should be calculated as an additional percentage (Z%), so that:

Delta f'a = (Z%) x (normal sewage billing)

ii) When the charge is fixed, the estimate should be made on the basis of reduced revenue collected, as a percentage of the overall total for the city.

Call:

Fa = monthly total billed for sewage for the whole city

Fa/30 = daily average billing

g% = estimated of percentage not collected, due to the disaster.

p = Number of days of suspended service

Then:

(18) Delta fa = (g%) x P x (Fa/30), in US%/period

iii) When there is no charge for sewage, there will, of course, be no corresponding reduction of income.

D. SECONDARY EFFECTS

In this section, the necessary elements, information, background data, and ways of making estimates for the global evaluation of the effects of the disaster on the Drinking Water and Sewage sector, in terms of the macroeconomic variables of the country, are presented.

1. IMPACT ON THE GROSS DOMESTIC PRODUCT

a) Lower production. This refers to the lower volume of water produced, from the moment of the disaster, and the lower production foreseen (and scheduled) for the period of damage repair and the recovery of normal productive capacity. For this calculation, lower production should be estimated as a smaller quantity of billed water, because normally there is a certain quantity produced which never reaches the consumer, due to leaks and other causes. The following procedure is recommended:

i) On the basis of the information of point 5 of section C, lower income due to lower billing should be estimated, since the disaster and up to the period considered in this point.

ii) Depending on the significance and characteristics of the direct damage (identified earlier) and according to the capacity of the corresponding drinking water companies (financial and repair and reconstruction capacity), it will be possible to estimate the time needed to return production and billing to normal.

iii) On the basis of that data, a chart should be prepared, which will include:

- ?? the lower monthly volume of drinking water billed, since the disaster and foreseen;
- ?? the average sale price of that volume to the public;
- ?? the reduced billing income, to date and foreseen;

iv) if the disaster involves various companies or cities, separate charts should be made for each.

b) Appraisal of sector operations, prior to the disaster

It is to be hoped that the general evaluator will have these data available at the national level, if possible, and specially for the affected area.

Macro-measurement of drinking water for Latin American cities is generally lacking, with only estimates of volumes collected and produced, or of losses through leaks, being available. For this reason, it may be most practical to estimate sector GDP on the basis of volumes billed to customers. Therefore:

- consult the national accounts and national institutions globally responsible for the sector, to obtain, if possible, data on the evolution of sector GDP for the previous 5 years, together with the appraisal of personnel responsible for sector operations, for the current year, as that perception existed prior to the disaster.

2. GROSS INVESTMENT

In this point, the effort should be made to identify the following main types of effect:

a) Projects being implemented and other investments foreseen which must be suspended or postponed

This information should be summarized in a chart which identifies the main projects affected and the amount involved in each. Finally, the reduction in investments foreseen, in each project, due to the disaster, for the current and following years should be estimated.

b) Loss of stock

In this instance, a chart should be made, registering the loss of stock, such as water in tanks and/or dams; and the loss of stored and/or available materials and replacement parts of works under way.

c) Investment needed for reconstruction and damage repair

The data for this item will come, basically, from the lists and the evaluation of direct damage, treated earlier, from which total and subtotal costs of damage may be extracted. On the basis of that data, a chart should be elaborated, including:

i) a list of damaged works, grouped by system, sub-system (and main works), and indicating the global cost of the damage suffered by each. This list should identify the works corresponding to different cities, different companies (if there is more than one company responsible for this service in the same city) separately, as well as distinguishing urban from rural elements;

ii) then, mention should be made of the investment foreseen for the coming years, to repair that damage;

iii) by way of example, the data from chart 2, of direct damage to "Alborada" City, are used:

Sub-systems considered	Direct damage	Investment Year 1	foreseen Year 2
A) Las Gaviotas collector	13 150	13 150	
B) Las Gav - City pipe line	28 600	28 600	
C) D. W. distribution network	94 380	94 380	
D) Administration building	117 500	17 500	100 000
E) Sewer network	126 000	80 000	46 000
F) Sewer discharge	386 400	186 400	200 000
TOTALS US$	766 030	420 030	46 000

The investment foreseen should reflect the relative urgency of the respective works, the engineering capacity of the companies and of the country, and the possibilities of financing. Specially, on the one hand, the country's capacity to undertake the projects, in light of extraordinary demand, should be weighed, and, on the other, its capacity to supply the necessary inputs for reconstruction. With regard to the latter point, it is useful to relate the extraordinary demand arising from the disaster to normal domestic and import supply capacities.

It is recommended that sector evaluators make specific reference to the potential and limitations they are able to perceive, with regard to reconstruction and damage repair and make recommendations (within the existing time and information limitations).

3. BALANCE OF PAYMENTS

This point refers to data the sector evaluator should provide for the general evaluator, facilitating the calculation of the effects of the disaster on the current account of the balance of payments. It includes the following factors:

a) Lesser exports of goods and services

The exportation of drinking water is rare, so that this item is only exceptionally relevant. If it is pertinent (as, for example, in the supply of the Panama Canal Zone), the value of less water exported is:

M$a = reduced income from water exports, in a given time period.
Mv = reduced volume exported, in a given year
T = Average charge of unit of volume utilized

Therefore: M$a = Mv * T = (MvO + mMvl + Mv2) *

The time periods and volumes to be taken into account are:

MvO = from the moment of the disaster until the end of that year
Mv1 = the first year after the disaster
Mv2 = the second year after the disaster

If a country exports engineering services related to this sector, it may happen that greater domestic demand, arising from the disaster, will reduce or annul that export capacity for a certain time. The value of that reduced exportation of services should be expressed as follows:

M$s = reduced value of services exported, in a given period
MsO = reduced value of services exported, in the year of the disaster
Ms1 = id. in the year following the disaster
Ms2 = id. in the second year following the disaster

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

b) Increased imports

In order to estimate the value of this item, the following should be considered:

i) the imports needed during the process of reconstruction and damage repair; these should be estimated on the basis of the sum of the imported components of each relevant category, which should have been inventoried and appraised already, as indicated above;

ii) increased imports rooted in indirect costs and emergency activities, for example, fuels, as part of indirect costs and, perhaps, materials and equipment needed for emergency activities, which, later, will not be used in reconstruction and definitive repair works.

iii) In order to estimate overall increased imports the following procedure should be applied:

Call:
Idd = increased imports due to direct damage (according to i)
Idd0 = id, during the year of the disaster
Idd1 = id, during the first year after the disaster
Idd2 = id, during the second year (etc.) after the disaster (if relevant)
Iddi = increased imports due to indirect damage (according to ii)
Idi0 = id, during the year of the disaster
Idi1 = id, during the first year after the disaster (if relevant)
Idi2 = id, during the second year (etc.) after the disaster (if relevant)

Thus: Idd = Idd0 + Idd1 + Idd2
Idi + Idi0 + Idi1 + Idi2

c) Donations

Included here are all donations in kind, equipment, material and machinery, which the sector receives from international aid. Although they will probably be concentrated in the period immediately following the disaster (year 0), donations foreseen for the following years should be indicated.

d) Reduced interest payments

If, due to the disaster, interest payments on sector debts are reduced, it is suggested that this be indicated for the year during which they occur.

4. PUBLIC FINANCES

The disaster may affect public finances in different ways, as follows:

a) Lower tax revenues given reduced production of goods and services

If water and sewage bills are subject to tax and, as a result of the disaster, the corresponding companies' billing is lower, fiscal or municipal income will also decrease, with regard to this item. The estimate of this value should be based on:

i) estimates made under the heading: "Lower income from reduced billing and losses of water";

ii) consultation with drinking water companies with respect to the percentage (p %) of those taxes and the amounts;

iii) with these data, the values for lower tax revenue should be estimated and expressed, as follows:

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

b) Lower public company income

Reduced billing, due to lower sales of water, indicated in the previous point, imply lower income for the companies affected.

Let: Mf = Mf0 + Mf1 + Mf2 = lower billing in years 0, 1, 2.

c) Increased current expenses for companies, related to the emergency

These expenses are, basically, those included in points 3 and 4. Emergency expenses are usually made at the time of the disaster, and so will probably be included in year 0.

MgE = MgE0 = Increased expenses due to the emergency, year 0.

d) Increased expenses due to investment in reconstruction works and damage repair

The relevant information for this aspect of public finances can be obtained, nearly completely, from charts similar to that of the previous example, related to gross investment.

If Mgi = increased expenses due to investment, then:

gi = Mgi0 + Mgi1 + Mgi2 = id, year 0 + year 1 + year 2

5. PRICES AND INFLATION

The damage caused by the disaster may affect (or not) the price of water or of the construction materials needed for damage repairs in that sector. This will depend on diverse factors, beginning with the magnitude of the disaster and the extent of the damage it has caused.

a) Possibilities of variations in the price of water

They are the following:

That the cost of producing water varies, due to the need to change the location or type of collector, or the type or types of treatment plants; the channel or height of the water; or due to lower aquifer levels.

If the price difference with respect to the price prior to the disaster is absorbed by the company, via subsidy, then there will be no impact on prices to the public.

Data on this matter should be supplied by the company responsible for the corresponding service. However, it is unlikely that, so soon after the disaster, a reasonable degree of certainty with regard to several of these factors will exist, so that estimates of future prices must be made on the basis of possible trends. If costs rise, as a result of the factors indicated here, the relation between the new cost per cubic meter and the old price should be indicated, or the anticipated variation in the price to the public should be indicated.

b) Possible impact on prices of construction materials

This is likely, due to increased demand, not only by this sector, but for use in repairs in other sectors, as well. For this reason, this issue should be examined within the evaluation team, as a whole.

From the perspective of the drinking water and sewage sector, it would be useful to have available an estimate of the increased demand for the main materials required for repair and reconstruction in the coming years; together with an estimate of domestic production capacity, in the face of increased demand, and the country's capacity to import those materials; and to consider whether or not the Government is going to impose price controls on those materials.

6. POSSIBLE IMPACT ON EMPLOYMENT

In order to estimate this effect, the following factors should be considered:

a) Destruction of infrastructure

Given that the water supply is vital for the population, the installations destroyed will be repaired as soon as possible. However, it may happen that the technology and design of new infrastructure will require a different number of personnel than was previously necessary, for its construction, operation and maintenance. If deemed relevant, that difference should be included.

b) During the construction and repair period

Given that requirements during the emergency phase itself fall beyond the scope of this manual, only the possible impact on employment during the reconstruction period is examined:

i) the employment rate may remain stable, due to the suspension of projects and works;

ii) it may rise, due to the demand for personnel for reconstruction and repair works and because normal projects and activities do not decrease;

iii) or a mixed situation may occur, because some projects are postponed, although not all.

What actually occurs will depend on governmental and drinking water company decisions. Therefore, it is from those instances that the sector evaluator should obtain the necessary information for estimating variations in the employment rate for years 0, 1 and 2 (if works will continue beyond this period, more years should be added).

The employment levels required and the time periods indicated in this point should be coherent with those indicated in the previous point, on reconstruction investment needs.

Chart 1
EXAMPLE OF SUMMARY INVENTORY OF DIRECT DAMAGE "ALBORADA" CITY[1]

Detail of damaged works or material	Unit	Quantity damaged	Percentage estimate of damage (R= %)
I. Drinking water supply system			
A) "Las Gaviotas" collector, 3 wells, 120 lt/sec.:			
Concrete well, 2 mt. in diametre, 25 mt. deep, cracks Asbestos cement pipe, with G joint, cracks and breaks	ml	10	25%
a) D = 200 mm	ml	150	
b) d = 250 mm	ml	120	
Semi-buried concrete tank, of 1 000m3; minor cracks and stucco	gl	1	10%
B) "Las Gaviotas-City" pipe line, L = 8,500 mts.of cast iron, D = 400 mm:	ml	540	40%
a) Cast iron pipe, D = 400 mm, breaks	ml	700	10%
b) Cast iron pipe, D = 400 mm, leaks at joints			
C) Drinking water distribution network (L total = 52 500 mts)			
Asbestos cement pipe, with damaged Gibault joints:			
a) D = 100 mm, leaks at joints	ml	2 900	15%
b) D = 250 mm, cracks and breaks	ml	2 800	30%
c) D = 300 mm, cracks and breaks	ml	3 200	30%
D) Service administration building			
a) Half of building collapsed	m^2	320	100%
b) Half of building with cracks and reparable damage	m^2	300	20%
II. Sanitation sewer system (of Alborada)			
E) Sewer network (L = 29 000 mts.) Compressed cement pipe, damaged:			
a) D = 175 mm, severe damage, change necessary	ml	3 900	100%
b) D = 200 mm, repair joints and cracks	ml	2 600	50%
c) D = 300 mm, repair joints and cracks	ml	3 200	50%
F) Sewer discharge Aqueduct 500 mm, compressed cement, L = 16 200 mts.			
a) D = 500 mm, broken; replace	ml	4420	100%
b) D = 500 mm, reparable damage	ml	2 200	50%

[1] This damage inventory is for “Alborada” City, an imaginary construct of between 35 and 40 thousand persons, of whom approximately 80% have drinking water and 40%, sewage service.

Chart 2
EXAMPLE OF DIRECT DAMAGE EVALUATION "ALBORADA" CITY[22]

Detail of damaged works or material	Unit	Quantity	R% damaged	P.U. $/ Unit	Subtotals $/item
I. Drinking water supply system					
A) "Las Gaviotas" collector, 3 wells, 120 lt/sec.:					
1. Concrete well, 2 mt. in diametre, 25 mt. deep, cracks	ml	10	25	500	1 250
2. Asbestos cement pipe					
a. D = 200 mm	ml	150	30	32	1 440
b. D = 250 mm	ml	120	50	41	2 460
3. Semi-buried tank	gl	1	10	80 000	8 000
B) "Las Gaviotas"-City pipe line					
4. a. D = 400 mm	ml	540	40	100	21 600
b. D = 400 mm	ml	700	10	100	7 000
C) Distribution network					
5. a. D = 100 mm	ml	2 900	15	12	5 220
b. D = 250 mm	ml	2 800	30	41	34 440
c. D = 300 mm	ml	3 200	30	57	54 720
D) Administration building					
6. a. Half of building collapsed	m^2	320	100	250	80 000
b. Half of building damaged	m^2	300	50	250	37 500
DRINKING WATER TOTAL					260 030
E) Sewer network					
Compressed cement pipe					
7. a. D = 175 mm	Ml	3 900	100	14	54 600
b. D = 200 mm	Ml	2 600	50	18	23 400
c. D = 300 mm	Ml	3 200	50	30	48 000
F) Sewer discharge					
8. a. D = 500 mm, replace	Ml	4 420	100	70	309 000
b. D = 500 mm, repair	Ml	2 200	50	70	77 000
TOTAL SEWER SYSTEM					512 400

[22]This damage inventory is for "Alborada" City, an imaginary construct of between 35 and 40 thousand persons, of whom approximately 80% have drinking water and 40%, sewage service.

II. COMMUNICATIONS AND TRANSPORTATION

A. INTRODUCTION

This a very broad and diversified sector, given that it covers everything related to transportation on land (road and rail), sea and by air, and all communications (telephone, telegraph and the mails). A natural disaster may produce very considerable (and very widespread) damage, both to physical infrastructure (direct damage), and to sector services. Given the interrelations between this sector and the rest of the economy, the secondary effects arising from damage in this sector may be extensive.

In light of the varied effects and uneven impact of different natural phenomena on this sector, what is included in this manual is necessarily selective and concentrates on the most probable damage and that which is susceptible to evaluation.

Direct damage refers mainly to the loss of infrastructure or of vehicles, in any transportation or communications sub-sector. Among these, damage to highway, rail, port and airport infrastructure can be mentioned, together with damage to telephone, mail, telegraph and conduit transportation; other infrastructural damage, including that to trolleys, trolley busses, pedestrian bridges, bicycle paths, post office installations, etc.; damage to automotive vehicles, rolling stock, ships, launches, aircraft, helicopters, garages, workshops, repair yards, etc. of the transportation and communications sector; and the loss of spare parts and warehouse stock, including --for the latter-- letters, telegrams, etc. Within the category of "infrastructure", the damage sustained by superstructure, such as railway signal equipment is included.

The evaluator must have ample experience in both engineering and transportation economics, because the evaluation of direct damage demands familiarity with civil engineering applied to the transportation and communications sector, while the evaluation of indirect damage cannot be adequately made unless the evaluator is familiar with how that sector is inserted into the economy, as a whole.

B. THE RELATIONSHIP BETWEEN TYPE OF DISASTER AND THE DAMAGE PRODUCED

In the previous section, reference was made to the possible categories of direct damage which could occur. However, the relative importance of that damage depends on the type of disaster in question.

For example, droughts affect other sectors much more than transportation and communications, although they may cause damage to highway infrastructure (via shrinkage of foundations); to railway infrastructure (via distortion of soldered rails, if high temperatures accompany the drought). At any rate, the cost of that damage is often of little importance in comparison with that suffered by other sectors. In contrast, flooding may cause damage in all the categories mentioned in the previous section. Earthquakes may also cause generalized damage, although their impact is usually greater in some sub-sectors such as railways and transportation via conduit than in others (airports, for example).

C. QUANTIFICATION OF DIRECT DAMAGE

1. DAMAGE TO INFRASTRUCTURE

On-site visits to the affected zone are a prerequisite for quantifying direct damage, as the eventual estimates prepared or being prepared by diverse sources are being gathered together. It will also be necessary to verify the accuracy of those estimates, in consultation with experts or other persons with direct knowledge of the impact of the disaster in those zones, in order to be able to assess the state of sector infrastructure and damaged equipment both prior to and after the disaster. It is evident that the destruction of old or decrepit equipment is less costly than the loss of new elements. As observed in the first part of this manual, it is important to appraise both destroyed equipment, at cost (taking its average cost and conditions into account), and what it would cost to replace it with new and surely modernized equipment. While the first of these estimates is closer to the value of the damage caused by the disaster, the second provides a better idea of the financial demands the economy will face during recovery, unless a reserve fund against the depreciation of the piece in question had been created.

The quantification of damage requires fairly broad and, at the same time, detailed knowledge, so that it is often necessary for the analyst to fly over the affected area in a helicopter or light aircraft. It will also be worthwhile to take photographs or slides, or to film a video for use in consultations about the extent of the damage, and include them in the report and the presentation which probably will have to be made on the impact of the disaster.

In order to estimate the costs of the demolition, rehabilitation or reconstruction of physical infrastructure, either partially or totally destroyed, ideally, the physical volumes involved (cubic meters of concrete, man-hours, tractor hours, at different sizes, etc.) would be estimated; then, unit costs would be defined and applied to those volumes, in order to estimate the total cost of each activity or component.

Within the short time available for damage evaluation, it is often impossible to proceed in this way, or, at least, not in all cases. Therefore, it will be necessary to rely on the judgment of engineers who are experts in the area. Those experts will usually be personnel of governmental organisms, such as the Ministry of Public Works and Transportation. The analyst responsible for evaluating transportation and communications sector damage should consult with them in order to improve the quality of his/her own estimates. In certain circumstances, official estimates may be too high or too low. A government, moved by the natural desire to promote international aid during the emergency period, may offer insufficiently well founded estimates, overly influenced by the first impressions; conversely, in line with domestic policy and so as to promote calm among the population, a government may not wish to disclose the true magnitude of the damage.

Together with the well founded opinion of national experts in the sector, the evaluator should also consult with resident engineers from such organisms as the World Bank (IBRD), the Inter American Development Bank (IDB) and the United Nations Development Programme (UNDP), in order to refine initial impressions as much as possible. Sub-regional financial institutions, such as Central American Bank for Economic Integration, the Caribbean Development Bank, and the Corporation for Andean Cooperation possess useful information about development projects in the transportation and communications sector.

The press may also serve as a source of alternate estimates, although they should be treated with caution. It often happens that figures about damage are very rough and sources, areas covered and methodology for calculating the estimates are seldom cited. However, very useful information can often be obtained from reporters who have visited the affected zones, which the analyst must then weigh.

It is worth insisting on the importance of an on-site visit to the affected zone, because, without it, the evaluator will find it difficult to correct or adjust official figures of damage.

In Chart 1, some average international construction costs, or the range in which they move, are presented as a reference point for the evaluation of direct damage. Naturally, the evaluator's final selection of prices should take the characteristics of the local economy, the specific nature of the disaster and other factors into account. The prices presented in the Chart only give indications of orders of magnitude.

The replacement of transportation infrastructure is the element of greatest weight within the direct damage attributable to the disaster. It includes demolition and rehabilitation costs --such as throwing a Bailey bridge across a river, for example-- and reconstruction costs, as well as those for the definitive replacement of the temporary bridge with a permanent structure. Insofar as possible, the estimate of direct costs should incorporate all those involved in the replacement of the damaged or destroyed element. There will, however, be a difference between the cost of the damage done and the investment required, which will surely include the "new" cost and certain technological improvements, resulting from the rapid process of change in the transportation and communications sector.

The basic problem of the replacement of old infrastructure with new may be illustrated as follows: imagine, for instance, a port crane with a useful life of 20 years. If it is destroyed by an earthquake in its 19th year, the real cost attributable to the disaster will be relatively low, because it would be necessary to replace the crane the following year at any rate. Theoretically, it is possible to calculate the relevant cost as the value of a new crane, plus the difference between the current replacement value of that crane, at the end of its useful life, without a disaster, minus the equivalent value, with disaster. (It is worth noting that this method of calculating direct costs corresponds more to reconstruction than to rehabilitation, because, in rehabilitation, the structure is not normally replaced with infrastructure of the same quality and longevity, but rather with transitory structures).

Mathematically, the methodology is as follows. The current value for replacing a truck, at V unit cost, every L years, with r% interest rate annually, and designating "a" as the proportion of useful life still left to the truck, it can be stated that:

$$C = \frac{V}{(1+r)^{aL}} + \frac{V}{(1+r)^{aL+L}} + \frac{V}{(1+r)^{aL+2L}} + \ldots$$

$$C = \frac{V}{(1 + r)^{aL}} \text{ Sigma } (1 + r)^{-xL} \quad dx$$

If V = 50 000, L = 10 and r = 10%, when a = 0, the value of C will be 81 371. If a = 0.5, C will be $50 524 and, if a = 1, C is $31 371. Therefore, on the basis of illustrative calculations, using the data indicated, if a truck is destroyed half way through its useful life, the current value of the eventual replacement of that truck will be $50 524, which is a kind of benefit from the disaster, because it would not have been necessary to face that expense, due to the destruction of the truck. However, instead, there will be other, higher, expenses. First, the truck must be replaced immediately, at a current cost of $50 000 and replaced, in ten years, at a current cost of $31 371, adding up to a total of $81 371 (that is, the current value of replacing a worn out truck periodically). This means that the cost of the truck would be $ [81 370 - 50 524] = $ 30 846.

This method can be employed, in turn, to estimate the net cost of losses in diverse categories of infrastructure or vehicles, using appropriate entry data in each case. As an alternative, net value can be calculated by attributing an approximate depreciated value to the damaged item, supposing a simple rule for the depreciation rate, the cost of the item new and a residual value.

It is important to avoid calculating that part of the value of new infrastructure and equipment, the technical quality of which is superior to that of the damaged elements, as costs to be attributed to the disaster although, as mentioned above, that value should be reflected in the financial investment needs. In the brief time available to the evaluator, it is usually difficult to discern the particular cost component related to technological improvement, within the overall cost of a new element. However, it is nearly always possible to make rough estimates. For example, if floods destroy a 1 500 horse power locomotive and a new 2 000 hp engine is purchased, only 75% of the price of the new engine could be assigned to the disaster.

Those rough estimates are inherently inexact because other factors are at play, which the evaluator will find it very difficult to take into account in the time available. For example, the new locomotive, even with 33% more power than the old engine, may produce considerably below its potential, due to diverse restrictions, such as the length of side tracks (which limit the length of the trains which can be hauled) and the maximum weights permitted on different branch lines, which could restrict the operational range of larger locomotives.

Continuing with the same example, it may happen that 1 500 hp locomotives are no longer made and, therefore, do not have a price. It may be possible to have them custom made but, in that case, their unit cost could easily surpass that of 2 000 hp locomotives.

2. ESTIMATING DAMAGE TO VEHICLES AND EQUIPMENT

The same principle of cost, without improvement (due to age and progress), discussed in the previous section, is equally valid for vehicles and equipment, in general, in the estimation of all types of direct damage within this sector. Thus, it will be equally necessary here to adjust the cost of new vehicles and equipment, purchased to replace those damaged by the disaster, in order to compensate for the greater technological content in the new elements.

Specially in the case of highway vehicles, it is possible to estimate the value of the (total) loss of vehicles by taking the market price of used vehicles as a point of reference. For example, in the case of a truck, model "y", year "x", the value of the loss will be calculated according to the market value of a similar truck. The same principle can be used to calculate the cost of lost aircraft, because there is a market for used aircraft. In the case of other means of transportation, it will be necessary to have recourse to one of the two methods presented above.

However, estimating the cost of damage to vehicles and equipment presents several specific problems. One of these is related simply to the calculation of the number of highway vehicles involved. For other types of transportation --such as, for example, trains and civil aviation-- the corresponding organisms usually know the number of vehicles damaged and, normally, the cost of repairing or replacing each unit.

However, sector evaluators will generally have to estimate the number of vehicles involved. If an earthquake or flood covers a stretch of highway, it will be possible to estimate the number of vehicles destroyed together with the highway, as long as data with respect to traffic volumes, in terms of the number of vehicles per hour, and average velocities, are available.

For example, if a highway carries 100 vehicles per hour, the average interval between vehicles will be 60/100 minutes, and, in terms of the distance they travel at 40 kms. per hour, [60/100 x 40/60] kms; that is, 0.4 kms. That interval between vehicles means a density of 2.5 vehicles per km. Therefore, if an earthquake covers one kilometer of highway, it could be expected that 2.5 vehicles would have been buried (or isolated).

Another problem related to vehicles is that the disaster may cause damage not only to vehicles but also to their occupants and cargo. With regard to costs for injured persons or the dead, the transportation and communications sector evaluator is not responsible for that estimate, although he/she should calculate the value of the total or partial loss of cargo.

The value of lost cargo can be calculated in different ways. In most cases of total loss, simply multiplying the average value per ton, by the quantity of tons lost, according to the different types of cargo involved, is sufficient. In other cases, specially in those involving agricultural or mining products, the value of cargo will depend on its placement in the market. In those cases, the ex-mine or ex-farm value can be added to transportation costs to the disaster site or, alternatively, the cost of transportation from the site of the disaster to its destination can be subtracted from market values. However, the relative importance of the cost of damage to cargo is usually so low that such sophistication in the calculation of the value of lost cargo is not justified.

In order to estimate partial damage to cargo, a specialist in the sector to which the cargo belongs could be consulted. Usually, the transportation and communications sector evaluator must coordinate his/her activities with colleagues in the agriculture, mining and industrial sectors, in order to ensure that damage to cargo in transit is calculated only once (and not twice or none). The value of farm produce often rises sharply as a result of natural disasters, because harvests are lost or it is not possible to ship produce to market, but it is not the responsibility of this sector evaluator to calculate those increases.

3. REHABILITATION AND RECONSTRUCTION TIME PERIODS

The current value of direct damage depends on when rehabilitation and reconstruction works are implemented. If done immediately, their current value will correspond to current costs; if there are delays, their current value will be less, in function both of opportunity costs of the capital invested and of the fact that, at greater temporal distance from the moment of the disaster, the necessary resources for implementing the works will be less scarce and, therefore, less costly. On the other hand, such delays increase indirect costs, because transportation will necessarily occur on a highway network damaged by the disaster or on a more costly alternate routes.

Theoretically, the evaluator should be able to determine the most opportune moment for effecting rehabilitation and reconstruction works by comparing the cost of the works needed with the higher costs of operation on a damaged highway network (with respect to those of operation on a rehabilitated and reconstructed network). In the same way, he/she should be able to calculate the economic benefits to be derived from the works and the corresponding rates of return. However, for reasons of time, the evaluator responsible for estimating damage is not asked to effect those calculations.

The correct determination of the time periods indicated above is very important, because not only the current value of direct damage but also the length of time during which the network will remain in poor condition due to the disaster and, therefore, the interval during which indirect effects will be generated depend on that estimate.

The time periods for rehabilitation and reconstruction depend on the following factors:

i) The magnitude of all works to be implemented and the relation among them. The physical distribution of damage, which may mean that some works must be implemented before others, given difficulties of access, is specially important.

ii) The availability of financial resources, which depends, indirectly, on other factors such as the needs of other economic sectors affected by the disaster, budget capacities, and the amounts of bilateral and multilateral cooperation available.

iii) The availability of physical resources. In this sector, the resource which imposes the most restrictions is usually that of heavy earth-moving machinery.

iv) Coordination among the different organisms involved, and

v) Climatic conditions following the disaster.

The transportation and communications sector evaluator will often be able to obtain estimates of the time periods required for reestablishing services from governmental sources --for example, the

Ministry of Public Works or public sector companies (such as the State railroad). However, the evaluator should rely on his/her own judgment and experience to re-evaluate those estimates, jointly with experts from other sectors or from international organisms with experience in similar cases, given that officially estimated time periods are often too optimistic.[23]

It is important to realize that time periods do not depend only on factors proper to the sector. One way of addressing this issue is the following: the sector evaluator should, first, estimate time periods which seem realistic, considering the magnitude and spatial and temporal distribution of the direct damage to be repaired. Then, he/she should contact the macroeconomist responsible for the overall evaluation of damage. A calendar of monthly costs for capital works related to recovery from the disaster should be presented first. The macroeconomist should then review that programme within the context of the overall availability of financial resources and the demands of other sectors. On performing that review, which, ideally, should be done for all sectors simultaneously, the macroeconomist should return to the transportation sector evaluator a revised version of the outlay programme, on the basis of which the sector evaluator will probably modify certain priorities, elaborating the definitive draft of the estimate of time periods.

4. ESTIMATING THE IMPORTED COMPONENT

The evaluator should estimate the imported component of the cost of direct damage, with a view to determining the impact of the disaster on the balance of payments. In the specific instance of the transportation and communications sector, the mere estimate of the imported component is insufficient to allow for determining that impact, because it is possible that, for example, the consumption of an additional domestic resource --for instance, oil-- during the reconstruction process, in an economy like that of Ecuador, Mexico or Venezuela, will lower the supply of that resource for exportation. In that case, fuel could be considered an imported product. However, in other cases, it is not so easy to arrive at a first approximation to the real impact of the disaster on the balance of payments.

