Handbook

for Estimating the Socio - economic and Environmental Effects of **Disasters**

Economic Commission for Latin America and the Caribbean
E C L A C

Section Five

Overall effects of damages

I. ENVIRONMENT

1. General considerations

As is well known, a people's quality of life and well-being depends to a great extent on the state of the environment. Ecosystems provide a range of goods (such as food, water, medicines and energy) and services (such as the dilution and transformation of waste, the regulation of the water cycle, carbon sequestration, the maintenance of biodiversity and recreation) that sustain and satisfy human life (see Table 1).

From an economic perspective, natural resources are considered assets (natural capital) from which goods and services are derived that help increase people's well-being. From this point of view, natural resources have a use value.[1] Natural heritage can also generate values unrelated to any direct or indirect use. These non-use values arise from the psychological benefits derived from, among other things, the mere knowledge that the resource exists (existence value) or the wish to preserve natural capital for future generations to enjoy (inheritance value).

Extreme events are part of nature, and ecosystems have evolved with them. For example, many ecosystems have adapted to occasional wildfire favored by drought: phyrophytic species in these ecosystems actually require fire for proper germination. Riverine habitats and ecosystems are often dependent on annual floods. When these events occur in remote areas without human intervention, they are not considered disasters.

However, where natural and human systems interact, qualitative and/or quantitative environmental change that detracts from people's well-being can result from extreme natural phenomena.

1 Direct use values derive from the consumptive use (for example, the use of firewood) or non-consumptive use (such as tourism activities) of natural resources. Indirect use values, also known as functional values, can be described as the benefits indirectly enjoyed by people as a result of the primary ecological function of a given resource. For example, the indirect use value of a wetland can derive from its contribution to the filtration of water used downstream.

For example, a hurricane can cover a beach with debris and prevent its recreational use; flooding can lead to contamination by wastewater; drought might affect the survival of an endangered species. Such environmental change can be permanent or temporary. A volcanic eruption with lava flows can result in irreversible changes in the landscape; however, changes in the atmosphere caused by the same eruption, such as pollution by the gases released, are temporary. Changes in people's well-being might arise from the temporary or permanent inability to use environmental goods or services, or the increased costs of their enjoyment without there being environmental change. For example, the destruction of a path leading to a beach might prevent (or make more costly) its recreational use even if the beach did not undergo environmental change.

Table 1
GOODS AND SERVICES PROVIDED BY ECOSYSTEMS

Ecosystem	Goods	Services
Agroecosystems	Food crops Fibre crops Crop genetic resources	Maintain limited watershed funtions (infiltration, partial soil protection) Provide habitat for birds, pollinators, soil organisms important to agriculture Build soil organic matter Sequester atmospheric carbon
Forest ecosystems	Timber Fuelwood Drinking and irrigation water Fodder Nontimber products (honey, fruit, spices, plant medicines, hunting, etc.) Genetic resources	Remove air pollutants, emit oxygen Cycle nutrients Maintain array of wathershed functions (infiltration, purification, soil stabilization) Maintain biodiversity Sequester atmospheric carbon Moderate wether extremes and impacts Generate soil Provide for aesthetic enjoyment and recreation
Freshwater ecosystems	Drinking and irrigation water Fish Hydroelectricity Genetic resources	Buffer water flow (control timing and volume) Dilute and carry away wastes Cycle nutrients Maintain biodiversity Provide aquatic habitat Provide transportation corridor provide for aesthetic enjoyment and recreation
Grassland ecosystems	Livestock (meat, leather, etc.) Water for human consumption and irrigation Genetic resources	Maintain array of wathershed functions (infiltration, purification, soil stabilization) Cycle nutrients Remove air pollutants, emit oxygen Maintain biodiversity Generate soil Sequester atmospheric carbon provide for aesthetic enjoyment and recreation
Coastal ecosystems	Fish and shellfish Fishmeal (animal feed) Seaweeds (for food and industrial use) Genetic resources	Moderate storm impacts (mangroves; barrer islands) Provide wildlife (marine and terrestrial) habitat Maintain biodiversity Dilute wates Provide harbours and transportation routes Provide for aesthetic enjoyment and recreation

Source: World Resources Institute (2001)

In Latin America and the Caribbean, national accounts do not yet expressly include most environmental assets and services. In other words, environmental accounts have not yet been included in the national accounts of countries, although some of the value of environmental services is included in the statistics of such sectors as agriculture, and tourism. Consequently, damage assessment methods in the past did not include estimates of the effects of disasters on the environment. Nevertheless, such estimates can be made by way of a series of indirect procedures.

Our proposed methodology of environmental damage assessment takes into account several major constraints, such as the scarce time available for carrying out the assessment, the lack of information on affected ecosystems and the paucity of markets for most environmental services. Moreover, environmental economics has only recently developed as a subdiscipline within economics, with much room for innovations and improvements in tools and methodologies for environmental valuation.

To undertake such an analysis, concepts must be defined in line with the ECLAC methodology and applied to the specific case of the environment, its assets and its services. Environmental capital or assets are made up of the ecosystems that provide society and economies with environmental goods and services. To assess the effects of a disaster on natural capital, one can begin by separating its components: physical medium (soil, water, air, climate); biotic medium (human beings, flora and fauna); perceptual medium (landscape, scientific and cultural resources); and interactions among the above-mentioned media. Thus, the environmental changes caused by a disaster can produce direct damage to such assets or to works built to take advantage of them; they may also lead to indirect losses when the related environmental services are reduced, diminished in quality or made more expensive.

Direct damage to the environment can be estimated as the value of the assets affected. If there is permanent destruction, direct damage can be considered to be close to the commercial value of the assets when a market exists for them. When there is no such market and a reversal of the environmental change is deemed appropriate, the direct damage can be approximated by estimating the cost of rehabilitating or recovering the assets. For example, if agricultural land is completely destroyed and restoration is not deemed appropriate (whether for technical or economic reasons), the direct damage will be the value of the land. If there is hillside erosion, direct damage can be estimated based on the cost of stabilizing the slopes through soil conservation works.

The presence of values not associated with use of the environment (such as existence values) and the lack of markets for many environmental goods and services pose theoretical and practical obstacles to conducting any economic valuation. When a value cannot be assigned to assets for the estimation of direct damage, estimates must be made by indirect means. For example, the direct damage to soils caused by mudslides can be estimated as the agricultural or forestry production precluded for a period sufficiently long to constitute a total loss. When damage to assets can be recovered naturally over a given period, the value of the damage can be estimated indirectly by measuring the amount of the environmental services the assets will not provide over the period required for recovery.

The many and varied cases of harm or damage must be analyzed individually to define or choose the method for estimating both direct and indirect damage to environment. These are described in the sections below, broken down into the procedures for each of the assets or resources mentioned above. Bear in mind that most of the damage estimated in this way will already have been measured or determined under the different social or economic sectors, and care must be taken not to count them twice at the moment of the damage review.

2. Assessment procedure

To carry out the economic assessment of the impact of a disaster on the environment, the environmental specialist must follow a procedure of successive stages in close co-operation with the sectoral specialists and the macroeconomist. Those stages are as follows:

i) Description of the environmental state before the disaster, representing the baseline for assessment;

ii) Identification of the impacts of the natural disaster on the environment;
ii) Qualitative environmental assessment;
iv) Classification of the effects on the environment;
v) Economic valuation of the environmental impact; and
vi) Overlap with other sectors.

The following sections describe each of these stages.

a) Description of the state of the environment before the disaster

To properly attribute the effects that really are due to the disaster, the pre-existing environmental situation must be appraised.[2] This stage consists of collecting, classifying and describing the environmental conditions involved (resources, natural or artificial systems, biodiversity) specific to the area in question and other areas included within the perimeter officially recognized as affected.

Apart from serving to correctly attribute the effects of the disaster, this process contributes to the analysis of possible links between the scale of the damage caused by the disaster and environmental deterioration prior to the event. For example, in the assessment of the damage caused by Hurricane Mitch in Central America (October 1998) it was established that the severe effects of the rains were aggravated by the previous actions of humans and previous disasters (The El Niño phenomenon of 1997-1998), such as deforestation and the loss of plant cover on slopes, inappropriate land use and the presence of human settlements in such risk areas as flood plains and mountainsides. The comparison of the effects of an extreme natural event between areas with greater and lesser degrees of environmental deterioration highlights the role played by the state of the environment in mitigating or intensifying damage.

Basic information to be collected. The environmental specialist will use a series of elementary steps, duly recording information, in a log or protocol and noting the date and source. These records serve not only for his or her own information but also to enable follow-up and application in similar, later assessments. This method must be based on the following steps:

Gather and collect basic material and bibliographic sources relevant to the problem and area in question, employing personal, library and institutional databases, primary, (books, official reports by independent institutions, NGOs, international institutions, United Nations institutions, foreign-aid banks, private enterprises) and secondary sources (newspaper and magazine articles, Internet sites, etc.);

2 In the case of long-duration disasters (such as droughts), the baseline will be represented by the closest approximation possible to what would have been the situation without a disaster. If the comparison is made with the situation before the disaster, effects due to another type of cause could be attributed thereto. If, for example, the area affected by forest fires is being assessed in the context of a drought, the area affected by forest fires in a normal year must be taken into account (if the information is available). The difference between these two values is what should be attributed to the drought.

Access directories of government institutions and NGOs that list contacts, project heads, spokespersons or ad hoc representatives that are relevant to the study of disasters;

Establish a plan of personal interviews (see following step), in coordination with relevant and appointed national contacts;

Meet with people in positions of responsibility, appointed technical specialists and other figures with knowledge and responsibilities or information relevant to the case in question;

Access laws and regulations while assuring familiarity with the legal framework of the country, state or region in environmental management, environmental control, watershed management, environmental conservation, and biodiversity, as well as in emergency prevention, institutional coordination and preparation, and reconstruction in general (works, infrastructure, environment);

Prepare a plan and guide field studies of affected areas and, if possible, of unaffected and/or pristine areas;

Conduct field interviews with officials, government spokespersons and community leaders while appraising other on - site studies or existing assessments;

Indicate how those factors for which no information exists were studied and quantified by the expert or group of advisers; and

Determine the steps to be followed to improve information and valuation.

Desk study. The desk study and assessment are carried out day by day, before and after meetings with the other specialists participating in the damage assessment, using the information available up to that moment. The first condition for an appraisal of the environmental quality of the area or district affected by the disaster is having access to good, sufficient and reliable information. The availability of quality information depends mainly on the country affected. The following should be used:

Environmental profiles and natural histories;
Reports on past disasters and preliminary reports on the disaster in question;
Maps of potential and actual wildlife and plant life areas, and of potential and actual land use;
Geological and geomorphological maps and reports;
Maps of weather and hydrogeological conditions;
Geographic information systems (GIS) at scales of 1:200,000 and 1:50,000 for large areas and several watersheds; in some cases a 1:10,000 or 1:5,000 level is appropriate; and
On - site, aerial or satellite photographs or films, relief maps (detailed logs must be kept of field trips to affected areas and to similar unaffected areas for purposes of comparison).

All this material will enable reasonably accurate definitions of the state of the environment before and after the disaster occurred. Gathering this information will allow the environmental specialist to undertake the comprehensive qualitative and quantitative study.

Definition of the areas and aspects of greatest interest. An initial screening should determine the points of greatest interest or importance, so that analysts can focus research and assessment on what is most representative of the problem. This is necessary because the time the group of specialists has available for the assessment is almost always very limited by mission cost considerations and the urgent need for post-disaster information. The scope of the study is almost always established within the first two or three days of the mission, after the most important environmental characteristics of the affected area and the probable impact have been taken into account.

If an environmental study group is available, each specialist should concentrate on the environmental variables in his or her professional field; their results can be combined later. A list or basic framework of systems, habitats or species important to each wildlife region (including protected areas that were affected) should be prepared. The most representative ecosystems and their pre-disaster level of environmental service provision (for example, water production CO_2 sequestration, biodiversity, ecotourism) must be taken into account. The chosen variables must be measured on site within the areas of influence in accordance with the behavior patterns and structure of the system where the phenomenon arose, thereby providing a general framework or scenario of the state of the environment.

The characteristics or value of the environment in question must be determined in line with the most important qualities and properties of natural resources, species and/or environmental services.[3] When determining the quality of ecosystems and environmental services, one must consider at least the following:

Unique or unusual land formations;
Protected areas or ecosystems (official or private);
Wildlife areas strategic to a region;
Areas important for the maintenance of natural systems (egg-laying, hatching, birthing and breeding areas; water collection areas, vital support systems) located outside of the country or region in question;
Areas important for the maintenance of species useful to agriculture, fish-farming, animal raising, and so on;
High-quality or unique communities of endemic plants or animals;
Communities of plants or animals that can be used for repopulation and ecological restoration;
Rare or unique habitats;
Biological corridors;

3 Inserts can be used to highlight questions of special interest. For example, in the assessment of the effects of Hurricane Keith in Belize (2000), an insert was included on the main characteristics and human pressures of one of the most important ecosystems in the region: The Meso-American reef system. See ECLAC, *Belize: Assessment of the Damage Caused by Hurricane Keith, 2000: Implications for Economic, Social and Environmental Development,* (LC/MEX/G.4 y LC/CAR/G.627), Port of Spain, Trinidad and Tabago, 2000.

Highly diverse biological communities;
Highly productive habitat (woodland, wetland, estuary, reef, etc.);
Refuge habitat for rare or endangered species;
Habitat for species that need large territories;
Area of seasonal importance to the feeding or reproduction of one or more species;
Areas that maintain a wild bank of domesticated species;
Habitat of great scientific or educational value;
Habitat of traditional importance for the provision of fuel, fabrics, food, construction materials or traditional medicine;
Areas of historic, cultural, religious or archaeological interest; and
Micro/meso/macro areas of aesthetic, landscape and recreational value.

b. Impacts of the disaster on the environment

The different types of natural hazards involving dynamic forces that change the earth's surface can be classed into two well-defined categories. First, internal geodynamic phenomena are governed by endogenous geophysical forces and processes that are part of the earth's crust; these include seismic and plate-tectonic activity, intra-plate activity, and volcanism. Second, hydrometeorological phenomena are mainly governed by extensive macroclimatic or global tropospheric processes, such as trade winds and monsoons, inter-tropical convergence, Hadley and Walker circulation, the El Niño (ENSO) phenomenon, polar fronts, tropical waves and storms, hurricanes and tropical cyclones. This group also includes dynamic processes with a local or focal influence related to the meso- and microclimate, such as tornadoes and waterspouts coastal, convective or orographic storms lightning storms. Some of these phenomena develop in the stratosphere (e.g., ozone layer).

Table 2 Summarizes the effects that natural phenomena can have on the physical, biotic and perceptual environments.

Table 2

THE EFFECTS OF LARGE-SCALE NATURAL PHENOMENA ON PHYSICAL, BIOTIC AND PERCEPTUAL ENVIRONMENTS

Phenomenon	***Effects***		
	On the physical environment	On the biotic environment	On the perceptual environment
Volcanic eruptions	Air pollution from gas emissions; Changes to course of rivers, beach erosion and coastline alterations; Rubble and mud flows caused by snow and ice or by collapse of volcano walls; Contamination of water bodies; Fires; Earthquakes and tidal waves.	Ill effects on human health: From the energy released From environmental changes such as air pollution (discomfort in mucous membranes, eyes, skin, respiratory system) and water pollution; Loss of vegetation and wildlife due to fires, avalanches and acid rain; Loss of habitat; Extensive ecological imbalance.	Drastic changes to the landscape (barren, desolate landscapes and loss of agrological mosaic) with los of aesthetic characteristics.
Earthquakes	Land and mudslides on mountains, cliffs and coastal bluffs due to effects of vibration; Large land movements on hillsides with high water table saturation; these can lead to damming and alter the course of waterways developments that can produce further avalanches; Elevation or subsidence from earthquakes; Environmental damage from effects on basic service infrastructure, such as water, electricity, gas, hydrocarbons (spills and fires or explotions of hydrocarbons and chemical products, etc.).	Ill effects on human health; From the energy released; From environmental changes such as air and water contamination from spills and fires; Damage to the vegetation cover of areas affected by landslides and avalanches.	Changes to the landscape due to landslide zones with loss of vegetation cover; More significant and even permanent changes can occur such as the appearance and disappearance of bodies of water.