Ideally, the estimate of imported components should be made through the use of an input-product matrix; however, in Latin America and the Caribbean, if such instruments exist, they are usually very out-of-date. Even when they exist and are up-to-date, their level of aggregation is usually so high that it is impossible to discriminate the imported portions of the elements of interest for the evaluation of the transportation and communications sector (such as renting tractors, the reconstruction of neighborhood streets, etc.). This makes the determination of the imported component of the goods and services produced within the country affected by the disaster more difficult.

In order to overcome these difficulties, the economic evaluations of transportation and communications projects, prepared by consulting firms for domestic and international entities and usually available in the country, should be used as a source for determining the imported portions of

[23]In an extreme case, that of a railway cut by flooding in December, 1982, the rail company estimated that the interruption would last six months, the evaluator estimated some three years, when, in March, 1992, replacement works had yet to begin.

different goods and services. Otherwise, the evaluator should consult local industrial economists and use his/her own judgment in estimating those portions.

The percentage of the imported component within the cost of an element of infrastructure or equipment fluctuates considerably from county to country, depending, among other factors, on the size of the economy, the country's industrial base and its supply of natural resources. Chart 2 presents the imported coefficients of total costs for diverse goods and services used in road works in Ecuador. For larger and more industrialized countries, such as Argentina, Brazil and Mexico, the imported portions will tend to be smaller.

Finally, the evaluator should distinguish the part corresponding to the public sector from that of the private sector. Normally, the costs of each sector are obvious, given that the supply of transportation infrastructure is usually the responsibility of governmental organisms, while the private sector operates services on the highway network and, occasionally, on navigable waterways, together with part of civil aviation.

It should be noted that the trend toward liberalization in Latin American economies means that it is ever less important to distinguish between imported and other components. Previously, many countries applied diverse types of exchange rates, with the result that a dollar, changed into pesos (or another currency) at the official rate (which evaluators generally prefer to use), appeared as having a lower value than if it had been exchanged in a parallel market, which usually reflects the true value of the currency more accurately. In those cases, it is important to specify costs in each currency, separately, given ambiguity with respect to the value of the dollar. Moreover, many countries have lowered import duties considerably. It is ever more frequent that, if an event such as a natural disaster were to occur, which would reduce the volume of exports or increase imports, the exchange rate would be adjusted, making the currency more expensive, stimulating exports and eliminating the structural differences between domestic products and those bought with dollars.

It is also worth mentioning the trend toward privatization which is transferring rail and port infrastructure, held in the private sector for may years, to the private sector. The operation of railways and commercial aviation is also being passed to the private sector. At times, in the case of railroads in Argentina or commercial aviation in Chile or Venezuela, for example, those services have been at least partially transferred to foreign concerns, further blurring the structural differences between imported and domestic elements.

D. INDIRECT DAMAGE

1. IDENTIFICATION OF INDIRECT DAMAGE

A natural disaster may cause damage to the road network which may, in turn, raise operating costs for vehicles which use those roads. Moreover, it may be necessary to detour traffic to alternate routes or other means of transportation or to suppress part of the demand for transportation. The indirect costs which a natural disaster may cause can be classified in four categories:

i) higher operating costs for vehicles on the same routes as before the disaster;

ii) higher operating costs for vehicles due to detours required because the usual routes are impassable;

iii) higher costs and lower income, resulting from use of alternative means of transportation; and

iv) profits lost from reduced movement of persons and goods, as a result of higher transportation costs caused by the disaster.

A natural disaster may cause other indirect effects, similar to those in other areas, although those in the area of highway transportation are often the most notable. In the same way, there may be indirect costs of a similar nature in the area of communications.

Moreover, the disaster may generate new demands for transportation. For example, it may be necessary to transport imported foodstuffs from ports to centres of consumption in under-supplied zones, in order to replace local harvests which were destroyed. One easy way of calculating the costs of such movements is to consider them as a change in the point of origin, from domestic production areas to the ports.

2. THEORETICAL FRAMEWORK FOR ESTIMATING INDIRECT DAMAGE

Figure 2 refers to the situation between only one pair of origin and destination points. In the "without disaster", the unit costs for transportation which the user takes into account when making decisions about the routes and means of transportation are represented by the interval Opo, on the vertical axis. As those user costs are taken into account, the volume of transportation generated would be equal to the distance OQo on the horizontal axis, which is determined by the intersection of an horizontal line through point Po and the demand curve. Although costs to users are OPo, real (economic) costs may be different, if, for example, there is a transportation subsidy. Moreover, it has been proven that the users themselves do not always calculate their transportation costs well (for example, because they do not know the weight of automobile maintenance in the cost of a trip). In Figure 2, real costs, "without disaster" are OCo, by route or transportation unit.

In the situation "with disaster", unit costs taken into account (that is, known costs) are OP1, and generate a volume of transportation equal to OQ1. Real costs, by unit of transportation, are OC1. The economic loss occasioned by higher transportation costs, with respect to the OQ1 units still in circulation, even with the higher costs supposed in the situation "with disaster", are represented by the area C1FAC0, that is, the increase of real costs between the situations prior to and after the disaster.

Losses arising from the elimination of transportation on deteriorated roads are the result of the difference between two components. First, less transportation means a loss of well being for the persons who no longer travel (or for consumers of products no longer shipped), illustrated in the Figure by the area GEQ0Q1. However, that reduction also implies saving the cost which would otherwise have been incurred, without the disaster. That saving is represented by the area ADQoQ1. Therefore, the net loss caused by the disaster, with respect to suppressed trips, is [GEQ0Q1] - [ADQoQ1].

This method can be applied to all pairs of points of origin and destination affected by the disaster. In fact, if a trip is no longer made by mode "a" or route "x" between any two points and the mode is changed to "b" or route "y", the calculation can suppose that one trip was first suppressed and another was generated. Thus, the following formula for estimating the change in well being B, caused by the disaster, may be applied in general:

Sigma qijm(0)cijm(0)-qijm(1)cijm(1)-0.5[qijm(o)-qijm(1)) (Pijm(0)-Pijm(1)])

Its value will usually be negative. In this formula, "i" is the zone of origin; "j", the destination; "m", the means of transportation; "o", the situation without the disaster; and "l", that after the disaster.

This explanation of principles should be interpreted by the evaluator in real cases, which are usually quite different, one from the other. (Below, in section F, the estimate of indirect costs in a real case is presented).

3. METHODOLOGY AND SOURCES

Once the procedure for estimating indirect costs has been developed, it is time to review the possible sources of the information about transportation costs required for the application of the formula in practice. Usually, those costs are found in economic feasibility studies for transportation projects, performed by consulting firms for domestic or international finance entities. Moreover, in some countries, the Ministry responsible for the area of transportation will have established certain parametres for this area. The "Highway Design Model" (HDM) of the World Bank, used in several Latin American countries, is a good source of information.

The evaluator should take into account the following factors, when estimating the indirect damage caused by a natural disaster: type of vehicle; type of road surface; and road surface condition.

Normally, these sources of information include costs, by type of vehicle and road surface, at times broken down into such detail (for example, the cost of fuel consumption on curves or grades) that it is too complex for use in the brief time available. At any rate, as a minimum, it will be necessary to obtain information about operating costs for vehicles on highways and roads in bad condition (such as would result from flooding), although the sources of information mentioned seldom contain estimates of this sort, so that the evaluator must estimate them as well as possible.

In fact, data which allow for the satisfactory determination of operating costs on road surfaces in diverse states of repair usually do not exist. However, they must be estimated, even if only roughly: to this end, the evaluator must rely on the specialized knowledge of economists, transportation engineers and local shippers.

In the best of cases, the reports prepared by consultants who have evaluated highway projects contain costs for operating on roads in bad, normal and good conditions, although those classifications do not correspond to the type of damage caused by natural disasters, which usually leave roads in very bad or the worst possible condition. Often, not even those estimates exist. Generally speaking, the evaluator will have to adjust the costs published in different sources, according to his/her understanding of the situation. Those adjustments should be made by cost category (maintenance, depreciation, fuel, etc.), in order to generate the calculation of total costs by adding those different categories. An important factor in adjusted costs is the speed which is expected to be possible on the damaged roads.

According to the formula presented above, Cijm costs are real or economic costs, excluding taxes and subsidies, while Pijm are those recognized by shippers and other road users and, therefore, should include all the elements taken into account by those users. There are, however, cases in which the users do not know the prevalent costs exactly. It may happen, for example, that private motorists do not take into account the cost of maintenance or wear of tires for each kilometre driven.

Normally, the salaries and wages of drivers, helpers, etc. are included among the components of vehicle operating costs. Those values must be included both in the cijm and pijm costs, because they reflect the consumption of economic resources, in the case of the first factor, and, in the second, because it is supposed that they are taken into account when the means of transportation or route is chosen.

With respect to non-work time involved in travel, the situation is not so clear. Transportation economists are generally agreed that (non-work) personnel costs should be included in pijm values, because it is logical to suppose that travelers will behave as though their time had value. Therefore, the pijm costs, in the case of m=autos, should include the value of the personal time of vehicle occupants. The inclusion of the personal value of travelers' time of on other means of transportation can also be justified, specially in the case of m=bus. The justification of the inclusion of the value of the time of bus passengers, within pijm, is based on the supposition that the bus driver would have taken it into account on deciding the route to follow or the number of stops to be made.

However, the bus transportation markets in many Latin American and Caribbean countries still contain imperfections which limit competition, so that the driver may ignore the time of his/her passengers, for example, preferring to stop to take on passengers, even though that may cost more in terms of the personal time of the passengers already on board than of the new passenger. For this reason, it is recommended that the value of the non-work time of bus passengers, in countries in which the market has already been liberalized, such as Chile, be included in Pijm costs, and be only partially calculated in countries where the bus market is still subject to strong regulation, such as Brazil.

For the appraisal of work time, a coefficient of approximately 125% of the hourly wage or salary is suggested, thus accounting for other expenses incurred by the employer, beyond wages and salaries, such as social security and administrative services. In the case of non-worked time included in pijm costs, research in many countries has revealed that passengers value every hour of travel as the equivalent of approximately 25% of family income for an hour worked.

A frequently encountered difficulty is the calculation of delays caused by a fallen bridge or other type of failure, which means that vehicles must wait in one place until the road is opened once again. For example, an earthquake or flood may leave a vehicle bridge over a river impassable; before it is replaced by a Bailey bridge, it may be necessary to unload trucks (busses and cars) on one side, transfer cargo and passengers to the other side on boats, and load them on vehicles waiting on the other side.

In some cases, the river crossing may be made on temporary bridges, which will only take the weight of light vehicles. In these cases, it will be necessary to calculate the cost of waiting for vehicles on both sides of the river. Typically, those costs include crew wages, interest on the capital invested in the vehicle and other costs incurred while the vehicle is stopped (such as that part of the depreciation which depends on the age of the vehicle, rather than its use). As well, the cost of the personal time of the passengers (as analyzed above) and the interest on the capital invested in cargo should be included, if pertinent.

4. ESTIMATING VOLUMES OF TRAFFIC

The volumes of traffic between pairs of zones affected by the disaster are not usually known, either before or after the disaster. However, there are usually data on vehicle flow, occasionally by type, on different highways, which reflect the situation prior to the disaster, to a degree. Those data are insufficient, alone, to determine the flows between pairs of zones (matrixes), except in exceptional cases. However, they do make a reasonable estimate possible which may serve as the basis for the evaluation of indirect damage. The evaluator should use his/her own judgment and experience to choose matrixes (without disaster) consistent with the data on flows, as well as with respect to the sending and attracting power of the different zones.

Since data on transportation flows in the zone after the disaster are only rarely available, the evaluator should base his/her estimate on: the known matrixes of traffic volumes prior to the disaster; transportation costs, that is, the pijm(0) and pijm(1), both with and without disaster, respectively; estimates of transportation demand elasticity with respect to its cost from the perspective of the user.

With regard to the last point, once an acceptable elasticity has been chosen (which may fluctuate between 0.25 and 1.00, depending on the circumstances), it can be applied to the volumes of traffic between each pair of zones (prior to the disaster), in order to estimate the corresponding post-disaster volumes. Occasionally, sufficient data about the disaster exist to allow the evaluator to calculate the implicit elasticity's, as a ratio between the increase in transportation costs (before and after the disaster) and the corresponding reduction in some transportation flows. (See the example presented in section F).

E. SECONDARY EFFECTS

The transportation and communications sector evaluator should estimate the impact of the sector's direct and indirect damage on the overall economy (growth of sector GDP), on the balance of payments and public finance. That is, the secondary impact on the main macroeconomic aggregates, derived from the effects of the disaster on the transportation and communications sector.

With regard to the effects of the disaster on the transportation and communications sector, the evaluator should supply the necessary information so that the macroeconomist will be able to estimate the reduction in production (in this case, services lent in physical terms or income not perceived by the human resources employed in the sector) during the recovery period of temporarily lost installed capacity. Sector GDP evolution, as anticipated before the disaster, should be appraised (or, instead, growth on the basis of recent behaviour should be projected).

The impact on the balance of payments may be due mainly to changes in the flows of both exports and imports, which may be caused by diverse factors: deterioration of the mining and air vehicle fleets, road and communications networks, etc. which affect the capacity to deliver goods and services abroad; fewer exports (and the corresponding loss of income for transportation, in the services account of the balance of payments) due to the impact of the disaster on exportable production; more imports to supplement destroyed domestic supply and for the reconstruction process which affect (positively) sector activities. In the example given in section F, a series of typical calculations made to determine the impact of indirect damage on imports are presented. The estimate is relatively simple, being basically the application of factors which represent the imported (or exportable) portions of different types of costs.

The sector evaluator should realize that goods and services imports may be reduced as a result of problems related to the operating capacity of the transportation sector.

In order to estimate the impact of indirect damage on tax revenues (and government subsidies), the same type of calculation as that recommended for imports should be made. That is, factors which express the proportion of each cost category (of operating trucks, aircraft, etc.) represented by the taxes paid or subsidies received, or the net impact of taxes and subsidies, are determined. Then, those factors are used to estimate net payments made to the State, both without and with the disaster.

F. EXAMPLE OF THE CALCULATION

1. BRIEF DESCRIPTION OF THE CASE

The example described in this section has been taken from a real case. For the sake of clarity, some simplifications have been made and the names of towns and other places have been changed. The main purpose of the example is to illustrate the way in which the evaluator should perform (and simplify) the calculations, in order to be able to complete them in the time available, while taking maximum advantage of the available data. It is unlikely that this example will serve as a guide in another concrete instance, given the specificity of each case.

The example refers to the destruction of a highway by an earthquake which, itself, caused great damage, as it also triggered land slides which covered the road, leaving it impassable. During the emergency period, cargo transportation (passenger transportation is not dealt with in this example, although the issue was addressed in the real case) continued, partially by aircraft and partially via river boats and trucks. The total capacity of those two alternatives was not sufficient to carry all the cargo shipped prior to the earthquake, so that part of the habitual demand remained "unsatisfied". It was estimated that an alternative road, which was already under construction at the time of the disaster, would be finished within four months. Once that alternative was ready, cargo transportation would be channeled over it. The replacement of the destroyed highway, possibly along somewhat different lines, would take much more time and, until it was finished, transportation costs would remain higher than those which prevailed prior to the disaster. Although this example deals mainly with the emergency, as such, it could also be applied to the rehabilitation period (until the alternative road is open).

Figure 4 presents the transportation network affected by the disaster and its consequences, in schematic form. Prior to the earthquake, approximately 60 trucks, each of which carried around 6.6 tons of cargo, made the 271 km. trip between Serrano and Petrópolis every day. (A survey of the ministry of Public Works - MOP - found that, on average, the trucks in the zone carried that tonnage). It is known that the operating costs of a truck on the type of road which constitute the highway network in the area is $ 123.50 per kilometre.

After the earthquake, the Air Force implemented a shuttle between Serrano and Petrópolis, with capacity for 60 tonnes of cargo, daily, charging $ 70 125 per ton, to cover costs. The private sector, encouraged by the Emergency Office, also began a combined transportation service which involved, first, a section by truck of some 203 kms., from Serrano to Puerto Tropical, where boats are used to transfer cargo for the stretch to Petrópolis. The boats charge $9000 per ton. They have a cargo capacity of 72.5 tons per day, and --the same as the capacity of air transportation-- is occupied completely. These are the only data available to the evaluator.

2. THE THEORETICAL FRAMEWORK OF THE PROBLEM

The theoretical framework is illustrated by Figure 4 (It must be noted that a standard scheme does not exist; each evaluator must develop it, according to the situation, his/her own judgment and experience).

Prior to the earthquake, trucks between Serrano and Petrópolis moved OQC tons, daily, at a unit cost of OCC pesos. After the disaster, the Air Force airlift was carrying OQA tons, at a cost of OCA pesos per ton. As well, QAQL tons were shipped, at a unit cost of CL pesos, and QLQC tons were not shipped, due to lack of capacity.

The loss to be calculated is illustrated by the marked area and consists of three components. First, the part bordered by the vertical QA and the horizontal CA represents the higher costs for transporting the OQA tons shipped by aircraft, instead of truck. Second, the part bordered by the verticals QA and QL and the horizontals CC and CL, which represent the higher costs of shipping QAQL tons via the combined system (boat/truck), instead of by truck alone.

Finally, the triangular area represents the loss arising from the incapacity to ship the same volume as before the disaster. In order to quantify that area, the evaluator will have to make some relatively daring decisions. Imagine that it is possible to arrange the non-shipped tonnage (after the earthquake) in terms of the importance of shipping them (measured by the amounts the producers, retailers or consumers are willing to pay to ship it). It may be supposed that there is a kind of transportation black market, so that the value charged for shipping will rise until demand is equal to the available supply of transportation. That is, the price of combined transportation would rise to OPL pesos. Therefore, to ship the first non-shipped ton, OPL pesos would not be offered. To ship the last non-shipped ton, not more than OCC pesos would be offered. That is, the transportation of the first non-shipped ton would cost OPL pesos, having cost OCC pesos before the earthquake. By not shipping it, OPL pesos are lost and OCC pesos are saved, leaving a net loss of PL-CC. In the same way, the loss with regard to the last ton is around zero.

3. VALUE OF TRUCK TRANSPORTATION WITHOUT EARTHQUAKE

It is known that the operating costs, per truck-km., are $ 123.53 and that, on average, trucks carry 6.6 tons of cargo. The distance between Serrano and Petrópolis, by road, is 271 kms. If truckers cannot find return cargo, the cost will be:

$$\$ \frac{(123.53)\ (271)\ (2)}{6.6} = \$\ 10\ 144 \text{ per ton.}$$

With return cargo, the price will be half that amount. It was estimated that, usually, transportation would cost an average of 7 050 per ton. That is the value of OCC in Figure 4.

4. VALUE OF COMBINED TRANSPORTATION AFTER THE DISASTER

It is known that the value by boat is $ 9 000 per ton and that the truck rate is $ 7 050, for a trip of 271 kms. Therefore, the value of combined transportation is calculated as follows:

$$\$\ [9\ 000 + (7\ 050) \left(\frac{203}{271}\right)] = \$\ 14\ 281 \text{ per ton.}$$

This is the value of OCL.

5. DEMAND ELASTICITY

It is known that the cost of air transportation (OCA) is $ 70 125 per ton and that 60 tons (OQA) are shipped by air, daily. It is also known that, before the earthquake, trucks charged $7050 for transportation between Serrano and Petrópolis and that 60 trucks made the trip daily, carrying an average of 6.6 tons, each. That is, 396 tons were shipped daily by truck.

A function of constant demand elasticity (e) is postulated, as follows:

$$Q = kc^{e}$$

Therefore,

$$\log Q = \log K - e\log c$$

and:

$$e = \frac{\log Q - \log K}{\log c}$$

The coordinate values of two points in the demand function are known, that is: (i) c = 70 125, q = 60 (air transport, with earthquake, represented by points CA and QA in Figure 4), and, (ii) c = 7 050, q = 396 (truck transportation, without earthquake, represented by points CC and QC) are known.

Therefore:

$$\frac{\log[60] - \log k}{\log[70\ 125]} = \frac{\log[396] - \log k}{\log[7\ 050]}$$

and: k = 573 986
and: e = - 0.8215

6. ESTIMATE OF DAILY LOSSES

The values for all the points identified in Figure 4, except PL, are now known. That is:

CA = 70 125	(entry datum)
QA = 60	(entry datum)
QL = 132.5	(entry datum)
CL = 14 281	(estimated)
CC = 7 050	(estimated)
Q = 396	(estimated)

Moreover, the demand function is defined:

$$Q = 573\ 986c^{-0.8215}$$

The point PL is obtained by entering the value OQL in the equation for the demand function, that is:

$$132.5 = 573\ 986PL^{-0.8215}$$

Therefore:

PL = 26 723

The area marked in Figure 4, which represents services lost as a result of the interruption of truck transportation due to the earthquake, can now be estimated. In this example, the "triangle" area was evaluated by integral calculus, rather than by analytic geometry. The use of calculus makes it possible to recognize the curved nature of the demand function, while the use of the alternative would mean considering that function as lineal. The difference between the two is minimal in most cases, although it could be important when the area, itself, is large or when the function is relatively convex. For this example, calculus was chosen on the basis of both considerations. Moreover, losses for different values of demand elasticity were evaluated, for which integral calculus made the computation of results easier.

Daily losses (Pd) are estimated:

$$Pd = \{(60)(70\ 125 - 7\ 050)\} + \{(72.5)(14\ 281 - 7\ 050)\} + \int_{7\ 050}^{26\ 723} Q.dc - (132.5)(26\ 723 - 7\ 050)\}$$

Note that this expression has the form (A) + (B) + (C). "A" represents losses with respect to cargo shipped by aircraft, with disaster; "B", losses with respect to cargo shipped by boat + truck; and "C" represents cargo non-shipped as a result of the disaster. The corresponding values are:

3 784 500 + 522 435 + 1 592 299 = $ 5 899 000 per day.

It was foreseen that the emergency (or, rather, the rehabilitation period) would last four months, which means that losses would amount to $ 719.7 million.

7. IMPORTED COMPONENT OF HIGHER TRANSPORTATION COSTS

The country affected by the earthquake was a net oil exporter. However, if fuel is reckoned as an imported product (based on the logic that domestic consumption reduces the surplus for export), the imported components of the different groups of costs involved are:

- truck transportation	0.84
- air transportation	0.85
- river transportation	0.20
- goods and services, in general	0.45

Before the earthquake, total transportation costs (between Serrano and Petrópolis) were $(396) (7 050) = $ 2 791 800 daily. Of this total, 84%, that is, $ 2 345 112, represented imported components.

After the earthquake, total costs are:

$[(60) (70 125) + (72.5) (14 281)] = $ 5 242 873

within which the imported component is:

${(60) (70 125) (0.85)+(72.5) (14 281) [(0.37)(0.84) + (0.63(0.20)]}
= $ 4 028 626 daily.

That is, taking into account only transportation costs over the route under consideration, imports increase, from $ 2 345 112, to $ 4 028 626 daily; that is, by $ 1 683 514. However, total transportation costs rise more, from $ 2 791 800 to $ 5 242 873; that is, by $ 2 451 073 daily. By spending more on transportation (ceteris paribus), the community will be spending less on other goods and services, including imported inputs, estimated at 45% of their value. Therefore, taking that reduction into account, imports decrease by $ 1 102 983 daily. Therefore, as a preliminary estimate, the impact of the disaster will increase imports by $ 1 683 514 - $ 1 102 983 = $ 580 531 daily.

FIGURE 1
Theoretic framework for the estimation of the economic value of the affected transportation by a natural disaster.

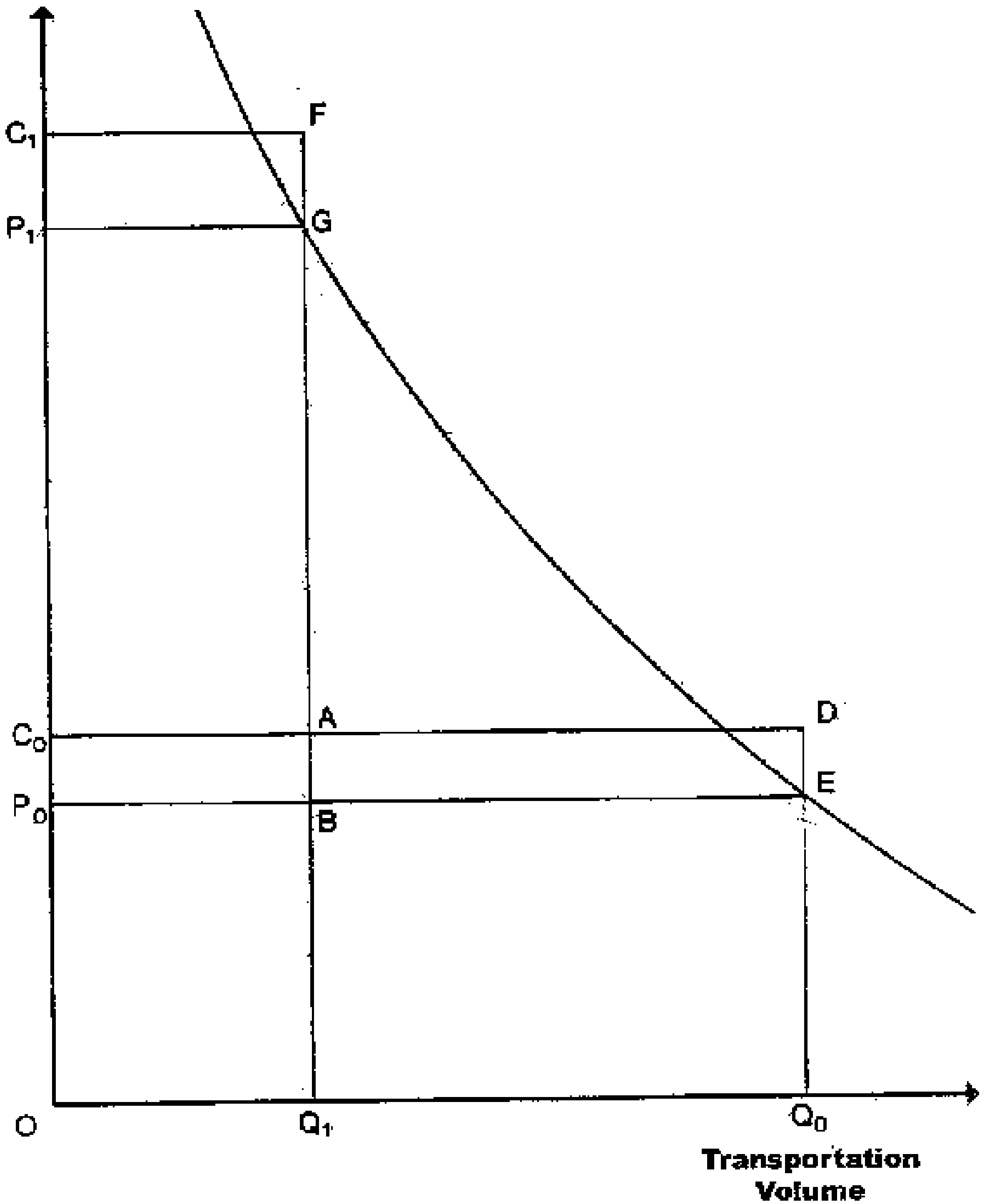

FIGURE 2

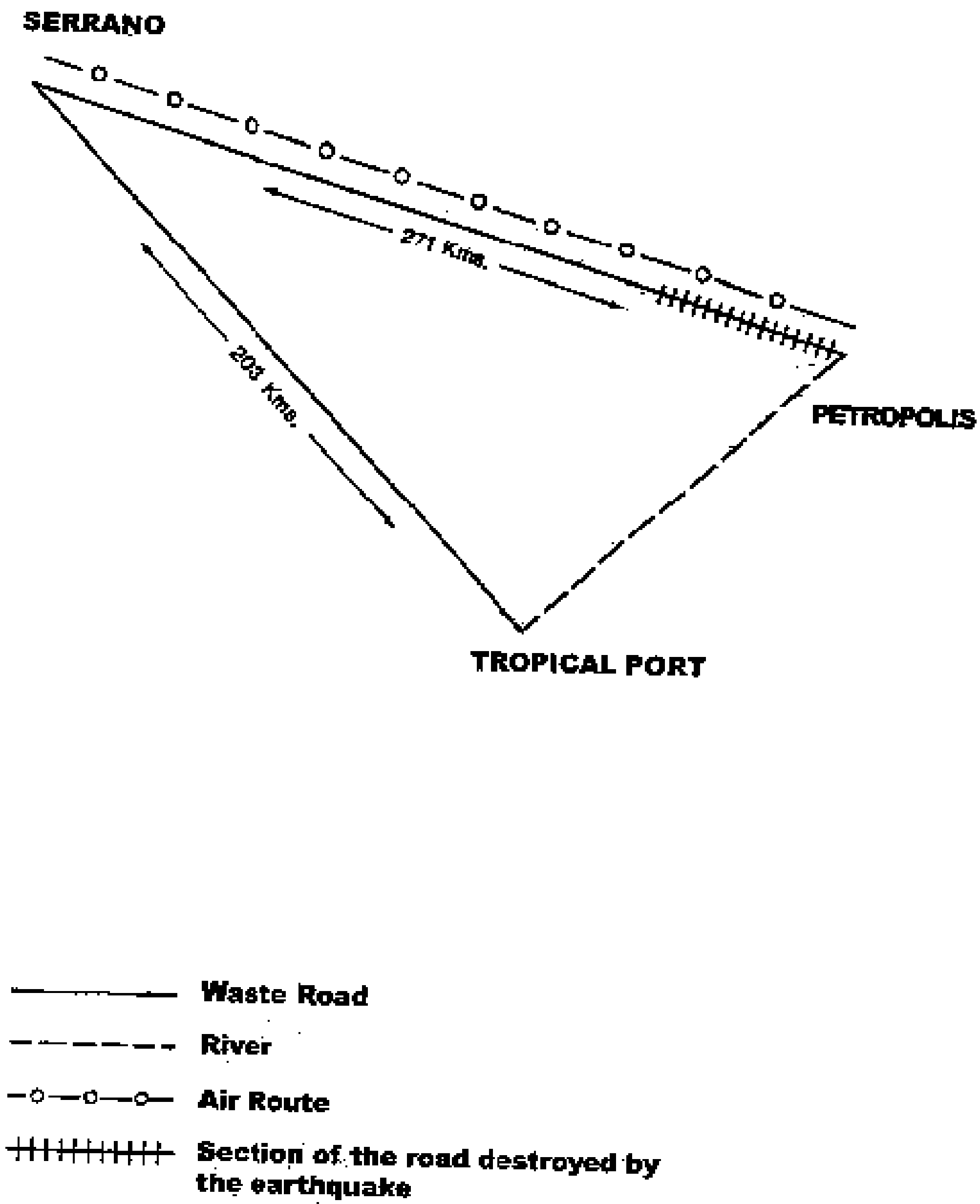
SERRANO
271 Kms.
203 Kms.
PETROPOLIS
TROPICAL PORT
Waste Road
River
Air Route
Section of the road destroyed by the earthquake

FIGURE 3
Losses by indirect damages

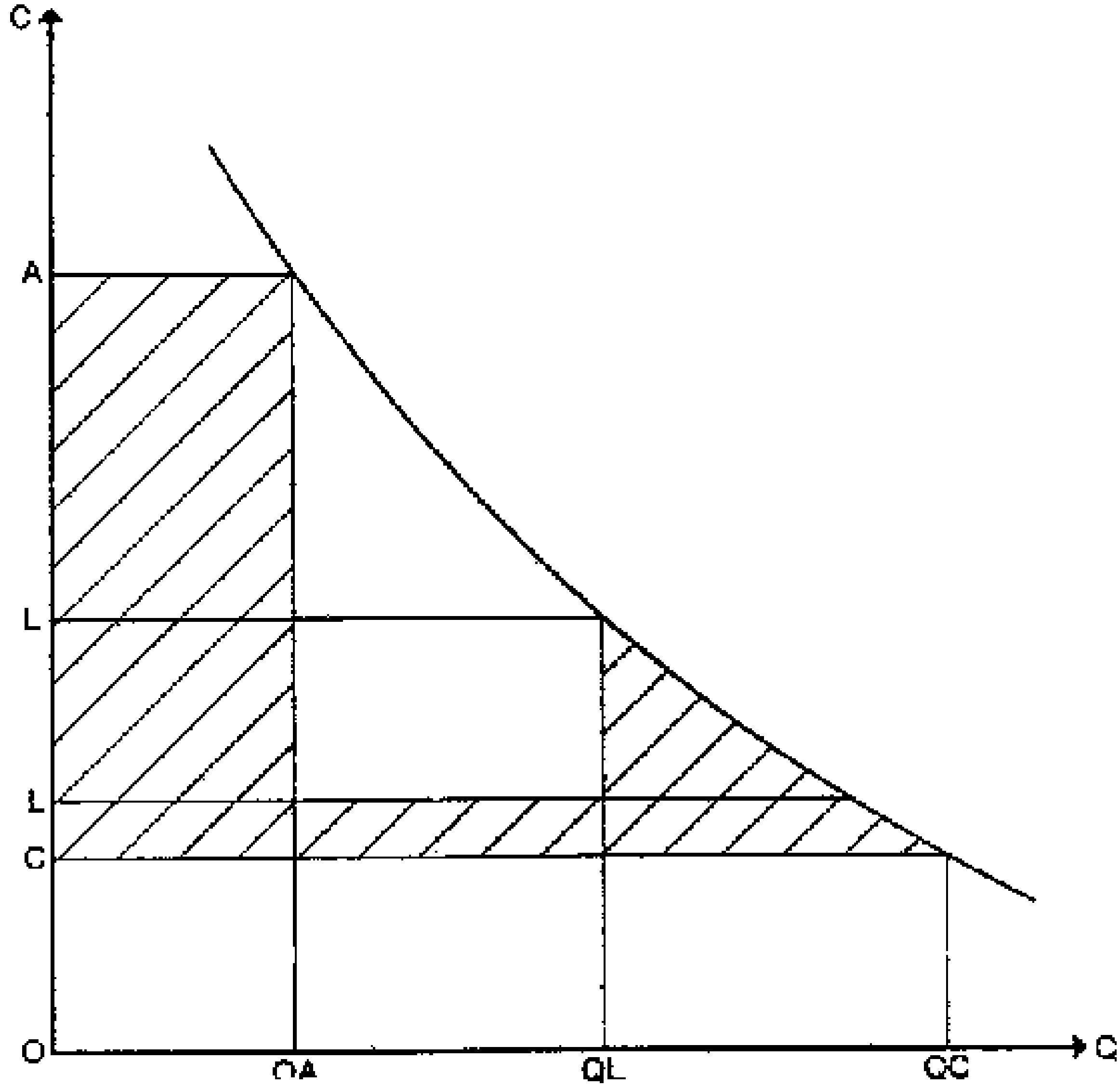

Chart 1
TRANSPORTATION SECTOR: ESTIMATE OF DIRECT DAMAGE

Fluctuation range for some construction prices

	Unit	dollars per unit
Construction of local dirt road according to terrain	km	40 000 to 1 500 000
Construction of local gravel road according to terrain	km	80 000 to 1 600 000
Construction of main highway, asphalt, two lane	km	200 000 to 2 000 000 according to terrain
Metal Bailey bridge	m	...
Earth moving	m3	5.00
Gravel surface	m3	18.00
Asphalt surface	m2	10.00
New automobile	1	10 000.00
Truck, three axles (new)	1	...
Urban bus, two axles (new)	1	...
Urban mini-bus, 20 seats (new)	1	...
Inter-urban bus, two axles (new)	1	...
Rent: caterpillar tractor	hour	300.00
Train rail, 75 pounds/yard	ton	1 100 00
Diesel-electric locomotive, 2 000 hp.	1	...

Chart 2
IMPORTED QUANTITIES OF GOODS AND SERVICES FOR ROAD WORK IN ECUADOR

Specific	Imported portion of financial cost
Chief of operations	0.00
Worker	0.00
Asphalt	0.25
Cement	0.40
Sand	0.10
gravel	0.10
Wood planks	0.10
Wood planks	0.10
Metal pipe	0.50
Cement pipe	0.20
depreciation and interest on tractors	0.70
Fuel	0.90
spare parts	0.80
Tractor repairs	0.65
Studies and design	0.10
Administrative costs	0.20
Unforeseen	0.65

Source: Working document 4-81, Economic Evaluation, Programme of Technical Assistance for the Office of Planning and Transportation Coordination, Ministry of Public Works and Communications of Ecuador, Quito, 1981.

III. ENERGY

A. CONCEPTUAL AND METHODOLOGICAL OBSERVATIONS

As in other sectors, damage in the electrical sector is both direct and indirect, on the basis of which reference is made to secondary effects. Direct damage refers to the immediate alterations suffered by physical infrastructural installations and inventories while the disaster occurs; indirect damage refers to the costs of responding to the demand for electricity during the recovery period and to unperceived net income or earnings during that period, which, in turn, are analyzed jointly with other effects in the evaluation of the overall macroeconomic impact (secondary effects) of the disaster.

With regard to damaged infrastructure, the repair and/or reconstruction costs necessary to restore the operating capacity which sector installations had before the disaster should be considered. As in other sectors, the option must also be faced here of deciding whether the operating capacity to be replaced should be identical to that which obtained prior to the disaster, or whether the normal specifications of efficiency and security for that type of installation, at the time of repair or replacement, should prevail. In fact, the latter criterion will be used when it is necessary to replace works and equipment which were completely destroyed. As has been stated often, the criterion of appraising at true replacement cost --which incorporates the technical changes which have occurred-- will yield more representative cost estimates of the works actually required and of the needed financial resources.

Cost estimates should include an appraisal of the time required for these projects, which, in turn, will serve as the basis for the quantification of the costs of supplying temporary services, as explained below in the section on indirect damage.

Estimating the stocks of equipment, material and raw materials affected or destroyed by the disaster is much easier and should be based on replacement costs, at current market prices. If identical products are not available at the time of the evaluation, equivalent elements should be used, insofar as they yield adequately similar results.

The quantification of indirect damage is more complex, because it is based largely on estimates. On the one hand, the behaviour of supply and demand during the recovery period should be projected; and, on the other, the financial results actually obtained during that period should be contrasted with those which would have occurred if the disaster had not happened. In the projection for the period "after the disaster", volumes will surely be smaller than those foreseen for the situation without disaster, because important consumers will find their needs or purchasing power significantly reduced. As well, although less certainly, demand may be higher than normal, when energy is needed in extraordinary quantities for reconstruction works. In fact, both these situations may occur, making it necessary to quantify net results.

Once post-disaster demand has been determined, which may be equal to, less or more than normal, the means for replacing it adequately should be identified. As a general criterion, the necessary supply of energy should be geared to achieving opportune and reliable results. Then, capital and operating costs should be estimated, the latter based on the time required for the rehabilitation of damaged or destroyed installations. Capital costs cover basically the acquisition of equipment, operating costs and those incurred for labour and material. It should be noted that payments made to permanent employees, temporarily unemployed for reasons attributable to the disaster, should be included in the item of personnel.

Finally, indirect damage should be estimated. To this end, first, net income foreseen for the recovery period should be estimated. In this regard, the cost of providing the supplemental energy supply mentioned above, together with the company's normal operating costs during the period in question, should be subtracted from the estimated sales income for the recovery period, following the disaster. It must be noted that this net income may be negative, in function of the purchasing power of habitual consumers after the disaster. Second, net income which would have obtained if the disaster had not occurred is estimated by subtracting total costs from gross proceeds, as in the preceding exercise. That information is usually to be found in the records of sector companies, in their short and mid-term programming departments. The algebraic difference --applicable in the event of real negative income-- between the two net incomes is the amount of total indirect damage. It should be noted that the additional costs involved in supplying supplemental energy, together with the income not perceived due to the disaster, are duly considered in this item.

These estimates of the costs of direct and indirect damage should be broken down, on the one hand, into their components of domestic and foreign currency, for the overall calculation of impact on the balance of payments. On the other hand, they should be divided into those corresponding to the government and those of the private sector, in function of the estimate of national accounts, for the calculation of secondary effects.

The evaluation methodology to be applied in the electrical and oil sectors is presented separately, as follows:

B. ELECTRICAL SECTOR

1. DIRECT EFFECTS

Direct damage in the electrical sector is grouped into three large categories: power generation installations; transmission and distribution systems; and dispatch centres.

a) Power generation installations

The generation of electrical energy involves, on the one hand, hydroelectric and geothermal complexes and, on the other, conventional thermal plants, powered by steam, diesel or gas. For the purposes of this presentation, public installations for the concentration of hydraulic and geothermal energy, corresponding to that type of power generation --given their special characteristics-- are discussed first and, then, generating plants themselves, which house equipment for transforming primary energy into electricity, are analyzed.

With regard to hydroelectric generation, the management of water resources may involve a wide range of works, such as storage and containment dams, canals, tunnels, oscillation tanks, reinforced pipe lines, etc. In this regard, it must be kept in mind that the damage sustained by these installations must be repaired in such a way that the control of the flows of water required for the generation of electricity is recovered, because, otherwise, the plant will remain inoperable, with the concurrent losses to the system, as a whole. These works are often located far from the main means of communication and access to them may be difficult, at least in certain times of the year. In these cases, the additional costs involved in providing access (which are not considered among the damage analysis of the transportation sector) should be included among the direct effects.

Evaluating rehabilitation and/or reconstruction costs for affected installations, requires estimating magnitudes, such as: cubic meters of earth to be moved, including the specific material needed; quantities of concrete, broken down by type and resistance; the length and other characteristics of water channels; lists of main mechanical components and of special installations. Then, costs should be estimated on the basis of current unit values for that type of work. Alternatively, and in function of the basic information available, a more detailed procedure may be followed, which will take into account the necessary labour, by specialty, the quantities of raw materials, the time construction equipment will be used, together with the unit cost of each of these inputs. It is worth noting that, in both alternatives, the type of damage sustained by the work in question, the availability of basic natural resources --earth, sand and gravel-- as well as of labour, both specialized and common, weigh strongly in the estimate of direct costs. In this regard, the estimates and price quotations of contractors with recent experience in the area or in similar regions constitute a valuable source of information.

With respect to geothermal power generation, the extraction and management of the resource includes supply wells, conduit pipe lines, and specialized equipment for processing and concentrating steam. Estimating damage to the availability and accessibility of subsurface steam requires the intervention of experts and field research which fall outside the limits of this presentation. However, the evaluator should attempt to make estimates in this regard, based on average costs of well infrastructure in the area under study or other sites with similar natural characteristics, all duly up-dated. The alternatives explained above for other hydroelectric works should be employed for the rest of this type of installation.

The remaining infrastructural elements for the production of electricity consist in the generating plants themselves, that is, the plant building and all types of mechanical, electrical and electronic equipment. First, the equipment which provides the motive power for the generator should be considered. Some of these are hydroelectric plants, while others use heat from boilers, pressure tanks, steam and gas turbines, etc. The former are designed individually in function of the characteristics of the site to be exploited and its replacements require the same consideration. However, respective costs may be estimated by up-dating the original investment on the basis of indexes which reflect trends in international prices for similar equipment. Recourse may also be had to statistics and manufacturer catalogues which provide prices for equipment for the concentration of hydraulic energy in hydroelectric plants, by ranges of water height (meters) and flow (m3/sec) of the water resource used.

Equipment for the mechanical management of steam heat and that produced by the combustion of oil derivatives, although endowed with specific characteristics according to the size and type of installation in question, are more uniform. This category includes geothermal and conventional plants, the latter classified as steam, diesel or gas --according to the fuel they use.

The determination of replacement costs can be made by following the general procedures outlined above for hydroelectric plants, which, in this case, will usually be easier to estimate, given the greater uniformity of the equipment in question. Plants have been provided with a whole range of mainly electric-mechanical equipment which, through the generator, convert the primary energy --hydraulic, geothermal and that derived from oil-- into electricity. In general terms, that equipment is similar in the different types of generating plant. However, they may differ in their degree of modernity and according to their specialized function. In order to determine replacement costs, data about the original investments should be examined first --specially if made in the not too distant past--, up-dating them vis-a-vis international inflation. An alternative is to examine manufacturer catalogues or available cost statistics for this type of equipment in specialized publications. (In this regard, see the information in the Annex).

These observations are relevant to those cases in which it is necessary to replace installations totally. When less serious damage has been sustained, requiring only repairs or rehabilitation, cost estimates should follow a technical evaluation of the magnitude of the damage and the real possibilities of restoration. This will require the participation of specialized personnel, with broad experience in the repair and maintenance of this type of equipment. For more precise estimates, laboratory tests of the equipment affected will be necessary, a requirement which supersedes the relatively brief time available to the evaluator for the calculation of the direct damage caused by a disaster.

Finally, there are the buildings which house the generating equipment. Direct damage to these elements is to be evaluated as for other buildings, as explained below.

b) Transmission and distribution systems

Included in this section are transmission, sub-transmission and distribution lines, together with every kind of sub-station directly related to the transportation of electric energy, from generating centres to final consumers.

High voltage lines, which employ large and expensive towers, are considered first. The evaluation of these elements calls for on-site inspections, using expeditious means of locomotion, such as automotive vehicles when lines are near open roads, and light aircraft and helicopters, when the lines go cross country. The number of damaged towers should be counted, their type noted, and the kilometres of cable affected estimated. For other derivative lines, with uniform spacing, it will only be necessary to determine the kilometres affected, noting if the damage is limited to the supporting structures or if it also involves important stretches of cable. It will also be necessary to quantify the transformers and other equipment which may have been affected.

Then, a list of damaged substations should be made, indicating, as precisely as possible, the equipment damaged, including outdoors installations and those within housings, which are part of the main substations.

The corresponding cost estimates should be based on the results of the inspection of these installations. To this end, the information available in affected electric companies or those of neighboring areas should be employed. Since these data are used with relative frequency, it is to hoped that they can be obtained without great difficulty. As was the case for generating plants, recourse may also be had to global or detailed costs obtained from contractors with relevant experience in the locality and from statistics and catalogues containing equipment prices.

These observations with respect to partially damaged installations, in contrast to those which must be totally replaced, are also applicable to transmission and distribution works.

c) Dispatch centres and other works

Other important electric company installations are the power monitoring and dispatch centres and administrative buildings. The former include buildings which house a wide range of equipment for monitoring and controlling the flow of electricity from generating plants to consumers. These range from the most elemental, which employ manual controls, to the most complex, equipped with modern systems of tele-monitoring and electronic computation, with high levels of automation and optimization of basic functions. In the evaluation of damage, when the total reconstruction of these installations is required, relevant global costs, by type of dispatch centre, should be used. When dealing with partially damaged equipment and structures, an inventory of the respective parts and an estimate of the extent and magnitude of the damage, will be necessary, a task which only experts in the matter can undertake, when specialized equipment is involved.

Damage to administrative buildings, as well as other installations affected by the disaster, should be relatively easy to evaluate, given that the structures and buildings involved are well known. Average global prices, by floor surface unit or horizontal coverage, should be used in the first instance as a basis for the quantification of that damage. More precise estimates can be made on the basis of the unit prices of the principal elements utilized in those works, such as flooring, walls, roofs, windows, etc.

2. INDIRECT DAMAGE

As noted above, indirect damage involves, on the one hand, the additional cost of temporarily supplementing energy needs while the affected installations are being restored and, on the other, the net income or surplus not received by electric companies during that period.

a) Provisional electricity supply

In order to calculate the additional cost incurred in the temporary provision of electric power, the temporal duration of restoration works or for the re-establishment of the normal functioning of damaged infrastructure should be estimated first. That factor will depend basically on the extent and magnitude of the disaster and should be determined by evaluating the direct damage mentioned above. Then, the real demand for electric power, during the period in question, should be estimated. In order to determine the scope and characteristics of that demand, the impact of the disaster on the main consumers (which normally include the industry, trade and residential sectors) should be taken into account. As a first step, the prospects for demand should be projected, according to the following criteria: residential demand in function of the number of dwellings not affected; industrial demand, based on the plants of that sector which can continue to operate, together with the anticipated demand for their products; the commercial demand, in light of the operational capacity of the establishments in the affected zone. Conjecture with respect to the purchasing power of consumers during the period after the disaster, which, logically, will affect demand, should be formulated. These exercises will serve as the basis for the estimate of the magnitude and global characteristics of the demand for electrical energy.

Then, the evaluator should examine the available alternatives for responding to the estimated temporary demand for power which, as noted above, will generally be less than that which would have been made if the disaster had not happened, although it may, exceptionally, be greater. Solutions which ensure the rapid restoration of service are to be considered, when addressing the question of the provision of the required electrical power.

When dealing with isolated systems, equipment "packages" , which can be rapidly transported and installed in the main load centres, are to be considered. Capital costs can be obtained with relative ease from specialized catalogues or on the basis of recent purchases of that type of equipment for special needs, such as emergency plants for industrial centres or to supply the needs of populations isolated from the national integrated electrical network.

Operating costs should be estimated on the basis of actual fuel consumption and the cost of locating the equipment in the selected area, which should preferably be placed as near as possible to the centres of gravity of the greatest demand. This estimate of operating costs should be complemented by adding materials and labour costs, which can usually be obtained from the accounting records of electric companies insofar as they deal with the operation of the same or similar equipment.

When dealing with interconnected systems, relatively near to neighboring systems, the cost of obtaining provisional energy is relatively easy to estimate. First, it should be discovered if those neighboring systems are able to supply the required energy and power. Then, the cost of interconnecting the systems should be calculated, which, in some cases, may involve new investments, such as in transmission lines, substation equipment, etc. Then, the rates at which the required electrical energy can be obtained should be calculated. If agreements for facing this type of emergency do not exist, a reasonable tariff, based on the additional operating costs to be faced by the supplier system for providing temporary electrical service, should be estimated. It may also happen that only part of those requirements can be attended by neighboring systems. In that case, the procedures described above for isolated and integrated systems should be followed, prorating the contribution of each. It should be noted that, since the task is to estimate the additional costs implied by the provision of temporary service, any reduction in operating costs, with respect to normal operating costs, such as variable costs of generation units which cease to operate as a result of the disaster, should be subtracted from these estimates and in all the alternatives explained above.

b) Other indirect damage

This section refers basically to the profits not realized by the electric company during the period of the restoration of its installations and the normalization of demand. It is logical to suppose that, during that period, consumers who need electrical energy to accelerate the recovery of their activities (or at least some of them) will be less able to pay for the power they consume, due to a decrease in their normal incomes. In light of this factor, and when relevant, lower rates will probably be established temporarily. On this basis, gross incomes should be estimated, as well as the real anticipated demand referred to in the previous section. From this gross income, total costs for the recovery period, including additional charges for the provisional service mentioned above, and the company's normal operating costs, should be subtracted. Thus, the net income for the period in question is obtained, which may be negative, when costs rise while income decreases.

Then, net income is calculated under the hypothesis that the disaster did not occur. On the one hand, anticipated income should be estimated, by applying the estimated average income to the normal projection of the demand for electricity. On the other hand, anticipated costs are estimated on the basis of recent behaviour, thus calculating net income for a normal situation. It is worth noting that this surplus is usually used by electric companies as an essential component for defraying capital investments required to meet future demand adequately and timely. Any significant drop implies the need to contract new loans which, in turn, are granted in function of the profitability of the company. Estimates for this second scenario are normally available in electric companies, given the nature of that activity, which requires permanently up-dated short and mid-term planning. Indirect damage --which, in this case, is equivalent to the benefits or surplus not realized due to the disaster-- should be calculated in terms of the algebraic difference between net income, calculated for the normal scenario, without disaster, and that corresponding to the real estimated situation, which includes the additional costs of providing electrical service during the recovery period. It should be noted that, when the net income estimated in the latter scenario is negative, it should be added to the net income estimated for the normal scenario, in order to obtain the total loss of profit due to the disaster.

3. IMPORTED CONTENT AND COST BREAK DOWN

In order to appraise the impact of the disaster on the balance of payments and national accounts, it is necessary to break direct and indirect costs down into outlays made in foreign and national currencies, on the one hand, and into public and private sector outlays, on the other. With regard to direct costs, all equipment, material and specialized labour, not available in the country and imported for reconstruction, correspond to outlays in foreign currency.

Local outlays cover mainly construction and repair costs, such as surveying, earth moving, structure construction, etc. However, the latter element may involve significant components of currency outlays for specialized equipment, tractors, trucks, cranes, etc., not available locally and which must be imported. To estimate this factor, it will be necessary to examine the available cost accounting records of electric companies or the archives of contractors with recent, local experience in that type of project.

The foreign currency component of indirect costs will only be relevant in terms of outlays to temporarily satisfy demands for electricity, in function of the equipment and material imported for that purpose. The cost of importing electricity from other countries, if such is the case, should be managed in the same way.

The break down of costs into public and private depends basically on the insertion of the affected electric company in the official or private sector. Moreover, when the government provides electricity, the possible participation of private operators in the activities undertaken, which usually involve contracts for the reconstruction or repair of affected installations, should be considered.

C. OIL SECTOR

1. DIRECT DAMAGE

a) Production works

Oil production is undertaken through the development of wells on land or at sea, with the subsequent extraction of crude. The following stages of transportation and storage for local refinement or export should be included in the area of specialized transportation and accounted for in the corresponding sector evaluation.

The development and control of producer wells requires the use of structures, equipment and installations, largely custom built according to the needs and characteristics of the local geography. These elements include towers to control drilling, deep well drills, marine platforms and a multiplicity of pipe lines and equipment for the management of the flow produced. The evaluation of damage related to the accessibility of that resource under ground or the sea, as well of the production capacity of the producer wells impacted by a natural disaster, requires the participation of specialized experts, who should undertake the relevant research and field work.

In general, those activities exceed the limits of this presentation, which refers rather to estimates which can be made in the short term. When a certain exploitation site is totally destroyed, a first approximation to the direct damage would be the amount already invested, actualized to the date of the disaster; and to the indirect damage, through the net commercial value of the production which would not be realized during the recovery period. Later, those appraisals can be made more precise by estimating the extent of damage to installations such as towers, drilling machinery and auxiliary equipment.

When it is necessary to replace installations completely, the estimates should be made using typical (up-dated) costs, which are usually available in the company's archives. Information about industrial equipment can also be obtained from manufacturers catalogues. Contractors with pertinent experience should also be consulted. When it is only necessary to repair partially damaged structures and equipment, a prior evaluation of the magnitude and extent of the damage should be made. That task can only be undertaken by qualified technicians, with broad experience in repair and maintenance, preferably familiar with the affected installations.

b) Refineries

Plants for the transformation of oil into its derivatives may be relatively simple, when only primary distillation is performed, or more complex, insofar as they incorporate more sophisticated equipment for the re-processing of some products or the removal of toxic substances, such as sulfur. In general terms, refineries include: different types of processing towers, storage tanks, a multiplicity of metal pipe lines of diverse sizes, and valves and other items for the management and control of fluids. The evaluation of damage caused by a disaster should follow the same or similar procedures as those indicated in the previous section, with respect to thermal plants for the generation of electricity. This is the case because many of the elements in these plants are similar to those employed in other industrial-type installations.

c) Distribution works

The distribution and sale of oil derivatives should be broken down in terms of the main consumer sectors, as follows: gaseous fuels for domestic-industrial fuel; liquid fuels for highway, shipping and air transportation; and tarry residues generally used in road construction. The basic installations consist in, on the one hand, poliducts, storage tanks, pumping stations, etc., and, on the other, typical service stations for supplying automotive vehicles and small boats, individually. The former belong essentially to the transportation or industrial sector. The evaluation of the latter elements should employ the procedures indicated elsewhere for that type of installation.

d) Other works

Buildings used for administrative purposes and recreational centres for personnel should be included in this section. This type of structure is common to all sectors, as noted above, and, consequently, the evaluation of damage caused by a disaster should employ the techniques already mentioned in relation to the destruction of housing.

2. INDIRECT DAMAGE

Indirect damage includes, on the one hand, the additional cost of supplying oil or its derivatives to satisfy energy demands while damaged installations are being repaired or reconstructed, and, on the other, the net income not perceived during that time, including the additional costs already mentioned.

a) Temporary provision of oil and derivatives

The estimate of the costs involved in the temporary provision of hydrocarbons should be based on the magnitude and characteristics of the damage sustained and the duration of recovery works. Those two factors will have been determined already, when the direct damage mentioned above was evaluated. Then, it is necessary to estimate the demand for oil and derivatives to be met to replace lost capacity and for consumption during the reconstruction process. To that end, account should be taken of the impact of the disaster on the main consumers, such as: residences, businesses and industries which will continue to require domestic gas; automotive vehicles and others which continue to function; kilometres of roads to be constructed or repaired with bituminous material, etc. On the basis of these data, and taking into account the purchasing power of affected consumers, the estimate of the new market situation should be made, in terms of needs and by type of product required.

Then, alternatives for meeting that demand should be analyzed. Various possibilities may emerge, depending on the availability and location of resources and the installations available for transportation and transferal. Tank trucks should be used for nearby supply and lesser quantities; previously installed pipe lines should be used for inter-region transfers, or sections should be constructed, if the investment is justified. Finally, marine transportation, the most commonly used means of transportation for the commercialization of oil and derivatives, should be used. This last option requires adequate port conditions and equipment; otherwise, it will be necessary to employ provisional installations, for use in emergencies.

On the basis of these considerations and once the most economical and viable alternative has been selected, the corresponding costs should be estimated. At any rate, the type of activity referred to corresponds more to the transportation sector and should be addressed in the respective chapter. Thus, capital and operating costs, including the cost of the hydrocarbons acquired, will be obtained. Given that international prices are well known, it is easy to estimate them.

b) Other indirect damage

As explained in greater detail in the section on the electrical sector, indirect damage arising from unperceived income should be quantified as follows. Net income for the real scenario after the disaster is determined. In this regard, it is worth repeating that it should be expected that gross income will drop, while costs will rise, as higher temporary supply costs are included. The results will very probably be negative. Then, the probable net income, which would have been perceived without the disaster, should be established, which is information which can be derived from the archives or projections of the relevant companies. In the extreme case that those archives have also been destroyed, the estimate should be made on the basis of data from other, basically similar companies. The algebraic difference between the net income, in normal conditions, and that of the real situation after the disaster, will yield total indirect damage, which will be equal to the profit not perceived by the company due to the disaster.

3. BREAK DOWN OF DIRECT AND INDIRECT DAMAGE

See the observations made in the section on the electric sector, which, briefly, explain that direct and indirect costs should be broken down as follows: on the one hand, into national and foreign currencies for the purposes of the balance of payments; and on the other hand, in terms of governmental and private costs, for purposes of national accounts.

ANNEX

Costs of some electric installations in the region

By way of general reference, a series of charts is included here, in which the costs of installations for the generation, transmission and distribution of electric energy are broken down. The first two areas, taken from an ECLAC document,[24] cover one hydroelectric and one thermal plant, considered to be representative of that type of installation in Latin America. The documents cited are recommended as reference works for the evaluation of damage in the electric sector caused by natural disasters.

The other charts included here refer to electric installations (transmission lines) in the Republic of Panama and were provided by the Instituto de Recursos Hidráulicos y Electrificación (IRHE).

Obviously, adjustments will have to be made in this information, in function of the country or region and the moment in which the disaster being evaluated occurred. In general terms, cash costs require less adjustment because they are based on prices of the international market. Moreover, costs in national currencies require greater adjustments, depending on the relations between salaries and materials for electric installations among the countries involved. At any rate, price fluctuations, both in foreign and local currencies, as a result of the behaviour of international and local inflation, should be taken into account.

[24] Evaluación de la demanda de maquinaria y equipo para la generación, transmisión y transformación de energía eléctrica (LC/L.335/Rev.1), Santiago, 1986. This document is part of a study realized by a Working Group on the prospects of the construction of capital goods in Latin America. With regard to electric energy, the Group prepared another document, titled Generación de energía eléctrica. Estudio de posibilidades de fabricación local de equipos (E/CEPAL/G.1312), Santiago, 1984.