Table 3

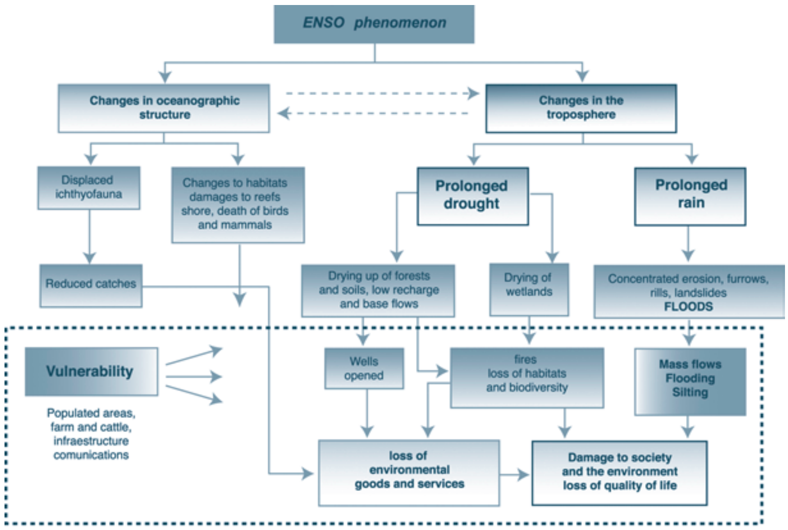
THE EFFECTS OF LARGE SCALE NATURAL PHENOMENA ON PHYSICAL, BIOTIC AND PERCEPTUAL ENVIRONMENT

Phenomenon	*Effects*		
	On the physical environment	On the biotic environment	On the perceptual environment
Tidal wave	ï Flooding of coastal zones; ï Intrusion of salt water in surface and subsurface bodies of water; ï Water contamination due to chemical spills.	ï Ill effects on human health; ï From the impact of the wave; ï From environmental changes water contamination and salination; ï Damages to coastal plant and wildlife from the impact of the wave and salt water flooding.	ï Significant affectation of the coastal landscape; ï Possibly more significant and even permanent changes such as the appearance and disapearance of bodies of water.
Floods *(of climatological, oceanic or other origin)*	ï Erosion, soil destabilization and landslides; ï Sedimentation and washing of rubble and detritus into adjoining lands and bodies of water; ï Possible damming and subsequent avalanches; ï Contamination due to spills of water and sewage treatment tanks and the collapse of sewer and plumbing systems; ï Contamination from chemical spills.	ï Ill effects on human health ï From the energy released ï From environmental changes such as water contamination; ï Effects on plant and animal life from the energy released, physical changes and effects from chemical contamination; ï Loss of vegetation cover; ï Loss of habitat.	ï Washing downstream of sediment and obstruction of natural drainage systems can cause changes, possibly permanent, to the course of water bodies and alter the coastline.
Landmass shifts	ï Erosion, soil destabilization and loss, and landslides and avalanches ï Sedimenatation and washing of rubble and detritus into adjoining lands and water bodies; ï Possible damming and subsequent avalanches.	ï Ill effects on human health principally due to the energy released; ï Landslides of forested land and destruction of vegetation cover; ï Twisting and bending of trees (where reptation occurs).	ï Drastic changes to the landscape, mostly localized.
Hurricanes and cyclones	ï Coastal erosion, changes to the granulometry of beaches and bathymetric changes brought on by tides and oceanic turbulence; ï Changes to geographic characteristics; ï Erosion, landslides and avalanches caused by rains; ï Instrusion of salt water into surface and subsurface bodies of water.	ï Death and migration of animals; ï Splitting and falling of trees due to winds; ï Loss of coastal vegetation (mangroves), marine plant life and physical damage to coral reefs.	ï Drastic changes to the landscape due to loss of vegetation and alteration of the coastline; ï See Floods.
Drought	Drying out and cracking of the soil; increase in the susceptibility of the soil to erosion and degradation; Decrease in the surface water reserves subsurface water table, increase in the temperature of water bodies, loss of capacity to dilute contaminants; well salination may occur in coastal zones due to over exploitaton; Drying up of wetlands;	Loss of vegetation cover due to drying up of vegetation cover and associated forest fires; Loss of biodiversity due to drying up of wetlands (often these are the habitat of species in danger of extinction and are part of the routes of migratory birds) and forest fires; Other ecological imbalances (such as death of pollinating birds and insects);	Drastic changes to the landscape due to loss of vegetation;
ENOS Phenomenon	See Floods and Droughts;	The appearance or increase in the incidence of some illnesses (malaria, dengue and others) is associated with the ENOS Phenomenon; Changes in the oceanographic structure, disappearance of phytoplankton, displacement and death of ictiofauna, death of coral populations; See Floods and Droughts;	See Floods and Droughts;

A figure with the causal linkages of the main impacts on the environment can be highly illustrative, as may be seen in the following two figures for the 1997-1998 ENSO phenomenon in Costa Rica[4] and the floods and landslides in Venezuela [5] in 1999. As with the description of the state of the environment before the disaster, inserts can be included as needed to deal with specific impacts. For example, in the assessment of the impact of Hurricane Mitch in Nicaragua, an insert was included on what happened at the Casita volcano;[6] in the case of the disaster in Venezuela, an insert was included on the environmental problems caused in the Port of La Guaira when containers storing chemicals were washed away.

Figure 1

LINKAGE OF THE IMPACTS ON THE ENVIRONMENT CAUSED BY THE EL NIÑO PHENOMENON OF 1997 - 1998 IN COSTA RICA



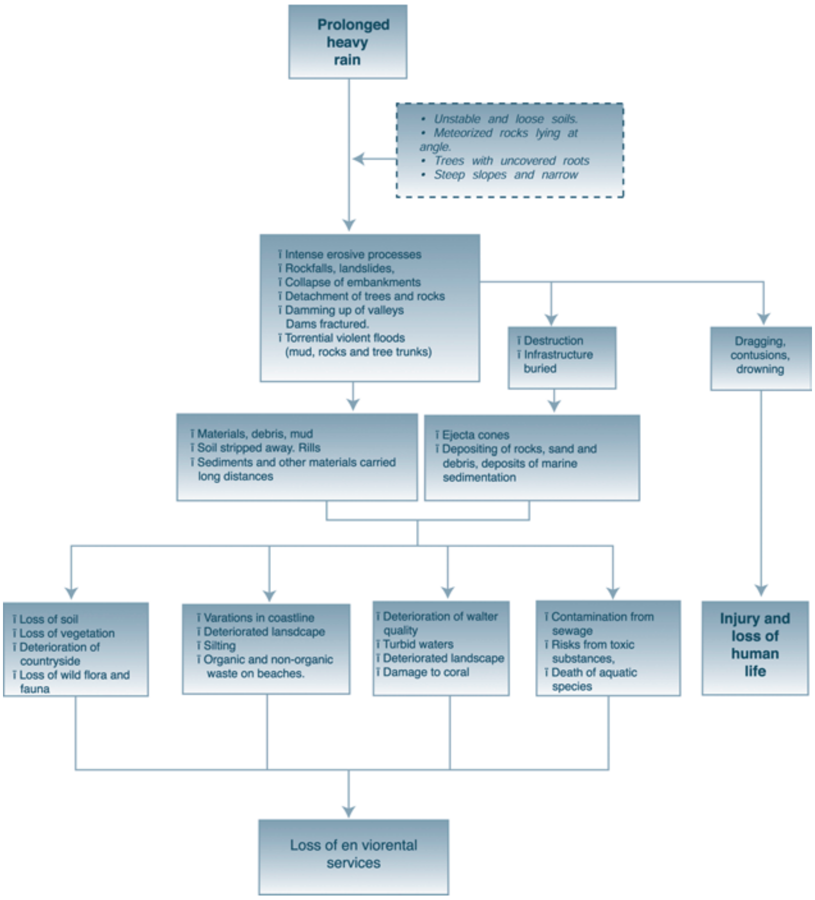
4 ECLAC, *Fenómeno de El Niño en Costa Rica durante 1997-1998: evaluación de su impacto y necesidades de rehabilitación, mitigación y prevención ante las alteraciones climáticas,* (LC/MEX/L.363), Mexico City, 1998.

5 ECLAC, *Los efectos socioeconómicos de las inundaciones y deslizamientos en Venezuela en 1999*, (LC/MEX/L.421/Add.1), Mexico City, 2000.

6 ECLAC, *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), Mexico City, 1999.

Figure 2

DETAILED STRUCTURE OF THE DISASTER GENERATED BY THE FLOODS AND LANDSLIDES IN 1999 IN VENEZUELA



C. Qualitative environmental assessment

It is difficult to provide an absolute scale for an expert or professional to a relative quality value for environmental impact assessments. However, the task is made easier when there are exact figures for an environmental variable and parameters established by environmental control bodies. If environmental specialists base their assessments on their experience and on the appropriate literature, they will be able to make an adequate, logical and consistent estimate.

The quality, intensity and extent of the effects of a natural phenomenon on the environment will vary according to the force released, the sensitivity and quality of the medium receiving it, the medium's capacity for recovery, the time it takes to recover and the partial or total loss of environmental assets or services. Human activities bring with them some inevitable and irreversible environmental impacts, most obviously involving land usage. Whether for working, production, storage, access roads or service areas, such uses are all negative impacts known as loss of vital space. However, the natural environment's recovery in the short, medium and long terms will normally be brought about by its own systems of ecological evolution (natural succession, natural recovery, self-purification of water, assimilation and transformation of chemicals and pollutants in the biogeochemical cycles, the atmosphere's photochemical reactions, etc.). The aim in this case is to restore the environment's ability to absorb the effects of the natural phenomenon, particularly when it is of great intensity and duration.

Once the environmental status study has been carried out and the necessary analysis has been made (preferably with an interdisciplinary exchange of information) the environmental specialist(s) will finally be able to judge the general importance or class of the alteration in the overall system. One of the proposals for studying human developments is that an environmental impact study should use six negative and four positive assessments of the effects on any natural or anthropogenic system. These assessments are based on results that can be induced from observations, professional experience, environmental matrices or models employed and data generated by analyzing a project or by applying artificial actions to a given environment in space and time. This qualitative method can be used in the case of disasters caused by extreme natural phenomena.

This assessment, which must be impartial, should preferably be made after completion of the study of the environment's features, of the environmental inventory and of such analyses as called for by the situation or by the institutional terms of reference. The classes of negative impact are given below and summarized in Table 3.

a) Zero Impact. Insignificant or very slight, with swift environmental recovery or with minimal or very low prevention or recovery costs.

b) Insignificant or Minimal Impact. Quantifiable impact that does not affect the system's stability. Recovery in the short or medium term; problems, alterations, changes and damage are insignificant when the benefits derived from the situation are taken into account.

c) Moderate Impact. Change is marked, but restricted to a relatively limited area. Slight regional impact; short-term recovery; moderate or acceptable problems; simple and cheap mitigation.

d) Severe Impact. Very marked regional or very extensive change. Recovery in the short or medium term if appropriate mitigation measures are implemented. A high level of discomfort and inconvenience, and mitigation is costly.

e) Very Severe Impact. Very extensive, heavy and harmful consequences in the region. Possibility of partial or slight recovery at a very high cost in the medium and long term. Fewer options for using the resource in the future. In the case of developments, it signifies a permanent threat to resources, health or life.

f) Total Impact. Even though only partially damaged, the system cannot recover; destruction is total. Loss of options for using the resource in the future. Where a human development is concerned, it will be imperative to forbid its installation or operation. In a disaster situation, natural recovery can take place in the very long term (more than 25 years).

Table 3

CLASSES OF ENVIRONMENTAL IMPACT

Enviromental impact	Damage Quality	Exent of the Damage	Recovery Term	Recovery Costs
Zero	Almost non-existent	Very limited range	Immediate Very short	None
Insignificant or minimal	Slight	Local	Short	Low
Moderate	Marked	Local Limited range	Short or Medium	Medium to high
Severe	Very marked	Local or extensive	Medium or long	High or very high
Very severe	Serious and destructive	Local or extensive	Medium or long	Very high
Total	*Total or almost total*	*Local or extensive*	*Very long or irreversible*	*Incalculable*

Source: adapted from Alfonso Mata, 1995

One advantage of this method is that it becomes much easier to interpret the appraisal after inputting quantitative values, such as a hurricane's wind speed, an earthquake's magnitude, the extent of a forest fire, fish catch data or the extent of a flooded area.

Good examples of this idea are the Fujita Scale of Tornado Intensity and the Saffir-Simpson Hurricane Scale. The former classifies tornadoes as weak (F0), moderate (F1), significant (F2), severe (F3), devastating (F4) and incredible (F5). The latter similarly classifies hurricanes into categories 1 (moderate), 2 (strong), 3 (severe), 4 (very severe) and 5 (devastating). Scales have also been used to give a qualitative and quantitative idea of the El Niño phenomenon by classifying occurrences as moderate, strong, and very strong according to the average changes in the ocean's surface temperature. In the case of hurricanes, each category has different geographical zones of damage intensity, which are established using approximately the same qualitative standards. Accordingly, they can be classified into zones of moderate, strong, severe and very severe impacts.

We now provide examples of qualitative environmental assessments based on relating to the damage caused to the environment by Hurricane Georges in the Dominican Republic in 1998 and by the El Niño phenomenon in Costa Rica in 1997-1998.

Table 4 shows a breakdown by category of the areas affected by mass movements caused by Hurricane Georges in the Dominican Republic. The skill shown by the observers during field trips made to determine areas, type and depth of mass movements such as landslides, together with analysis of aerial photographs taken before and after the disaster, made it possible to estimate the percentage of the area affected and associate it with a qualitative description of the damage.

Table 4

CLASSIFICATION ON THE AREAS AFFECTED BY LANDSLIDES AND AVALANCHES CAUSED BY HURRICANE GEORGES IN THE DOMINICAN REPUBLIC IN 1998.

Category	Affected area (%)	Estimated damage
D1	10	Slight
D2	30	Moderate
D3	50	Severe

Source: Adapted from Lücke, O. & R. Mora. 1998.

Table 5 shows the characteristics of the protected areas damaged as a result of Hurricane Georges and the impact classification defined by the authorities of the affected country.[7]

7 ECLAC, *República Dominicana: evaluación de los daños ocasionados por el huracán Georges, 1998: sus implicancias para el desarrollo del país*, (LC/MEX/L.365), Mexico City, 1998.

Table 5

CHARACTERISTICS OF THE PROTECTED AREAS IN THE DOMINICAN REPUBLIC AFFECTED BY HURRICANE GEORGES IN 1998 AND THEIR CLASSIFICATIONS IN TERMS OF RELATIVED IMPACT

National Parks and equivalent reserves (1)	Affected area km²	Life zone (2) and special feature	Degree of environmental impact (3)
NP Armando Bermúdez	*766*	*S-wf and S-rf, the greatest altitudes in the Antilles*	*Moderate*
NP Cuevas de Borbón or El Poumier	*0.25*		*Severe*
NP Del Este	*430*	*S-mf, S-df, Habitat of birds and plants, solenodon and hutia*	*Very Severe*
Isla Catalina	*22*	*S-rf*	*Very Severe*
NP Isla Cabritos (Lake Enriquillo)	*25*	*S-df endangered species*	*Minimal*
NP Jos del Carmen Ramírez	*764*	*S-wf and rS-rf, larger*	*Moderate*
NP Laguna de Cabral or Rincón	*240,54*	*Turtle and endemic fish*	*Severe (flooding)*
NP Redonda and Limón Lagoons	*107,7*	*S-rf*	*Moderate-severe*
NP Los Haitises	*1375*	*S-mf, endemic species*	*Severe-very severe*
NP Mount La Humeadora	*420*	*S-rf*	*Very Severe*
NP Sierra de Bahoruco	*800*	*LM-mf*	*Minimal*
NP Sierra de Neyba	*407*	*LM-mf*	*Moderate*
Lomas de Barbacoa	*22*	*LM-rf and LM-mf*	*Moderate-severe*
NP Valle Nuevo	*657*	*LM-rf and M, source of rivers Yuna and Nizao*	*Moderate-severe*
RC Ébano Verde	*23.1*	*LM-rf and LM-mt*	*Moderate-severe*
SR Quinta Espuela	*72.5*	*LM-mf*	*Moderate*
UP Santo Domingo and Botanical Garden	*16.4*		*Very Severe*
Total	***6,796***		

Source: ECLAC, 1998
[1]Abbreviations: NP: National Park; SR: Scientific Reserve; UP: Urban Park.
[2]Life zone (in the Holdridge sense, see Appendix XIII), Tasaico 1962.
Abbreviations: S: subtropical; M: montane; LM: lower montane; mf: mosst forest; wf: wet forest; rf: rain forest; df: dr
[3]Areas affected by Hurricane Georges according to the National Planning Office of the Dominican Republic.

Table 6 shows another example of qualitative assessment, related to the El Niño phenomenon in Costa Rica in 1997-1998. This classification makes it possible to clearly define the values of the environmental services lost in the affected areas.