COST BREAK DOWN FOR SOME ELECTRIC INSTALLATIONS IN LATIN AMERICA

CONTENTS OF THE ANNEX

FIGURE 1
Diagramme of 230Kv. Transmission line.
Simple circuit. - 750 ACAR conductor

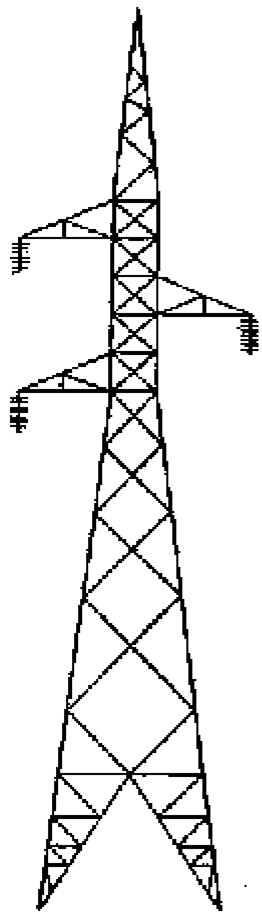

FIGURE 2
Diagramme of 230Kv. Transmission line.
Double circuit. 750 ACAR conductor

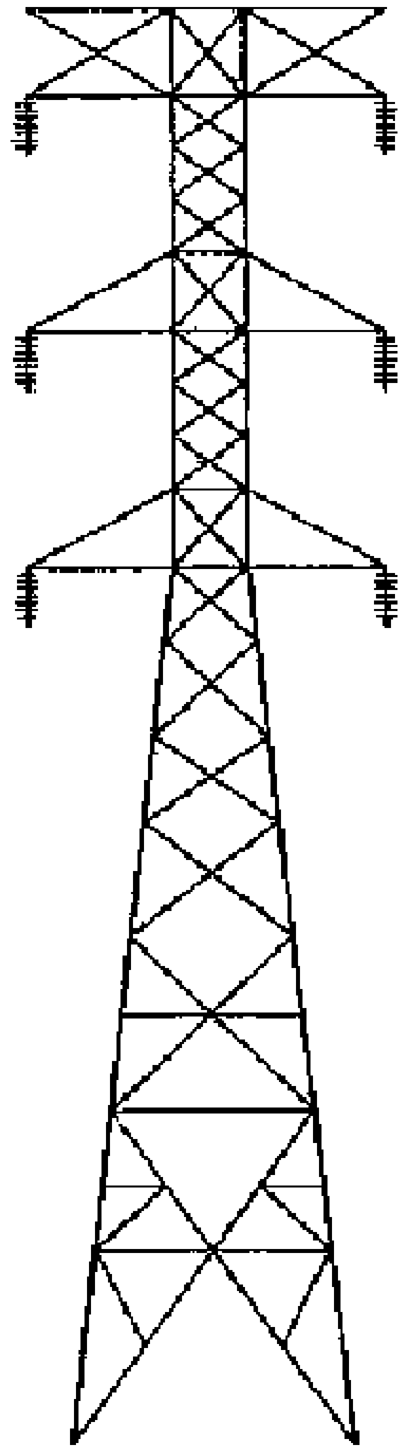

FIGURE 3
Diagramme of 115 Kv. Transmission line.
Simple circuit. - 636 ACSR/AW conductor

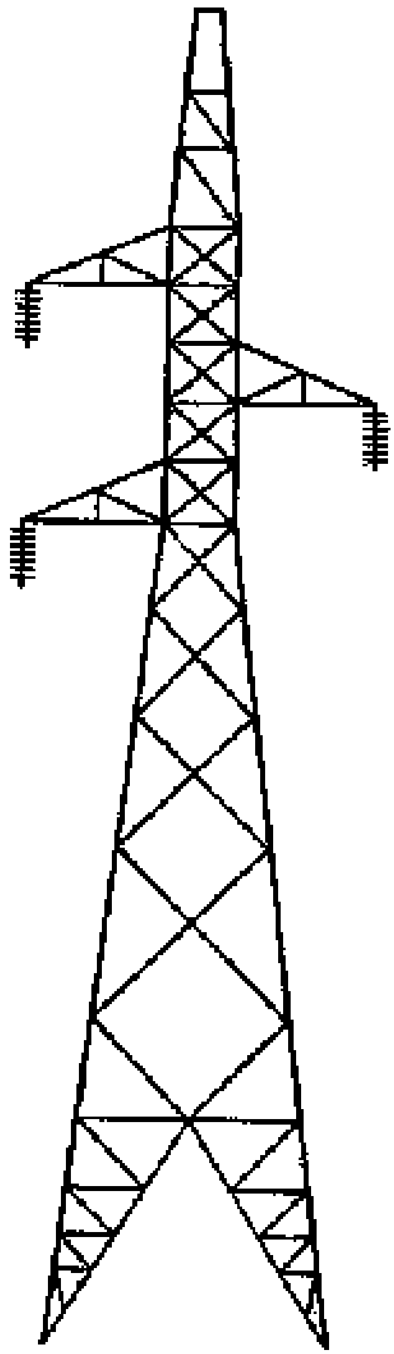

Figure 4
Diagramme of 115 Kv. Transmission line.
Double circuit – 636 ACSR / AW conductor.

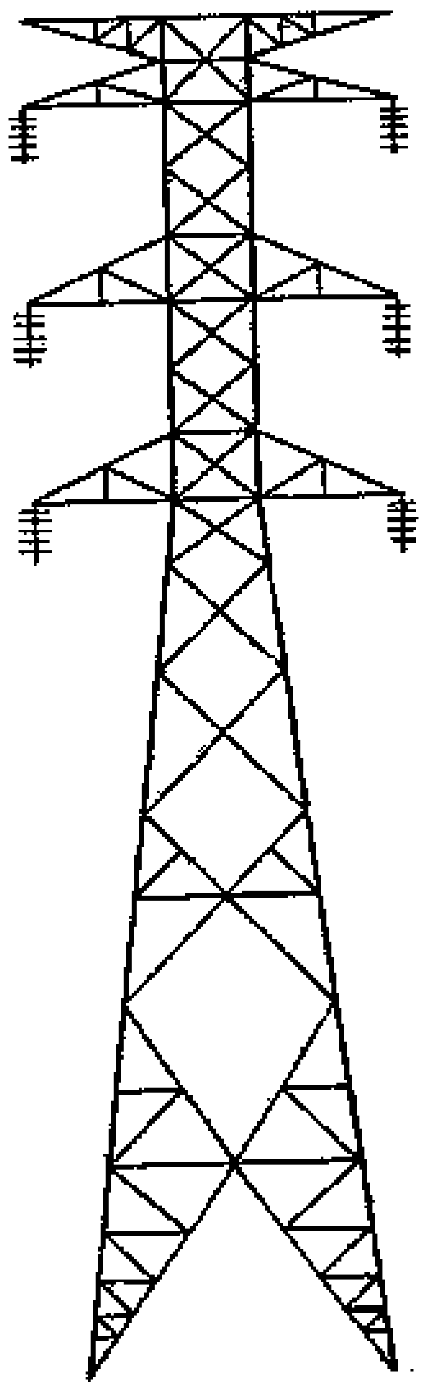

Chart 1
BREAK DOWN OF THE MAIN EQUIPMENT OF A 300W HYDROELECTRIC PLANT

Equipment	Weight (Tons)	Unit price Ton/MW	Unit price (dollars/kilo)	Ex-factory value (millions of dollars)a/
Boiler and structural equipment				
Large gates (radial and flat, more than 30 tons)	703	2.34	5.0	3.52
Mid-size and small gates	367	1.22	5.0	1.84
Hydraulic grills	71	0.24	3.5	1.74
Bridge-crane and gate crane structures	265	0.88	5.0	1.33
Metal structures	580	1.93	3.5	1.74
Galvanized structures (High tension yard)	160	0.53	4.0	0.64
Armour for pressure pipe lines	1 500	5.0	2.5	3.75
Subtotal	3 466	12.15	3.6	13.07
Mechanical and electrical equipment				
Turbines	680	2.27	7.0	4.76
Generators	1 216	4.05	9.3	11.3
Escape valves	834	2.78	8.0	6.67
Power transformers	336	1.12	5.5	1.85
Auxiliary and monitoring transformers	25	0.08	10.0	0.25
Security and maneuvering equipment	20	0.07	20.0	0.4
Mechanical components and controls for bridge cranes and gates	gl.	-	-	4.7
Instruments	gl	-	-	2.00
diverse equipment	200	0.33	15.0	3.00
Subtotal	3 311	11.04	10.55	39.93
Total	6 957	23.19	6.9	48.00

Source: ECLAC estimates, based on plans.

a/ Does not include mounting.

Chart 2
BREAK DOWN OF THE MAIN EQUIPMENT OF A 150MW THERMAL PLANT, FED ALTERNATELY WITH COAL OR FUEL OIL

Equipment	Weight (Tons)	Unit price (dollars / kilo)	Ex-factory value (millions of dollars)
Boiler and electrostatic precipitator	1750	18	31 500
Support structure, ducts and chimney	700	5	3 500
Air pre-heater	280	5	1 400
Fans	50	10	500
System of pulverizing and moving coal	147	7.5	1 100
Oil storage	200	7.5	1 500
Ash transportation	200	6	1 200
Turbo-generator (158 MW 3,600 rpm)	366	24	8 800
Heaters and heat exchangers	67	12	800
Condensers and *	280	10	2 800
Feed, condenser and circulation pumps	50	10	500
Condensation, recuperation and water tanks	200	3.5	700
Fuel tank	100	3.0	300
Cooling tower	150	6	900
Water treatment system	100	7	700
Condensation treatment system	50	8	400
Fire protection system	75	8	600
Metal structure (main building)	750	3.5	2 625
Secondary metal structures	75	3.5	265
Structure of bridge-crane 35/10 ton and 17m.	50	8	400
Compressed air system (compressors)	4	30	120
Main transformer 175 mVA 230 KV	125	8	1 000
Starter transformer 15/20 mVA 4.16 KV	30	9	270
Auxiliary transformer 15 mVA 16 KV	15	10	150
Power and current transformers	10	10	100
Switch panels and unit substation	50	15	750
Motor control centre	20	25	500
Circuit breakers, lightning rods, switches	46	20	920
High pressure pipe line systems	200	5.5	1 100
Low pressure pipe lines	400	3.5	1 400
Valves (700 units)	12	10.0	1 200
Diverse equipment: ducts, lights, support structures, thermal insulation	250	10	2 500
Bridge-crane mechanism	b)	-	500
Electrical and control instruments	120	25	300
Maintenance work shop and laboratory	b)	-	1 000
Total	730	10.67	75 000

Source: ECLAC estimates.

a) Does not include mounting.

b) Tons included in other items or insignificant.

Chart 3
COSTS OF HYDROELECTRIC GENERATION

	YEARS OF INTEREST	FACTOR	INTEREST RATE 12%			
			S PAOLO	SOLEDAD	CHANG1	CHANG2
INSTALLATION MW			33	28	300	301
COST /KW WITHOUT IDC			1 972	2 286	2 110	1 752
% YEAR 1	3.5	1.49	9.26	9.22	10	10
% YEAR 2	2.5	1.33	24.63	24.61	20	20
% YEAR 3	1.5	1.19	40.74	40.78	40	40
% YEAR 4	0.5	1.06	25.37	25.39	30	30
% YEAR 5	0	1.00	0	0	0	0
IDC			426.02	423.45	434.24	360.56
TOTAL COST/KW			2 398.02	2 779.45	2 544.24	2 112.56
USEFUL LIFE -YEARS			50	50	50	50
O AND M FIXED/KW-YEAR			13.8	13.8	13.8	13.8
REPLACEMENT B/KW-YEAR			.00	.00	.00	.00
INSURANCE B/KW-YEAR			.00	.00	.00	.00
COST OF GENERATION						
ANNUAL COST OF CAP. B/KW			288.76	334.69	306.37	254.39
AVERAGE ENERGY GWH			145.9	141.5	1 614	1 567
NOMINAL GWH/KW			4 421.21	5 053.57	5 380.00	5 205.98
% PLANT FACTOR			50.47	57.69	61.42	59.43
UNIT COST C/KWH			6.53	6.62	5.69	4.89

Chart 4
COSTS OF THERMAL GENERATION

TYPE		Years Of Interest	Factor	INTERESTRATE 12% - FUEL COST UNTIL 2000 Coal	Coal	Oil	Oil	TG
Nº OF UNITS				1	2	1	2	
MW/NOMINAL UNIT				75	75	75	75	60
COST/KW WITHOUT IDC				1 430	1 245	922	721	410
% YEAR 1		3.5	1.00	17	19	17	19	0
% YEAR 2		2.5	1.00	28	30	28	30	0
% YEAR 3		1.5	1.00	36	34	32	34	35
% YEAR 4		.5	1.00	16	17	16	7	65
% YEAR 5		0	1.00	7		7		
IDC				.00	.00	.00	.00	.00
TOTAL COST/KW				1 430.00	1 245.00	922.00	721.00	410.00
USEFUL LIFE -YEARS				35	35	35	35	30
O AND M FIXED/KW-YEAR				30	30	30	30	1
O AND M VARIABLE B/MWH				.5	.05	.5	.5	.9
REPLACEMENT B/KW-YEAR				3.58	3.11	2.31	1.80	1.03
INSURANCE B/KW-YEAR				3.58	3.11	2.31	1.80	1.03
FUEL C/MBTU				204.79	204.79	420.73	420.73	613.7
THERMAL OUTPUT BTU/KWH				10 460	10 460	10 000	10 000	13 000
GENERATION COSTS								
FUEL C/KWH				2.14	2.14	4.20	4.20	7.97
ANNUAL * COST B/KW				226.32	200.30	145.92	1 116.00	58.39
FP%	KWH/KW							
5	438			53.81	47.87	37.52	30.69	21.30
10	876			27.98	25.81	20.86	17.44	14.64
20	1 752			15.06	13.57	12.53	10.82	11.30
30	2 628			10.75	9.76	9.75	8.62	10.19
40	3 504			8.6	7.86	8.37	7.51	9.64
50	4 380			7.31	6.72	7.53	6.85	9.30
60	5 256			6.45	5.95	6.92	6.41	9.08
70	6 132			5.83	5.41	6.58	6.09	8.92
80	7 008			5.37	5.00	6.28	5.86	8.8

Chart 5
BREAK DOWN OF THE ESTIMATED COST OF A 230KV. TRANSMISSION LINE SIMPLE CIRCUIT. 750 ACAR CONDUCTOR
JANUARY, 1988
($/Km)

DESCRIPTION	MATERIALS	LABOUR	TOTAL
1. Insulators and hardware	3 104	1 117	4 221
2. Conductors	12 090	5 199	17 289
3. Cables*	1 195	514	1 709
4. System grounding	1 503	857	2 359
5. Towers	13 680	7 524	21 204
6. Foundations	3 094	9 745	12 839
7. Right of way	-	2 400	2 400
Total Base Cost	34 665	27 356	62 021
8. Transportation			3 467
9. Contingencies			3 467
10. Engineering and Administration			10 343
Total Cost			79 297

Chart 6
BREAK DOWN OF THE ESTIMATED COST OF A 230KV. TRANSMISSION LINE DOUBLE CIRCUIT. 750 ACAR CONDUCTOR
JANUARY, 1988
($/Km)

DESCRIPTION	MATERIALS	LABOUR	TOTAL
1. Insulators and hardware	6 280	2 235	8 443
2. Conductors	24 180	10 397	34 577
3. Cables*	2 390	1 028	3 418
4. System grounding	1 503	857	2 359
5. Towers	21 803	11 991	33 794
6. Foundations	5 325	19 774	22 099
7. Right of way	-	2 400	2 400
Total Base Cost	61 409	45 682	107 090
8. Transportation			6 141
9. Contingencies			6 141
10. Engineering and Administration			17 906
Total Cost			137 277

Chart 7
BREAK DOWN OF THE ESTIMATED COST OF A 115KV. TRANSMISSION LINE SIMPLE CIRCUIT. 636 ACSR/AW CONDUCTOR
JANUARY, 1988
($/Km)

DESCRIPTION	MATERIALS	LABOUR	TOTAL
1. Insulators and hardware	1 865	671	2 536
2. Conductors	11 310	4 863	16 163
3. Cables*	1 195	514	1 709
4. System grounding	1 503	857	2 359
5. Towers	12 184	6 701	18 885
6. Foundations	2 625	8 269	10 894
7. Right of way		1 800	1 800
Total Base Cost	30 681	23 675	54 356
8. Transportation			3 068
9. Contingencies			3 068
10. Engineering and Administration			9 074
Total Cost			69 566

Chart 8
BREAK DOWN OF THE ESTIMATED COST OF A 115KV. TRANSMISSION LINE DOUBLE CIRCUIT. 636 ACSR/AW CONDUCTOR
JANUARY, 1988
($/Km)

DESCRIPTION	MATERIALS	LABOUR	TOTAL
1. Insulators and hardware	3 720	1 343	5 072
2. Conductors	22 620	9 727	32 343
3. Cables*	2 390	1 028	3 418
4. System grounding	1 503	857	2 359
5. Towers	19 494	10 722	30 216
6. Foundations	4 725	14 884	19 609
7. Right of way		1 800	1 800
Total Base Cost	54 461	40 359	94 820
8. Transportation			5 446
9. Contingencies			5 446
10. Engineering and Administration			15 857
Total Cost			121 569

Chart 9

COST BREAK DOWN FOR A SIMPLE LINE DIAGRAMME, NEW ONE SWITCH SUBSTATION. 230KV. YARD

(Balboas of January, 1988)

	MATERIALS	LABOUR
1. 1 switch 230 KV. 2000A.	116 000	
2. 1 manual tri-polar knife switch with 230 KV ground	17 500	
3. 1 manual tri-polar knife switch without 230 KV ground	16 000	
4. Grounding system	3 470	
5. Auxiliary services	45 000	
6. Illumination	15 000	
7. 3 lightning rods 192 KV	24 000	
8. Hardware, structures and supports	37 915	
9. Cables, conductors and ducts	31 244	
10. Security and monitoring equipment	150 000	
11. Supervision and control	20 000	
12. Communications equipment	180 000	
SUBTOTAL MATERIALS	656 129	
13. Land		6 275
14. Electrical installations		98 419
15. Civil works	45 929	85 297
TOTAL BASE COST	708 334	183 716
16. Transportation	42 500	28 333
17. Contingencies	70 833	
18. Engineering and administration		106 250
TOTAL	821 667	318 300
TOTAL COST	1 139 967	

Chart 10
COST BREAK DOWN FOR A DIAGRAMME OF A NEW SWITCH AND A HALF SUBSTATION WITH TWO SWITCHES. 230KV. YARD
(Balboas of January, 1988)

	MATERIALS	LABOUR
1. 2 switch 230 KV. 2000A.	232 000	
2. 1 motorized tri-polar knife switch with 230 KV ground	211 500	
3. 4 manual tri-polar knife switches without 230 KV ground	64 000	
4. Grounding system	6 830	
5. Auxiliary services	60 000	
6. Illumination	15 000	
7. 3 lightning rods 192 KV	24 000	
8. Hardware, structures and supports	67 733	
9. Cables, conductors and ducts	42 053	
10. Security and monitoring equipment	150 000	
11. Supervision and control	20 000	
12. Communications equipment	180 000	
SUBTOTAL MATERIALS	883 116	
13. Land	9 500	
14. Electrical installations		132 467
15. Civil works	61 818	114 805
TOTAL BASE COST	954 434	247 272
16. Transportation	57 266	38 177
17. Contingencies	95 443	
18. Engineering and administration		143 165
TOTAL	1 107 144	428 615
TOTAL COST	1 535 758	

Chart 11
COST BREAK DOWN FOR A DIAGRAMME OF A NEW SWITCH AND A HALF SUBSTATION WITH THREE SWITCHES. 230KV. YARD
(Balboas of January, 1988)

		MATERIALS	LABOUR
1.	3 switch 230 KV. 2000A.	348 000	
2.	2 motorized tri-polar knife switch with 230 KV ground	43 000	
3.	6 manual tri-polar knife switches without 230 KV ground	96 000	
4.	Grounding system	10 700	
5.	Auxiliary services	60 000	
6.	Illumination	15 000	
7.	6 lightning rods 192 KV	48 000	
8.	Hardware, structures and supports	99 312	
9.	Cables, conductors and ducts	70 001	
10.	Security and monitoring equipment	300 000	
11.	Supervision and control	20 000	
12.	Communications equipment	360 000	
	SUBTOTAL MATERIALS	1 460 013	
13.	Land	9 500	
14.	Electrical installations		220 502
15.	Civil works	102 901	191 102
	TOTAL BASE COST	1 582 413	411 604
16.	Transportation	94 945	63 297
17.	Contingencies	158 241	
18.	Engineering and administration		237 362
	TOTAL	1 835 600	712 262
	TOTAL COST	2 547 862	

Chart 12
COST BREAK DOWN FOR A SIMPLE LINE DIAGRAMME,
NEW ONE SWITCH SUBSTATION. 115KV. YARD
(Balboas of January, 1988)

	MATERIALS	LABOUR
1. 1 switch 115 KV. 1600A.	73 000	
2. 1 motorized tri-polar knife switch with 115KV ground	11 600	
3. 1 manual tri-polar knife switches without 115 KV ground	10 100	
4. Grounding system	2 194	
5. Auxiliary services	33 750	
6. Illumination	15 000	
7. 3 lightning rods 96 KV	15 000	
8. Hardware, structures and supports	25 703	
9. Cables, conductors and ducts	25 317	
10. Security and monitoring equipment	150 000	
11. Supervision and control	20 000	
12. Communications equipment	150 000	
SUBTOTAL MATERIALS	531 664	
13. Land	3 900	
14. Electrical installations		79 750
15. Civil works	37 217	69 116
TOTAL BASE COST	572 781	148 866
16. Transportation	34 367	22 911
17. Contingencies	57 278	
18. Engineering and administration		85 917
TOTAL	664 426	257 694
TOTAL COST	922 120	

Chart 13
COST BREAK DOWN FOR A DIAGRAMME OF A NEW SWITCH AND A HALF SUBSTATION WITH TWO SWITCHES. 115KV. YARD
(Balboas of January, 1988)

		MATERIALS	LABOUR
1.	2 switch 230 KV. 1600A.	146 000	
2.	1 motorized tri-polar knife switch with 115 KV ground	17 400	
3.	4 manual tri-polar knife switches without 115 KV ground	40 400	
4.	Grounding system	4 376	
5.	Auxiliary services	45 000	
6.	Illumination	15 000	
7.	3 lightning rods 96 KV	15 000	
8.	Hardware, structures and supports	45 308	
9.	Cables, conductors and ducts	32 424	
10.	Security and monitoring equipment	150 000	
11.	Supervision and control	20 000	
12.	Communications equipment	150 000	
	SUBTOTAL MATERIALS	680 908	
13.	Land	5 750	
14.	Electrical installations		102 136
15.	Civil works	47 664	88 518
	TOTAL BASE COST	734 332	190 654
16.	Transportation	44 059	29 373
17.	Contingencies	73 432	
18.	Engineering and administration		110 148
	TOTAL	851 813	330 176
	TOTAL COST	1 181 989	

Chart 14
COST BREAK DOWN FOR A DIAGRAMME OF A NEW SWITCH AND A HALF SUBSTATION WITH THREE SWITCHES. 115KV. YARD
(Balboas of January, 1988)

		MATERIALS	LABOUR
1. 3 switch 115 KV. 1600A.		219 000	
2. 2 motorized tri-polar knife switch with 115 KV ground		34 800	
3. 6 manual tri-polar knife switches without 115 KV ground		60 600	
4. Grounding system		6 888	
5. Auxiliary services		45 000	
6. Illumination		15 000	
7. 6 lightning rods 96 KV		30 000	
8. Hardware, structures and supports		65 806	
9. Cables, conductors and ducts		54 855	
10. Security and monitoring equipment		300 000	
11. Supervision and control		20 000	
12. Communications equipment		300 000	
SUBTOTAL MATERIALS		1 151 949	
13. Land		5 750	
14. Electrical installations			172 972
15. Civil works		80 636	149 753
TOTAL BASE COST		1 238 335	322 546
16. Transportation		74 300	49 533
17. Contingencies		123 834	
18. Engineering and administration			185 750
	TOTAL	1 436 469	557 829
	TOTAL COST	1 994 298	

Chart 15

BREAK DOWN OF COSTS (BASE COST: JANUARY, 1988)
PROJECT N¦ 01 BID 10
NAME OF PROJECT: MONOPHASE LINE 19.9/34.5 KV
+++TYPICAL KILOMETRE+++

DESCRIPTION	FOREIGN MATERIAL	DOMESTIC MATERIAL	LABOUR
SUBTOTAL 1	7 027	0.0	3 724
LISTING FACTOR	0.0	0.0	0.0
SUBTOTAL 2	7 027	0.0	3 724
CONTINGENCIES (10% OF MATERIAL)	703	0.0	
SUBTOTAL 3	7 729	0.0	3 724
TRANSPORTATION (6% AND 4% OF MATERIAL IN SUBTOTAL 2)		422	281
SUBTOTAL 4	7 729	422	4 005
ENGINEERING (10% OF TOTAL)			1 216
ADMINISTRATION COSTS (5% OF TOTAL 4)			608
TAXES (30% FOREIGN AND 5% DOMESTIC OF SUBTOTAL 3)		2 821	
TOTALS	7 729	3 243	5 829
TOTAL DOMESTIC COST	9 071		
TOTAL FOREIGN COST	7 729		
TOTAL ESTIMATED COST	16 801		

Source: Instituto de Recursos hidráulicos y Electrificación (Charts III.3.3.19 to 3.3.24)

Chart 16

BREAK DOWN OF COSTS (BASE COST: JANUARY, 1988)

PROJECT N¦ 01 BID 12

NAME OF PROJECT: MONOPHASE LINE 19.9/34.5 KV

+++TYPICAL KILOMETRE+++

DESCRIPTION	FOREIGN MATERIAL	DOMESTIC MATERIAL	LABOUR
SUBTOTAL 1	5 342	0.0	2 831
LISTING FACTOR	0.0	0.0	0.0
SUBTOTAL 2	5 342	0.0	2 831
CONTINGENCIES (10% OF MATERIAL)	534	0.0	
SUBTOTAL 3	5 876	0.0	2 831
TRANSPORTATION (6% AND 4% OF MATERIAL IN SUBTOTAL 2)		321	214
SUBTOTAL 4	5 876	321	3 045
ENGINEERING (10% OF TOTAL)			924
ADMINISTRATION COSTS (5% OF TOTAL 4)			462
TAXES (30% FOREIGN AND 5% DOMESTIC OF SUBTOTAL 3)		2 145	
TOTALS	5 876	2 465	4 431

TOTAL DOMESTIC COST	6 896
TOTAL FOREIGN COST	5 876
TOTAL ESTIMATED COST	12 772

Chart 17
BREAK DOWN OF COSTS (BASE COST: JANUARY, 1988)
PROJECT N¦ 01 BID 13
NAME OF PROJECT: MONOPHASE LINE 19.9/34.5 KV
+++TYPICAL KILOMETRE+++

DESCRIPTION	FOREIGN MATERIAL	DOMESTIC MATERIAL	LABOUR
SUBTOTAL 1	11 557	0.0	6 125
LISTING FACTOR	0.0	0.0	0.0
SUBTOTAL 2	11 557	0.0	6 125
CONTINGENCIES (10% OF MATERIAL)	1 156	0.0	
SUBTOTAL 3	12 713	0.0	6 125
TRANSPORTATION (6% AND 4% OF MATERIAL IN SUBTOTAL 2)		693	462
SUBTOTAL 4	12 713	693	6 587
ENGINEERING (10% OF TOTAL)			1 999
ADMINISTRATION COSTS (5% OF TOTAL 4)			1 000
TAXES (30% FOREIGN AND 5% DOMESTIC OF SUBTOTAL 3)		4 640	
TOTALS	12 713	5 333	9 586

TOTAL DOMESTIC COST	14 920
TOTAL FOREIGN COST	12 713
TOTAL ESTIMATED COST	276 632

Chart 18
BREAK DOWN OF COSTS (BASE COST: JANUARY, 1988)
PROJECT N¦ 01 BID 14
NAME OF PROJECT: MONOPHASE LINE 19.9/34.5 KV
+++TYPICAL KILOMETRE+++

DESCRIPTION	FOREIGN MATERIAL	DOMESTIC MATERIAL	LABOUR
SUBTOTAL 1	6 789	0.0	3 598
LISTING FACTOR	0.0	0.0	0.0
SUBTOTAL 2	6 789	0.0	3 598
CONTINGENCIES (10% OF MATERIAL)	679	0.0	
SUBTOTAL 3	7 468	0.0	3 598
TRANSPORTATION (6% AND 4% OF MATERIAL IN SUBTOTAL 2)		407	272
SUBTOTAL 4	7 468	407	3 870
ENGINEERING (10% OF TOTAL)			1 175
ADMINISTRATION COSTS (5% OF TOTAL 4)			587
TAXES (30% FOREIGN AND 5% DOMESTIC OF SUBTOTAL 3)		2 756	
TOTALS	7 468	3 133	5 632
TOTAL DOMESTIC COST	8 765		
TOTAL FOREIGN COST	7 468		
TOTAL ESTIMATED COST	16 233		

Chart 19
BREAK DOWN OF COSTS (BASE COST: JANUARY, 1988)
PROJECT N¦ 01 BID 07
NAME OF PROJECT: MONOPHASE LINE 19.9/34.5 KV
+++TYPICAL KILOMETRE+++

DESCRIPTION	FOREIGN MATERIAL	DOMESTIC MATERIAL	LABOUR
SUBTOTAL 1	14 268	0.0	7 562
LISTING FACTOR	0.0	0.0	0.0
SUBTOTAL 2	14 268	0.0	7 562
CONTINGENCIES (10% OF MATERIAL)	1 427	0.0	
SUBTOTAL 3	15 695	0.0	7 562
TRANSPORTATION (6% AND 4% OF MATERIAL IN SUBTOTAL 2)		856	571
SUBTOTAL 4	15 695	856	8 133
ENGINEERING (10% OF TOTAL)			2 468
ADMINISTRATION COSTS (5% OF TOTAL 4)			1 234
TAXES (30% FOREIGN AND 5% DOMESTIC OF SUBTOTAL 3)		5 729	
TOTALS	15 695	6 585	11 836

TOTAL DOMESTIC COST	18 421
TOTAL FOREIGN COST	15 695
TOTAL ESTIMATED COST	34 116

Chart 20

BREAK DOWN OF COSTS (BASE COST: JANUARY, 1988)

PROJECT N¦ 01 BID 19

NAME OF PROJECT: MONOPHASE LINE 19.9/34.5 KV

+++TYPICAL KILOMETRE+++

DESCRIPTION	FOREIGN MATERIAL	DOMESTIC MATERIAL	LABOUR
SUBTOTAL 1	10 347	0.0	5 484
LISTING FACTOR	0.0	0.0	0.0
SUBTOTAL 2	10 347	0.0	5 484
CONTINGENCIES (10% OF MATERIAL)	1 035	0.0	
SUBTOTAL 3	11 382	0.0	5 484
TRANSPORTATION (6% AND 4% OF MATERIAL IN SUBTOTAL 2)		621	414
SUBTOTAL 4	11 382	621	5 898
ENGINEERING (10% OF TOTAL)			1 790
ADMINISTRATION COSTS (5% OF TOTAL 4)			895
TAXES (30% FOREIGN AND 5% DOMESTIC OF SUBTOTAL 3)		4 154	
TOTALS	11 382	4 775	8 583
TOTAL DOMESTIC COST	13 358		
TOTAL FOREIGN COST	11 382		
TOTAL ESTIMATED COST	24 740		

MANUAL FOR ESTIMATING THE SOCIOECONOMIC EFFECTS OF NATURAL DISASTERS

Part Four

ECONOMIC SECTORS

INDEX

I. AGRICULTURE AND LIVESTOCK HUSBANDRY

A. INTRODUCTION

1. GENERAL OBSERVATIONS

Not all disasters affect the farm and livestock sector in the same way nor with the same intensity and, in fact, some disasters affect mainly only farming. For this reason, the evaluator should, first, in coordination with the other evaluators, make an accurate appraisal of the characteristics of the disaster, its impact on different sectors and, naturally, define the role of each evaluator within the context of the final report.