Table 6

MAIN ENVIRONMENT IMPACTS ON WILDLIFE PRODUCED BY THE EL NIÑO PHENOMENAN IN THE HUETAR AND CHOROTEGA REGIONS OF COSTA RICA IN 1997 - 1998 a/

Impact on	Cause	Intensity	Recovery period	Notes
Wetlands CaÒo Negro WLR	Drought	Severe	<5 years	Lower water level in lagoons and swamps
Wetlands CaÒo Negro WLR	Fire	Very Severe	<1 year	Damage to undergrowth and surrounding grass
Cedar trees in CaÒo Negro WLR	Fire	Irreversible, without spontaneous recovery	<20 years by importing species	The Maria cedar tree is unique to the Northern area. Once it has been burnt it will not recover
Riverside forests	Drought	Moderate	1 year	Late flowering, loss of fruits
Birds resident in CaÒo Negro	Fire	Very Severe	<10 years	Loss of habitat
Migrant birds at CaÒo Negro WLR	Fire	Very Severe	Unknown but could be swift	Loss of habitat
Land mammals	Fire	Very Severe	Unknown	Death of individual animals
Bats	Fire	Severe	Unknown	Loss of the habitat of a magnificent predator on insects and seed disperser
Batrachians Herpetofauna	Drying of wetlands	Moderate	Medium term	Reduce populations; smaller habitat
Threatened Ichthyofauna	Drying of wetlands	Severe	Variable	Tropical garfish (Astractosteus tropicus), a threatened living fossil.
Sea fishing	Oceanic imbalance	Severe	Variable	Fisheries displaced, greater effort. Coral reefs die
Trout breeding	Reduce currents	Moderate	Short term	Reduce flow of fresh water
Palm and undergrowth	Undergrowth burnt	Severe	Unknown	Disappearance of predators on pests

Source: ECLAC, 1998
Abbreviations: NP: National Park; WLR Wildlife Reserve

d) Classification and assessment of the effects on the environment

The next step is to classify the disaster's effects on the environment in terms of direct and indirect damage in order to make them compatible with the economic assessment methodology. Bear in mind that direct damage derives from changes in the quantity or quality of the environmental assets (environmental change): loss of soil and vegetation, loss of quality and/or quantity of water, changes in the dynamics of ecosystems and so forth. The disruption of human-made capital that prevents (or makes it more costly) the use of environmental assets is also considered direct damage: disruption of water-distribution networks or water-treatment facilities; disruption of communication networks and means of transport that make it impossible to carry out activities entailing the use of environmental goods and services; and so on. Indirect damage consists of modifications to the flows of environmental goods and services arising from a temporary inability to use the environmental resources due to the damage caused by the disaster up to restoration of natural and/or man-made capital.

Once the environmental impacts have been identified and classified into direct and indirect damage, the next step is to quantify and assess them. This is the most difficult stage of the assessment task, mainly because of time constraints, and the quality of the information is crucial.

The quantification process establishes the magnitude of the identified environmental effects: the area of burnt forest or of eroded soil, the length of beach damaged, the reduction in the volume of fishery catches, the reduced flow of water, the presence of pollutants in the water, the number of individual members of a species killed and so on. The assessment process puts an economic value on the identified environmental effects. In most cases, quantification comes before assessment, although quantification is not always necessary to assign a value to the environmental effect. In practice, different situations arise.

In many cases, neither quantification nor assessment can be carried out. For example there is rarely sufficient time available for disaster assessments to obtain quantitative information about the impact on specific species (without use value) or on other variables that form part of the ecosystems' dynamic. Also, it will only be possible to describe these impacts qualitatively, even if they can be identified and sustained. For example, in the case of fauna it is hardly ever possible to ascertain the number of affected individuals. Even if it were possible to obtain this information, it would be impossible to allocate a value to each of the affected individuals.[8] Consequently, in such a case it would only be possible to identify the environmental effect. However, if a project to introduce new individuals were planned, its cost could be used as an approximation of the value of the individuals lost.

The foregoing situation also occurs when there are changes to the landscape (variations to the coastline, for example) that have no significant effect on productive activities (for example, in the case of tourism). On other occasions, although it might be technically feasible, detailed information is not available or is of low quality. For example, it can be very difficult to determine the area of soil lost due to flood-generated erosion when the affected area is large and there are no remote sensors that might, be able to supply aerial photographs.

8 There are, for example, approximations of the existence value of endangered species, although they refer to the species as a whole and are not applicable to a specific number of individuals. The methodologies applied, as well as having been called into question, require a great amount of information.

e) Economic assessment of environmental damage

The purpose of assessing damage in this methodology is to identify the magnitude of the impact on the environmental resources and services and on the economy of the country or region affected.[9] It eventually also allows one to propose strategies and plans to restore the environment after a disaster has occurred.[10]

As mentioned earlier, there are several distinct types of environmental values. Use values apply when goods and services that contribute to people's well-being are derived from the natural resources. Non-use values are not related to any direct or indirect use and arise from the psychological benefits derived from, among other things, the mere knowledge that the resource exists (existence value) or the wish to preserve natural capital for future generations to enjoy (inheritance value). Option values are defined as the benefits accruing from the preservation of options for the use of a particular resource when there is uncertainty about either its possible future use or its future availability.[11]

There are different procedures for appraising natural assets.

- An estimate of the economic value of an environmental asset in the event that there is a market value for said goods. In this case, provided that prices are not distorted, the environmental changes can be appraised directly using market prices. If a natural resource provides several services and there is no market value for all of them, this procedure cannot be used to provide a reliable measure of the resource's economic value.
- An indirect estimate of the environmental goods for which there is no market by measuring the market prices of related economic goods (surrogate markets). The techniques used to make these estimates cannot be used to measure non-use values.
- An indirect estimate made after consulting users about the value that they ascribe to the environmental goods for which there is no market. This procedure can be used for both use and non-use values.

9 One of the problems associated with environmental assessment is the calculation of the population that suffers loss of well-being, since some of the environmental services have the nature of a general public good (e.g. the maintenance of biodiversity and the fixation of greenhouse effect gases). This means, for example, that the damage caused when a forest fire releases carbon into the atmosphere affects the entire world as well as the country directly involved. The international community has created financial mechanisms such as the Global Environment Fund (GEF) to encourage countries to implement activities that generate global environmental benefits, although they do not directly benefit from them. The method used here is to include all damage regardless of the area involved (private, national, global).

10 It is normal in environmental analysis to make this kind of assessment by measuring (in monetary terms) the costs and benefits of the environmental changes so that they can be compared with other market values. Such a comparison makes it possible to make: prior assessments of alternative courses of action that involve both environmental changes and alterations in the allocation of other economic goods (cost-benefit analysis) and subsequent assessments of the impacts of real environmental changes on well-being in order to calculate the possible compensation for damage or to assess the economic efficiency of the restoration measures.

11 Although some authors consider that the option value is a special variety of use value, others include it among non-use values.

Only a few environmental goods or assets can be measured directly in terms of their market value. Consequently, indirect procedures are commonly used to estimate them.[12]

Indirect procedures provide objective measurements of the damage brought about by different causes, and they allow one to identify and measure the physical relationships that describe the relationships of cause and effect. One such procedure is the production function method; others are based on different costs such as those of prevention, relocation, sickness, human capital and restoration. Because it is commonly used for these purposes, the restoration cost method is described in the following inserts.[13]

Restoration Cost Method

The economic benefits $\mathbf{B_t}$ derived from an environmental attribute EA (for example water of a given quality for human consumption) can be expressed as:

$$B_t = f(EA)$$

For the sake of simplicity, it is assumed that if EA = 0, then $B_t = 0$ (alternatively it can be considered that if EA = 0, the water can continue to be used, although at a higher cost since it will have to be treated in each home). If a disaster affects EA such that EA = 0, the economic damage should be measured indirectly from the present value of the lost benefits (PV). Alternatively, it can be assessed from the restoration cost C (investments required to return the water to its original quality). Assuming that the investment in restoration is "immediate", restoration is economically efficient when C □ PV, and for this reason an estimate that uses C will generally underestimate the economic damage. In principle, when C > PV, restoration should not be carried out; if it is, the economic damage will be overestimated.

Direct environmental damage is also produced when the damage to the man-made capital prevents, or increases the cost of, the use of environmental assets. This damage is mainly caused by the total or partial loss of other forms of capital, such as physical infrastructure.

The restoration cost to be considered is that of restoring the man-made capital, which is an indirect estimate of the environmental damage. As when making a direct estimate of damage, the economic benefits B_t derived from an environmental attribute EA (for example water of a given quality for human consumption) require a physical asset K (for example, the water distribution system).

$$B_t = f(EA, K)$$

12 This classification is based on the work of Pearce and Turner (1990) and Turner et al. (1995).

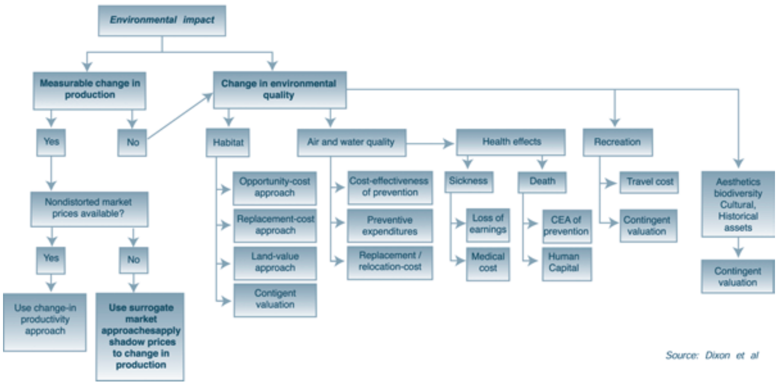
13 The restoration cost approach has been used often in the cost-benefit analysis of new projects and policies. In some countries, such as the United States, it is the basis for estimating damage compensation. The Integrated System of Economic and Environmental Accounting proposed by the United Nations considers this approach to be a possible method for environmental valuation. United Nations, *Integrated Environmental and Economic Accounting: An Operational Manual*, New York, 2000.

In this case, it is assumed that the disaster has not affected EA, and for simplicity it is assumed that if K = 0, then $B_t = 0$ (alternatively it can be considered that if K = 0, the water can continue to be used, although at a higher cost). If a disaster affects K such that K = 0, the economic damage should be measured from the present value of the lost benefits (PV). Alternatively, it can be assessed from the restoration cost C (investments required to rebuild the water distribution system). Assuming that the investment in restoration is "immediate", restoration is economically efficient when C □ PV, and for this reason an estimate that uses C will generally underestimate economic damage. In principle, when C > PV restoration should not be carried out (if it is, the economic damage will be overestimated).

The other estimation methods can also be used, according to the basic information available.[14] The graph in Figure 3 shows the procedures or methods that can be used to evaluate the different types of environmental change in different situations. Because of its importance in relation to the assessment of other economic sectors, the change-in- productivity approach (or the production - function method) is shown in a box.

14 For a more detailed explanation of these methods, see Dosi, D., *Environmental Values, Valuation Methods, and Natural Disaster Damage Assessment,* (LC/L.1552-P), ECLAC, Santiago, Chile, 2000.

Figure 5
ENVIRONMENTAL IMPACT VALUATION METHODS.



Source: Dixon et al

Despite the use of restoration cost as a preference method, it is still necessary to assess the damage during the time taken to restore the asset. Also, there are situations in which this method cannot be used (because of the characteristics of the natural asset which has been affected, because it would not be economically efficient or because restoration is not going to be carried out). In such circumstances, when technically possible, one of the other existing methodologies will have to be used to assess the damage. The final choice of the assessment technique to be used will depend on a series of criteria and circumstances. Ultimately, the choice of technique is going to be influenced by the amount of information needed, its availability and the ability to obtain it at a reasonable cost within the time limit.

Most available techniques are inherently incapable of estimating all the value categories. For example, some of them focus on estimating a particular use value, such as the cost of travel for recreation values; hedonic prices for area environmental attribute values; or the prevention cost for values related to health risks.

Change - in - productivity approach

This approach seeks to exploit the relationship between environmental attributes and the output level of an economic activity. The underlying assumption is that when an environmental attribute enters a firm's production function, the economic impacts of environmental changes may be measured by looking at the effect on production and by valuing that effect at market (or shadow adjusted) output prices. The monetary estimates obtained in this way should not be interpreted as the "true" value measure, but as a proxy of the environmental change's ultimate welfare impacts. Under this approach, the value of natural capital is considered as resource inputs into production: land for agricultural production, forest as a source of timber, etc. If the natural resource of interest provides multiple goods and services, some of which are unmarketable, this valuation approach would fail to provide reliable measures of the resource's value. However, in the context of natural disaster damage assessment, this approach allows estimation of the environmental contribution to economic activities (agriculture, forestry, fishery) that are assessed separately.

If Y is the activity's output, ENV the environmental variable(s) of interest, and X_i (I = 1…..N) other inputs, the production function might look like this:

$$Y = f(X_i, ENV)$$

A change in ENV (e.g., an increase or decrease in water pollution) will decrease/increase output levels. Broadly speaking, when Y is a marketed good, and the observable price is not affected by relevant market-failures, this price can be used to estimate the value of a change in ENV.

This approach is closely linked to the concept of economic rent. Economic rent is the return on a commodity in excess of the minimum required to bring forth its services. Rental value of the natural capital is therefore the difference between the market price and the cost of production/extraction. For example, in the case of agricultural and livestock production, the contribution of the environmental asset (agricultural and pasture land) can be estimated as the difference between the market value of the output and the production costs. In the case of forest resources, the value of roundwood production and other non-timber goods less production costs would represent the contribution of forests to economic activity. When an environmental change produces a diminution in the natural asset productivity, it can be assessed by multiplying the output change by the current output price.

This is the simplest way of using this valuation approach. Its main caveat is that it ignores possible prices changes and this is not the case when significant and widespread changes in environmental conditions could entail non-negligible price effects. Market failures, such as open-access conditions (present in many fisheries, in which economic rent is close to zero) represent another problem for the use of this approach.

The time available and the cost make it practically impossible to make estimates based on contingent assessment methods (which are potentially capable of estimating both use and non-use values). Nevertheless, if such a study for any of the affected areas (species) existed before the disaster, then this method should be used to estimate damage.

The environmental value transfer procedure is the process by which a demand function or the value of an environmental attribute or of a group of such attributes obtained in one context is used to estimate environmental values in another context. The use of estimates from earlier studies to assess the costs and benefits of new projects, environmental regulations or other policies is common in the field of public decision-taking, and it has been formally recommended and adopted by several agencies for the economic assessment of environmental impacts.

The use of this technique is justified by the resources saved. The constraints of time and other resources that affect disaster assessments make this a particularly interesting method. Protocols exist for the implementation of this technique, which involves three major steps:

(1) Identification and selection of original studies

Once the analyst has identified the relevant ecological and economic cause-effect relationships which are believed to drive changes in people's welfare resulting from the environmental changes that are expected to occur or that have actually occurred at the study site (the "transfer context"), the analyst has to identify previous studies that can potentially quantify such changes.

Once a search of the literature or other available sources has revealed potential candidates for transfer, the analyst should evaluate their transferability and select the most appropriate one(s). Several criteria have been suggested for assessing the transferability of existing studies. Besides their scientific soundness, special attention should be paid to the original studies' relevance: that is the original study context and the transfer context should match as closely as possible. In particular, the magnitude of environmental changes and the affected "environmental commodities" must be similar; the baseline environmental conditions should be comparable; the affected populations' socio-economic characteristics should be similar.

(2) Synthesis of available information

Finding studies that adequately satisfy the aforementioned general criteria may prove difficult. If analysts are able to pick up several useful studies, however they face the problem of exploiting all the acquired relevant information in an efficient and sensible way.

The simplest approach consists of using the bundle of selected studies to get a range of possible estimates (lower bound and upper bound estimates) or simple descriptive statistics (e.g., the mean and standard error).[15] More sophisticated approaches exist, such as meta-analysis techniques.

(3) Transferring information

After identifying relevant studies and synthesizing available information in some way, the next step consists of transferring such information, in order to get cost (or benefit) estimates. This can require ad hoc adjustments to the available estimates and may entail some arbitrary decisions.

The Discount Rate

Bearing in mind that natural resources are considered to be economic assets whose values can be indirectly estimated from service flows, an assessment of environmental damage should account for the variations in these flows during the period in which they occur. To do this, it is necessary to identify the times that the loss of environmental services begins and ends, to estimate annual losses of well-being and to choose discount rate.

The use of discount rates is the subject of wide-ranging, and as yet unsettled, theoretical debate. In principle, the difficulty of choosing an appropriate discount rate can be avoided if a political decision has been taken to restore the natural capital's productivity, provided that the restoration is technically possible and is in fact carried out. However, this will only be the case when restoration is carried out immediately after the disaster and the recovery of the natural capital's productivity is also "immediate".[16] In reality, if restoration is not carried out immediately or if its execution will take more than one year, a discount rate should be used to express the cost of restoration at present values so as not to overestimate the damage. The same thing happens when the restoration is immediate but does not enable total immediate recovery of the environmental services. The three alternative scenarios shown below will make this clear.