The civil engineer will often be unable to evaluate damage to agricultural infrastructure until the agricultural evaluator has appraised the general situation of that sector and the damage done to equipment which will hinder farm and livestock sector operations; for example, destruction of farm installations, flooded trench silos, clogged irrigation or drainage canals, etc. In this type of situation, coordination among evaluators is of utmost importance, in function of time and the work priorities of the farm evaluator.

As noted above, some disasters, such as droughts or flooding in farm regions, have their most severe impact on the farm and livestock sector. Others, such as hurricanes, have significant impact on agriculture, even though those effects depend on the characteristics of the phenomenon and its geographical extent. Nevertheless, hurricanes in the Caribbean region have affected both farm and urban zones with equal violence. Some disasters, such as earthquakes, when they destroy storage silos and affect the availability of foodstuffs, affect the farm and livestock sector only indirectly; some landslides may affect rural and urban zones equally.

Therefore, the evaluator should, first, concentrate on clearly defining the scope of the phenomenon to be evaluated, so as to better plan his/her work and delineate its inter-sectoral ramifications. The farm specialist should also evaluate the immediate and future availability of foodstuffs. This is a factor common to all disasters because, as daily routines are interrupted by the disaster, habitual flows are disrupted and food may become scarce. In certain types of disaster, the emergency makes it necessary to abandon conventional activities, by imposing emergency tasks and interrupting or complicating the supply of foodstuffs. Concern for possible food shortages may be vital, depending on the disaster, and the farm and livestock evaluator is responsible for perceiving and quantifying them, as well as for suggesting ways of facing those shortages. Earthquakes are a clear example of situations in which food is needed immediately; a drought poses the problem of future shortages, given that the phenomenon makes it impossible to produce and endangers future harvests.

Once again, farm evaluator familiarity with the characteristics of the disaster is a first step in his/her specific task, because that knowledge provides a preview of the scope of the evaluation itself. For example, hurricane winds are devastating. It is important to know the storm's trajectory so as to define the affected regions exactly and, naturally, to determine the crops involved. Moreover, a hurricane nearly always generates torrential rains which may last for days and cause flooding. Often, crops, such as the African palm, resist strong winds but may succumb to lengthy flooding. Moreover, each disaster has different implications, depending on its origin. Earthquakes are nearly

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always very local events; droughts, on the contrary, may even affect several countries. In other cases, natural phenomena have multiple effects, as in the case of generalized climatic change, such as that which occurred in the Andean plateau in the early 1980s, which caused droughts in the high country and heavy rains and flooding on the coasts, seriously affecting three countries.[1]

It is also important to consider the time of year when the phenomenon which causes an agricultural disaster occurs. A hurricane in the month in which coffee plants are in flower may cause definitive damage to that year's crop, because, with the flower destroyed, the plant will not produce fruit and the anticipated harvest will be considerably reduced, if not totally lost.

The same may occur with annual crops. The impact of a flood is not the same if it occurs when plants are very young, because it may be possible to re-plant, as when it occurs shortly before harvest time. In the latter case, the investment has been greater and it will surely be impossible --for lack of time-- to re-utilize the land that year. Naturally, the magnitude of the damage in these two cases is different. For that reason, the type of crop should be mentioned. For example, a hurricane which hit a Caribbean island in the 1970s came ashore in a zone of coffee plantations, which were affected. In some areas, they were totally destroyed and trees were uprooted, while, in others, destruction was only partial and, naturally, damage was less.[2]

In the event of a disaster, permanent crops usually suffer more serious damage because they grow more slowly. When plantations are partially lost, the land must be planted again; often infrastructure must be rebuilt (canals, drains, storage facilities, etc.), and several years must pass before the new plants will produce.

The farm evaluator should determine lost production as soon as possible. In a zone of subsistence farming, the repercussions on the region may be high socially, because those producers will not be able to meet their most immediate subsistence needs.

If a zone which produces for farm trade is affected, the quantification should be limited to the loss of produce, the evaluation of the country's overall needs and the determination of the need for supplementary imports, if necessary. On the other hand, when the zone produces raw material for industry (sugar cane, sisal, vegetables for canning, etc.), there may be subsequent implications for industry, including the possibility of work stoppages, with impact on employment and the income of those affected. Some industries, such as sugar mills, have their supply zone on neighboring land; when plantations are destroyed and production drops, the days worked at the mill also drop and it is very difficult to supply cane from other regions, due often to shipping costs or other transportation problems generated by the disaster itself.

2. DESCRIBING THE DAMAGE

On describing the damage, the farm evaluator should indicate the type of crop involved and the geographical extent of the damage. If it is a permanent crop, damage will occur in different degrees, depending on whether the crop was totally lost, or only partially damaged, if the damage only

[1] See CEPAL, Los desastres naturales de 1982-83 en Bolivia, Ecuador y Perú, (E/CEPAL/G.1274), 1983
[2] See CEPAL República Dominicana :Repercusiones de los huracanes David y Federico sobre la economía y las cobnciciones sociales, (E/CEPAL/G.1098), 1979.

affects this year's production, etc. The description should be accompanied by a quantification of the affected area and production. This is necessary because the same phenomenon --for example, a hurricane-- may totally destroy plantations in its path but, at the same time, may generate excessive rains which flood some crops, which suffer for that reason --such as banana plants-- or which lose their flower --such as the coffee plant-- due to strong winds. One phenomenon may cause all these different types of damage, so that the evaluator must describe the nature of the phenomenon, in order to be clear with respect to the multiplicity of probable effects when calculating costs.

A hurricane which struck the northern zone of a country on the Central American Isthmus in the 1970s is a good example of this problem.[3] The phenomenon landed on the north eastern Atlantic coast, entering a river valley with an East-West orientation, and damaged a highly productive zone, of excellent soils, the main products of which were bananas, African palm, corn, rice and livestock. The banana plantations, which practically disappeared, were in the centre of the hurricane's path and only 50 km. inland. However, on the other side of the river, 25 kms. further on, there were oil palm plantations which not only resisted the strong winds but also subsequent flooding, for 15 days. The rice and corn planted in the zone practically disappeared, although that located in the upper reaches of the valley survived. As for livestock, nearly all minor stock, such as fowl, pigs and goats, disappeared, as did some of the cattle, which did not manage to find refuge in the upper reaches of the valley. Thus, many ranchers lost their stock, which represented all their capital, not so much because it died but because it moved and, later, did not or was not allowed to return.

The effort should be made to describe the entire range of effects on the farm and livestock sector: on natural resources, on physical infrastructure and working capital; blocked or clogged canals, machinery totally or partially destroyed, dead animals, etc. Disasters usually damage soils, which should also be described in detail to facilitate quantification. Excessive rains may cause landslides or river overflows which destroy farm land, be it good land or not, which can never be recovered, constituting serious economic and ecological damage. A volcanic eruption may cause temporary damage by destroying crops, but may be beneficial in the mid- and long terms by increasing crop yields.

The destruction of terraces, the accumulation of debris, etc, cause losses, but those resources can be restored exactly as they were prior to the disaster. Detailed descriptions will make it possible to identify repercussions on future production or on stored produce or inputs. A hurricane, which also causes flooding, may bring about a drastic reduction in milk and egg production, which may last several months and have a psychological impact on the animals which reduces their productivity. Although the evaluator may be unable to quantify this type of indirect effect, they should at least be mentioned in the report, if deemed appropriate.

It is easier to describe stored produce or inputs because only product type and quantity need be identified, and whether the damage was total or partial. In some cases, a product is only rendered unsuitable for one specific use, while it remains apt for another. For example, damaged corn, originally destined for human consumption, may still serve for fodder.

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[3] See CEPAL, Informe sobre los daños y repercusiones del Huracán Fifi en la economía hondureña, E/CEPAL/AC.67/2), 1974

3. SOURCES OF INFORMATION

Given the limited time available for the task at hand, the evaluator should have recourse to all elements which will make it possible to characterize the phenomenon and the damage it has caused, from the perspective of the farm and livestock sector. For this purpose, potentially useful provisional information, elaborated during the emergency phase, will probably be available.

In fact, one of the first steps taken by the authorities of countries affected by a disaster is to make a rough global estimate of its economic implications and its impact on diverse sectors. Those pre-evaluations identify the most severely damaged zones, the scope of the phenomenon and its impact on the economy. It often occurs that, due to speed with which they are effected and subjective factors related to its impact, the damage and its effects are over-estimated, so that caution is needed on verifying the information contained in those pre-evaluations. They are, however, very useful as a means of identifying affected geographical areas and crops.

Immediately after the disaster, the government concentrates on quantifying the nature of the damage. That information is vital for the evaluator because, usually, experts who reside in the affected regions and know the types of crop involved, the yields and all other indicators needed to refine the report, have participated in those pre-evaluations. Statistical series for several years should also be examined, because they will explain trends and yields in the regions affected and will indicate, in quantitative terms, what the production and its value would have been, had the disaster not occurred. This will make the eventual comparison between the pre-disaster situation and that which obtained after the event possible.

Initially, the evaluator should attempt to gather as much information as possible from diverse sources, even though it appears to be contradictory. This will make eventual verifications possible and allow for the use of that data which the evaluator deems best reflect what happened. For this reason, it is indispensable that the evaluator visit the affected region as extensively as possible. Field trips may, at times, be complicated by damage to the means of communication, so that recourse should be had to air transportation --preferably helicopter-- given the ease with which stops can be made in different places. If visiting the whole region is difficult given the lack of facilities,[4] the evaluator should give priority to field visits in function of the available facilities, the extent of the physical damage (for example, if there are many homeless persons and infrastructure has been destroyed), and according to its economic importance (for example, if coffee plantations, whose production amounts to half of the currency generated by the country, have been destroyed, etc.). At any rate, he/she will have to be selective and should visit that zone which is more economically and socially relevant.

During the visit, local functionaries and persons affected by the disaster, who have first hand experience and information which will aid in the comprehension of the magnitude of the disaster and its effects, should be interviewed. Technicians of different levels and specialties should be contacted; for example, the representative of the Ministry of Agriculture may have an overall vision, while the field technician has a very particularized view of the zone where he/she works. Contact should also be established with the merchants, lenders of services, dealers in agricultural inputs, etc.,

[4]Occasionally, all air transportation is dedicated to emergency activities an is unavailable for other types of missions.

who know the structure and magnitude of local demand for food and raw material originating in or destined for agriculture. All these data will assist the evaluator in the conformation of his/her own vision of the facts.

Preparation for these interviews should involve the definition of what is to be learned in the field. If estimates of damage to infrastructure are not available at the central level, the field visit will be an excellent opportunity for obtaining that information. If, on the contrary, there are unverified estimates, the interviews will make verification possible. To know what is sought or what is needed and how to obtain it are, in brief, essential for the evaluator.

No type of information nor any opportunity to discuss the disaster should be neglected. For this reason, the farm evaluator should interview national personnel who participated in the preliminary evaluation or who are involved in agriculture in different ways; for example, personnel from the relevant planning office, Directors of specialized institutions involved in the zone, such as coffee, cattle, banana, etc. institutes; representatives of coffee grower or cattlemen's associations, dust crop pilots, etc. The same should be done with international personnel active in the affected zone. (Development projects of FAO, PMA, BID, and the World Bank, etc.).

The companies which process agricultural products in the region, such as pasteurizing equipment, packers, canneries, etc., should also be interviewed because they may assist in the appraisal of the effects implied by the lack of raw material and may provide the evaluator with rapid additional indications about employment, recovery times, etc.

Finally, the press may serve as a useful source of knowledge about the phenomenon, specially in the first stage. Press clippings and other journalistic information should be collected.

B. QUANTIFICATION OF DAMAGE

1. DIRECT DAMAGE

Direct effects on the agricultural sector refer to a range of damage to the supply of fixed and circulating capital, which may be broken down into that sustained by arable land (which it may take years to recover); that sustained by infrastructure, including irrigation works, installations, silos, etc.; that sustained by equipment (tractors and other farm machinery); and by stock (of cattle and harvested crops, pasturage inputs, etc.). See Chart 1 for an example.

a) Loss of land

When land is destroyed --by erosion or total sedimentation-- it is difficult to estimate its cost because replacement is not possible. The resource has been lost and nothing can be done about it. In those cases, it should be assigned a value equal to what that land would produce in 10 years, according to average production levels in the zone. For example, if an hectare of bananas produces an average yield valued at 20 000 dollars, in 10 years it would produce 200 000 dollars. And that would be the value of each hectare lost in the disaster.

When land can be totally recovered, even when it has been covered with trees, branches and other debris deposited by flooding, recovery costs can be calculated on the basis of costs for clearing an hectare covered with shrub vegetation. This information can be obtained from a land clearing business, either private or from the national institute of development. The same holds true for destroyed terraces or elevation curves. The farm evaluator should estimate the number of square meters of buildings destroyed and, assisted by civil engineers, calculate the recovery cost of the destroyed resources.

It is difficult to evaluate the damage sustained by land which has been invaded by a foreign agent but which, essentially, has not been rendered useless, as may be the case with a volcanic eruption, accompanied by extensive deposits of ash on land. That land may not produce, in the short term, and only when the situation which originated the disaster has stabilized will nature once again allow vegetation to grow in the region. The time that takes may vary. For example, a volcanic eruption in a Central American country, which occurred when cotton was being harvested, affected its fibre, thus lowering its commercial value. The following year, agriculture could be renewed because the ash layer was not thick and farm machinery managed to mix the ash with the soil. Surely, if the ash deposit had been thicker, recovery time costs would have been greater and, naturally, the direct and indirect effects would have been more severe. The value of lost harvests and of those which could not be brought in, due to adverse conditions, should be included among the indirect effects.

b) Damage to infrastructure and equipment

Production infrastructure (machinery, equipment, irrigation works, warehouses, etc.) may suffer damage. In order to calculate those losses, estimates should be made in each case of the amount lost, in terms of kilometres of irrigation or drainage canal, number of farm or livestock installations totally lost (preferably in m2 constructed), etc. All buildings, insofar as possible, should be calculated in square meters of damaged construction, because, in this way, a civil engineer will be in a better position to calculate replacement costs.

c) Production losses

When crops are completely destroyed by a disaster, the surface area affected should be quantified and the costs incurred by farmers, according to the maturity of the crops should be estimated so as to obtain the total cost of the crops lost. If livestock has been totally destroyed, it will be necessary to determine the number of animals involved, multiply it by the average estimated market value to obtain the total sum involved.

Care must be taken to calculate permanent crops separately from annual crops. The relevant unit values for costs are different in each case. When annual crops are destroyed --depending on the time of year, whether they are dry land crops or whether irrigation is available--, estimates of the cost of replanting damaged areas, both so that farmers ensure their income for the year and so that the country will balance the supply of produce, should be estimated.

Estimating the replacement value of permanent crops is somewhat more difficult. To this end, annual costs involved in restoring the plantation to its former levels of production must be identified. (Income lost while the plantation is growing should be included as an indirect effect).

In some plantations, it will be necessary not only to replant damaged areas, but to repair production infrastructure, such as cables for moving bunches of bananas to packing plants, internal tram ways for moving personnel or inputs, etc. The farm evaluator should also quantify those costs, directly related to production. They are easy to calculate with the aid of local personnel and, specially, the affected farmers or companies.

d) Loss of stock

When the disaster strikes after harvests that have been brought in and they are in silos or warehouses, their condition must be estimated to determine the degree of loss. To this end, the commercial sale price should be applied to lost tonnage. The same procedure should be followed for all inputs lost or damaged, assigning them their replacement value.

In the case of livestock, it is necessary to distinguish among stock being fattened, breeding and stud stock, given that they have different unit prices.

Moreover, some livestock activities --such as poultry production-- can be replaced rapidly; beef husbandry, on the other hand, has high recovery costs and a long time is required. Apart from the capital lost (livestock), the expense required to build the herd back up to its pre-disaster levels should be estimated, in the case of commercial beef production.

In regions of small farm or mixed agriculture, livestock husbandry is usually only complementary to farmer income. Nearly all families have chickens, pigs and some steers. In this case, quantification should distinguish animals of greater value (such as draft animals, given that their disappearance has repercussions for the future) from that of the minor animals which complement farmer income and constitute an important source of protein in the family diet, but are difficult to quantify. In those cases, it is recommended that they be designated as a percentage of total family income and of that of the zone (between 10%, for zones of infra-subsistence agriculture, and 40%, where family subsistence farming is more developed). The judgment about the percentage to be assigned depends on the experience of the evaluator and the value judgments made during the field visits.

Fodder, harvested previously, may also be lost in its storage place, either in silos or packed dry. The recovery costs for silage and dry fodder should be estimated with the aid of local technicians and livestock farmers of the region.

As for the criteria for determining the value of direct damage, it has already been stated that, in most cases, the real replacement costs or market prices of the destroyed goods at the time of the disaster should be used, although efforts should be made to avoid use of the speculative prices which may occur. Some will be easy to calculate, such as the recovery of both capital and production inventories, given that the prices of those elements are usually available in the trade sector.

As for infrastructure, given that buildings are under consideration, costs should be calculated by a civil engineer with the assistance of the farm evaluator, who should prepare an inventory of what has been damaged so as to facilitate the work of the engineer. In some cases, it will be necessary to make small temporary investments, for example, to make an irrigation system operative, which, with its dressed wall channels, has been damaged but is still functional, if the necessary machinery is rapidly available. That cost should be estimated by the farm evaluator, leaving the cost of repairing the walls, which will be made later, to the civil engineer.

2. INDIRECT DAMAGE

Indirect damage consists mainly in farm and livestock production which will not occur during the recovery period. This may be due to the total or partial destruction of land, physical infrastructure, roads, storage capacity, etc. A general rule is to formulate loss estimates in terms of physical volume, taking into account the characteristic productivity level of the affected zone, disagregated by crop type. The cost of the works needed to avoid or mitigate the effects of similar natural phenomena in the future are often included as indirect costs.

Some times, the disaster affects permanent crops during their growth, not destroying them, but limiting that year's production. The most representative case is coffee, in some regions, and fruit, in others. Those crops flower and the permanence of the flower is important for the development of the fruit; if that does not occur, the crop is lost or the yield is of little commercial value. In that case, the evaluator should determine the value of the income not perceived and include it as an indirect effect.

As noted above, certain types of disaster reveal the need to construct defense systems against future disasters. Part of the indirect damage caused by a hurricane in a Central American country was the sequel of floods, themselves caused by excessive rains and the incapacity of the river to evacuate water rapidly to the sea. Large amounts of debris, produced by the natural phenomenon were deposited in the river bed and at its mouth, given the inadequacy mentioned above and the lethargic flow of its waters. This led to continual overflows (nearly every year), making dredging operations at the mouth and along the final stretch of the river necessary. Costs such as these should be included among indirect costs because they constitute investments made to restore normal operational patterns to the zone. Other cases may arise, such as the construction of river banks, rectification of channels, wind break reforestation (in zones subject to high winds, landslides, etc.).

With regard to livestock production, mention has already been made of diminished production due to the emotional impact of the disaster. For example, after a hurricane, chickens cease to lay eggs, animals lose weight, cows produce less milk and, in some cases, cease giving completely, etc. Since quantification for evaluation is difficult, this factor should be assigned its total value, which experience has shown to be not more than 20%. In some cases, when the disaster zone has acquired a degree of industrial specialization (for example, in a zone of dairy production), reductions in local production may be greater and damage more severe. In that case the evaluator should make a more intense evaluation effort, seeking the advice of local experts and, even undertaking field visits and direct interviews with affected persons.

Verifying the state of pasture land and grasses is particularly important in the case of cattle raising. When the disaster involves flooding, the water which covers grasses for a long time may destroy them, as occurs with Star, Jaragua and Taiwan grasses. When this occurs, the cost of re-seeding should be calculated in terms of surface area destroyed. Farm credit banks possess information about those costs.

Where subsistence farming is prevalent, the disaster may produce food shortages, usually corrected through donation or food for work programmes. If those programmes continue after the emergency period itself, their costs should be defined as indirect and be estimated on the basis of the affected population, in combination with a basic food basket, made up of the most commonly consumed foods in the region. The relevant time period is that necessary for subsistence farming to be restored in the zone.

3. UNIT COSTS FOR EVALUATION

In the course of the investigation, the evaluator should obtain price lists from diverse sources, so as to be able to select the most appropriate price for the item being evaluated, when the time comes to calculate costs. The most common lists are: government at cost prices; commercial prices; producer prices; consumer prices; and import prices. The use of these lists is determined by the item in question and its market destination.

a) Government at cost prices

Generally, governments operate imports programmes through which they pass goods along to consumers at subsidized prices. This may occur when food is lacking at the national level or in the case of a particular project. A government may import machinery or subsequently barter for it with domestic produce, using it subsequently in development programmes or selling it through credit programmes run by farm credit banks.

Those governmental acquisition prices, which are usually very low, may be used in very special cases when, for strategic or immediate reasons, the rehabilitation programme will be operated entirely by the government.

b) Commercial prices

Commercial prices for goods and services are indispensable for calculating many of the costs of a disaster. Given that the brief time available makes it difficult to undertake a survey of commercial businesses, the governmental offices which manage price lists, such as the Ministries for Trade or Economy, should be consulted. Commercial prices should be used when inventories are to be replaced (machinery, farm inputs, tools, reproduction stock, etc.).

c) Producer prices

Statistical centres usually maintain broadly focused records of prices paid to farmers for their produce, specially when government entities guarantee prices. Those prices should be used to calculate the cost of goods brought in from non-affected areas of the same country and when, for some reason, commercial prices are not paid. This criterion may also be applied when processing industries which habitually acquire raw material from the affected zone must have recourse to other zones of the country to satisfy their needs. In those cases, the price paid to farmers is used to calculate the cost of goods attributable to the disaster.

d) Consumer prices

The price consumers pay for products is usually higher than that paid to the producer, due to commercialization costs. For some calculations, those prices should be used, specially when the affected population is preeminently urban, as occurs in the case of earthquakes, floods in cities and urban centres, hurricanes which affect population concentrations, etc.

For example, after earthquakes, temporary camps are constructed (which may last years) to attend to the homeless, in which food is distributed free during the reconstruction period. Those costs, attributable to the disaster, should usually be calculated in terms of consumer prices, even though the food comes from aid programmes or donations, involving no cost to the country, because, even so, that food represents an additional cost caused by the disaster.

e) Import prices

Finally, it will occasionally be necessary to import a certain type of good which the affected country does not or cannot produce. In this case, a list of appropriate prices at real, that is, importation, values should be obtained, which include insurance, shipping and commercialization margins. Those items are usually vehicles and all kinds of machinery (tractors, pumps, harvesters), certain kinds of equipment (automatic milking machines, grain elevators, grain dryers, decauville cars, etc.). In this regard, the evaluator should consult commercial firms which deal with the relevant types of product or project managers in government offices which will surely have information about those products for the calculation of project costs.

C. SECONDARY COSTS

In order to calculate the overall effects of damage on the gross domestic product, a chart of production in normal conditions should be prepared, in order to obtain a basis for comparison with anticipated post-disaster production. That comparison is made for all, or for the most important, products, (which involve at least 85% of the affected country's or region's agricultural GDP). Physical and value units should be used, with any of the prices mentioned above which reflect the situation and conditions of the disaster zone (See chart 2). This will make inventory voids visible and reveal global implications for the sector. The identification of those voids and their cost should then be used in the calculation of total costs within the farm and husbandry sector.

Chart 3 presents capital replacement costs, at the farm level, globalizing the data contained in another chart, where they have been disagregated by the different concepts employed in the evaluation. The example contained in that chart will make the evaluators's task of calculating the global estimate easier.

Another chart (whose format is presented in chart 4) should also be prepared which breaks down replacement costs related to damage sustained by the infrastructure which serves the region as a whole. In this case, many items should more properly be evaluated by the civil engineer than the agronomist, although they should be noted in the farm report so that the civil engineer will subsequently make the appropriate calculation.

It is often very important that the analyst include a nutrition appraisal in his/her evaluation, which will identify national food needs for the entire rehabilitation period, from the time of the disaster until domestic produce is once again available. In that appraisal, all available foods should be taken into account, regardless of their source. Chart 5 presents a format which may be useful for that exercise.

D. FINAL RECOMMENDATIONS

tailed evaluation of the farm and husbandry sector, specially when the impact of the disaster has been most significant in that sector --that is, when the disaster has been caused by a hurricane or flooding or drought--, is very important for the global economic evaluation, which is, at bottom, what is being sought. For this reason, the evaluator should prepare beforehand, gathering analytic and explanatory material on the farm sector in the country in question and in the affected zone, if possible. This will include diagnoses, development programmes, farm projections financed by international banks, reports of organizations such as FAO, PMA, IDB, the World Bank, etc.; reports on the country's main exports trade prepared by specialized multinational offices such as UPEB, for bananas, GEPLACEA, for sugar, etc. The reports prepared by the US Department of Agriculture, through the Foreign Agricultural Service, on national farm sectors are also useful, as are the Latin American economic and social progress reports of the ID, and others. Finally, Chart 6 presents a list indicating some farm produce prices.

Chart 1
Damage In the Agriculture and Livestock Sector
(in millions of sucres)

Sector, subsector and headings	Total	Damage Direct	Indirect	Import/export component a/
Total	1794	335	1459	731
Agricultural sector	1633	180	1453	731
Losses of capital	180	180	-	-
- Eroded /silted lands (400 hectares)	40	40	-	-
- Infrastructure including irrigation works	127	127	-	-
- Products in storage	13	13	-	5
Production losses (through abandonment or lack of access	1 063	-	1 063	726
- Coffee (20 000 hectares)	751	-	751	726
- African palm	140	-	140	-
- Corn, beans	95	-	95	-
- Green oranges	67	-	67	-
- Other products	10	-	10	-
Emergency crop programmes	390	-	390	-
Livestock sector	161	155	6	-
Losses of capital	155	155	-	-
- 3 000 head of cattle	105	105	-	-
- Lost/ silted up pasture land (2 500 hectares)	50	50	-	-
Losses from reduced milk production owing to lack of access				

Source: ECLAC, based on figures provided by the Ministry of Agriculture and other sources.

a/ Import or export requirements which cannot be met

Chart 2

Evaluation of Physical and Economic Damage to Agriculture, By Regions and Zone

	Area planted prior to hurricane	General total		Totally		Partially		Value of losses at farm level a/ (thousands of DLLs.)	Percentage structure %
		Hectares	%	Hectares	%	Hectares	%		
National total	475 502	202 239	42.5	84 357	17.7	117 002	24.3	257 127	100.0
Central region	61 451	48 075	78.2	30 067	40.9	10 003	29.3	143 706	55.9
South-western region	56 621	17 826	31.5	9 355	16.5	6 471	15.0	13 994	5.4
Southern region	46 317	12 253	26.5	5 232	11.3	7 021	15.2	15 010	6.2
Eastern region	34 169	21 325	62.4	6 926	20.3	14 399	42.1	10 334	4.2
Northern region	117 393	37 301	31.0	14 303	12.2	22 998	19.6	43 392	16.9
Northwestern region	30 657	11 007	36.1	4 794	15.6	6 293	20.5	3 422	1.3
Northeastern region	128 984	54 292	42.1	13 600	10.5	40 692	31.6	26 692	10.3

Source: Secretary of State for Agriculture

Note: Percentages are calculated with respect to the area planted prior to the hurricanes

a/ Includes capital replacement costs – which, in the case of permanent crops, will be spread over several years – but does not include loss of stockpiles nor the effect of production stoppages, so that these figures do not necessarily coincide with those of chart 1, Section II of this Chapter (Buildings and industrial installations, by type of business).

Chart 3
DAMAGE TO CAPITAL PROPERTY AT FARM LEVEL

Concept		Description of damage	Cost
1.	Affected land	35 hectares covered by sand, totally lost 150 hectares covered by debris, but recoverable	
2.	Irrigation and drainage system	100 km of primary canals 750 km of secondary canals 210 km of clogged drains	
3.	Destroyed machinery and equipment	10 tractors 2 planters 3 pumps 5 trailers 1 pickup truck 7 spray pumps Diverse equipment	
4.	Lost products and inputs	21 tonnes of corn 5 tonnes of corn seed 50 sacks of fertilizer 1 500 lt of gasoline 17 000 burlap sacks	
5.	Other production goods	16 mules 70 bails of hay, etc.	
6.	Buildings and installations	1 silo of 700 m2, built of concrete and brick 2 adobe silos of 950 m2 1 run down milking shed, etc.	

Chart 4
DAMAGE TO INFRASTRUCTURE

Concept	Description of damage	Cost
1. Access roads	70 km of gravel access road in bad condition 2 Bailey bridges of 22 m long, destroyed	
2. Infrastructure	6 km of main line, destroyed from post 14 to post 27 7 intakes, with their equipment 800 m of electrical line 20 telephone posts 1 transformer, etc.	

Chart 5
Nutrition Appraisal

Product	Consumption per inhabitant (kg)	Total consumption (t) 1/	Total post-disaster production (t)	Donations (t)	Necessary allocations (t)	Costs (thousands of ha.)
Corn	125	875 000	670 000	200 000 2/	205 000	205 000
Beans	30	210 000	200 000	3/	10 000	30 000
Sorghum	-	-	-	-	-	
Rice	-	-	-	4/	-	
Wheat	-	-	-	5/	-	

1/ On the basis of a population of 7 million
2/ Donation via Public Law 480 of the Government of the United States
3/ Different donations from friendly countries
4/ Donation from the Word Food Programme (WFP)
5/ Cash donation for the purchase of rice from the Government of the Federal Republic of Germany.