1. The restoration (whose total cost is C) is carried out immediately (t = 0), but the capital will be recovered over time t = n. During this time, the people affected suffer annual losses of well-being B_t (t = 0, … n). In this case, the economic damage caused by the disaster will be

$$D = C + \sum_{t=0}^{n} \frac{B_t}{(1+r)^t} \quad (1)$$

2. The restoration is executed in time t = n and, once completed, enables the immediate restoration of productivity. In this case,

15 For example, in a study aimed at assessing the total economic value of Amazonian deforestation, Torras (2000) exploits previous studies which have focused on specific forest value categories (direct use, indirect use, and non-use values), and calculates the annual per-hectare economic loss by using the mean of the estimates from these studies. In this way the author arrives at an estimated total annual value of a representative hectare of Amazon rain forest of US$1 175 (1993 prices). Although the methodology employed is quite crude, the paper provides valuable information about a large number of empirical studies in developed and developing countries aimed at estimating forest values.

16 Although this situation is unlikely to be found in reality, there are similar situations, such as when restoration consists of cleaning debris from a beach used for recreation.

$$D = \frac{C}{(1+r)^n} + \sum_{t=0}^{n} \frac{B_t}{(1+r)^t} \quad (2)$$

3. Finally, the restoration is carried out in time t = n, but recovery of the asset's productivity will take t = n+s. In this case,

$$D = \frac{C}{(1+r)^n} + \sum_{t=0}^{n+s} \frac{B_t}{(1+r)^t} \quad (3)$$

Most of the conceptual problems related to the discount process –intergenerational equity, uncertainty about future preferences and uncertainty about the discount rate itself– can be avoided if the recovery phase is not "too long".[17] In this case (short - term environmental damage), the personnel in charge of the disaster assessment should use a "standard" discount rate, such as (for example) that used for cost-benefit analysis of public projects.

Other approaches can also be used. For example, Kunte, A., et al (1998) used a discount rate of 4% for estimating the value of natural capital as resource inputs into production of the countries of the world.
Kunte, A., K. Hamilton, J. Dixon and M. Clemens. *Estimating National Wealth: Methodology and Results; Series Indicators and Environmental Valuation of the World Bank* (paper circulated to encourage thought and discussion), Washington, 1998.

3. Estimating the environmental damage

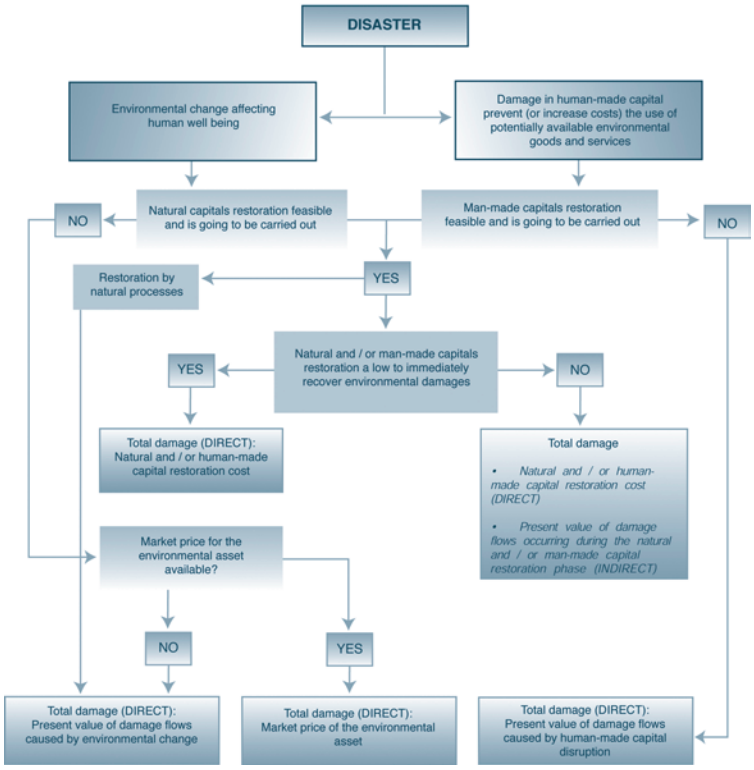
When making preferential use of the restoration cost method to assess damage, the environmental specialist should remember that there are differences between the restoration of a natural asset and the restoration of man-made capital.

First of all, it may not be technically possible to restore the natural asset. Second, when it is possible, it may take more time to restore the natural capital than the man-made capital infrastructure. Third, unlike man-made capital, natural capital is sometimes restored by natural processes, provided human intervention allows. This is the case, for example, of some types of forest after a fire or of the sandy beaches on some islands following the erosion caused by hurricanes or tropical storms. In this last case, there is no point in making an assessment by applying the restoration cost, and other methods will have to be used. The following graph illustrates the procedure for making an economic assessment of environmental damage.

17 The longer the restoration stage, the more difficult it is to identify a suitable discount rate. Therefore, the Principle of Caution advises a downward adjustment of the "standard" discount rate. However, it is not easy to say how much the rate should be reduced.

Figure 4

PROCEDURE OF ECONOMIC ASSESSMENT OF ENVIRONMENTAL DAMAGE



The definitions of direct and indirect damage, the direct and indirect ways of estimating damage and the calculation methods described previously should be borne in mind when studying the following specific examples of damage caused to different environmental assets and services.

a) Damage to the air

The air is often affected by the pollution caused by natural events, such as volcanic eruptions, as well as that caused by human activities. It is clearly not feasible at present to ascribe a value to pure air for human consumption. Any definitive alteration in air quality can only be estimated indirectly by calculating the cost of air cleaning programmes that might be undertaken (restoration cost). These are not normally put into effect to counteract natural disasters, but are used in the case of urban environmental degradation caused by human activities. In this sort of case, the assessment will be based on the annualized investments required to implement the clean-air projects.

The indirect damage resulting from temporary air pollution can be measured according to the corresponding increase in economic flows (higher current expenses) required for health and defensive expenditures throughout the period needed to re-establish normality.

A theoretical example of this situation would be a volcanic eruption that pollutes the air in a city and reduces visibility for interurban transport in the zone of influence. The air would only be cleaned naturally with the passing of time (probably by the action of rain), so it is not feasible to assess direct damage. However, it is possible to determine the resulting indirect losses during a three-month period, which is the time required for the situation to return to normal, by measuring the higher costs of medical care for the population, the cost to the population of buying masks (to avoid respiratory problems) and the increased costs derived from the use of longer, more expensive routes to carry people and goods (because of transportation difficulties). The tourism sector might also be affected by a lower flow of visitors. These types of indirect damage will, however, have been assessed under the health, transportation and tourism sectors.

b) Damage to water resources

There are two types of damage that can occur: changes in the quantity and quality of the water (natural asset) and damage or destruction of water works and distribution systems (man-made capital).

The assessment of direct damage is different in each case. In the first case (reduction in the quality or quantity of water), it is usually difficult to ascribe a value to the damage caused to the asset. Nevertheless, an assessment can be made indirectly based on the annualized investments needed to construct water purification/cleansing works or systems. In the second case (damage to man-made capital), the direct damage can be estimated through the cost of rehabilitating or reconstructing the existing systems, whether these supply water for human or industrial consumption, electricity generation or agricultural irrigation.

Calculations of indirect damage in the case of pollution are based on the higher operating costs and lower income of the existing treatment plants, as well as on the defensive expenditure incurred by private individuals (e.g., the purchase of filters) and on the increased cost of providing the population with medical care. If water works or distribution systems have been affected, the indirect damage is also assessed according to the higher costs and lower income of the companies providing the service.

An example of this is damage caused by increased silting in rivers due to heavy rains in a catchment area where water is collected for human and industrial consumption. Assessable direct damage is the cost to the water treatment plant of repairing the works in the catchment area and cleaning its equipment. Investments in forestation to protect the catchment area can also be included under this heading. Indirect damage, on the other hand, includes the increased cost of operating the plant because more energy is needed to pump water from further away, as well as the fall in income due to reduced billing during the time needed for its restoration, when the plant is either unable to operate or capable of only limited operation.

In the case of floods that damage agricultural irrigation systems, the direct damage would be equal to the cost of restoring or replacing the irrigation systems, while the indirect damage would be equal to the present value of the difference between the market value of production and the production costs during the time that the repairs or reconstruction are being carried out.

When there is drought or insufficient water to meet needs, direct damage is not assessed. However, the production that will not be obtainable during the drought in the agricultural and livestock, industrial and commercial sectors (including services), as well as the increased costs and reduced income experienced by the providers of services such as electricity and drinking water, is assessed as indirect damage.[18] As in the case of air pollution, much of this damage will already have been assessed in the infrastructure, health and agricultural sectors.

c) Damage to the land and seabed

The land can be permanently or temporarily affected by the action of a natural or anthropic event. In some cases, the impact may be positive, as when deposited materials have the medium-term effect of making the soil more fertile or when unexpected rains make production possible in areas that are normally arid.[19]

In the case of a negative impacts, direct damage can be assessed directly by taking the market value of the affected land, provided that this is not economically distorted. Alternatively, it can be assessed by calculating the present value of the farm production less the production costs (economic rent) that would no longer be obtained. In the case of repairable damage, the direct damage can be assessed as the cost of restoring the affected area through, for example, soil conservation projects. In the case of irrigated land its value implicitly incorporates the value of water.

18 See, for example, the case of the losses caused in Central America by the drought of 2001, in ECLAC, L.510/Rev.1, february 12, 2002.

19 This would be the case of the soil that received deposits of ash with a high mineral content from the Chinchón volcano in Mexico and, as a result, became more productive. A similar situation occurs with extensive areas of normally dry land in Ecuador that become productive temporarily because of the action of unexpected rains caused by the El Niño phenomenon.

In the case of land used for housing and human settlements, the assessment of the direct damage to the natural asset is based directly on the land's commercial value (in fact, urban land fits better in the concept of constructed capital). The assessment of the damage caused to the man-made capital (infrastructure and services) is based on the restoration or replacement value. These assessments are normally included in the housing and human settlement sectors.

During a natural disaster such as a hurricane, the waves that are generated by the intense winds will often have a significant impact on the seabed and marine ecosystems. The waves interact with the seabed and can cause considerable reshaping, which extends to the shoreline. The impact may be positive, as in the case of sand brought to the shoreline from offshore reserve areas, a process known as cross-shore sediment transport.

In the case of beaches, pieces of land or buildings for recreation or tourism that have been flooded, silted up or covered by debris deposits, the assessment of direct damage will be based on the cost of clean-up and the cost of beach restoration (including sand refill) when such measures are economically feasible. This damage assessment may have been made in the tourism sector.

Where soil rehabilitation is technically and economically feasible, the assessment of indirect damage should be based on the present value of the difference between the market value of the output crops and crop production costs during the period required for the rehabilitation. If a natural event makes production feasible in areas that are normally arid, the new production should be deducted from the losses to determine the event's net effect. This assessment is normally made in the agricultural sector. Given that farm production is the first link in a chain, it is also necessary to estimate the fall (or rise) in industrial production and in the commercial sector's sales resulting from the fall (or rise) in farm production.

Disaster-induced indirect damage related to the housing and human settlements sector is normally assessed under that sector. Indirect damage to tourism should be assessed as the income that will not be received during the time that the beaches are being rehabilitated. This figure forms part of the damage assessment of the tourism sector.[20]

d) Damage to biodiversity

Some disasters have extremely negative impacts on forests and vegetation. Fires, droughts, hurricanes and heavy rains are capable of causing permanent or temporary damage to large areas of forests and mangrove swamps.

20 Likewise, tourism sector income that cannot be generated because of direct damage to roads and other means of communication (although tourism installations have not been damaged) should also be considered as indirect damage.

The assessment of the direct damage in such cases can be based on the commercial value of wood and non-timber products in natural forests or plantations that are in production less the production, costs (economic rent). In the case of natural woodlands not being exploited for their timber,[21] the direct damage can be assessed indirectly by calculating the value of the environmental services (such as sequestration and storage of carbon, conservation of biodiversity and regulation of the water cycle) and goods (such as firewood and non-timber products when these are exploited) that will be unobtainable for a long period (the length of the period should be defined by the environmental specialist).[22] Mangrove forests provide environmental goods and services such as timber, fisheries and other species habitat, maintenance of estuarine water quality and shoreline protection. If actions are planned for the recovery of forests, mangroves swamps or urban parks, the assessment of direct damage is based on the restoration cost.

An example of this is provided by the Costa Rican forests that were damaged by fire during the drought caused by El Niño in 1997-98. Since they were expected to recover naturally, direct damage was assessed based on the present value of the forest services that would not be obtainable during the recovery period.[23]

When forests and mangrove swamps are only partially or temporarily affected, the assessment of indirect damage should be based on the present value of the environmental services that will be unobtainable during the period needed for the assets to recover. If the assets are totally lost with no possibility for recovery or if restoration is deemed a very long-term proposition, indirect damage should not be assessed.

It is not normally feasible to make an assessment of direct damage in the case of wild animal species, whose loss reduces biodiversity.[24] However, where repopulation is planned, the cost can be used as in indirect way of assessing the damage. A similar situation occurs with loss or direct damage caused to the coral formations that are mainly found on Caribbean coasts. Hurricane waves can damage coral reefs, as the horizontal and vertical action of the waves can break off pieces of coral. After such an event, and in cases where coral damage has been reported, it may be necessary to carry out an underwater video reconnaissance, or to rely on local dive professionals to estimate the aerial extent of damage.

21 In the case of protected areas, another way of valuing damage in natural forests not used for timber extraction is through the opportunity cost of preservation (the foregone benefits from converting them to pasture or agricultural land). This value must be considered as the minimum value of the protected area.

22 Some countries have mechanisms for payments of environmental services that permit a direct approximation of the value (partial or total) of services associated with forests.

23 ECLAC, 1998, *The* El Niño phenomenon in Costa Rica in 1997-1998; Assessment of its impact, and rehabilitation, mitigation and prevention needs in light of climatic *change,* (LC/MEX/L.363), Mexico City

24 In very special cases. direct damage to certain wild species could be estimated when there is a market for products or hunting licenses (sport or traditional). However, while a commercial value could be assigned to a specimen of the species (a partial approximation to its total economic value), estimating the affected population is more problematic.

In this case, it would also be possible to make the assessment indirectly on the basis of the environmental services (coastal protection recreation, fishing, biodiversity conservation) provided by the coral reefs as ecosystems.[25] The main difficulty with this method lies in estimating the chances of natural recovery and the length of time that it will take.

As the waves travel over the reefs to shore, they often uproot seaweed beds. An example of this was recorded in Belize in the Inner Passage between the mainland and the cayes, after Hurricane Keith. That event uprooted hundreds of hectares of seaweed beds, which were seen floating on the surface of the sea in large mats. Assessment of the value of this ecosystem can be linked to the cost of seaweed replanting programmes, evaluated on a per hectare basis; another option is the estimation of the sand producing potential of the seaweed beds and the subsequent valuation of the beach enhancing potential of this sediment.

Where damage is caused to the coral formations and emblematic species that attract tourists, it is possible to base an assessment of indirect damage on the income that will not be obtainable by the tourism sector during the time that it will take to recover the former environmental conditions.[26] However, this can only be done when the activities are identifiable in economic terms (e.g., lower takings from entry fees to land and marine parks; less income for recreational diving businesses).

e) Environmental damage by man-made capital disruption and overlap with other sectors

As indicated above, environmental damage can arise from man-made capital disruption (disruption of water distribution networks and roads, loss of buildings such as hotels, etc.) that prevents the use of environmental goods and services. Restoration cost of man-made capital is the way to estimate this direct environmental damage. Under thisapproach, it is necessary to distinguish two situations:

(1) When man-made capital is closely and exclusively linked to the use of environmental goods and services, man-made capital restoration cost can be considered as a proxy for environmental damage. This is the case of water distribution networks that allow the use of water or roads that are only used for recreation in natural areas (for example, inside a national park).

25 Reviewing work done in assessing reef value in Australia, Aruba and Jamaica may assist in assigning a monetary value to the damaged reef. Valuation rates can vary from US$7 500 per hectare to US$500 000 per hectare, depending on the location of the reef and its role in the overall ecosystem. Recent work on coral reef valuation includes the importance of coral to the pharmaceutical industry. Restoration actions (such as coral transplantation) are sometimes carried out.

26 A concrete example of this is the case of the Caribbean island of Anguilla, whose coral formations and beaches have often been swept by the wave of hurricanes and tropical storms in recent years, negatively affecting tourism occupancy rates after such events. See ECLAC, 1995, *The macro-economic effects and reconstruction requirements following hurricane Luis in the Island of Anguilla,* (LC/MEX/L.289 and LC/CAR/L.462), Mexico City.

(2) In many cases, however, man-made restoration cost also encompasses the use of non-environmental goods and services such as infrastructure (e.g., roads) used for trade or human transportation, but not exclusively linked to recreation. Hotels in nature areas allow for both nature-based recreation and other goods and services (food, lodging, fun, etc.). In these situations, human restoration costs include the present value of both environmental goods and services, and non-environmental goods and services. Consequently, this approach can overestimate environmental damage.

Something similar happens when estimating indirect damage, for example when environmental damage temporarily prevents tourist activities. In this case, only part of the tourist expenses can be considered exclusively "environmental" and it is not always easy to segregate this component. One instance in which it is possible to determine a specifically environmental component is via entry fees charged to enter protected areas or taxes used for environmental protection; these can be used as a proxy for the environmental contribution to the economic activity. However, a deeper exploration of such damage could be very difficult.[27]

Thus, in both cases (direct and indirect environmental damage), it may be difficult to isolate an accurate figure for environmental damage distinct from that of other sectors. This will depend on the available information. This problem is partially overcome (in terms of taking into account all environmental damage) when considering that most environmental damage is already considered in the assessment of other sectors (agriculture, tourism, infrastructure, health, etc.).

To summarize, the following figure shows the different situations in which environmental damage assessment can be divided.

27 The approach for estimating the economic rent generated by the environment in tourist activities is through the difference between the market price (for example, room rate per night) and the hotel production costs (salaries, inputs and other expenses, including a normal rate of return of the investment). Hotels located in places with special landscapes can charge higher prices than others with less favored locations. The same occurs within a hotel; rooms with the best views are more expensive.

Table 7

DIFFERENT TYPES OF ENVIRONMENTAL DAMAGE ASSESSMENT

Direct and indirect environmental damage
I Without monetary valuation. Damage described or qualitatively assessed.
II Monetary valuation. Environmental damages not included in the assessment of other sectors.
III Monetary valuation. Environmental damages included in the assessment of others sectors. They can be easily isolated from other sectors.
IV Monetary valuation. Environmental damages included in the assessment of other sectors. It is difficult,if not impossible,to isolate them from other sectors.

Monetary assessment of environmental damage is limited to the situations described in boxes II and III in the figure. The amounts obtained in box II will be added to the estimations of other sectors to get an overall assessment of direct and indirect damages. The summ of boxes II and III, will provide a clearer idea of the damage suffered by the environment and facilitate a comparison with other sectors. However, when arriving at overall figures of damage, the amounts of box III must be separated to avoid double counting.

The following table shows the types of environmental damage classified according to the different categories described above and the sectors in which they are most likely to have been included.

Table 8

TYPES OF ENVORONMENTAL DAMAGES AND OVERLAP WITH OTHER SECTORS

Direct and indirect environmental damage	
I Without monetary valuation. Damage described or qualitatively assessed.	
II Monetary valuation. Environmental damages usually not included in the assessment of others sectors. (i) Environmental damage usually that is assessed on the basis of the cost of environmental restoration, especially when the conservation of de affected environmental asset is the responsibility of the country's environmental bodies. This is usually the case with protected natural areas and (ii) environmental damage that is assessed by variations in the flows of goods and services for which there are no clearly established markets (e. g., environmental services provided by forest; such as the sequestration of atmospheric carbon or regulation of the water cycle). The most common damages included in this category are: • Loss of environmental services linked to the damage of ecosystems such as forest, mangroves, coral reefs, etc. • Damage to the infrastructure of protected areas (roads, signposts, research centers, etc).	
II - III Monetary valuation. Damages in which the frontier between environment and other sectors assessments is not very clear. It could depend on the organization of the assessment team or on the institutional organization of the country affected.	Sectors in which environmetal damage could have been assessed
• Damage to infrastructure and equipment related to environmental sanitation, such as dumps and garbage collection and treatment facilities and equipment • Restoration of urban parks	Water and sanitation sector and/or housing and human settlements
• Lower earnings from protected areas (terrestrial or marine parks) entry fees • A fall in taxes used for environmental protection (e. g.,additional airport or hotel taxes that are levied on foreign visitors in certain countries)	Tourism
III - IV Monetary valuation. Environmental damages usually included in the assessment of other sectors. Isolating environmental damage depends on the availability of information. • Loss or loss of quality of agricultural and pasture land • Loss or agricultural and forestry production • Loss of fish catch	Sectors in which environmetal damage have been Agriculture and Fishing sectors
• Water distribution problems caused by contamination, disruption of distribution in infrastructure and/or availability • Health problems linked to changes in environmental conditions	Health, drinking water and sewage sectors
• Losses related to the tourism sector	Tourism
• Changes in energy production and distribution caused by environmental changes (e. g.,silting of dams or disruption of distribution networks) • Loss of sub-soil assets (e. g.,oil spill)	Energy sector
• Relocation of houses exposed to new threats • Diminution of house values caused by environmental changes (including changes in landscape)	Housing and human settlements
• Problem in transport (terrestrial, maritime and fluvial) caused by landslides, floods, silting of ports and rivers, etc. • Changes in environmental conditions that demand restoration actions (e. g. water courses divert demending to undertake drainage actions).	Infrastructure: communication and transport sector

When the summary is prepared, the global specialist or analyst must ensure that there has been no double counting, so that all comparisons made later (for example, with the GDP of the affected country or region) will be valid and give a true picture of what really happened because of the disaster.

APPENDIX XII
EXAMPLES OF ENVIRONMENTAL DAMAGE CALCULATIONS

Example 1: Environmental damage caused by a hurricane

The wind, waves, and rain produced by a hurricane have affected an area of a country noted for the wealth of its environmental heritage. The main economic activities of the affected area are fishing and the tourism attracted by its beaches and diving around its coral reefs. The following table presents the identified changes to the environment and the human-made capital that affect the people's well-being.

Table 1

IDENTIFICATION OF CHANGES IN THE ENVIRONMENT AND MAN-MADE CAPITAL AND THE ENVIRONMENTAL GOODS AND SERVICES INVOLVED

Identified enviromental changes	**Enviromental goods and services involved**
• *Deaths of seabirds and destruction of their habitat (nesting and breeding places)*	• *Wildlife habitat* • *Recreation (tourism)*
• *Changes in the quality of the sea water: turbidity, floating sea-grass, faecal contamination from flooded septic tanks*	• *Navigation* • *Fishing* • *Recreation (tourism)*
• *Changes to the shoreline: erosion, silt barriers, loss of beaches and beaches littered with debris*	• *Land (property)* • *Recreation (tourism)*
• *Damage to sea-grass beds: mechanical damage, excess siltation, smothering and loss of fishing habitats*	• *Fishing* • *Wildlife habitat*
• *Mangrove swamps: defoliation and uprooting of plants least tolerant especies exposed to saltwater flooding*	• *Coastal protection* • *Wildlife habitat* • *Fishing*
• *Coral reefs: Localized mechanical damage and other impacts (asphyxia and growth of algae)*	• *Coastal protection* • *Recreation (tourism)* • *Fishing* • *Unique ecosystem (existence value)*
• *Changes in the sanitation conditions caused by flooding and overflowing of septic tanks and sewer lagoons*	• *Health conditions* • *Recreation (tourism)*
Infrastructure and equipment affected	
• *Tourism and fishing infratructure: Hotels, piers, boats, fishing gear and seawalls*	• *Recreation (tourism)* • *Navigation* • *Fishing*
• *Destruction of septic lagoons and tanks*	• *Health conditions* • *Recreation (tourism)*

Direct damage to environmental assets is measured on the basis of their market value (when there is one) or of the investments in restoration planned by the government and other participants in the affected country. The indirect damage includes the loss of income during the time that the infrastructure and natural capital are being restored (when their recovery is not instantaneous). As will be seen, part of the damage has already been included in the assessments of other sectors (fishing, tourism and infrastructure). The calculations of direct and indirect damage are shown below with a chart explaining the assessment process.

Table 2

ASSESSMENT OF ENVIRONMENTAL DAMAGE

A. ENVIRONMENTAL DAMAGE NOT ASSESSED IN OTHER SECTORS	
A.1 DIRECT ENVIRONMENTAL DAMAGE	***US $000***
1. Properties lost due erosion of the coast (including beaches) *Measured at places where there is a market for plots of land. The lost area measures 6,400 m^2 at a price of USD 200/m^2. Damage is considered to be irreversible or very long-term.*	*1,280*
2. Clean-up of beaches for tourism purposes *in tourism areas, investment made shortly after the hurricane by the municipal authority (financed by the hotel keepers) to clean up the debris and rests of vegetation. The total cost of USD $ 280,000.*	*280*
3. Damage to the mangrove swamps (partial assessment) *The priority for the environmental authorities is the recovery of the belt of mangrove swamps that offer greatest protection against the effects of storms . It is estimated that an area of 2,300 hectares of mangrove swamps was damaged. A replanting programme is projeted for the 500 hectares situated in the most vulnerable places whose natural recovery is thought difficult. The cost of replanting is USD $ 4,800 per hectare. The environmental value of the rest of the damaged mangrove swamps is not assessed.*	*2,400*
4. Damage to the coral reef *A. study of a similar ecosystem in a Caribbean island to appraise the coral reef in the area takes the following environmental services into account: recreation (linked to tourism); fish habitat; coastal protection; maintenance of biodiversity; source of sand for beaches and dunes. The study calculates that the present value of a hectare of coral is between USD $ 90,000 and USD $ 320,000. No option value or existence values are calculated. According to the environmental authority, an area 7,000 m long and 75m wide has been seriously affected, with irreversible damage or very long-term recovery. The value used (simple average) is USD $ 205,000 per hectare.*	*10,762*
5. Direct damage not assessed *The following direct damage has been identified but not assessed since no restoration measures are planned and there is no information that would make it possible to use another assessment methodology.* • *Destruction of avian habitats:* • *Changes in the quality of the seawater (turbidity, floating seawced); linked with the fishing, tourism, and transportation sectors;*	
TOTAL DIRECT DAMAGE	***14,722***
A-2 INDIRECT ENVIRONMENTAL DAMAGE	
6. Indirect damage not assessed *This consists of the environmental services lost during the recovery period of the mangrove*	
TOTAL INDIRECT ENVIRONMENTAL DAMAGE	***0***
A. TOTAL ENVIRONMENTAL DAMAGE	***14,722***

Table 3

ASSESSED IN OTHER SECTORS, WITH ISOLATION OF COSTS

B. ENVIRONMENTAL DAMAGE ASSESSED IN OTHER SECTORS	
B.1 DIRECT ENVIRONMENTAL DAMAGE THAT CAN BE ISOLATED FROM OTHER SECTORS	
7. Restoration of the following infrastructure and equipment:	
• ***Fhising sector*** *(information obtained from the person responsible for the sector). Includes i)equipment and fishing vessels; ii)cold storage facilities; iii)stored fish and seafood*	4,780
• ***Drinking water and sanitation*** *(information obtained from the person in charge of infrastructure). Includes damage to the drinking water and drainage systems (pumping stations, storage tanks, septic pits, etc)*	1,655
TOTAL DIRECT DAMAGE	**6,435**
B.2 INDIRECT ENVIRONMENTAL DAMAGE THAT CAN BE ISOLATED FROM OTHER SECTORS	
8. Changes in environmental goods and services flows during the restoration period of the human-made capital and natural capital:	
• ***Tourism sector*** *(information obtained from the person in charge of the sector). Includes the fall in income due to lower takings from visitors: i)entry fees to marine parks (for diving); ii)lost airport departure taxes used for environmental protection*	935
• ***Fishing sector*** *(information obtained from the person in charge of the sector) Assessment of the reduction in the catches until they return to normal levels, i.e. the recovery of fishing vessels and equipment and normal sea conditions. Value of lost catches estimated at US$ 4.6 million; costs of production are 75% of revenues.*	1,150
• ***Drinking water and sanitation*** *(information obtained from the person in charge of the sector). Includes additional costs for carrying water, chemical treatment, energy consumed by emergency equipment, and prevention campaigns, and lower billing beacause less water is provided*	1,138
TOTAL INDIRECT DAMAGE	**3,223**
TOTAL ENVIRONMENTAL DAMAGE THAT CAN BE ISOLATED FROM OTHER SECTORS	**9,658**

Table 4

ASSESSED IN OTHER SECTORS, WITH NO POSIBILITY FOR ISOALTION OF COSTS

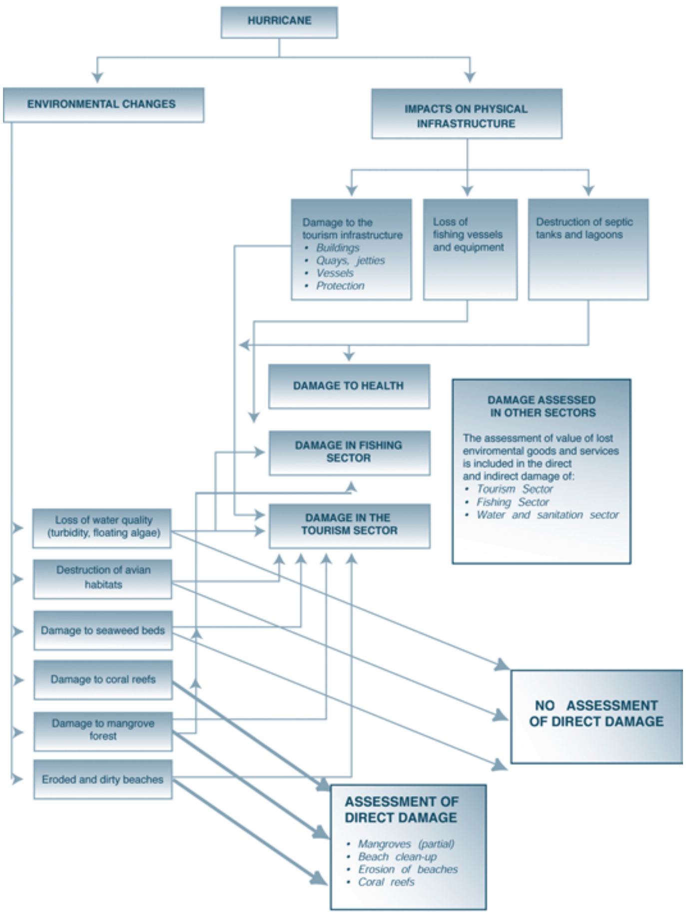
C. ENVIRONMENTAL DAMAGE ASSESSED IN OTHER SECTORS	
C.1 DIRECT ENVIRONMENTAL DAMAGE THAT CANNOT BE ISOLATED FROM OTHER SECTOR	
9. Restoration of the following infrastructure and equipment: • Tourism sector (information obtained from the assessment team responsible for tourism). Includes the cost of replacing i)hotels(building, forniture, equipment, facilities, including a golf courses); ii)gift shops; iii)restaurants; iv)quays and tourist craft; v)sea-walls. Restoration costs add up US$ 62 million. Part of this figure corresponds to the value of the lost environmental services related to the tourims, but it is not easy to estimate it.	N/A
C.2 INDIRECT ENVIRONMENTAL DAMAGE THAT CANNOT BE ISOLATED FROM OTHER SECTORS	
10. Changes in environmental goods and services flows during the restoration period of the human-made capital and natural capital: • Tourism sector (information obtained from the person in charge of the sector). Includes the fall in income due to lower takings from visitors to hotels (lower occupancy) and other tourism-related income (restaurants,gift shops, transportation, etc.). Its estimation adds up US$18 million. Part of this damage are the lost environmental services related to tourism during the restoration period.	N/A

The following table summarizes the environmental damage assessment:

(US$000)	Not assessed in other sector	Assessed in other sectors
Isolated from other sectors	14 722	9 658
Not isolated from other sectors		Not estimated 80 000

Figure 1

PROCESS FOR ECONOMIC ASSESSMENT OF ENVIRONMENTAL DAMAGE



The complete assessment of environmental damage includes, therefore, the damage (both direct and indirect) assessed by the sectoral specialists and that assessed by the environmental specialist.

Example 2: Assessment of damage to the environmental services provided by forests

This example concentrates on the assessment of damage to the environmental services provided by forests, since this is one of the most likely effects of an extreme event. The event has been simplified to show only this damage, and there is no analysis of links to other sectors.

An extreme event has affected a region in a country in the following way:

- Primary forest: 3 200 hectares destroyed. Most of the area cannot be recovered or is recoverable in the very long term.
- Secondary forest: 6 100 hectares destroyed. Most of the area cannot be recovered or is recoverable in the very long term.
- Shade coffee plantations: 7 200 hectares affected, of which 60% (4 320 hectares) is considered incapable of recovery. The remaining 2 880 hectares might recover over a period of five years.