Chart 6
Prices of Some Farm Products

Category and characteristics	Price a/
Tractors	
Ford 6600 77 Hp	16 760
Ford 6610 84 Hp (Imported)	20 590
Ford 6610 103 Hp (Imported)	23 675
TW-25 164 Hp	40 335
Certified Seed (tonnes) b/	
Corn	310
Beans	285
Silage sorghum	175
Grain sorghum	329
Rice	136
Soybeans	274
Wheat	114
Chemicals and insecticides (tonnes)	
Methilic paration 80%	2 170
DDT 100%	1 052
DDT 75%	1 276
BHC	469
Toxafero	789
Fertilizers (tonnes)	
Urea (bulk)	88
(in sacks)	102
Ammonium nitrate (bulk)	70
(in sacks)	81
Ammonium phosphate (bulk)	197
(in sacks)	224
Ammonium sulphate (bulk)	46
(in sacks)	56
Phosphoric acid (bulk)	166
Anhydrous ammonium (bulk)	91
Triple phosphate (bulk)	109
(in sacks)	123
Simple superphosphate (bulk)	46
(in sacks)	54
Potassium chloride (bulk)	110
(in sacks)	125
Potassium phosphate (bulk)	199
(in sacks)	213
Potassium nitrate (bulk)	241
(in sacks)	254
Complex fertilizers	
20-10-10 (bulk)	121
(in sacks)	138
18-12-106 (bulk)	103
(in sacks)	121
17-17-17 (bulk)	165
(in sacks)	185

a/ At Mexican market prices, $2 281.00 pesos per dollar
b/ Certified seed price during the 1987 Spring-Summer cycle

II. INDUSTRY AND TRADE

A. INTRODUCTION

This chapter has been organized in three sections. The first refers to common aspects to be taken into account in the evaluation of the damage caused by natural disasters to industry and trade. The other two sections refer to those two sectors, separately, although according to the same methodology of presentation, namely: general appraisal of the magnitude and characteristics of the disaster within the sector; methodology and sources of information for quantifying direct damage; nature and method of estimating indirect effects; modalities for appraising the impact of both categories of damage on the behaviour of the main macroeconomic variables (secondary effects); and, finally, ways of determining public sector priorities to respond to the demands of both sectors in response to the disaster.

In each section, reference is made to the statistical sources usually available in the countries of the region, to the methodology considered to be the most reasonable in each case, and the type of information to be obtained from official sources during field work and through contacts with industrial and trade associations.

B. ASPECTS COMMON TO BOTH SECTORS

From the perspective of this manual, the two sectors have certain traits in common. Value added is generated in both sectors in large, mid-sized and small establishments. The differences among these three strata mean that the effects of a natural disaster on them will also be different. Large establishments --both in industry and trade-- generate a large part of overall production and, generally, are more modernized than the others. Therefore, in both sectors, they possess a proportionately greater part of the supply of capital. They generally have more solid installations and are often insured against natural disasters.

Although in structural terms, small establishments in Latin America and the Caribbean have been loosing relative weight, a phenomenon clearly observable in census information about their number and the value added they generate, they still maintain an important percentage of employment, both in industry and trade, a rising trend during the 1980s due to the slow growth of productive employment which gave rise to a significant increase of informal activity, specially in trade, and most specially in the large cities. The precarious conditions in which this broad segment operates increase their vulnerability to natural disasters.

Both industry and trade are concentrated in large cities, although trade, specially small establishments, are somewhat less polarized. For this reason, damage to industrial and processing sectors occurs in strict correlation with whether the effects of the disaster under analysis are urban in character or not. That is, when the disaster affects mainly the countryside (droughts, floods), its effects are generally felt less in these two sectors than in others, given their concentration in cities and, among these, in the larger cities. In those cases, however, agro-industry suffers the most. In fact, hurricane force winds in coastal areas have had powerful impact on trade and manufacturing in many capital cities of the region, specially in the countries of the Isthmus and Caribbean, where the principal cities are near or on the coast.

These structural traits of industry and trade clearly affect not only the type and magnitude of the damage caused by a natural disaster but also the needs and support required for rehabilitation. Large establishments which, given the size of their investments in machinery and equipment, buildings and stockpiles, suffer proportionally greater damage, are more likely than smaller establishments to have insurance against this type of damage, as mentioned above, so that their property losses are somewhat mitigated.

Micro-businesses, on the other hand, given that they usually function in the homes of their owners and use basically domestic inputs, react --generally-- with greater flexibility and speed to save stocks of inputs and finished products which constitute most of their assets. Moreover, the urgent need to recover their only source of income means that small tradesmen and artisans rapidly restore their production processes, effecting repairs themselves. For these reasons, experience has shown that mid-sized manufacturing and trade businesses need proportionally more assistance to recover.

C. MANUFACTURING SECTOR

1. GENERAL OBSERVATIONS

In order to generate a general overview of the effects of the disaster on the industrial sector rapidly, thus delimiting the problem and making it possible to refine successive evaluations and formulate an accurate diagnosis of the sector which will enable the authorities to define priorities for sector recovery, the evaluation should begin as follows:

a) Collecting information on industry

Obviously, this is one of the first tasks for the sector evaluator, although the speed with which he/she must act means that action must be selective. In the case of industry, the most relevant information is:

i) the most recent industrial censuses (National Statistical Office) and continued production series (Central Banks and Planning Offices);

ii) periodic surveys (Ministries of Industry and Central Banks);

iii) industrial associations (Bulletins and statistical information);

iv) institutions which group industrial areas (for example, textiles, appliances, construction supplies, etc.);

v) other sector associations such as, chambers of small businesses, industrialized workers' unions, social security institutions, etc.; and

vi) information occasionally available from municipalities (license and permit offices) about the location of businesses in the affected zone.

This background information, complemented by subsequent field work, will be used in both the following two points and in the evaluation of direct, indirect and secondary damage.

b) Delimiting the affected zone

The national authorities responsible for the emergency generally act with great speed, elaborating diagrammes of the affected area and nature of the damage, and occasionally making field surveys which provide a first approximation to the number of industrial establishments destroyed or damaged.

On the basis of familiarity with the affected geographical area and other data provided by the authorities, the attempt should be made, on the basis of the latest available industrial census (complementing that data with the information usually available in industry ministries and municipalities), to estimate the number of affected establishments; their relative size; the employment they generate; and the branch of industry to which they belong.

On the basis of this information, complemented by the periodic evaluations performed by ministries and planning offices, the sector evaluator should form an idea of the industrial process at the time (or period) of the disaster. That appraisal (both quantitative and qualitative) is very important for understanding the circumstances in which the disaster occurred and its possible macroeconomic impact.

The evaluator should conduct an informal survey among the owners or managers of the principal industrial companies affected and, on the basis of that sample, of mid-sized and small industries as well, in order to form an idea of the magnitude and characteristics of the damage done and the most urgent sector needs, both during the rehabilitation stage and for full recovery.

Each of the components of the evaluation: direct damage, indirect damage and secondary effects, are dealt with in greater detail below.

2. DIRECT DAMAGE

Once he/she has formed a general idea of the effects of the disaster on the manufacturing sector, of their geographic extent and the probable type of damage, the evaluator should move on to a more precise estimate.

The most probable direct damage to the manufacturing sector can be grouped as follows: buildings and installations; machinery and equipment; furnishings and transportation equipment; inventories of finished products, spare parts and raw materials; and irrecoverable documents.

These estimates should be made in direct consultation with the governmental instances linked to the sector and relevant associations, groupings, etc. The available official appraisals should be verified in the field. Current replacement prices for lost capital assets can be obtained, from lists of internationally valid unit costs, among other sources; from imports unit prices; or those which appear in the projects which the national development bank may have on hand, and which should, as far as possible, be from industrial areas similar to and of the same size as those which have been affected.

For the propose of calculating damage, it is very useful to address large, mid-sized and small industry separately.[5] Large industries usually have more precise accounting records. In that case, the estimates should be made to a large extent on the basis of interviews with company executives. In the case of small businesses, the weight of immobilized assets, within total assets, is very much less, a fact which, together with the precarious nature of their accounting records, makes it necessary to make rougher and less discriminatory estimates.

The estimate of direct damage usually begins with the total number of manufacturing establishments in the country, with respect to which the number of those affected by the natural phenomenon is projected.

To illustrate the type of methodology which could be applied in the calculation of direct, indirect and secondary damage to the manufacturing sector, a hypothetical example of a natural disaster is presented, as follows.

Suppose that a hurricane has affected the Golf of Mexico, hitting the State of Veracruz, specially the coastal area, with an impact zone of approximately 2 500 km2.

The last available industrial census was used to generate a first approximation to the number of establishments possibly affected, and their characteristics in terms of size, branch of industry, assets value, general production and employment. This information is summarized in charts 9 and 10.

The general characteristics of industry, State-wide, are as follows:

Concept	State of Veracruz	National total	Percentage participation
Number of establishments	6 081	119 212	5.0
Employees (thousand of persons)	53	1 747	3.0
Total fixed assets (millions of pesos)	9.2	171.3	5.4
Value added	5.2	182.8	2.9

This information makes it possible to conclude that, if destruction were total in the State of Veracruz, losses to total national industry would be between 3% and 5.5%, measured either in terms of number of establishments, number of employees, fixed assets or value added. Thus, a "ceiling" is created for the subsequent detailed evaluation.

Another significant fact deduced from census data is that, in the State of Veracruz, 89% of the industrial establishments employed less than 5 persons, but that the large establishments (with more than 250 employees), of which there were around 40, possessed 85% of the physical industrial infrastructure and generated around 80% of the value added. For the sector as a whole, the capital/product ratio was 1.6%. In the example, the industries of greatest weight in the State (from

[5] A conventional definition is: large, those which emply more than 200 workers; mid-sized, those which emply between 200 and 40; and small, those with less than 40 workers

the point of view of capital, employment and added value) were those related to processing cereals, sugar, knitting, fertilizer, petrochemicals, steel, and boat building and repair.

Census data such as these serve, among other purposes, to help verify the data obtained from official surveys and estimates, and direct visits, on the basis of the following adjustment parametres:

> i) the growth of the number and type of industrial establishments between the census year and the year of the disaster, and
>
> ii) the impact of the inflationary process on the values of domestic currency which appear in the census.[6]

Continuing with the example, suppose that a first approximation made by the Emergency Committee indicated that the hurricane had affected around 1 100 industrial establishments, destroying 14 large companies, among which the sugar, boat building and chemical industries were prevalent; it affected some 300 mid-sized and 400 small industries fairly severely; and caused minor damage to another 350, of which 250 were small and 100, mid-sized. To proceed with the evaluation on the basis of this initial information, the four main categories for damage were employed:

a) Buildings and installations

To estimate losses in this area, in terms of replacement prices, it is necessary to know both the physical area destroyed or damaged and the current value of a square meter of industrial space. The latter factor varies according to the size of the company (large companies, with the machinery and technology they employ, require constructions and installations better and more complex than mid-sized businesses and even more so than small industries). Suppose that the information about the 14 large companies was provided by the Ministry of Industry and rectified during field visits and conversations with company executives. The value of a square meter constructed (including installations), at replacement cost, was fixed at around 450 000 pesos (200 dollars).[7] (See chart 1).

The average size of the mid-sized and small establishments, including storage, work shops and sales space, was defined in consultation with business associations at 1 400 and 500 m2, respectively. The price for a square meter of space was defined at 400 000 (some 180 dollars) for the mid-sized businesses and 250 000 pesos (110 dollars) for small industries. For severely damaged establishments (both mid-sized and small), total replacement costs were calculated on the supposition that the cost of demolishing the damaged section would be practically equal to the value of the recoverable section (which would not need to be rebuilt).

Field visits made it possible to conclude that, on the one hand, repair of buildings in mid-sized industries, which had sustained minor damage, amounted to 25% of the total replacement cost of their buildings, and in small industries, 35%.

[6] For example, the gross product of the State of Veracruz, which in 1975 was some 5 200 million pesos (grosso modo some 20 million dollars), as has been seen, would correspond to some 957 billion pesos in mid 1988

[7] The exchnge rate used at the time of this anlysis was 2 250 pesos to the dollar

Thus, total building and installation losses were estimated at around 257 billion pesos (equivalent to some 114 million dollars). (See chart 1 again)

b) Machinery and equipment

As in the previous category, the main problem is to find adequate replacement prices. The values which appear in censuses refer to the accounting records of the companies; therefore, they exclude accumulated depreciation (in function of the number of years of useful life since acquisition). They also reflect acquisition prices (except in some countries with inflation where periodic revaluation of physical assets is encouraged). These limitations are specially severe in the case of machinery and equipment, for which technical change is more rapid, so that the replacement price must take that factor into account.

It is supposed that, as in the case of buildings, the large industrial companies affected have calculated their losses of machinery and equipment directly, in consultation with national authorities. The evaluator then checked those figures with the current value of the destroyed equipment, on the basis of the unit value of recent imports. These data, adjusted in this way, reveal that investments in machinery and equipment (per worker) are currently three times higher in the petrochemical industry than in the sugar industry and seven times higher than in the boat building industry.[8] The respective results are presented in chart 4.

With respect to direct damage in this area in mid-sized and small industries, the example supposes that, given the multiplicity of areas affected and the lack of coherence in the data gathered by direct surveys, the evaluation should base its estimates to a large extent on census parametres, duly evaluated and up-dated. Among the mid-sized companies either destroyed or partially damaged, those related to food processing, clothing, cement and metal working predominate; in contrast, among the small industries, basically food processing, clothing and different forms of repair services were most prevalent.

The starting point for this estimate was the ratio between machinery and equipment, and workers, by area, obtained from the census, which yielded a figure of 60 000 (1975 pesos) for the mid-sized industries, and 20 000 for small businesses. It was then supposed that those assets had been used for half their useful life,[9] so the values were doubled. In this way, the respective coefficient was 9 600 dollars per worker in the first, and 3 200 in the latter category. Then, on the basis of the current exchange rate (2 250 pesos to the dollar), those values were expressed in current pesos. The average number of workers for mid-sized industries was fixed at 30 and, for small industries, 5 workers.[10] As was the case for buildings, it was supposed that mid-sized industries with minor damage lost 25% of their machinery and equipment, while small businesses lost 35%.

[8] Calculated in current dollars, this amount to 27 000, 9 000, and 4 500, per worker, respectively.
[9] That is, the census value represents 50% of their value when new.
[10] Given the type of industrial areas affected, these averages are different from those for the State of Veracruz, as a whole.

c) Furnishings and vehicles

Larger industries usually have a proportionately larger supply of these items, both given the superior working conditions of their employees and because they often have lifts and a fleet of vehicles for transporting raw materials and finished products. (Smaller industries usually hire these services). In order to appraise these elements (depending on the time available and the significance of the damage sustained), current market values for furnishings and vehicles similar to those destroyed should be obtained, hopefully with relative ease.

However, if the weight of this factor is expected to be relatively slight, indirect estimates will suffice. For example, there is a certain proportionality between investments in furnishings and equipment and that in buildings and installations (for all industry in the State of Veracruz, furnishings and vehicles amounted to 60% of the value of buildings and installations). However, it has been observed that that ratio declines in direct relation to the size of the establishment. In the example used here, it is supposed, as in the two previous areas, that the estimates of damage in the 14 large industries affected were obtained directly from them or official sources, with samples being taken only to certify their reliability.

As for mid-sized and small industries, a basically indirect method was used, based on census reports, by area, because in some areas, such as refrigeration and cement works, the relative weight of the fleet of vehicles within total assets is greater. On average, the furnishings and vehicles/building and installation ratio was 50% for mid-sized industries and 20% for small establishments. In the case of companies with more severe damage, the total destruction of these elements was supposed, while for those which sustained minor damage the same percentages of 25% and 35% as for the other two areas discussed above were maintained. The respective estimates are presented in chart 2.

d) Inventories

This category ends the evaluation of damage to the physical assets of the industrial sector. As is known, it consists in: finished products (by the company itself); products in process; raw materials; and other goods (such as spare parts and others not related directly to production).

This is the category most severely affected by natural disasters because, generally due to problems of space, the installations in which inventories are stored are less protected than those which house machinery and equipment.

The 1975 census generated several basic sets of data for estimates of the damage caused by the hurricane to the inventories of the affected industries in the State of Veracruz. It is understood that 30% of total inventories consists in imported products (mainly inputs and machinery spare parts). Then, it was decided that the value of all inventories was equal to 15% of the gross value of manufacturing production and 30% of the fixed assets of industry in that State. On the basis of this information and field work, the estimates presented in chart 2 were made, always assuming that the figures for large companies were obtained from official sources. For mid-sized companies, estimates for those with substantial damage were based on the application of a ratio of 30% damage to fixed assets; while, for small establishments, given their relative scarcity, circulating capital, inventories were estimated at only 15% of fixed assets.

In establishments with minor damage, both mid-sized and small, loss of inventories was somewhat more severe than that of fixed assets, according to the field surveys taken and for the reasons given above; that is, instead of 25% and 35% of their total value (see chart 1), they were estimated at 40% for both strata.[11] Thus, relative losses in this category amounted to 207 billion pesos, three fourths of which were sustained by mid-sized establishments (see chart 2).

Adding this figure to the three previous amounts produces a total of 972 billion pesos in fixed asset losses in the industrial sector, or some 430 million current dollars. As can be observed, within this total, the greatest weight is that of machinery and equipment (35%), followed by buildings and installations (26%), inventories (22%), and furnishings and vehicles (17%).

In order to complete the estimate of the direct damage to the manufacturing sector, the destruction of financial documents in the hands of the affected companies was estimated. Those deemed irrecoverable, according to the estimates of the local Chamber of Industry, amounted to only 5 billion pesos, so that direct losses rose to a grand total of 977 billion pesos.

The imported component of direct losses or, rather, the cash needed to replace fixed assets and inventories destroyed or damaged, should be estimated on the basis of diverse sources (such as, the structure of domestic and imported prices in investment projects available in the Development Bank and macroeconomic statistics relating imports to gross investment). The pertinent research, within the context of the example, yielded the following figures:

	Loss of fixed assets (millions of dollars)	%	Imported component (millions of dollars)
Buildings and installations	114	10	11
Machinery and equipment	151	38	57
Furnishings and vehicles	74	10	7
Inventories	92	30	30
Total	431		105

In brief, industry in the State of Veracruz would require some 100 million dollars for rehabilitation, mainly to import machinery, equipment, spare parts and certain raw materials.

[11] Assuming, as for the previous case, that inventories represent 30% of fixed assets for mid-sized companies and 15%, for small businesses.

3. INDIRECT DAMAGE

Damage to industrial establishments will obviously affect production, both by suspending operations and as a result of the relative scarcity of inputs caused by the temporary interruption of communications and trade channels. The higher costs incurred by use of longer alternative shipping routes should be added as indirect damage and will be specially significant for the sugar and cement industries affected by the disaster. Losses arising from the suspension of exports for these reasons --which occurred with greatest impact on the mid-sized petrochemical and canning companies in the example-- should be taken into account, as well as the tax revenue which the government does not perceive from suspended production and sales. In order to complete the estimate of the indirect effects of the hurricane, the emergency costs incurred by companies to face the situation should be added.

In this example, it is supposed that the estimate of production losses, stemming from damage to the plant itself and supply problems, etc., was made on the basis of data generated by surveys performed by the Veracruz Industrial Association, and verified and corrected on the basis of the calculations presented in chart 12, which presents values of production per worker in the different sizes of establishment and industrial areas.[12] In order to convert those values into current pesos, their equivalent in dollars during the census year was calculated and they were converted once again into pesos, at the current exchange rate (2 250 pesos to the dollar).

The figures of chart 12, relative to production per worker, were multiplied by the number of workers employed by the affected companies, thus producing an estimate of their gross annual product. In function of the anticipated interruption of operations as a result of the disaster and until those establishments would be rehabilitated, fractions of annual production were calculated, in terms of two months, one month or 15 days. Chart 12 presents the methodology utilized in detail and includes the calculation of value added, on the basis of the losses in gross production values. As indicated in the chart, the census VA/VBP ratios calculated according to establishment size and type were used, in the understanding that, by reflecting technological productions relations, they are still valid, given that they change little over time.

The final results of these estimates yield total losses to the gross value of production of 84 200 million pesos (some 37 million dollars), which were generated, by type of company, as follows:

	Millions of pesos
Large companies	14 500
Mid-sized companies	66 800
Small companies	2 900
Total	84 200

[12]The annual figure was divided by six, in the case of large and mid-sized companies, and by 12 for small industries, in order to account for the time during which operations were suspended (two months and one month, respectively).

Contact with the local Chamber of Industry made it possible to form a general notion of which companies were important exporters (petrochemical, cement, tobacco). The conclusion was that, of the 37 million dollars of production lost, 15 million correspond to products which were not exported.

According to the methodology described above, losses of value added were 31 600 million pesos. (See chart 12).

The impact of production losses on public finances was moderate, given that the State would not perceive 4 700 million pesos of value added tax revenue and export tax revenues.

Finally, the impact on employment was negligible, because most companies chose to retain their staffs during the rehabilitation process, using them for debris removal and reconstruction.

Chart 3 presents a summary of the direct and indirect damage to the industrial sector.

4. SECONDARY EFFECTS

In this part of the evaluation, the background data and quantification which --when integrated with the other sectors-- make it possible to appreciate the global effects of the disaster on the main macroeconomic variables should be presented. Given the nature of damage sustained by industry in the example, its effects are only significant at the level of the gross product, the balance of payments and public finance. It is important that the evaluator form an idea of the conditions in which the sector was developing and of sector prospects prior to the disaster. Those elements are basic reference points for weighting the effects of the disaster.

Thus, in the example, it is supposed that, within the global critical period which affected the country beginning in 1982, total GDP growth had been projected at 1.5% and for industry at 2%, for 1983; with a surplus of 8.4 billion dollars in the merchandise account (remainder from 20.6 billion in exports and 12.2 in imports); a situation of relative balance in current accounts; and a financial deficit in the public sector equivalent to 10% GDP.

Within a trend of somewhat more rapid growth in the State of Veracruz than in the rest of the economy during the 1980s given the surge in the petrochemical sector, growth of 3% was foreseen for industry in that State for 1988. The value added by that industry was, in turn, 5.5% of that of all industry in 1987. Chart 4 presents the effects of the disaster on those projections. As can be observed, the losses caused by the storm in Veracruz produced a decline in GDP of around 32 billion pesos (see chart 12), with the result that the industrial growth rate foreseen for that year dropped to practically half of its original value (from 3% to 1.6%), although its impact on national industrial growth, a reduction form 2% to 1.9%, was nil.

The impact of the disaster on the balance of payments did not, in itself, affect national totals nor those of public finance, although their impact will be observable when added to the impact of other sectors on those macroeconomic variables. Finally, the adverse impact on the current accounts balance of payments were 120 million dollars, to which the greater demand for capital from multilateral sources for the reconstruction of petrochemical plants, estimated at 50 million dollars, should be added.

At the same time, the demand on the Government of Veracruz to rebuild the industrial sector, which consisted in a set of small factories, valued at 500 million pesos, should be added to the loss of tax revenue due to lost production. The impact on the balance of payments and public finance is summarized as follows:

Impact on the balance of payments (millions of dollars)

Fewer exports (sugar, petrochemical, cement)	15
More imports (inputs and capital goods)	105
Negative impact on surplus in current accounts	120
Demand for capital from international financial institutions	50

Impact on public finances (millions of pesos)

Reduced value added tax revenues	4 700
Increased local government expense to rehabilitate the industrial base	5 000

5. PRIORITIES FOR RECOVERY AND REHABILITATION

The chapter on industrial sector evaluation ends with an account of the action the government should undertake to facilitate recovery, from the perspective of the businessmen affected. In this regard, the affected industrialists and sector associations and chambers should be surveyed, to reveal what support is needed for sector rehabilitation, both from the public sector and abroad.

D. THE TRADE SECTOR

1. GENERAL OBSERVATIONS

The methodological description of the evaluation of the impact of a natural disaster on trade activities will be much briefer than that of the industrial base because it is very similar to that sector and many points need not be repeated. Moreover, in the example used to illustrate that methodology, detailed reference to sources and calculation procedures will be much briefer, except when sector specificity advise otherwise. In fact, certain characteristics of the trade sector are different from those of the industrial sector and should be kept in mind during the evaluation. These are: the average size of establishments, in terms of employees, is less; the relative weight of machinery and employees is less; the relative weight of machinery and equipment among total physical assets is also less; the opposite obtains with regard to inventories.

The trend noted above in the industrial sector, of the growth of mid-sized establishments as opposed to small businesses, is even more pronounced in the trade sector, where the proliferation of department stores is noteworthy, although their growth has affected mid-sized companies more than small businesses, which endure because they most often serve very peripheral or rural areas. Moreover, information about trade is usually less plentiful and less reliable than for industry, so that the evaluator should rely comparatively much more on the opinions and judgments of sector and professional associations of the country and region under study. For example, there are hardly any continued series of the level of trade activity in any country of the Latin American region, except GDP estimates which are very global and indirect.

Finally, along these same lines, detailed reference will not be made to the methodology and sources used, when they were totally analogous to what was described in detail for the industrial sector.

2. DELIMITING THE AFFECTED AREA

Continuing with the example introduced above, it is supposed that the natural disaster affected a large number of trade establishments of different sizes in the State of Veracruz, with considerable damage inflicted mainly by the rains which followed the storm which destroyed an important segment of inventories and many buildings and their furnishings. The natural phenomenon, which occurred in the coastal area around the port of Veracruz, and destroyed (according to the example followed throughout this chapter) a large number of establishments and small shops, both in the port itself and in three other population centres on the coast.

Chart 5 presents some data from the 1975 census which makes it possible to gauge the relative weight of trade activity in the State of Veracruz within the national total. This is between 4% and 6%, according to the indicator used. Charts 12 and 13 also present statistical data which provide a more detailed characterization of trade activity in that State, according to type and size of establishment. It is known that the Emergency Committee (or the Veracruz Chamber of Commerce) reported, shortly after the disaster, that 2 100 of the 30 000 commercial establishments in the State of Veracruz had been affected or destroyed. That information can be broken down as follows:

	Number of establishments	Destroyed	Partially damaged
Department stores	5		5
Fruit stalls	500	500	
Miscellaneous	1 200	400	800
Shoe and clothing stores	300	200	100
Gas stations and repair garages	50		50
Total	2 055	1 100	955

3. DIRECT DAMAGE

Generally, the information available does not allow for detailed estimates of the areas which constitute the fixed assets of the companies affected. Therefore, the evaluation of direct damage should be broken down into only four categories:

- Buildings and installations
- Furnishings and office machinery
- Inventories
- Debtor documents

a) Buildings and installations

In order to calculate this component, the floor space affected was multiplied by the replacement value of a square meter constructed (the latter element was adjusted to include demolition costs and the value of the commercial installations).

Research in Mexico City to evaluate damage to the trade sector after the earthquake of 1985,[13] concluded that the floor space usually occupied by small shops (which are the majority[14]) varied between 50 and 500 m2, with an average of around 100 m2. That average was used in the exercise presented in this chapter for all establishments affected, except for fruit stalls (or market stalls), for which average floor space was taken from the same source (12 m2) and gas stations and repair garages (500 m2), and department stores (1 500 m2). The replacement value of a square meter of commercial construction (defined in broad terms, as explained above) currently fluctuates around 350 000 pesos per square meter (some 155 dollars).[15] In contrast, for fruit and market stalls, the most acceptable price for a square meter was 100 000 pesos (some 45 dollars). Moreover, the more solid buildings of gas stations and repair garages were appraised at 700 000 pesos per square meter, a price which was also used for department stores. Finally, repairs of partially damaged buildings were estimated, on average, at 30% of their replacement value, in accord with earlier experiences in this regard.

The results of this exercise are presented in chart 6, where it can be observed that three fourths of the value of the damage sustained corresponds to small businesses. Of that value (40 billion pesos), approximately half corresponds to the total reconstruction of buildings and installations, and the other half to repairs.

b) Furnishings and equipment

Generally, these elements have less relative weight among total fixed assets here than in the industrial sector and detailed research to appraise them is not justified. In earlier evaluations, estimates have been used which relate the value of furnishings and equipment to that of buildings and installations. The most adequate figure for that ratio seems to be 20% for small commercial operations and 40% for the rest. The figures in chart 6 were generated according to that criterion, assuming that its weight is similar in both destroyed and partially damaged establishments. The replacement value of furnishings and equipment, calculated in this way, amounts to some 10 billion pesos for the entire trade sector.

c) Inventories

As stated above, this item has great relative weight within the value of the assets of this sector, given its nature as intermediary between producer and consumer. In this case, surveys revealed that, generally, inventories correspond to the value of, at most, two months' sales, on average, throughout

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[13]See ECLAC, Daños causados por el terremoto de México y sus repercusiones sobre la econom?a nacional, (LC/G.1367), 1985

[14]According to the 1975 census, 96% of the commerical establishments in the country employed less than five persons (See Annex IV).

[15]A figure around 150 dollars was used in some earlier ECLAC evaluations

the sector.[16] Moreover, it has been observed that there is also a more or less stable relationship between the value of buildings and installations and that of inventories, perhaps due to the buildings' storage capacities (see chart 14), although this varies according to type of trade. Those ratios were used in the following calculation related to the replacement value of lost inventories in Veracruz a result of a natural phenomenon. (See chart 6).

d) Debtor documents

Finally, losses arising from the destruction of documents or those considered unrecoverable amounted to 5 billion pesos, according to the Chamber of Commerce, and corresponded to 10% of the document portfolio of the destroyed businesses.

Direct total losses to trade thus amounted to 158 billion pesos, that is, some 69 million dollars.

4. INDIRECT DAMAGE

Surveys led to the conclusion that small trade businesses, with official aid, could reopen in one month, and the rest of the trade sector in two months.

In the case of trade, the main function of which is to provide a service, production losses during the period when operations are suspended should be estimated, not on the basis of sales not made (it is not a case, as in the industrial sector, of goods which could not be produced), but rather on the basis of idle cash. This, in turn, for the purposes of this evaluation, can be identified with value added.

To this end, the income (or product) which each worker (sales person or owner) generates, on average, was estimated, for small, mid-sized and large trade establishments. On the basis of annual figures, those for one or two month interruptions were calculated. Chart 7, which presents the respective figures, shows that accumulated GDP losses for the trade sector amounted to 5 600 million pesos (2.5 million dollars). As indicated in that chart, some 10 000 workers were affected, but, given that 90% of them work in small shops (their only source of income), they were employed immediately in rehabilitation tasks; therefore, there was very little unemployment.

No export companies were affected, so that foreign sales were not lost. In contrast, the loss of inventories and equipment requires a certain increase in imports, because, according to Chamber of Commerce estimates, of the 100 billion pesos in lost inventories and the 10 billion in furnishings and equipment, 30% and 20%, respectively, were imported and must be replaced. In dollars, those additional imports, together, amount to some 15 million dollars.

5. SECONDARY EFFECTS

Finally, the loss of 5 600 million pesos of value added in trade meant a 3% decrease in anticipated GDP growth in that sector, to 2.4%. The impact at the national level was insignificant (from 2.0 to 1.9%). (See chart 9).

[16] This estimate was ratified by census data of trade in the State of Veracruz in 1975, when annual sales were 14 200 million pesos and accumulated inventories were 2 100 million.

The impact on the trade balance was only an additional 15 million dollars in imports; on the public sector, lower value added tax revenues, amounting to 3 100 million pesos (calculated as 15% of the value of gross sales not made, estimated, in turn, at 20 700 million pesos).[17]

[17]These were calculated on the basis of the census ratio between the value added tax and the gross value of trade sales in the State of Veracruz, which was 0.27.

Chart 1
Industrial Buildings and Installations by Type of Company: Calculation of Damage
(at replacement prices)

Company	Area affected in m^2	Cost per m^2 constructed	Total value (millions of pesos)
Totals			257 075
Large	20 000	450	9 000
10 sugar companies 1/	6 000	450	2 700
2 boat building companies	5 000	500	2 500
2 resin and synthetic fabric companies			
Mid-sized			
300 severely damaged 2/	420 000	400	168 000
100 with minor damage	140 000	100	14 000
Small			
400 severely damaged	200 000	250	50 000
250 with minor damage	125 000	87 000	10 875

1/ In this example it is supposed that these companies, which are among the most important in the State of Veracruz, gave indirect information about affected floor space.

2/ Average floor space per establishment: 1 400 m^2 for mid-sized, and 500 m^2 for small businesses.

Chart 2
SUMMARY OF DIRECT DAMAGE TO THE INDUSTRIAL SECTOR IN TERMS OF FIXED ASSETS AND INVENTORIES

Companies	Number of companies	Employment (number of persons)	Buildings and installations	Machinery and equipment	Furnishings and vehicles	Inventories	Total
Total	1 064	6 250	257.1	340.4	167.5	207.0	922.0
Large companies	14	1 800	14.2	90.2	14.5	35.0	153
Sugar mills	10	600	9.0	24.6	7.0	8.0	48.6
Boat builders	2	800	2.7	16.0	5.0	12.0	35.7
Petrochemical plants	2	400	2.5	49.6	2.5	15.0	69.6
Mid-sized	400	1 200	182.0	232.2	141.0	160.0	715.2
Severe damage	300	9 000	168.0	216.0	134.0	155.0	673.0
Minor damage	100	3 000	14.0	16.2	7.0	5.0	42.2
Small	650	3 250	60.9	18.0	12.0	12.0	102.9
Severe damage	400	2 000	5.0	14.4	10.0	11.0	85.4
Minor damage	250	1 250	0.9	3.6	2.0	1.0	17.5

Source and methodology: See accompanying text.

Chart 3
INDUSTRIAL SECTOR

	Damage		
	Total	Direct	Indirect
A) Summary of direct and indirect damage (billions of pesos)			
Fixed assets	765.0	765.0	-
Inventories	207.0	207.8	-
Documents	5.0	5.0	-
Production losses	84.2	-	84.2
Total	1 061.2	977.0	84.2
B) Foreign component (millions of dollars)			
Increased imports			105
Fewer exports			15
Total negative impact on trade balance		180	

Chart 4
IMPACT OF THE DISASTER ON INDUSTRIAL GROWTH
IN THE STATE OF VERACRUZ WITHIN THE NATIONAL TOTAL

Industrial sector GDP (billions of pesos)					
	1987	1988			
		Anticipated prior to the disaster		After the disaster	
		Growth rate	Absolute value	Growth rate	Absolute value
National	43 700	2%	44 700	1.9	44 238 1/
State of Veracruz	2 400	3%	2 470	1.6	2 438 1/

1/ Obtained by subtracting losses of 31,600 million pesos of GDP, calculated in the chart, from the value anticipated prior to the disaster.

Chart 5
STATE OF VERACRUZ: TRADE OF 1975

		Participation on the national total, %
Number of establishments	29 500	6.5
Persons employed	62 500	5.7
Fixed assets (millions of pesos)	1 193	4.3
Sales (millions of pesos)	14 218	4.3
Value added (millions of pesos)	3 853	4.3

Chart 6
LOSSES IN FIXED ASSETS AND INVENTORIES

	Losses in fixed assets	Losses in inventories	Total fixed assets and inventories
		(in billions of pesos)	
Small shops	38.9	70.0	108.9
Department stores and others	11.4	32.5	43.9
Total	50.3	102.5	152.8

Chart 7
TRADE: CALCULATION OF LOST VALUE ADDED

	Number of establishment	Employment		Annual value added per worker (in thousands)		Accumulated losses2/ (in millions of 1988 pesos)
		By establishment1/	Total	Dollars1/	1988 pesos	
Small shops	1 500	5	7 500	2.5	5 600	3 500
Fruit and market stalls	500	3	1 500	1.5	3 400	425
Gas stations and repair garages	50	15	750	5.0	11 200	1 400
Department stores	5	15	75	10.5	23 600	300
Total	2 055		9 825			5 625

1/ Calculated on the basis of the 1975 census for similar types and sizes of establishment. The valid exchange rate was 12.50 pesos to the dollar.

2/ Annual values (calculated by multiplying the value added per worker by the total employment in affected establishments) were divided by 12, for small shops, and by 6, for the rest, to account for GDP not produced, during the interruption of one or two months.

Chart 8
TRADE: IMPACT OF NATURAL DISASTERS ON GDP GROWTH

	1987	Previsions for 1988	
		Prior to the disaster	After the disaster
		(1987 prices)	
GDP generated by trade			
a) In billions of pesos			
Veracruz	1 770	1 820	1 814
National total	41 100	41 900	41 894
b) Trade rates of growth			
Veracruz	2.0	3.0	2.4
National total	0.6	2.0	1.9

Chart 9
CHARACTERISTICS OF MANUFACTURING INDUSTRY IN THE STATE OF VERACRUZ
BY BRANCH

		Number of establishments	Persons employed	Fixed assets: Total	Fixed assets: Machinery and equipment	Fixed assets: Buildings and other constructions	Fixed assets: Furnishings and transportation equipment	Added Value (million)
						(millions of pesos)		
201	Fruit and vegetable processing and canning	12	1 445	30	18	9	3	40
202	Cereals and other grain processing and mill products	1 973	4 675	258	128	98	32	251
203	Sugar mill and alcohol distillation	215	15 673	2 411	1 773	357	281	1 047
204	Slaughter house and meat processing, preservation and packing	12	78	8	1	7	-	4
205	Processing and treatment of milk products	45	350	65	40	13	12	18
207	Wheat products	794	3 215	136	61	32	43	182
208	Chocolate, candy, sweets, syrups, concentrates and colouring agents for food	11	328	118	84	30	4	37
209	Diverse food products	875	2 976	126	85	21	20	178
211	Elaboration of alcoholic beverages, except malts	17	110	3	1	1	1	6
213	Elaboration of sodas and non-alcoholic beverages	60	2 076	154	78	17	59	198
220	Processing and production of tobacco products	14	844	19	11	4	4	38
231	Preparation, spinning, knitting and finishing of white fibres, except crochet	13	4 405	523	404	110	9	460
239	Crochet and other textile products	4	117	2	1	1	-	1
241	Outer wear garment factory	446	781	6	3	1	2	16
243	Other articles made from textiles and other materials, except clothing	85	135	2	1	1	-	3
251	Footwear factory, except those made of rubber or plastic	34	87	1	1	-	-	2
252	Leather and skin and artificial materials factory	52	151	2	2	-	-	5
261	Lumber, plywood and similar products	3	17	2	2	-	-	1
263	Other wood and cork products, except furniture	87	225	2	2	-	-	6
271	Building and repair of furniture and accessories, except those of metal and molded plastic	273	242	7	4	2	1	11
281	Wood cellulose, paper and cardboard	4	1 243	516	430	72	14	327
291	Editorial industry	17	232	20	15	3	2	15
292	Printing, binding and similar activities	135	507	17	13	2	2	18
301	Basic industrial chemical production	6	540	373	323	32	18	165
302	Fertilizers and plaguicides production	5	2 436	1 534	1 231	257	46	555

Chart 9 (continuation)

303 304	Resins and synthetic or artificial fibres, paints, varnishes, lacquers and the like, soaps, detergents, perfumes, cosmetics production	5	1 009	374	346	14	14	94
305	Pharmaceutical and medicinal production	5	423	85	53	24	8	56
309	Other chemical products	6	22	1	1	-	-	1
321	Rubber goods	12	115	9	8	-	1	8
322	Plastic materials and products	5	14	1	1	-	-	1
331 332	Earth, china and porcelain articles and those of glass and glass products	4	546	302	289	-	13	201
333	Clay products for construction	198	506	4	1	2	1	6
334	Cement, lime and plaster production	10	854	504	382	104	18	105
335	No metals minerals industries	113	736	23	13	3	7	27
341	Basic iron and steel industries	5	4	1 222	1 100	9	13	682
351	Farm implements and hand tools, hard ware and iron work	281	693	10	6	2	1	18
353	Metal structure products, tanks, boilers and the like	10	1 098	83	78	2	3	79
359	Other metal products, except machinery and equipment	22	156	9	7	1	1	15
361	Building, assembly and repair of farm machinery, implements and tractors	10	41	1	1	-	-	2
363	Building, assembly and repair of machinery, and equipment for specific industries	13	484	20	13	3	4	48
364	Building, assembly and repair of office machinery	41	84	1	1	-	-	2
369	Building, assembly and repair of machinery, and equipment for common use in several industries	90	1 136	97	86	2	9	142
371	Building, assembly and repair of transformers, motors and other machinery and equipment for the generation and use of electrical energy	7	68	1	1	-	-	4
379	Building of other apparatus, accessories and electrical supplies	6	36	-	-	-	-	1
381	Building and assembly of automobiles, busses, trucks and sub-parts	19	250	12	7	4	1	14
383	Building and repair of ships, aircraft and their parts	15	1 981	312	111	67	134	128
393	Jewelry, silver work and paste jewelry production	17	45	1	1	-	-	1
399	Other manufacturing industries	17	45	1	1	-	-	2
Total		6 081	53 499	9 307	7 219	1 307	781	5 222

Source: 1975 industrial census, Secretary of Programming and Budget of Mexico.

Chart 10
INDUSTRY IN THE STATE OF VERACRUZ BY ESTABLISHMENT SIZE 1/

	Number of establishments	Persons employed	Fixed assets (millions of pesos)	Value added (millions of pesos)
	1. Absolute values			
Total	6 106	66 146	11 550	7 434
Up to 5 persons	5 556	10 431	192	224
From 6 to 50 persons	539	6 955	402	397
From 51 to 250 persons	69	7 704	1 082	8 063
251 or more persons	42	41	9 874	5 950
	2. Percentage structure			
Total	100.0	100.0	100.0	100.0
Up to 5 persons	89.4	15.8	1.7	3.0
From 6 to 50 persons	8.8	10.5	3.5	5.3
From 51 to 250 persons	1.1	11.6	9.4	11.6
251 or more persons	0.7	62.1	85.5	80.0

	Persons per establishment	Fixed assets per person ratio (thousands of pesos)	Capital/product ratio
	3. Significant ratios		
Total	11	175	1.55
Up to 5 persons	2	18	0.85
From 6 to 50 persons	13	58	0.01
From 51 to 250 persons	112	140	125
251 or more persons	978	241	1.66

Source: Annex 1.

1/ The figures in the chart include mining activity; therefore they differ from those of Annex 1 which refer only to manufacturing.

Chart 11
MACHINERY AND EQUIPMENT LOSSES IN SMALL AND MID-SIZED INDUSTRIAL COMPANIES

	Number of companies	Total employment	Machinery and equipment per worker			Total (billions) (5 x 2)
			Census 1975	Value new a/	Millions of current pesos	
			(thousands of 1975 pesos)			
	(1)	(2)	(3)	(4)	(5)	
Mid-sized						
with major damage	300	9 000	60	120	24.0	216.0
with minor damage b/	100	3 000	15	30	5.4	6.2
Small						
with major damage	400	2 000	20	40	7.2	14.4
with minor damage c/	250	1 250	8	16	2.9	3.6

a/ It was supposed that census values reflected the value of the equipment half way through its useful life.
b/ 25% of assets destroyed.
c/ 35% of assets destroyed.

Chart 12

ESTIMATE OF LOSSES IN TERMS OF THE GROSS VALUE OF INDUSTRIAL SECTOR PRODUCTION

	Number of companies	Number of workers	Gross value of production per worker (thousands of 1975 pesos)	(thousands of dollars)	(thousands of 1988 pesos)	Gross value of total annual production (millions of current pesos)	Gross value of production	Value added of lost production a/	VA / VBP ratio
Total	1064	16 050	-	-	-	-	84 200	31 600	0.37
Large companies	14	1 800	-	-	-	-	14 500	6 500	
Sugar mills	10	600	164	13	29 200	17 500	2 900 b/	1 200	0.4
Boat builders	2	800	90	7	15 700	12 600	2 100 b/	1 500	0.70
Petrochemical	2	400	180	14	31 500	56 700	9 500 b/	3 800	0.40
Mid-sized	400	12 000	220	17	38 200	-	66 800	23 400	0.35
With major damage	300	9 000	220	17	38 200	343 800	57 300 b/	-	
With minor damage	100	3 000	220	17	38 200	114 600	9 500 c/	-	
Small	650	3 250	80	6	13 500	-	2 900	1 700	0.60
With major damage	400	2 000	80	6	13 500	27 000	2 200 c/	-	
With minor damage	250	1 250	08	6	13 500	16 900	700 d/	-	

a/ Calculated on the basis of the census ratio between the aggregate value and the gross value of production, by company size and type.
b/ Calculated on the basis of a production interruption of two months.
c/ Calculated on the basis of a production interruption of one month.
d/ Calculated on the basis of a production interruption of fifteen days.

Chart 13
CHARACTERISTICS OF THE TOTAL NATIONAL TRADE SECTOR 1975

By number of persons employed	Number of establishments	Persons employed (thousands)	Persons per establishment	Value added (millions)	Value added per person (thousands)
Total	473 202	1 102	2.3	89 059	81
Up to 5	455 479	682	1.5	23 745	35
From 6 to 25	14 002	161	11.5	23 627	147
From 26 to 100	3 181	144	45.0	23 470	163
More than 100	540	115	213.0	18 217	158

Chart 14
CHARACTERISTICS OF TRADE IN THE STATE OF VERACRUZ
BY ACTIVITY, 1975

Purchases and sales by activity		Number of establishments	Persons employed	Fixed assets	Inventories	Amount of sales	Value added
				(millions of pesos)			
Total		29 494	62 472	1 193	2 129	14 217	3853
611	Unprocessed food	2529	3 507	29	38	320	88
612	Livestock and food of animal origin	2914	4 239	44	14	358	138
613	Processed food, beverages and tobacco	15 474	26 187	3 090	313	3278	313
621	Clothing, accessories and textiles	3 255	6 476	85	320	1071	305
622	Personal items (except clothing)	620	1 777	27	76	351	114
623	Other personal items	1 059	2 729	54	153	721	178
631	Appliances	520	2 026	42	163	616	220
632	Other household items	822	1 262	11	30	121	38
640	Department stores	200	3 514	87	248	1798	468
650	Gas, fuels and lubricants	410	2 096	110	22	1110	233
661	Farm and forestry raw materials	4	159	2	4	57	12
622	Construction materials	715	3 036	122	270	1163	340
669	Other raw materials	137	315	6	12	74	22
671	Machinery, implements and spare parts	68	567	20	93	446	139
672	Office equipment and furniture	41	209	9	17	88	29
673	Technical and scientific equipment	13	49	1	2	11	4
680	Transportation equipment and accessories	479	3 744	145	326	2241-	666
691	Real estate	5	7	1	6	3	1
699	Diverse articles	229	573	6	22	248	37

Source: 1975 trade census, Dirección Nacional de Estadística y Censos de México

MANUAL FOR ESTIMATING THE SOCIOECONOMIC EFFECTS OF NATURAL DISASTERS

Part Five

GLOBAL EFFECTS OF DAMAGE

INDEX

I. SUMMARY OF DAMAGE

The first part of this manual provides a detailed description of the general methodology and the best sources of information for evaluating the full scope of the damage caused by a natural disaster. On the basis of the conceptual definitions presented, and before going on to the chapter on estimating the effects of this phenomenon on the principal macroeconomic aggregates (such as economic growth, public finances, inflation or employment), this chapter will describe a methodology for quickly obtaining a summary of the direct and indirect damage, which can then be used, in aggregate form, to evaluate the global impact of the disaster.

It is worthwhile reviewing what was discussed in the chapter of part one that deals with the definition of damage and other effects of a disaster.

In schematic terms, the effects of a natural phenomenon were categorized in that chapter as follows: those which have an impact on capital stock (direct damages); and those that affect production flows of goods and services (indirect damages), which in turn are reflected in the behaviour of the principal macroeconomic aggregates (secondary effects). The first-mentioned (direct damage) occurs, generally speaking, at the time of the disaster, or a few hours thereafter; the last two types of effect, on the other hand, involve the idea of duration and, depending on practical experience and the magnitude of the phenomenon, are understood as lasting for a period of up to five years.

From the standpoint of the objectives of the evaluation, it is essential to sum up the damage done, and this recapitulation makes it possible not only to evaluate the global order of magnitude of the damage (and the financial cost to the economy for the repair or replacement of what has been damaged) but also, in doing so, to identify the most severely affected economic and social sectors, distinguishing between damage to the public sector and damage to the private sector. Lastly, the summary of damage should include a list of imports which it is estimated will be required as a result of the external component involved in repair or replacement in connection with direct damage, and these import requirements should be listed separately in each of the sectoral evaluations.

The information contained in the summary of damage discussed in this chapter is also fundamental for determining what activities will have priority in the rehabilitation and reconstruction programme being elaborated by the authorities of the country affected by the disaster.

As indicated earlier, this summary is an attempt to calculate the quantifiable effects on capital stock and on production flows, which in turn simply represents the aggregation of direct and indirect damage. This is a somewhat hybrid concept, which is justifiable from the standpoint of the objective being pursued, namely, to arrive at an evaluation of the entire scope of effects caused by the disaster in the "first round".

The summary should not, therefore, include the secondary effects; otherwise duplications will occur. As stated repeatedly, secondary effects measure the impact of direct damage on the medium-term behaviour of the principal macroeconomic variables and on the fundamental balances of the economy (balance of payments, public finances and inflationary processes).

The global evaluator will prepare the chapter summarizing the damage by constructing a table or tables which will aggregate the information supplied by each sectoral expert concerning direct and indirect damage. The sectoral experts, in turn, will be alert to the possibility that the indirect damages of a disaster might produce net benefits to the society rather than harm or losses. If these are deemed to be significant, they should be estimated and subtracted from the total damage figure.

Table 1 presents a summary of damage. As can be seen, it is recommended that the damage be disaggregated by sector, as to whether it affects the social sectors, economic infrastructure or productive sectors, in accordance with the corresponding order followed throughout this manual.

Depending on the amount of time, information and human resources available, it may be feasible in the part of the summary table concerning direct damage, to break down damage to the following: a) buildings (including those that have been completely destroyed and those that can be repaired); b) machinery and equipment; and c) stocks, as in the case of damage estimates made by evaluation teams following an earthquake.[1]

In this case, the summary table would have a more detailed format (see table 2), maintaining the breakdown between public and private sectors and presenting a slightly different sectoral breakdown than in table 1.

On the basis of table 1 (or, where possible, the breakdown shown in table 2), the global expert would describe in the corresponding text of the report the total amount of the damage, and then characterize it as to its nature, the most severely affected sectors, the disaster's relative impact on the public and private sectors and the resulting import requirements, and would then draw conclusions about the financial requirements (both internal and external) for repairing or replacing what has been damaged.

[1]See ECLAC, Damage caused by the Mexican earthquake and its repercussions upon the country's economy (LC/G.1367), Santiago, Chile, 1985

Table 1
Summary of Damage Caused by the Disaster

	Million in pesos			Million in Dollars		
	Total	Direct	Indirect	Total	Direct	Indirect
Total						
Social Sector						
Housing						
Health						
Education						
Infrastructure						
Water and Sewage						
Communications and transport						
Energy and electricity						
Economic Sectors						
Agriculture and cattle						
Raising						
Industry and Commerce						
Other Sectors						
Emergency expenditures						
Demolition and removal of debris						

a/ Calculated with average exchange rate from pesos to US Dollars

Table 2
Estimation of Direct and Indirect Damage for Public-Private Sectors

		Total									Direct			Indirect	
Sector, Sub-sector	Total	Public	Private	Total	Repair Public	Private	Total	Building public	Private	Total	Equipment total	Inventory	Total	Public	Private
Total															
Social Sectors															
Housing															
Health															
Education															
Infrastructure															
Water and sewerage systems															
Communication and transportation															
Energy and electricity															
Economic sectors															
Agriculture and cattle															
Industry and commerce															
Other sectors															
Emergency expenditures															
Demolition and removal of debris															

II. GLOBAL EVALUATION

The final chapter of the evaluation should provide an overview that will help determine the full extent of the disaster's socio-economic impact, both on national economic development as a whole and on each of the main variables, highlighting the sectors or areas which were hardest hit and the period of time over which they will continue to feel the effects. It should therefore note, inter alia, losses of assets; ecological damage; and the impact of the disaster on the rate of economic growth and income, the external sector, public finances, employment, the level of prices and inflationary processes.

Below is a description of the content of this global chapter; the different concepts used are spelled out and a few suggestions are made as to a methodology for elaborating the chapter in relation to:

?? the globalist's functions and the general content of the global chapter on evaluation;
?? the situation before the disaster: recent economic development; some outstanding features; and economic policy priorities;
?? the behaviour that had been expected during the year of the disaster before the disaster occurred; and
?? the post-disaster situation; general economic effects - on the rate of growth and the population's income; on the external sector and the balance of payments; on public finances; on employment; and on prices.

A. FUNCTIONS OF THE GLOBALIST AND ELABORATION OF THE GLOBAL CHAPTER ON EVALUATION

In general, the globalist shall elaborate his chapter on the basis of reports prepared by sectoral experts. However, on his own, he shall also obtain information and evaluations in the disaster area concerning the macroeconomic effects of the disaster. To that end, he shall establish contact with globalist economists in economic ministries or departments.

There are two approaches to understanding the global "dimension", which are complementary and not mutually exclusive. In the first approach, it is arrived at by looking at the disaster in terms of the behaviour of the broad aggregates and their interrelationships. In the other approach, the impact of the disaster is determined by piecing together sectoral, regional or partial information. Taking these two approaches simultaneously, the globalist can verify the consistency of different estimates in order to obtain more reliable results.

Another fundamental goal of the globalist's field work should be forming his own view of the economic behaviour that was expected to take place before the disaster occurred and how that behaviour had been reflected in the main aggregates, both in the year in which the disaster occurred and in the following year or years. This topic will be raised again in the next section.

In addition to the "global chapter" - that is, the chapter which summarizes the repercussions of the disaster on the economy and society - the globalist shall be responsible for other aspects of the evaluation described in this manual. One aspect consists of "recapitulating" the direct and indirect damage included in the above section; frequently, he is also the one who must calculate the financial implications it will have for the economy, and both the additional financial and technical cooperation the international community will be expected to contribute during the rehabilitation and reconstruction process, which typically lasts for two years but which, in certain cases - depending on how great the impact is - has lasted up to five years.

The initial part of the evaluation report generally includes an introduction with a very succinct description of both the characteristics of the disaster and how extensive its impact was. The globalist's participation in this task is also important.

A general recommendation to sectoral evaluators that ties in with the globalist's work is that, in so far as possible, direct information should be presented in physical magnitudes. It will thus be possible, if necessary - which occurs especially in high-inflation countries - to make assessments at replacement value or adjust assessments based on cost of acquisition according to the replacement value, which is crucial to determining the financial requirements for restoring destroyed or damaged assets.[1]

The global evaluation should give the net results; in other words, the difference between the negative and positive effects. The recovery of the construction sector, for example, is a phenomenon that starts to become apparent in a relatively short time and that to some extent compensates for the lower levels of activity being projected for most productive sectors.

The global chapter may include a number of headings, such as "Effects on economic development" or "Repercussions of the disaster on the economy"; in certain cases, the phrases "in the short term" or "in the medium or short term" may be added, depending on how far into the future the effects of the disaster are projected. As indicated, most of the time, such projections are limited to a maximum term of five years, although the destroyed urban services infrastructure and the devastated farmland, woodlands and other plantations may take longer to replace; this should be reflected in the report.

B. THE PRE-DISASTER SITUATION

As mentioned, one of the globalist's functions will be to form his own fully developed idea of trends in the economy in question prior to the occurrence of the disaster, of its main problems and the salient features of the economic policy that was being implemented. This is a necessary backdrop for assessing how the disaster affected the economy and key areas of the country's economic policy, and the new challenges being posed to the economy. Central banks, planning ministries and ECLAC itself prepare annual reports or have the necessary information to develop this topic.

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[1] One of the chapters in Part I of the manual sets forth the criteria for appraising direct damage and discusses the advantages and disadvantages of using the "acquisition" or "replacement" cost, depending on the situation. In this connection, the necessary flexibility must be maintained. In some cases, it may be useful to give both results, for this will show both the cost of the losses and give an idea of their replacement value (which takes into account the technological improvement deemed necessary to include when replacing destroyed assets). The relevance of this latter option is obvious in the case of the destruction of makeshift human settlements

C. BEHAVIOUR EXPECTED DURING THE YEAR OF THE DISASTER

The globalist shall play an outstanding role in this respect. Based on often fragmentary interviews and information, he shall formulate projections on how the economy had been expected to function prior to the occurrence of the disaster and how this might have been reflected in the main aggregates: economic growth, inflation, exports, imports, balance of payments, external debt, etc. This speculation will be of great use not only in his work, as has already been seen, but also in the work of other members of the evaluating team.

The most important global sources of information used to evaluate such trends generally include, inter alia: i) projections of economic growth for the year - at times semester or even quarterly projections are also elaborated by planning offices or ministries or by central banks; ii) the fiscal budget adopted and budget estimates for the following months made prior to the occurrence of the natural disaster (Ministries of Finance); and iii) some other macroeconomic statistics generally compiled by Statistics Institutes: harvest growth index, trends in the manufacturing industry, monthly inflation trends, urban unemployment surveys, etc. By extrapolating on the trends shown by these statistics during the months for which they are available, the globalist will be able to estimate what the annual behaviour would have been had the disaster not occurred.

It is more difficult for the globalist to obtain global assessments of how the economy is functioning in the disaster-struck area or region, since planning ministries, regional development corporations, and state or provincial governments have only very recently begun to implement statistical programmes at the regional level. Naturally, the availability of this type of information would be extremely useful for the global expert's characterization of the situation and of the disaster area's economic outlook.

In projecting the macroeconomic effects of the disaster on the balance of payments, trends in the main balance-of-payments aggregates must be analyzed, e.g., exports, imports, external financing, levels of international reserves and of external indebtedness. Trends in the prices and supply of the chief export products must also be taken into account in projecting the level of pre-disaster exports. This topic will be taken up again later. The estimated amount of the debt service is another vital element; the viability of making payments must be considered in the light of the new financial conditions and requirements that will emerge in the wake of the disaster.

The same holds true with regard to other major macroeconomic aggregates: among the most significant are public finances - including the projected deficit before the disaster occurred - trends in the consumer price index and in employment.

D. SITUATION FOLLOWING THE DISASTER

1. GENERAL ECONOMIC EFFECTS

On this subject, the report should present, first of all, a summary appraisal of the disaster's repercussions in all economic sectors. This summary must include both losses of existing assets (direct damage) and the interruption of flows of assets (indirect damage), as well as secondary effects on the main macroeconomic variables mentioned earlier. The object is basically to recapitulate and analyze the data in table 2, which illustrate the extent to which the disaster has damaged physical infrastructure and natural resources, interrupted the production of goods and services and boosted import requirements, for a period which is conventionally set at two years but which can last up to five, depending on the magnitude of the disaster.

This analysis is essential for designing rehabilitation and reconstruction programmes and for targeting the international cooperation that may be required. For the latter purpose, the various amounts often must be shown not only in local currency - at current prices of the period in which the evaluation was carried out-, but also in their equivalents in United States dollars. The text should also summarize the disaster's effects (which should later be disaggregated) on economic growth, per capita income, employment, inflation, exports and imports, and public finances.

The disaster's impairment of the normal functioning of the economy should be described in terms of its effects on economic infrastructure and stocks; transportation routes; ports, airports and communications; the marketing network; the generation of energy; the availability of national and imported inputs; tourist facilities; higher prices for certain products; the availability of foreign exchange; etc. All these factors should be viewed from the perspective of the economy's trends and characteristics at the time of the disaster. The corresponding analysis could be supported by a table summarizing the main economic indicators for the most recent period, and how the disaster has affected them (see, for example, table 3).

2. EFFECTS ON ECONOMIC GROWTH AND INCOME

The aggregate that best expresses variations in the overall level of economic activity is the gross domestic product (GDP). The globalist expert should, therefore, estimate the disaster's effects on the growth rate of this variable, and the extent to which they alter the rate projected before the disaster. As stated previously, these calculations are generally relevant for one to two years beyond the year of the disaster.

Constant prices - preferably current prices at the time of the evaluation- should be used in the calculations to illustrate the disaster's real effects on the economic growth rate. The expression of the main aggregates that make up domestic supply (gross output by branch of activity) and demand (expenditure for public and private consumption and capital formation) in current values for the year or period in which the disaster occurred often poses a statistical problem, since, in many countries of the region, these figures are only available in constant prices of a given year (usually a census year, such as 1980).