The country's government has introduced a scheme whereby landowners who conserve the forests will be paid for environmental services. This payment will be made for 20 years. The environmental services and annual monetary values included under this scheme areas follows: [28]

Table 5
VALUE OF THE FOREST ENVIRONMENTAL SERVICES

Environmental Service	Primary forest (USD/ha/year)	Secondary forest (USD/ha/year)
Carbon fixing	*38*	*29*
Water protection	*5*	*3*
Biodiversity protection	*10*	*6*
Recreation (natural beauty)	*5*	*3*
Total	**58**	**41**

28 The World Bank uses the figure of 20 dollars per ton of carbon emitted as an estimate of the damage caused by carbon dioxide emissions. This figure represents the current value of the damage to economic assets and the fall in human well-being for the time the polluting unit is in the atmosphere. There is still no agreement as to the carbon sequestration capacity per type of vegetation.

The shade coffee plantations are agroforest systems that provide agricultural products while conserving the ability to provide typical forest environmental services. An environmental assessment study of the area has taken into account the provision of one good (firewood) and three environmental services (protection of water production and flood control; soil stabilization and conservation; and maintenance of biodiversity). The study does not take into account the environmental service of carbon fixing because the branches cut in the annual pruning are burned.

There is an estimated timber production of 14 m3/ha/year with a value per m^3 of 56 dollars/ha/year. The value of the other three environmental services is 21dollars/ha/year. The total value therefore is 77 dollars/ha/year.

Table 6

ASSESSMENT OF ENVIRONMENTAL DAMAGE

DIRECT ENVIRONMENTAL DAMAGE	USD$ 000
1. Loss of environmental services provided by primary forests. *The method used to assess the value of the loss of the 3,200 hectares of forest is baed on the government's decision to pay for the conservation of forests (i.e. there is a market for environmental services).* *By using the formula below with a discount rate of 7 per cent (that used by the government to evaluate its investment projects), the income from conservation over the next 20 years is expressed at its present value.* $VP = +\sum_{t=0}^{20} \frac{58}{(1.07)^t}$ *The present value of the future income flows is USD 672/ha. For 3,200 ha., this comes to*	2,150
2. Loss of environmental services provided by secondary forests. *This is calculated in the same way as the previous example, but the value of the annual payment per hectare is changed as shown in the following formula.* $VP = +\sum_{t=0}^{20} \frac{41}{(1.07)^t}$ *The present value of the future income flows is USD 475/ha. For 6,100 ha., this comes to*	2,897
3. Loss of environmental services provided by shade coffee plantations *In this case, it is considered that the value of the land has already been included in the farming sector assessment, although it ought to be taken into account in an extended assessment of environmental damage. The value of the environmental services taken into account is calculated for the non-recoverable area (4,320 ha) as in the previous case. The same formula is used as in the previous cases, and the value of the annual benefit per hectare is introduced* $VP = +\sum_{t=0}^{20} \frac{77}{(1.07)^t}$ *The present value of the future income flows is USD 893/ha. For 4,320 ha., this comes to*	3,858
Total direct environmental damage	**8,905**
IN DIRECT ENVIRONMENTAL DAMAGE	
4. Loss of environmental services provided by shade coffee plantations during rehabilitation period *There is a loss of environmental services during the recovery period of the 2,880 hectares of plantations that are capable of recovery (it is considered that the necessary investment is included as direct damage in the farming sector assessment, although it ought to be included in an extended assessment of environmental damage). For calculation purposes it is considered that the production of firewood and environmental services recover lineally over five years. Therefore,* $VID = 2{,}880 * [77 + 77*0.8/(1.07) + 77*0.6/(1.07)^2 + 77*0.4/(1.07)^3 + 77*0.2/(1.07)^4]$	610
Total indirect environmental damage	**610**
Total enviromental damage	**9,515**

APPENDIX XIII

LIFE ZONE SYSTEMS

The relationship between climate and vegetation has been recognized for many years, eventually leading researchers create a worldwide environmental classification system for geographically defining various habitats and natural biotas. Physical environmental factors (soils, nutrients, climate patterns, lighting, seasonality, humidity) that constitute a region's constant or cyclical characteristics are determinants in the development or presence of natural ecosystems that biologically define the area in question. These environmental parameters are the basic reference points for L.R. Holdrige's method of classifying life zones. This system recognizes discrete natural units so that they can be easily distinguished in the field, whether they consist of indigenous vegetation or forms that have been greatly altered. By employing universal parameters that can be easily measured with the same precision in any region and fed into the same model using identical formats, it is applicable to the entire globe.

The application of this system offers the following advantages:

1. Achieving a useful cartographic expression of diverse plant categories or formations that make up a region, country or continent in all of its latitudinal, and altitudinal, climatic, soil and hydrographic variations;
2. Determining the quality and potential of ecosystem servcies in a specific area (e. g., water production or absorption of carbon dioxide).
3. Forecasting the potential environmental impact of any human development or major natural events;
4. Choosing the areas that would be most conducive to farming, forestry or livestock activities (land use planning);
5. Identifying naturally existing communities with an eye toward stressing the importance of their conservation; and
6. Predicting bio-geographical scenarios in response to global climatic changes.

The four main analytical elements in the life zone system (Holdridge, 1979) are heat factors expressed in terms of biotemperature; the use of logarithmic increases in mean annual biotemperature and precipitation to express significant change in natural vegetation units; the ratio between biotemperature and potential evapotranspiration (humidity), on the one hand and the humidity and real evapotranspiration, on the other; and the ratio between evapotranspiration and biological productivity (Tosi, 1997), which is intimately related to environmental services.

In short, the life zone system reflects the relationship between the physical environment and all biota as expressed on three levels:

- Level 1: Bioclimate or life zone;
- Level 2: Vegetation association or ecosystems; and
- Level 3: Successional state (vegetation cover).

The system is thus based on the idea that it is possible to objectively define groups of ecosystems or plant associations on the basis of clear relationships with specific temperature, precipitation and humidity conditions. Holdridge referred to these as life zones, understood to be a group of natural associations, which are divided and subdivided accordingly, regardless of whether each group includes a chain of varying landscape or environmental units that may range from swampland to watershed. Life zones are also equally balanced between the three leading climatic principles of heat, precipitation and humidity, while recognizing that these associations may vary according to the altitudinal variations within a single region. This method of classification allows for recognition of the multiplicity of potential ecosystems or vegetable associations to be found within each of the world's 120 life zones or bio-climates. Vegetable association have been broken down into the following categories:

- One climatic association

- Three atmospheric associations

  Temperature associations (hot, cold)
  Humidity associations (arid, humid)

- Five soil associations

  Humidity associations (arid, semi-arid, humid)
  Fertility associations (fertile, sterile)

- Water associations

Furthermore, each of these systems includes a wide range of potential successional stages from a climactic or ideal state to those marked by extreme disturbances of a natural or anthropogenic nature. In this manner, all levels of vegetation corresponding to each of the successional states can be found in a broad array of conditions defined in physiognomic rather than in floristic terms.

Verifying System Validation

The life zone system has been validated through extensive mapping of tropical and subtropical regions with comparisons between similar areas based on limited meteorological data and observations on the relationship between climate, vegetation and patterns of land use. All of the countries of Central America, as well as Bolivia, Colombia, the Dominican Republic, Ecuador, Haiti, Jamaica, Paraguay, Peru, Puerto Rico, Santa Lucia and Venezuela have been environmentally mapped based on the life zone system. In addition, a preliminary macro-scale or partial mapping has been done of Australia, Brazil, Mexico, Mozambique, Nigeria, Thailand, Timor, Papua New Guinea and the United States. In most countries, these maps are accompanied by supplementary descriptive and explanatory texts.

Life zone definition based on climatic data

According to this system, life zones are defined based on mean annual readings of temperature (biotemperature), precipitation, humidity and meters of elevation above sea level. These are defined as follows:

- Biotemperature: mean annual temperature in centigrade conducive to plant life (between 0 and 30°C);
- Precipitation: the mean volume of any form of precipitation (rain, snow, sleet) in millimeters; and
- Humidity: the ratio between temperature and precipitation, independent of other sources of humidity. The best formula is called the potential evapotranspiration factor (in millimeters), which is achieved by multiplying the biotemperature by factor 58.93.

The second and third levels of life zones

Holdridge conceived of life zones defined by parameters applicable to the entire globe, such as biotemperature, precipitation and humidity. Nevertheless, specific environmental factors play a major part in defining the ecosystems of specific local landscapes. These conditions are the framework for defining a second subdivision that includes soil type, precipitation patterns, soil humidity patterns, the prevalence of strong (damp or dry) winds and the frequency of heavy fog. The presence or absence of any of the above factors moves the area in question left or right, or higher or lower, on the Holdridge Life Zone Model.

The variety of the floristic composition and the structure and physionomy of the vegetation of a region or country generally tends to narrow as one moves to higher elevations along the same latitudes, relative to a wet tropical rainforest with a sub-alpine landscape near the equator. A similar divergence can be seen with precipitation levels and seasonality in an arid tropical forest versus a very humid tropical forest at the same latitudes.

Within a life zone or formation, limiting factors can condition or make possible the development of many associations: mangroves, rocky costal zones, lagoons, dry steppe, windy hills and a range of other systems.

The system recognizes four basic associations (and possible combinations thereof): climatic, soil, atmospheric and moisture conditions. Climatic associations occur when precipitation and monthly distribution such as biotemperature are normal for the life zone, there are no atmospheric aberrations such as strong winds or frequent fog cover and the soil is typical for the zone. Soil associations appear when conditions are more or less favorable in relation to those for a normal (zonal) soil for the corresponding life zone. Atmospheric associations are those in which the weather varies from the norm in that area. Moisture associations involve all forms of wetlands (whether saltwater, brackish or freshwater) but logically exclude deep bodies of water.

The broad, climatically defined life zones are further subdivided into associations based on local environmental conditions and actual vegetation cover or land use. Generally speaking, the associations tend to make the vegetation appear more arid or humid than normal for such a life zone. For example, an association of fertile soil with supplemental water from a Tropical Rainforest has a metabolism similar to that of a Very Humid Tropical Rainforest; similary an area designated as an Arid Tropical Forrest might appear to be a Very Arid Tropical Forrest owing to a monsoon climate pattern with a vertisol soil that is wet in the rainy season and dry and cracked in the dry season.

The third level of the system contemplates provisional changes to ecosystems resulting from natural succession introduced by humans or animals. Life zone systems catalogue those changes as part of the successional state, and owing to their very short life span they are handled as part of land use.

One must be very careful with regard to apparent disparities between local vegetation and the corresponding life zone designation, which occasionally refers to the original vegetation of the climatic association. By the time the field survey is conducted, the area may have experienced some successional change or alteration of the climatic association. However, such a concern only arises when the system is not being applied properly. For example, wherever human activity has altered plant life, the nomenclature of the life zone should project the potential (or ideal) vegetation assuming that conditions would allow for a full recovery through a natural process of environmental succession.

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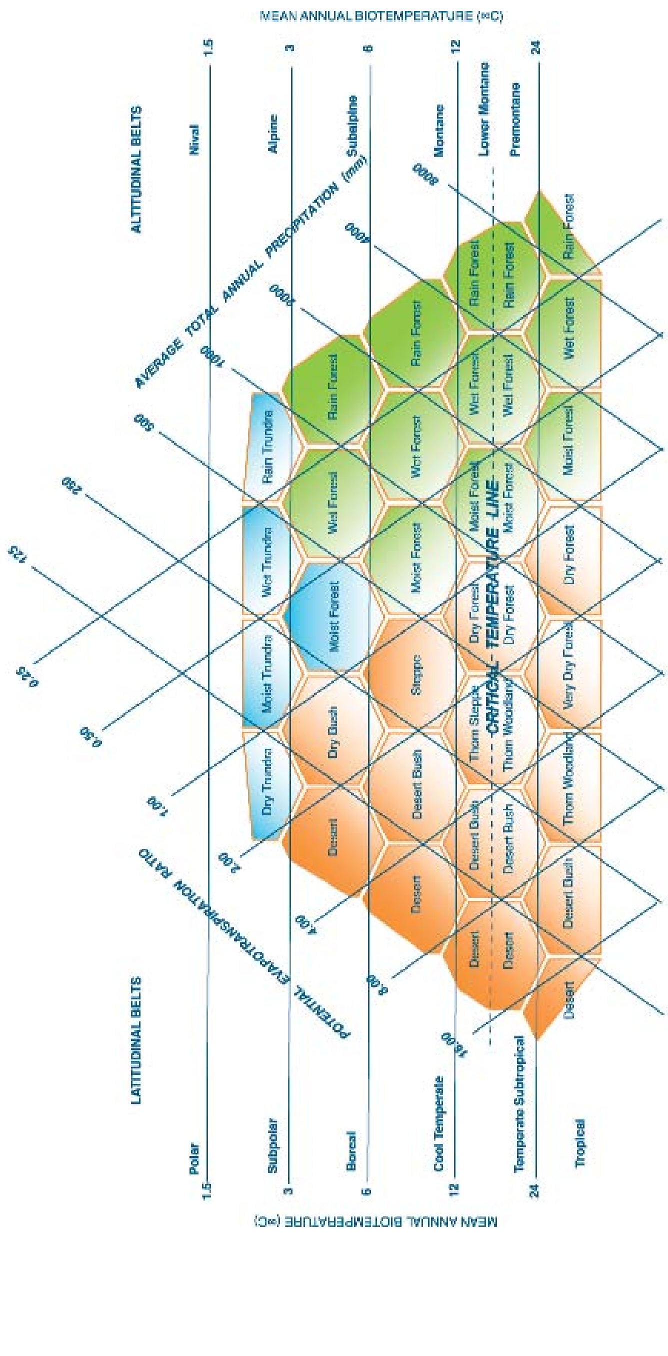
HOLDRIGE LIFE ZONES OF THE WORLD



Source: Tropical Science Center, San José, Costa Rica.

II. THE IMPACT OF DISASTERS ON WOMEN

1. Introduction

The differential impact of disasters on women is a subject new to the Handbook. Its inclusion partly reflects a growing awareness in the international community that full development can only be achieved when women and the resources they represent are fully integrated in the development process and are empowered to improve the economic, social and political conditions of developing countries within a framework of sustainable development.[1] This addition also, and perhaps chiefly, reflects an understanding that men and women reveal vulnerabilities peculiar to their sex when confronted by disaster situations. In the face of this reality, it is essential to keep a clear gender focus to be able to support women facing a disaster and to reinforce their capacity to overcome these situations. Such an awareness can reshape reconstruction tasks or projects.

Rather than making the differential impact of disasters on women and their role in reconstruction a separate sector in this analysis, we treat it as a broad theme that cuts across the entire spectrum of social, economic and environmental sectors. Similarly, this theme should not be considered the exclusive province of women, nor should analysis of such issues be relegated exclusively to a team member chosen to conduct gender analysis. Instead, it should be seen as a social subject of multisectoral scope on which all specialists in each discipline must cooperate.

Just as a post-disaster reconstruction programme contains projects meant to re-establish production in a given sector, it must contain projects addressing the specific needs of vulnerable social groups. Such initiatives make it possible to mend the torn fabric of society while facilitating economic recovery. It is thus essential to determine the specific impact on the women of an affected country or region in order to design actions and projects that help to reduce their opportunity cost and increase their ability to recover. Disasters should also be seen as an opportunity to improve pre-existing conditions, including sex equity. Reconstruction, therefore, should not be thought of simply as a process of replacing what has been lost, but also as an opportunity to perform actions that make the most underprivileged groups less vulnerable, favor sex equity and improve living conditions for women, especially those who are heads of households.

1 See, for example, page 14 of Directrices y guía de conceptos del Comité de Ayuda para el Desarrollo sobre la igualdad entre mujeres y hombres, published by the Office for International Cooperation and for Latin America, Ministry of Foreign Affairs, Madrid, 1998.

One of the consequences of a disaster is the decapitalization of women and the reduction of their share of productive activities in the formal and informal sectors. Not only do they sustain direct damages or production losses (housing and means of production), but they also have relatively high opportunity costs because they lose income when they have to apply themselves temporarily to unpaid emergency tasks and an increased amount of unpaid reproductive work, such as caring for their children when schools are closed because they are being used as shelters for disaster victims.[2] Such reproductive work is usually granted a lower status than paid work because of the greater physical toll that it takes on women. It is also a continuous job, without weekends off or vacations, which limits women's mobility and can sometimes even prevent them from exercising their rights as citizens.[3]

Regardless of who the head of the household might be, women's contributions to family budgets are as important as men's. Although a woman might not hold a paid job, she may generate household income from a variety of informal sector activities, whether from the backyard economy or from a small home-based business, thus allowing her to combine productive tasks with reproductive ones. Activities of this sort (both productive and reproductive) are not included in official national accounts. However, if the income from them were to be taken into consideration, we would see that men and women more evenly contribute to sustaining a household.