The globalist expert must therefore consult with national experts in order to select the most appropriate and reliable price index (be it the GDP deflator, the wholesale price index or the cost-of-living index) for converting these figures into current values of the year in which the disaster occurred. This conversion is vital for correctly estimating the magnitude of losses in GDP or income caused by the disaster, and their effects on the expected growth rate. Once this adjustment is made, data for the following year (or the following two or more years) should be expressed, to the extent possible, in constant prices of the year the disaster occurred; i.e., eliminating the effect of inflation. This is important because the aim of this calculation is to estimate the disaster's effects on the real growth rate.

As mentioned earlier, the estimate should also include positive-sign effects of the reconstruction process, from the viewpoint of economic growth.

The globalist expert will receive each sectoral expert's loss estimates (at producer prices in the case of goods that will no longer be produced while production equipment is being repaired). In other cases, the losses represent income that will no longer be received (especially in the case of small businesses, handicrafts, various service industries, hotels, restaurants, cinemas, etc.). All of these should be combined into a general table that will enable the globalist expert to estimate the economic growth rate during the reconstruction period.

Depending on the sources available and the activity in question, the sectoral experts may estimate production losses in any of three ways: (i) products and services which, owing to the destruction of infrastructure and equipment, will no longer be produced; (ii) income that will no longer be received for the same reasons (estimated on the basis of wages, salaries and profits that will not be forthcoming while production plants are being rehabilitated)[2]; or (iii) in the special case of the housing rental sector, according to the methodology used in national accounts; i.e., the rent paid by tenants plus the rent imputed to the owners for the service they receive from their own dwellings. In this case, the sectoral expert should estimate losses in the output generated by this activity as an indirect effect, imputing to the dwellings destroyed, while they are being rebuilt or repaired, the approximate average rents being paid, by category, at that time.

The sectoral experts should provide the necessary data (basically contained in the calculations of indirect damage)[3] to help the globalist expert incorporate the expected growth rate for the current year and for the following year (if such a projection exists) into his basic table illustrating the level of total and sectoral GDP in the year or period in which the disaster occurred. He will then be able to determine how those projections should be changed on the basis and as a consequence of the disaster. Of course, the possibility of disaggregating the information by branch of activity will depend on the amount of data provided and the time available for the evaluation team's work, which -as emphasized repeatedly- is generally very short.

[2]For small businesses in which a wide variety of goods or services is produced, this method of estimation is more feasible and reliable than the method described in point (i).

[3]In calculating indirect damage, the sectoral evaluators will undoubtedly have estimated: (i) the volume (or units) of losses in projected production of goods and services for the period of recovery of productive capacity; (ii) the prices of those goods and services (producer prices or, in the case of services, consumer prices); and (iii) the gross value of these losses, based on a combination of these data.

The globalist expert, for his part, must -if the sectoral evaluator has not done so- convert these gross amounts to added values, so that they can be incorporated into the estimates of GDP and the effect of the disaster on the latter's growth rate can be calculated. In this process, information from national accounts is generally used, in which ratios between gross values and added values are usually given for large economic sectors and branches of activity. These data could also be obtained from an input-output table, if it is fairly recent (so that the ratios are still valid). Table 1 shows the ratios between the added value and gross value of production in a medium-sized Latin American country, by economic sector and branch of industry.

Following is an attempt, based on an actual case, to use the proposed methodology to calculate the effects of a natural disaster on the economic growth rate.

The disaster consists of a severe storm followed by intense rainfall, affecting a large part of the coastal region of a country in mid-1990 and causing serious losses in agriculture and electrical infrastructure, and also affecting the population of some cities and towns, destroying industrial activities, dwellings and businesses.

After gathering and evaluating the relevant information, the sectoral experts give the globalist expert their calculations of indirect damage, i.e., of the amount of goods and services that will fail to be produced for the rest of the year and in the following year. The globalist expert will combine this information into a table showing the various economic branches that make up the GDP. These data appear, according to the example chosen, in the first two columns of table 4 (gross value of the production lost, valued at current prices of the period in which the disaster occurred). As these amounts indicate, for some tertiary activities the calculation of the gross value of production makes no sense, since GDP is normally calculated directly (and not by subtracting inputs from the gross value of production). In these cases, as in the case of general government, banks, other services, etc., the method for calculating GDP uses the income generated (or no longer generated); i.e., wages and salaries, interest and profits. In other words, the sectoral experts must, in these cases, estimate losses in GDP mainly on the basis of the pay that will no longer be collected for a determined period and/or the income of individual businessmen in the case of personal service providers.

For all other sectors or branches, the globalist expert should express the gross values as added values in order to incorporate them into the GDP table and determine their effects on expected growth (see table 5).

Continuing with this example, the last two columns of table 4 show the result of this conversion. The disaster caused reductions of GDP in nearly all activities, agriculture being the hardest hit.

The biggest impact was in the year of the disaster (1990). The effects projected for the following year were considerable only in export agriculture and ownership of dwellings, where reconstruction takes more time. The effect on the construction sector the following year was positive.

The globalist will have also prepared a table for suitably incorporating the information calculated in the last two columns of table 4. Indeed, table 5 gives the sectoral GDP of the year prior to the disaster (1989), and also the projected growth for the current year and the following one before the disaster struck (columns 1,2,4,6 and 8), all at prices of the year in which the disaster took place (in this case, mid-1990).

In the example given, the disaster caused the growth rate of the agricultural sector to decline from 3.1% to 1.2% the year it occurred (1990), owing to losses in exportable output (which would later be reflected in the balance of payments) and in output for the domestic market, which dropped from 2.5% to 0.4% and from 3.0% to 0.3%, respectively. Secondary sectors were only moderately affected, except for mining. Among the services, the most impacted sector was electricity generation, whose growth rate fell from 7% to 4.4%. The growth rate of the economy as a whole was only moderately affected (declining from 4.5% to 3.8% growth of total GDP). Agriculture continued to be significantly affected the following year, due to the impact on crops sown, forests and land, but thanks to the expected surge in construction and the recovery of the other sectors, the effect on the overall growth predicted for 1991 before the disaster was virtually nil (see table 5).

Calculating the effect on income is another way of analyzing the impact of the disaster on the level of activity (which should not be added to the effect on income). At times, it is helpful to break down the effect on income to specific strata of the population (especially when the lower percentiles are affected), in order to design programmes to absorb unemployment by providing reconstruction-related jobs in both rural and urban areas. Obviously, these estimates would be closely related to estimates of the effects on the population on employment. At times, these phenomena affect real income by accelerating inflation, due to inelasticities in supply caused by the temporary interruption of normal supply channels.

3. EFFECTS ON THE EXTERNAL SECTOR AND THE BALANCE OF PAYMENTS

In making their estimates, sectoral evaluators will have calculated among the secondary effects those that affect the balance of payments of the current account and, if pertinent, the external financial requirements of reconstruction. The globalist expert, in turn, will have to depend on estimates of the balance of payments for the overall economy and its projection for the year in which the disaster occurred (and the following year, if possible). This information should be completed with information about other basic magnitudes of the external sector of the economy, such as external indebtedness, debt service and international monetary reserves.

The current account of the balance of payments during the year of the disaster will have to be estimated by the globalist expert on the basis of the following main items: i) lower exports of goods --due to output either being destroyed or diverted to the domestic market in response to supply problems-- and services. Services are affected when the country suffers losses in its merchant fleet, tourism, or in the productive capacity of firms that export services, like engineering, etc.; ii) more imports, indispensable during the restoration phase (such as fuel, foodstuffs to replace lost harvests, more inputs); for the following year, reconstruction-related imports should be estimated by the sectoralists on the basis of the imported component of the assets destroyed; iii) donations in kind or money received because of the emergency; iv) disaster-related insurance and reinsurance, and v) possible reduction in interest payments on the external debt in virtue of agreements made with creditors in the face of the emergency (see table 6).

The capital account of the balance of payments should be estimated by the globalist expert essentially on the basis of the need for medium- and long-term external financing of restoration and reconstruction during the two years following the event. The globalist should also take into account additional external financing to confront a possible worsening of the imbalance on current account arising from the previous projections.

As seen in the example given in table 6, the natural disaster trebled the deficit on the current account of the balance of payments in the year in which it occurred, from US$ 100 million to US$ 300 million; the deficit rose to US$ 370 million the following year. Depending on the nature of the disaster, additional imports could be needed for several years, a fact that would have to be considered in balance-of-payment projections.

A rise in the deficit will create more need for external financing, which will somehow have to be made compatible with external debt commitments the country might have and the level of its reserves, probably through a change in the conditions governing external financing and debt service.

4. THE EFFECT ON PUBLIC FINANCES

Here, the sectoralists should include the following among their estimates of secondary effects: i) lower taxes collected due to the decline in the production of goods and services, income loss, and lower expenditures for consumption; ii) higher recurring expenditures related to the disaster, especially to meet the needs of the population and repair damaged public services, and iii) larger investments during the restoration and reconstruction phase. The globalist should put coherence into information that might be contradictory because of its diversity of sources, and then estimate the deficit on government accounts during the year of the disaster and the following two years, in order to determine the financial requirements that will have to be faced by the public sector during that period.

5. EMPLOYMENT

Reports on social and economic sectors should include estimates of the overall effect on employment arising from: i) the destruction of productive capacity or social infrastructure, and ii) employment requirements during the emergency and the restoration phase.

6. PRICES AND INFLATION

Although the globalist evaluator cannot be expected to attempt to measure general levels of inflation before and after the disaster, he should at least offer an opinion based on sectoral reports about the effect that constraints on supply, food (due to destroyed harvests), manufactured goods, marketing channels, transport systems, etc. could have on the prices of specific goods and services that will have to be supplied by alternative means. The impact of these variations on the overall level and on relative prices will have to be seen and included in the description of the overall impact of the disaster.

Table 1
Ratio Between Addd Value and Gross Value of Production By Production Sector 1

SECTOR	VA/GVP (%)
AGRICULTURAL SECTOR	
Crop-farming	45.0
Livestock-raising	46.5
Forestry	51.0
Fishing and hunting	41.5
MINING	
MANUFACTURING	30.0
Food	25.5
Beverages	28.0
Tobacco	70.0
Textiles and clothing	32.0
Leather and footwear	21.0
Wood and furniture	40.0
Paper and printing	42.0
Chemicals and chemical products	43.5
Petroleum and petroleum products	10.5
Rubber and plastic products	32.5
Non-metallic mineral products	38.5
Iron, steel and non-ferrous metals basic industries	26.5
Metal products	38.5
Non-electrical machinery	35.0
Electrical machinery	42.0
Transport equipment	41.0
Other industries	35.5
ELECTRICITY, GAS AND WATER	58.0
CONSTRUCTION	49.0
COMMERCE	74.5

1 Data obtained from a recent input-output table for a medium-sized Latin American country.

Table 2
Summary of Damage Caused by the Disaster
(in millions or billions of the national monetary unit)

	Direct	Indirect	Public	Private	Imported component of direct damage
Overall Total					
1. Social sectors and urban infrastructure					
Housing 1					
Health and social welfare					
Aqueducts and sewer systems					
Education					
Public buildings					
Urban pavements					
Theatres, churches, monuments and archaeological sites					
Archeological sites 2.					
2. Production sectors and supporting infrastructure					
2.1 Infrastructure					
Highway transport and bridges					
Railway transport					
Ports and airports					
Telecommunications					
Electricity generation					
Agricultural infrastructure 2					
2.2 Sectors					
Crop-farming, livestock-raising, forestry and fishing 3					
Mining 4					
Industry					
Commerce					
Tourism					
Financial and other services linked to production					

1 Including destroyed or damaged dwellings and durable goods inside them.
2 Including irrigation works, silos, local roads, etc.
3 Of course, in some cases these subsectors are best presented separately in this summary table (even if they are already disaggregated in the sectoral chapter).
4 Depending on the type of disaster and the productive structure of the country; it may be best to present damage to the hydrocarbons subsector separately from the rest of mineral and metallurgic production.
5 These figures could be expressed in current dollars or in percentages of the first column.

Table 3
Some Main Economic Indicates

	1988	1989 Before the disaster	1990 After the disaster
Gross domestic product a/			
Per capita gross domestic product a/			
Exports of goods. F.o.b. b/			
Imports of goods f.o.b. b/			
Consumer prices c/			
Recurring government revenues a/			
Total government expenditures a/			
Fiscal deficit (percentage of GDP)			
	Millions of dollars		
Balance on current account			
Net international reserves			
External public debt disbursed			
External debt servicing			
External debt servicing (as percentage of exports)			

Table 4
Disaster-Related Losses in Gross Value and Value Added of Production of Goods and Services

	Gross value of production		Value added 2	
	1990	1991	1990	1991
Primary activities	…	…	27 190	10 100
Export agriculture	20 000	10 000	9 000	4 500
Domestic consumption agriculture	8 600	2 000		
Stock-raising	14 000	6 000		
Forestry	4 000	2 000		
Fisheries	3 000	2 000		
Second activities	…	…	13 740	-1 000
Manufacturing	16 800	2000	5 040	600
Construction	2 000	-10 000 3	1 000	-4 900 3
Mining				
Hydrocarbons	6 000	2 000	3 300	1100
Other minerals	8 000	4 000	4 400	2200
Tertiary activities 4	…	…	18 000	8 500
Trade	4 000	2 000	3 000	1 500
General government	…	…	2000	…
Transport and communications	…	…	1 200	1 000
Banking and insurance	…	…	200	200
Electric energy and drinking water	2000	1000	1 600	800
Ownership of dwellings 5	…	…	8 000	4 000
Other services	…	…	2 000	…

1/ In this example, the disaster is presumed to have occurred in mid-1990
2/ Calculated on the basis of the coefficients in Annex I that relate value added to gross value
3/ Corresponds to an increase in output owing to reconstruction
4/ Except for trade, electric energy and drinking water; for the other tertiary sectors, the methodology normally used provides a direct estimate of loses of generated income, therefore the distinction between gross value of production and value added makes no sense.
5/ See the method of calculation in the text

Table 5
Effect of the Disaster on the Rate of Economic Growth (Billions of 1990 pesos)

	1989	Projections				Annual growth rates (%)			
		1990		1991		1990		1991	
		Before disaster	After disaster	Before disaster	After disaster	Before disaster	After disaster	Before disaster	After disaster
Priority activities	1 605	1 655	1 621	1 715	1 704	3.1	1.2	3.6	2.9
Agriculture	805	825	808	850	844	2.5	0.4	0.3	2.3
For export	350	360	351	370	365	3.0	0.3	2.8	1.4
For domestic consumption	455	465	457	480	479	2.2	0.4	3.2	3.0
Stock-raising	450	460	451	575	472	3.0	0.2	3.0	2.6
Forestry	200	210	208	220	219	5.0	40	4.0	4.0
Fisheries	150	160	159	170	167	6.0	6.0	5.5	5.5
Secondary activities	3 200	3 370	3 356	3 555	3 556	5.3	4.9	5.5	5.5
Manufacturing industry	2 500	2630	2 625	2 775	2774	5.2	5.0	5.5	5.5
Construction	300	320	319	340	345	6.5	6.3	6.0	7.8
Mining	400	420	412	440	437	4.0	3.0	4.5	4.0
Tertiary activities	4 930	5 145	5 127	5 365	5 357	4.4	4.0	4.2	4.1
Commerce, restaurants and hotels	2 800	6 930	2 927	3 060	3 058	4.5	4.5	4.5	4.4
General government	350	360	358	370	370	3.0	2.3	3.0	3.0
Transport and communications	450	470	469	490	489	4.5	4.2	4.3	4.0
Banking and insurance	150	160	160	170	170	5.0	5.0	5.0	5.0
Electric energy and drinking water	180	190	188	205	204	7.0	4.4	8.0	7.4
Ownership of dwellings	350	360	352	370	366	2.8	036	2.8	1.7
Other services	650	375	673	700	700	4.0	3.5	4.0	4.0
TOTAL	9 735	10 170	10 109	10 635	10 617	4.5	3.8	4.6	4.4

Table 6
Effects of the Disaster on the Balance of Payments (millions of dollars)

	1990				1991	
	Before disaster		After disaster			
	Revenues	Outlays	Revenues	Outlays	Revenues	Outlays
Exports of goods	1 000		900		950	
Imports of goods		1 200		1 350		1 500
Exports of services including tourism	200		100			
Imports of services		100		150		120
Emergency donations			100		50	
Insurance and reinsurance			100		50	
Total	1 200	1 300	1 200	1 500	1 250	1 620
Deficit on current account						

29 de mayo de 2001

LISTA DE DOCUMENTOS DE LA CEPAL SOBRE LA ESTIMACION DE LOS EFECTOS SOCIOECONOMICOS DE LOS DESASTRES NATURALES

	NOMBRE	Inglés	Español
1.	*Informe sobre los daños y repercusiones del terremoto de la ciudad de Managua en la economía Nicaragüense* (E/CN.12/AC.64/2/ Rev.1, 13 de enero de 1973		X
2.	*Informe sobre los daños y repercusiones del Huracán Fifí en la economía hondureña* (E/CEPAL/AC.67/2/Rev.1, 17 de octubre de 1974		X
3.	*Evaluation of damage caused by the Grenada Rainstorm and its implications for economic development programmes* (E/CEPAL/CDCC/9), 29 December, 1975	X	
4.	*Informe sobre los daños causados en Antigua y Barbuda por el sismo del 8 de octubre de 1974 y sus repercusiones* (E/CEPAL/1001), 3 de abril de 1975. *Report on the damage caused in Antigua and Barbuda by the earthquake of 8 October 1974 and its repercussions* (E/CEPAL/1001), 10 April, 1975	X	X
5.	*Daños causados por el terremoto de Guatemala y sus repercusiones sobre el desarrollo económico y social de país* (CEPAL/MEX/76/Guat.1), Febrero de 1976		X
6.	*Report on the effect of hurricane "David" on the island of Dominica* (Note by the Secretariat) (E/CEPAL/G.1099), 16 October, 1979	X	
7.	*República Dominicana: Repercusiones de los huracanes David y Federico sobre la economía y las condiciones sociales* (Nota de la Secretaría) (E/CEPAL/G.1098/Rev.1), Octubre de 1979 *Dominican Republic: Effects of hurricanes David and Frederick on the economy and social conditions* (Note by the Secretariat) (E/CEPAL/G.1098/Rev.1) October, 1979	X	X

	NOMBRE	Inglés	Español
8.	*Nicaragua: Las inundaciones de mayo de 1982 y sus repercusiones sobre el desarrollo económico y social del país* (E/CEPAL/G.1206), 2 de julio de 1982		X
9.	*El Salvador: Los desastres naturales de 1982 y sus repercusiones sobre el desarrollo económico y social* (E/CEPAL/MEX/1982/L.30), 19 de noviembre de 1982 *El Salvador: The natural disasters of 1982 and their effects on economic and social development* (E/CEPAL/MEX/1982/L.30), 3 February 1983	X	X
10.	*Guatemala: Repercusiones de los fenómenos meteorológicos ocurridos en 1982 sobre la situación económica del país* (E/CEPAL/MEX/1982/L.31), 24 de noviembre de 1982		X
11.	*Repercusiones de los fenómenos meteorológicos de 1982 sobre el desarrollo económico y social de Nicaragua* (E/CEPAL/MEX/1983/L.1), 5 de enero de 1983		X
12.	*Ecuador: Evaluación de los efectos de las inundaciones de 1982/1983 sobre el desarrollo económico y social* (E/CEPAL/G.1240), 9 de mayo de 1983		X
13.	*Los desastres naturales de 1982-1983 en Bolivia, Ecuador y Perú* (E/CEPAL/G.1274), 27 de diciembre de 1983 *The natural disasters of 1982-1983 in Bolivia, Ecuador and Peru* (E/CEPAL/G.1274), 26 January, 1984	X	X
14.	*Daños causados por el movimiento telúrico en México y sus repercusiones sobre la economía del país* (LC/G.1367), 15 de octubre de 1985 *Damage caused by the Mexican earthquake and its repercussions upon the country's economy* (LC/G.1367), 23 October, 1985	X	X
15.	*Report on the natural disaster caused by the Nevado del Ruiz Volcano in Colombia* – Background document (SG/SM.1/2), 4 December, 1985	X	

	NOMBRE	<u>Inglés</u>	<u>Español</u>
16.	*El terremoto de 1986 en San Salvador: Daños, repercusiones y ayuda requerida* (LC/MEX/L.39/Rev.1), 21 de noviembre de 1986, más addendum conteniendo Perfiles de Proyectos LC/MEX/L.39/Add.1/Rev.1), 24 de noviembre de 1986		X
17.	*El desastre natural de marzo de 1987 en el Ecuador y sus repercusiones sobre el desarrollo económico y social* (LC/G.1465), 22 de abril de 1987 *The natural disaster of March 1987 in Ecuador and its impact on social and economic development* (LC/G.14765), 6 May, 1987	X	X
18.	*Capacitación para la prevención de desastres naturales en América Latina* (LC/R.655), 9 de junio de 1988		X
19.	*Daños ocasionados por el huracán Joan en Nicaragua: Sus efectos sobre el desarrollo económico y las condiciones de vida, y requerimientos para la rehabilitación y reconstrucción* – Nota de la Secretaría (LC/G.1544), 17 de noviembre de 1988, más addendm conteniendo <u>- Perfiles de proyecto de rehabilitación y reconstrucción</u> (LC/G.1544/Add.1), 17 de noviembre de 1988 *Damage caused by hurricane Joan in Nicaragua. Its effects on economic development and living conditions, and requirements for rehabilitation and reconstruction* – <u>Note by the Secretariat (only) (LC/G.1544, 2 December, 1988</u> *Damage caused by hurricane Joan in Nicaragua. Its effects on economic development and living conditions, and requirements for rehabilitation and reconstruction needs. <u>Rehabilitation and reconstruction project outlines</u>* (LC/G.1544/Add.1), 9 December, 1988	X	X
20.	*Informe del Taller de expertos sobre el proyecto: prevención de desastres naturales en América Latina y el Caribe* (Santiago, 5 y 6 de septiembre de 1989) (LC/R.800), 22 de septiembre de 1989		X

	NOMBRE	Inglés	Español
21.	*Situación actual en materia de previsión de caudales e inundaciones en América Latina y el Caribe* (LC/R.777/Rev.1), 25 de septiembre de 1989		X
22.	*Propuesta para definir el alcance del proyecto de previsión de caudales e inundaciones en cuencas seleccionadas de América Latina y el Caribe (LC/R.779/Rev. 1) 26 de septiembre de 1989*		X
23.	*Efectos económicos de la erupción del volcán Cerro Negro en Nicaragua* (LC/L.686/Rev.1), 20 de mayo de 1992		X
24.	*El maremoto de septiembre de 1992 en Nicaragua y sus efectos sobre el desarrollo (LC/L.708), 24 de septiembre de 1992* *The Tsunami of September 1992 in Nicaragua and its effects on development* (LC/L.708), 20 October, 1992	X	X
25.	*The impacts of natural disasters on developing economies: Implications for the international development and disaster comunity* – Internal circulation: INT.05-94, 27 September, 1994	X	
26.	*Impacto económico de los desastres naturales en la infraestructura de salud* (LC/MEX/L.291), 8 de enero de 1996 *The economic impact of natural disasters on health infraestructure* (LC/MEX/L.291), 12 January, 1996	X	X
27.	*Los efectos macroeconómicos y las necesidades de reconstrucción de la isla de Anguila después del huracán Luis* (LC/MEX/L.289), 26 de enero de 1996 *The macro-economic effects and reconstruction requirements following hurricane Luis in the island of Anguilla* (LC/MEX/L.289), 5 December, 1995	X	X
28.	Los efectos macroeconómicos y las necesidades de reconstrucción en Sint Maarten, Antillas Neerlandesas, después de los huracanes Luis y Marilyn (LC/MEX/L.290), 30 de enero de 1996 *The macro-economic effects and reconstruction requirements following hurricanes Luis and Marilyn in Sint Maarten, Netherlands Antilles* (LC/MEX/L.290), 6 December, 1995	X	X

	NOMBRE	Inglés	Español
29.	*Efectos de los daños ocasionados por el huracán César sobre el desarrollo de Costa Rica en 1996* (LC/MEX/L.312), 27 de septiembre de 1996 *Effects of the damage by hurricane Cesar on the development of Costa Rica in 1996* (LC/MEX/L.312), 23 October, 1996	X	X
30.	*Los efectos del huracán César sobre el desarrollo de Nicaragua en 1996* (LC/MEX/**L.316**), 15 de octubre de 1996 *Economic and social impact of hurricane Cesar on the development of Nicaragua in 1996* (LC/MEX/**R.570**), 23 September, 1996	X	X
31.	*El fenómeno El Niño: Su naturaleza y los riesgos asociados a su presencia recurrente* (LC/MEX/R.641), 28 de enero de 1998		X
32.	*Análisis costo-efectividad en la mitigación de daños de desastres naturales sobre la infraestructura social* (LC/MEX/R.643), 16 de marzo de 1998		X
33.	*Ecuador: Evaluación de los efectos socioeconómicos del fenómeno El Niño en 1997-1998* (LC/R.1822/Rev.1) (**LC/MEX/R.657/Rev.1**) más addenum conteniendo Perfiles de Proyectos (LC/R.1822/Add.1) (**LC/MEX/R.657/Add.1**), 16 de julio de 1998		X
34.	*El fenómeno El Niño en Costa Rica durante 1997-1998* – Evaluación de su impacto y necesidades de rehabilitación, mitigación y prevención ante las alteraciones climáticas (LC/MEX/L.363), 3 de noviembre de 1998, más addendum conteniendo Perfiles de proyectos (LC/MEX/L.363/Add.1), 3 de noviembre de 1998		X
35.	*República Dominicana: Evaluación de los daños ocasionados por el huracán Georges, 1998* – Sus implicaciones para el desarrollo del país (LC/MEX/L.365), 4 de diciembre de 1998, más addendum conteniendo Perfiles de proyectos (LC/MEX/L.365/Add.1), 4 de diciembre de 1998		X

	NOMBRE	Inglés	Español
36.	*Report of The Joint ECLAC/ECCB Mission to Assess the Macroeconomic Effects and the Reconstruction Requirements Arising from The Impact of Hurricane Georges on Saint Kitts and Nevis* (Incorporating Social and Environmental Aspects), General – 22 December, 1998	X	
37.	*Honduras: Evaluación de los daños ocasionados por el huracán Mitch, 1998* – Sus implicaciones para el desarrollo económico y social y el medio ambiente (LC/MEX/L.367), 26 de enero de 1999 *Honduras: Assessment of the damage caused by hurricane Mitch, 1998* – Implications for economic and social development and for the environment (LC/MEX/L.367), 14 April, 1999	X	X
38.	*Guatemala: Evaluación de los daños ocasionados por el huracán Mitch, 1998* – Sus implicaciones para el desarrollo económico y social y el medio ambiente (LC/MEX/L.370), 4 de febrero de 1999 *Guatemala: Assessment of the damage caused by hurricane Mitch, 1998* – Implications for economic and social development and for the environment (LC/MEX/L.370), 23 April, 1999	X	X
39.	*Efectos macroeconómicos del fenómeno El Niño de 1997-1998* – Su impacto en las economías andinas (LC/MEX/R.688), 8 de febrero de 1999		X
40.	*El Salvador: Evaluación de los daños ocasionados por el huracán Mitch, 1998* – Sus implicaciones para el desarrollo económico y social y el medio ambiente (LC/MEX/L.371), 15 de febrero de 1999 *El Salvador: Assessment of the damage caused by hurricane Mitch, 1998* – Implications for economic and social development and for the environment (LC/MEX/L.371), 21 April, 1999	X	X
41.	Nicaragua: *Evaluación de los daños ocasionados por el huracán Mitch, 1998* – Sus implicaciones para el desarrollo económico y social y el medio ambiente (LC/MEX/L.372), 3 de marzo de 1999 *Nicaragua: Assessment of the damage caused by hurricane Mitch, 1998* – Implications for economic and social development and for the environment (LC/MEX/L.372), 19 April, 1999	X	X

	NOMBRE	Inglés	Español
42.	Costa Rica: *Evaluación de los daños ocasionados por el huracán Mitch, 1998* – Sus implicaciones para el desarrollo económico y social y el medio ambiente (LC/MEX/L.373), 4 de marzo de 1999 *Costa Rica: Assessment of the damage caused by hurricane Mitch, 1998* – Implications for economic and social development and for the environment (LC/MEX/L.373), 26 April, 1999	X	X
43.	*Centroamérica: Evaluación de los daños ocasionados por el huracán Mitch, 1988* – Sus implicaciones para el desarrollo económico y social y el medio ambiente (LC/MEX/L.375), 18 de mayo de 1999 *Central America: Assessment of the damage caused by hurricane Mitch, 1988* – Implications for economic and social development and for the environment (LC/MEX/L.375, 21 May, 1999)	X	X
44.	*América Latina y el Caribe: El impacto de los desastres naturales en el desarrollo, 1972-1999* (LC/MEX/L.402), 29 de septiembre de 1999		X
45.	*El terremoto de enero de 1999 en Colombia: Impacto socioeconómico del desastre en la zona del Eje Cafetero* (LC/MEX/L.374), 27 de abril de 1999		X
46.	*Anguilla: An assessment of economic and other damages caused by hurricane Lenny*		
47.	*Los efectos socioeconómicos de las inundaciones y deslizamientos en Venezuela en 1999* (LC/MEX/L.421, 14 de febrero de 2000		X
48.	*Un tema de desarrollo: La reducción de la vulnerabilidad frente a los desastres* (LC/MEX/L.428), 7 de marzo de 2000 *A matter of development: How to reduce vulnerability in the face of natural disasters* (LC/MEX/L.428), 7 March 2000 BID/CEPAL	X	X
49.	*Belize: Assessment of the damage caused by hurricane Keith, 2000. Implications for Economic, Social and Environmental Development* LC/CAR/G.627 – LC/MEX/G.4, 30 November, 2000, mas addendum conteniendo *Annex: List of Project Profiles for the reconstruction process* LC/CAR/G.627/Add.1 – LC/MEX/G.4/Add.1.	X	

	NOMBRE	Inglés	Español
50	*El terremoto del 13 de enero de 2001 en El Salvador. Impacto socioeconómico y ambiental* (LC/MEX/L.457), 21 de febrero de 2001 *Perfiles de Proyectos* (LC/MEX/L.457/Add.1) *El Salvador: Evaluación del terremoto del martes 13 de febrero de 2001. Addendum al documento de evaluación del terremoto del 13 de enero* (LC/MEX/457/Add.2), 28 de febrero de 2001		X