Although the differential impact of disasters on women should be treated transversally throughout the damage assessment (both in their sectoral and geographic dimensions), we have chosen to handle it on two levels in this Handbook. The first is by including in each sector (whether social, economic or environmental) an additional section about the way in which a disaster's differential impact on women should be assessed. The second is to include this separate chapter on how to obtain a preliminary estimate of the total impact of a disaster on women and how to orient reconstruction projects towards them.

It must be clearly borne in mind (and a mention made of the fact in the assessment report) that this transversal assessment is not fully comparable to overall economic impact findings inasmuch as some valid parameters for the assessment of the impact on women are not included in national accounts. It is also important to avoid problems of double accounting by simply folding the impact on women into the other sectoral assessments, which should have already contemplated such damage and losses.

2 Reproductive work is defined as activities required to renew the work force (child care, education of future generations of human resources, provision of meals, etc.), ensure the availability of its productive members (housekeeping, provision of meals, personal care and attention in home and community) and care for those who are no longer active members of the work force because of age, sickness or handicap.

3 Gálvez P., *Thelma, Aspectos económicos de la equidad de género*, p. 20, Serie Mujer y Desarrollo No. 35, ECLAC, Santiago de Chile, June 2001.

2. The overall impact of a disaster on women

Each sectoral specialist should produce the most detailed information possible needed to ascertain a disaster's overall impact on women. The following is a description of one approach to measuring that impact. As in the other sectors covered in the Handbook, damages are classified as direct (i.e., on property) or indirect (i.e., on economic flows).

a) Direct damages

The quantification of all the direct damages sustained by women should take into account all the property they possess.[4] When the head of the household is a woman, this covers loss of or damage to the dwelling itself, as well as household furnishings and appliances. If she runs a home-based workshop or micro or small business, the assessment should include its equipment and machinery, as well as any other productive property she owns. It should include her farm animals, fields and crops if she is engaged in activities in the so-called backyard economy. In all of the above cases, evaluations should include stocks of goods produced, whether stored at home or nearby.

Damage estimates for such property belonging to women will come directly from the sectoral assessments, in which damages will have been broken down by sex. Only the part that refers to damage in the private sector will be used. For this reason, the women's specialist should refer to the corresponding chapters in each relevant sector and co-operate directly with each of the sectoral specialists in estimating and breaking down the data.

b) Indirect losses

While the Handbook considers ways of estimating most indirect losses by following the instructions for separating damages by sex, there are also indirect losses that only affect women, namely, those that are related to the increase in reproductive work created by the disaster and its aftereffects. Therefore, a methodological innovation is required.

Indirect losses sustained by women have four main components: loss of productive employment outside the home; loss of household production and income, including that of the backyard economy and of small or micro - businesses run by women from home; the increase in reproductive work; and other damage of a financial nature stemming from outstanding debts or loans.

i) Loss of productive employment outside the home and related income. This refers to the temporary loss of a paid job that a woman holds outside her home, whether its nature is domestic, industrial or commercial or, for that matter, technical, professional or executive. Such temporary unemployment stems from damage caused to formal production systems, and its duration will depend on the time needed to re-establish or reconstruct them.

4 The backyard economy includes the rearing of poultry, goats, sheep and pigs, as well as the benefit obtained from milk, eggs, wool, etc. It also includes fruit trees and produce grown on small plots located near the home.

Once again, estimates under this heading should be taken directly from the sectoral assessments or from the employment assessment, and the women's specialist should cooperate with the sectoral specialists to facilitate the breakdown of damage by sex.

In any case, the value of this indirect damage is obtained by multiplying the number of days or weeks during which remunerated employment is interrupted by the average unit wage for each level of income. Unit wages should be those used for each of the sectors. (The sources from which they can be obtained are described in the relevant chapters and are not repeated here). Obviously, the period of temporary unemployment for women should coincide with that used for analysis purposes in the other sectors.

ii) Loss of household production and income. Here we strive to estimate the temporary loss of production and income from home-based women's enterprises, regardless of whether the head of the household is a woman. These temporary losses include those sustained in the backyard economy and by micro and small enterprises run by women from their homes.

Partial estimates of temporary losses in the backyard economy are made by either the housing or the agriculture specialist, who must work with the women's specialist to estimate the losses for each sex and to make a joint recovery-time estimate for the activity in question. A sampling of affected women is also needed to determine whether the estimates made by the sectoral specialists include all the components of the backyard economy or whether additional estimates will be required.

Production losses in formal sector small and micro businesses are normally assessed by industrial, commerce and services sectors analysts. The employment specialist cooperates closely with them to estimate or measure the unemployment or temporary loss of income caused by the temporary interruption of production in these areas. The women's specialist should also work closely with those analysts to separate this indirect damage by sex. As with the backyard economy, it is useful to undertake a sampling of the affected women to ensure that all losses have been included and to determine whether the estimates of the sectoral specialists should be supplemented with additional estimated data from the sampling.

Similar cooperation between the women's specialist and those focused on industry, commerce and services is also necessary to assess the lost production in women-owned, home-based small and micro businesses in the informal sector that may have been destroyed or damaged. The method for estimating or measuring losses of this sort is described in the relevant chapter. The same specialists should work together to estimate the time it will take for production to recover.

iii) Increase in women's reproductive work. Disaster situations always bring an increase in women's unpaid reproductive work. The greater physical workload and emotional toll must be quantified if the total impact of a disaster on women is to be ascertained. This task is the responsibility of the women's specialist, who may require support from other members of the assessment mission in the form of relevant information about each sector's activities, the way they have been affected and, most importantly, how long women's increased reproductive responsibilities are likely to last.

Estimates of the increase in women's reproductive work should be made in comparison to a baseline situation, which has to be established for each particular case. Different patterns of reproductive work may be found in the same country depending on the customs or environmental and spatial conditions (e.g., urban and rural) of the affected areas. It is necessary to make a list of common forms of reproductive work activities, for which analysts must examine the relevant literature, speak with local specialists and undertake a quick sampling, when feasible. If no such quantitative information is available, data can be obtained from a sampling of affected women; failing this, one may assume that they dedicate at least eight hours a day to this unpaid work.

Later it will be necessary to determine the new pattern of reproductive activities that women have to perform as a result of the disaster, based on either representative samplings or, if this is not possible, estimates. In addition to the usual baseline activities cited previously, this assessment should consider that women have assumed new activities connected with the performance of emergency-related tasks, rehabilitation and reconstruction, and that other activities they performed previously will now take longer.

Typical examples of reproductive tasks during the post-disaster stages are volunteer work in refugee camps and time spent queuing to receive food. When gauging the increased time devoted to household work one should include the additional time spent hauling water and collecting firewood because usual sources have been damaged or curtailed; collectively preparing meals in refugee camps; caring for children whose schools have been closed; purchasing goods that require transport along roads in bad state of repair; and so forth.

By comparing the time dedicated to reproductive work, in the post-disaster situation with the normal or baseline situation, it is possible to determine the additional time (with the appropriate disaggregations or spatializations) women spend in reproductive work every day due to the disaster.

This calculation should be expressed in monetary terms; perhaps the only way to accomplish this is to make a suitably adjusted comparison with the value of productive work. For example, the average monthly wage for women (separated at least into urban and rural wages) could be divided by 30 eight-hour days instead of by 22 working days.

To determine the total amount of the disaster-related increase in women's reproductive work, one should estimate the duration of the abnormal situation, which will undoubtedly vary for each activity, area or sector, depending on the type and severity of the damage. The women's specialist should cooperate closely with each of the sectoral specialists to ascertain, or at least estimate as precisely as possible, the different factors that will determine the duration of each situation that increases women's reproductive work.[5]

5 For example, the time needed to restore the electricity or water supply and to refurbish housing (whether rural or urban) or schools is a key determinant, since these factors force women to spend more time on reproductive work.

Once the value of the additional time spent in reproductive work and the duration of the different post-disaster recovery situations have been ascertained, it will be possible to estimate the total indirect cost arising from the increased reproductive work that can be validly attributed to the disaster.

Care should be taken to avoid double acounting. When a disaster forces a woman or group of women to temporarily perform reproductive rather than productive work, only the income lost as a result of being temporarily suspended from paid work should be taken into account. The lost pay will undoubtedly be higher than the value of the temporary increase in reproductive work.

iv) Other indirect damages. Women frequently purchase goods through formal or informal credit as a way to increase their and their families income or to improve the quality of life, Such goods might be damaged or completely lost because of a disaster before the credit has been completely repaid.

Strictly speaking, to avoid double accounting when the loss of a good purchased in this way is already recorded as part of direct damages to family property or housing one should not add the amount of the outstanding balance of the credit to the value of the lost goods (as housing, trade, industry or services specialists routinely do). It is, however, valid to include penalty interest that may be charged for late payment of the outstanding balance until the woman once again begins to earn her normal income. A further item that could be recorded under the heading of lost goods is the higher amount of interest that a woman would have to pay if she were to refinance the debt so as to include not only the outstanding balance, but also new funds with which to buy new goods to replace the goods that were lost.

An example of how to assess the impact of a disaster on women is presented in Appendix XIV. It is based on information obtained during the earthquakes that occurred in El Salvador in early 2001.

3. Sources of information

Basic information on women’s participation in social and economic activities can usually be found in population censuses. In many Latin American and Caribbean countries, the 2000 censuses have already been started or completed. If the results of these recent censuses are not available, specialist can use information from the most recent household surveys, which are regularly carried out in the countries. Information from both censuses and household surveys can be obtained from each country’s statistics office.

A second local source of information on women’s participation in development activities is the Human Development Report published annually by the United Nations Development Programme (UNDP). This can be obtained from any local UNDP office.

Finally, national universities and organizations that promote sex equality usually have a large amount of relevant documented information. The gender specialist should also consult these organizations to obtain additional relevant information and to elicit their assistance for any rapid surveys or samplings that may be needed during the assessment.

Basic information on the subject may also be found in the ECLAC Annual Statistics, which offers comparable data from different countries. Further information about populations and their characteristics appears in the publications and on the web page of the Latin - American Demography Center (Centro Latinoamericano de Demografía – CELADE). Updated country information from the Gender Index System (maintained by ECLAC's Women and Development Unit) is available at http://www.eclac.org/mujer/.

CELADE's Redatam software uses information from the censuses and household surveys of a country or any of its geographical or political subdivisions, thus enabling the specialist to determine the distribution of any variable to be analyzed. It is easy to use, and its usefulness in assessing the impact of disasters was demonstrated in the 1999 flooding in Venezuela and the earthquakes in El Salvador in January-February 2001.

APPENDIX XIV
A REAL CASE EVALUATION

This appendix describes the assessment of the overall impact on women of the earthquakes that affected El Salvador in January and February 2001.[6] It is based on information described in documents prepared by ECLAC for each of these events, as well as on information obtained through a sample survey undertaken by a consultant on gender issues who was part of the ECLAC assessment team.[7]

1. Assessment of direct damages

The direct damage assessment is based on individual assessments made by the specialists in each of the affected sectors. As we briefly describe below, several different procedures and sources of information were used to prorate the value of direct damage between sexes.

a) Housing

The method used to place a value on direct damage caused to women's share of housing was to identify the amounts contributed by each gender to the household's total income. An alternative would have been to try to obtain figures on the ownership by sex of each affected dwelling, but this would have been too time consuming and would not necessarily have provided a fair view of the way in which the cost of the dwelling was financed. A previous nationwide study revealed that on average women's contribution to the home was equal to or greater than men's in 49% of urban households and in 56.6% of rural households.

Once the amount of direct damage to urban and rural dwellings (including furniture, other goods and appliances) had been ascertained and multiplied by the above coefficients, it was estimated that damage to women's household property amounted to 146.1 million dollars. ECLAC's methodology for assessing housing damage contemplates 70% to 80% of lost or damaged assets in women's backyard economy, so care should be taken to avoid double accounting later on.

b) Industry, trade and services

In this case, use was made of available statistics on women's share of the ownership of industrial, commercial and service establishments. These showed that women owned 40% of small and micro industrial businesses, 60% of commercial businesses and 71% of service businesses. Large industrial and maquila businesses were exclusive male domains.

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6 ECLAC, *The January* 13, 2001, *Earthquake in El Salvador: Socio-economic and Environmental Impac*t, (LC/MEX/L.457), Mexico City, February 21, 2001, and ECLAC, *El Salvador: Assessment of the Tuesday January 13, 2001, Earthquake*, (LC/MEX/L.457/Add.2), Mexico City, February 28, 2001.

7 Arenas Ferriz, Angeles, *Estimate of Damage to Production Activities of Women who Lost Their Homes and the Shadow Value of Their Work in the Emergency and Rehabilitation and Reconstruction Tasks* Madrid, 2001.

Once the specialists for each of these sectors had estimated the value of property lost in each of the subsectors or activities where women held a significant share, it was multiplied by the above percentages. On this basis, it was calculated that total damage to women's share of the property in these sectors amounted to 117 million dollars.

c) Backyard economy

This heading includes the women-owned assets located at home that are used to produce foodstuffs for the family's own consumption, as well as for occasional sale. A relatively large percentage of these losses was already measured in the housing sector for urban areas and in the agricultural sector for rural areas.

The housing and agricultural sector specialists had estimated the value of the loss of productive assets and of domestic animals in homes. Nevertheless, a detailed analysis, including information from a survey among affected women, showed that damage to backyard economy assets had not been included in sectoral estimates and that their value would amount to about 20% of the damage to household goods and appliances in the housing sector, plus a similar percentage for damage to sheep, goats and pigs. The direct loss to backyard economy assets was estimated at 37.7 million dollars.

2. Indirect losses

a) Loss of employment outside the home and related income

Information about the number of jobs lost because of damage caused by the earthquake was available because the employment specialist worked together with the sectoral specialists to develop these figures. The UNDP's Human Development Report for 2000 was the source for data on women's share of jobs in each of the productive sectors and their average monthly income figures.

The survey undertaken by the women's specialist was a source of additional information, especially about women workers who lost their jobs; it corroborated, and in some cases supplemented, the estimates made by the sectoral specialists.

The available information covered jobs lost by women in assembly plants and in the agricultural sector, specifically in activities related to coffee and fisheries. In the case of women domestic workers, rough estimates were made based on the assumption that 15% of the women workers in the 150 660 homes destroyed had lost their jobs. The findings of the survey corroborated these figures. In each case, the urban or rural monthly wage was used, as appropriate. When calculated over the five-month period required for the most immediate rehabilitation and reconstruction activities, this yielded the results shown below:

	Months	USD/month	Millions of USD
Agriculture	3,700	111.03	0.4
Small, micro, med. bus.	105,750	226.60	24.0
Maquila	…	226.60	…
Domestic service	45,400	226.60	10.3

Therefore, the total amount of income from paid employment lost by women was estimated to be 34.7 million dollars.

b) Lost production in the home

For this heading, it was necessary to combine some of the lost-production data from the sectoral estimates with data obtained from the survey of affected women.

Specifically, estimates of backyard economy production losses, based on information obtained from the survey, were incorporated after verifying that they had not been included in the calculations by productive sector specialists. Future losses in backyard economy production for the five-month period were estimated at 25 million dollars.

A similar calculation was made to estimate losses in home-based productive activities (the small workshops or micro businesses operated by women from their homes). The information obtained from the survey of affected women made it possible to make a preliminary estimate of 91.8 million dollars, from which was deducted the amount of losses already measured and recorded by the specialist in the commerce, industrial and services sectors for small and micro businesses not based in the home (24 million dollars). In other words, this type of home-based activity was estimated to have lost production over a five-month period worth 67.8 million dollars.

Estimates of the increased amount of reproductive work among affected women were made based on survey data that revealed that urban and rural women in El Salvador devote an average of eight hours per day to reproductive work, over and above the time that they spend on their productive activities. The survey also showed that during the five-month rehabilitation and reconstruction period, women's daily reproductive work swelled to 14 hours in the urban sector and to 16 hours in the rural sector as they queued for food, helped to take care of children, the aged and sick, and obtained water from more distant sources.

A value of 1.29 dollars per hour was set on urban women's time. This figure was calculated by dividing the average urban monthly wage by 176 (eight hours per day for 22 days a month). In the case of rural women, a value of 0.46 dollars per hour was adopted. The latter figure was obtained by dividing the average rural monthly wage by 240 (eight hours per day for 30 days a month). These estimated losses amounted to 276.5 million dollars.

c) Other indirect losses

The amount of penalty interests that women would will have to pay because their earnings were significantly reduced during the period of rehabilitation and reconstruction was calculated on the basis of information gathered during the survey with regard to their outstanding credit balances.

This showed that 43% of women in the urban sector had an average debt of 240 dollars, while 35.5% of rural women had an average debt of 1 600 dollars. When a penalty interest rate of 3.5% was charged on these amounts for five months, the loss to the women was estimated to be 21.1 million dollars.

3. Summary of damages and losses

In the following table, the cost of direct damage to women's property has been added to formal and informal income lost by women. The result is the total amount of damage sustained by women.

Table 1

Type of damage	Amount, millions of USD
Direct damage	***300.8***
Housing, furniture and appliances	*146.1*
Industry, trade and services	*117.0*
Backyard economy property	*37.7*
Indirect damage	***414.4***
a) Loss of employment outside the home and income there from[8]	*(34.7)*
Lost production from home-based activities	*116.8*
Backyard economy	*25.0*
Informal micro and small businesses	*24.0*
Productive activities	*91.8*
Increase in reproductive work	*276.5*
Other damage	*21.1*
Total damage	***715.2***

These estimates show that total damages sustained by women in El Salvador because of the earthquakes would amount to 715.2 million dollars. Forty-two percent (300.8 million dollars) of the total represents decreases in assets owned by women before the disaster, while indirect losses of production and income account for the remaining 58% (414.4 million dollars). Total indirect losses totals (duly subtracted from the figure for lost earnings through unemployment outside the home to avoid double accounting) were valued at 241.8 million dollars for increased reproductive work, 116.8 million dollars for informal and formal production losses and an estimated 21.1 million dollars in penalty interests on outstanding debts at the time of the disaster.

These figures apply exclusively to women in the private sector. If the prorated damage in the public sector of which women are also users were added, the total damage sustained by women would amount to 1.004 billion dollars, or 314 dollars per capita. These figures cannot be validly compared to per capita income or GDP, since they include values for items such as the backyard economy and women's reproductive time, which are not recorded in the national accounts.

8 This amount should be deducted from the total so as not to partially duplicate the figure for the increase in reproductive work.

III. DAMAGE OVERVIEW

1. General comments

Once the social, economic and environmental impacts of a disaster have been assessed, a recapitulation of damages is needed to arrive at an analysis overview, which marks the culmination of the assessment and lays the basis for the subsequent macroeconomic analysis. It should include the total amount of damage and losses, together with breakdowns that identify the most affected sectors, geographic areas and population groups. In addition to quantifying the total impact in monetary terms, this overview must make it possible to identify the sectors and geographical areas requiring priority attention, thus serving as an invaluable input for defining reconstruction strategies, plans and projects.

Based on the sectoral estimates made using the uniform assessment methodology discussed in previous chapters, the overall damage assessment specialist must prepare a summary of both direct damage and indirect losses in order to arrive at a figure for the total amount of damage caused by the disaster under analysis.

Special care must be taken to avoid double accounting: damage recorded in one sector must not be included under another sector, a common mistake in the case of indirect losses related to production chains (for example, production, processing and commercialization). Similar care should be taken to ensure that the total damage estimate includes only losses that can be measured in terms of national accounts. Other cases, such as the differential impact of the disaster on women or on the environment, require somewhat different estimation procedures.

Once total damage and losses have been estimated, selected breakdowns will be required to provide a complete overview of the general impact of the disaster and to enable future comparisons. The following three types of breakdowns should be made:

- Total direct damage and indirect losses;
- Total damage to assets and production and increased costs or decreased income in the provision of services; and
- Total damage to public and private sectors.

The distinction made between total direct and indirect damages facilitates projections of the effects on assets and on future economic performance, respectively. The amount of direct damage is a measure of the efforts that will have to be made in order to replace lost assets in the affected country or region. Indirect losses or effects reflect changes in economic flows that will be used by the macroeconomics specialist to project post-disaster economic performance in the affected country or region.

The breakdown into damage to assets and production, and on the one hand changes in costs and income in the provision of services, on the other, will enable a further analysis to identify asset losses, decreases in production, effects on national finances and the impact on enterprises that provide public services, as well as possible increases in the population’s cost of living. Direct damages include both destroyed assets and losses of production that was ready for consumption at the time of the disaster.

These two types of direct damages must be estimated separately to allow for subsequent macroeconomic analysis. Indirect effects include future production losses, as well as higher costs and decreased revenues in the provision of services such as water and sanitation, electricity and transportation. Therefore, this second breakdown will provide a measure of total damage and losses of assets and production, as well as the indirect effects on the finances of the public sector and of both public and private enterprises that provide basic services.

The breakdown of the total damage into public and private sectors will enable the determination of some characteristics of reconstruction programmes, by defining the relative efforts required from the state and from private individuals or enterprises. Even though the cost of reconstructing public infrastructure must be met by the government –which allows a determination of the amount of future public financing requirements– the latter may also have to establish financial schemes or credit lines for the private sector affected by the disaster, especially in the case of the lowest-income population or of strategic sectors of the national economy.

In addition to the breakdowns described above, the damage overview specialist must determine how total damage was distributed among sectors in order to identify those which were most affected and which, therefore, should be given the highest priority in the reconstruction strategy and plans.

3. Net damages

Insurance of assets and production is becoming common in Latin America and the Caribbean. Therefore, a net amount of damage can be obtained by deducting insurance payments from the total amount of damage. However, insurance coverage varies from country to country and within subregions.[1] The damage overview specialist should determine this net damage figure on the basis of information provided by the sectoral specialists.

Moreover, major foreign consortia usually reinsure local insurance companies. There can be a significant positive effect derived from foreign currency inflows in the form of reinsurance payments. This effect must also be estimated so that the macroeconomic specialist can use it in the subsequent analysis of future (national or local) economic performance.

4. The costs of reconstruction

As mentioned in the introductory chapter of this handbook, reconstruction costs are not equal to total damages. Damage is estimated as the present value of lost or damaged assets, whereas replacement must take into account price increases on construction and goods, as well as the additional cost of disaster prevention and mitigation measures. Therefore, the damage overview specialist must also determine total reconstruction costs using information provided by the sectoral specialists.

1 The degree of insurance coverage and a country's level of development would seem to be correlated, with the exception of the Caribbean where –probably due to the influence of the former colonial powers– the degree of coverage of assets tends to be high.

There is another noteworthy difference between the total amount of damage and the cost of reconstruction. The cost of reconstruction includes the replacement of lost assets but excludes the value of production losses and the amount of increased spending and decreased revenues in the provision of services. It must also include the financial cost of reactivating production when necessary. One example of the latter would be the amount of credit required to refinance producers in various sectors when they have sustained significant damage or losses in their activities, such as farmers who need to refinance equipment loans when flooding or drought has caused the loss of harvests. Therefore, the cost of reconstruction will unavoidably be different from the total amount of damage caused by a disaster. When direct damages constitute a high fraction of total damages, the cost of reconstruction can be significantly greater than the total amount of damage. On the other hand, when indirect losses are greater than direct damages, as in the case of floods or droughts, the cost of reconstruction would be lower than the total amount of damages.

5. The magnitude of the disaster

To determine the impact that a disaster will have on the affected region or country, the total amount of damages must be compared to regional or national variables. This comparison will provide an indication of the reconstruction efforts required, and a measure of whether the affected region or country has sufficient capacity to face reconstruction by itself or requires foreign cooperation. The magnitude of the disaster may be determined by comparing the total amount of damage and its components and macroeconomic variables, such as:

- Total amount of damages as a percentage of GDP;
- Total amount of production losses as a percentage of GDP or the country’s exports;
- Total amount of lost assets compared to the annual rate of gross fixed capital formation, local construction sector output or the national debt; and
- Total amount of damage as a function of the population of the country or region affected.

The comparison between the total amount of damage and GDP provides a measure of the impact a disaster might have in terms of a country or region’s economy. In small Latin American countries or Caribbean islands, the magnitude of a disaster might constitute a high proportion of GDP or even be greater than its total, whereas larger economies may easily absorb the effects of disasters of limited scope.[2] This type of comparison also reflects the intensity of efforts that the country will have to make during recovery and reconstruction.

2 In this regard, Hurricane Mitch caused total damages in Honduras that represent 79% of GDP for the preceding year; the floods in Venezuela in 1999 caused total damages that exceeded 166% of the GDP in the state of Vargas; and the 1985 Mexico City earthquake caused total damages amounting to approximately 4% of national GDP.

A comparison between total production losses and GDP gives an idea of the general effect of a disaster on national or regional production or on future economic growth, whereas comparing production losses against exports might indicate the impact on the foreign sector of the affected country or region.

The comparison between the amount of damage to assets and the annual gross rate of fixed capital formation indicates the additional effort the country will have to make in construction. The comparison with the construction sector's domestic output gives an indication of the national capacity for reconstruction and of the period required to carry it out. The comparison between damage to assets and the amount of national foreign debt of the affected country can provide an idea of how much debt will have to be assumed to finance the reconstruction effort.

Determining the amount of total per capita damage and the ratio of damage to per capita GDP provides an idea of the negative effects on the living conditions of the affected population. It also provides a means of comparing the effects of different disasters occurring in the same country at different times or in different places.

6. The geographical distribution of damages

The Redatam tools described in the section on social sectors allow one to determine the geographic distribution of total damages and identify the most highly affected regions or geopolitical entities that, therefore, must receive priority attention in reconstruction plans.

The damage overview specialist, in close cooperation with the geographic information systems and population specialist, must determine the spatial distribution of total damage and damages per capita. This will provide more accurate estimates of how the population has been affected. It is a good idea to produce maps showing the geographic distribution of damage per inhabitant and of the ratio between per capita damage and GDP.

Such maps can be combined with those that describe the distribution of poverty in a given country, thus giving decision makers a tool for defining a geographical distribution of resources for reconstruction.

7. The identification of the effects on vulnerable groups

On the basis of sectoral analyses, the damage overview specialist must be able to identify the most highly affected population groups. These must include the lowest-income groups –the map that shows the spatial distribution of total damage compared to per capita income or GDP is a very useful tool for this purpose– along with women, children and the aged and the population involved in micro and small enterprises.

APPENDIX XV
AN EXAMPLE OF DAMAGE RECAPITULATION ANALYSIS

The recapitulation of damages caused by the earthquakes that struck El Salvador on January 13 and February 13, 2001, is described below to illustrate the type of analysis required in this regard.

The total amount of damage and losses caused by the earthquakes of January and February 2001 in El Salvador was estimated at 1.6 billion dollars.

Of this amount, 58% (939 million dollars) consisted of direct damages, and the remaining 42% (665 million dollars) of indirect effects or losses. Thus, the country's assets sustained the greatest damage, with the rest affecting economic flows throughout 2001 and in subsequent years. The following table details the aforementioned figures.

Tabel A

SUMMARY OF DAMAGE CAUSED BY THE JANUARY AND FEBRUARY EARTHQUAKES IN EL SALVADOR
(Millions of dollars)

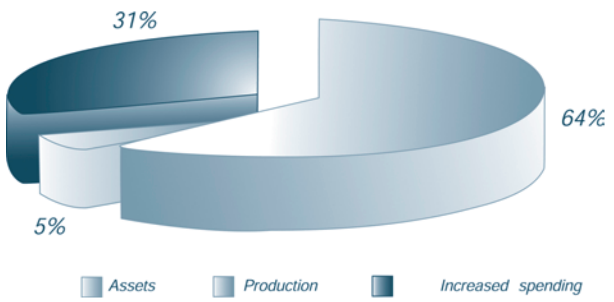
Sector and subsector	Damage			Property	
Totals	*1,604*	*939*	*665*	*567*	*1,037*
Social	**617**	**496**	**120**	**238**	**379**
Education and culture	*211*	*190*	*20*	*69*	*142*
Health	*72*	*56*	*16*	*72*	--
Housing	*334*	*250*	*84*	*97*	*237*
Infrastructure	**472**	**97**	**375**	**171**	**301**
Electricity	*16*	*3*	*13*	*3*	*13*
Water and sanitation	*23*	*19*	*4*	*13*	*10*
Transportation	*433*	*75*	*358*	*155*	*278*
Productive sectors	**339**	**244**	**96**	**15**	**324**
Agriculture and fisheries	*93*	*39*	*55*	*13*	*80*
Industry and comerce	*246*	*205*	*41*	*2*	*244*
Environmental affects	*103*	*102*	*1*	*103*	--
Other damages and expenses	*73*	--	*73*	*40*	*33*

Source: ECLAC estimates

The total amount described above can be broken down into the following types of damage or loss:

Type of damage	Millions of dollars
Asset losses	1,025
Production losses	84
Increased spending and decreased income	495

These figures reveal that most of the damage was to physical infrastructure and equipment (64% of total damage), followed by an increase in costs and diminished income in the provision of some services (mainly transportation) (31%) and losses in production (5%); this breakdown is presented in the pie chart below. This damage distribution coincides with the patterns expected of such geological phenomena.[3]



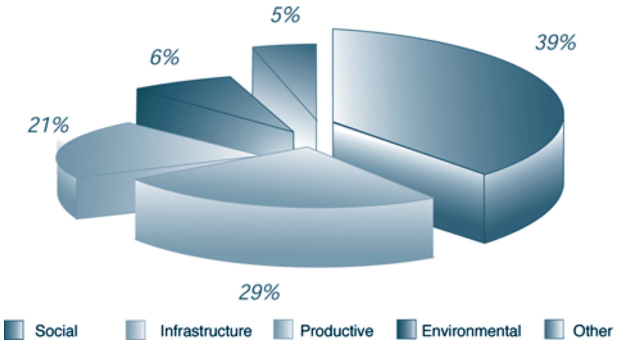
The fact that two-thirds of the total damage was to privately owned property and only a third to public properties is of special relevance, since this suggests characteristics the reconstruction program is likely to assume.

The distribution of total damage among affected sectors is as follows:

Sector	Damage, millions of dollars
Social	617
Infrastructure	472
Productive	339
Environmental	103
Other damages and costs	73

3 In the case of disasters caused by hydro-meteorological phenomena, most losses are in production activities. In this regard see Jovel, Roberto, Natural Disasters and Their Socio-economic Impact, in *ECLAC Review,* No. 38, Santiago, Chile, 1986.

As the following figure shows, social sectors felt the brunt of the impact (sustaining 39% of total damages), followed by infrastructure (29%), productive sectors (21%) and the environment (6%).



The hardest hit individual activities or sectors were transport and communications (433 million dollars), housing and human settlements (334 million dollars), industry and commerce (246 million dollars) and education and culture (210 million dollars). See Table A, above.

The total amount of damage (1.6 billion dollars) is by itself very high, but it must be put into context to better understand its impact on national economic development and the population's living conditions. Total damage was equivalent to 12% of the country's GDP and slightly over 40% of national exports for the previous year (2000). Damage to assets was the equivalent of 42% of the annual rate of gross fixed capital formation and about four times construction industry output.

The earthquakes' impact on the national economy obviously should not be underestimated, but nationwide data fail to fully convey the true dimension of the tragedy.[4] Most of the damage was sustained precisely by the social sectors –housing, education and health– and by the productive sectors of industry and commerce, in particular small producers and entrepreneurs and the lower-income strata of the population.

4 By way of comparison, 1988's Hurricane Mitch caused damages equivalent to 13% of the GDP of the entire Central American region. Moreover, reconstruction would have taken at least four years even if it had been possible to focus the construction industry's entire capacity on that endeavour.

Geographic or spatial distribution analysis also helps to demonstrate the magnitude of the impact of the disaster on the population. The following table presents such a breakdown for each department in the country, showing total and per capita damage, as well as the ratio between total damage and GDP in each of the affected geopolitical entities.

Table B

SPATIAL DISTRIBUTION OF DAMAGE CAUSED BY THE JANUARY 2001 EARTHQUAKES IN EL SALVADOR

Departament	Total damage, in million US$	*Per capita* damage US$ per inhabitant	*Per capita* GDP, US$ per inhabitant[5]	Total damage versus GDP,%
Ahuachapán	*20.3*	*64*	*2,242*	*2.9*
Cabañas	*3.5*	*23*	*2,191*	*1.1*
Chalatenango	*1.4*	*7*	*2,578*	*0.3*
Cuscatlán	*147.1*	*735*	*3,335*	*22.1*
La Libertad	*263.6*	*399*	*5,121*	*7.8*
La Paz	*270.5*	*943*	*3,020*	*31.2*
La Unión	*4.1*	*14*	*2,803*	*0.5*
Morazán	*0.8*	*5*	*2,475*	*0.2*
San Miguel	*47.5*	*101*	*3,526*	*2.9*
San Salvador	*199.5*	*103*	*4,142*	*2.5*
San Vicente	*243.7*	*1,533*	*2,671*	*57.4*
Santa Ana	*94.7*	*175*	*3,356*	*5.2*
Sonsonate	*127.0*	*289*	*3,252*	*8.9*
Usulután	*180.4*	*534*	*2,789*	*19.1*

Source: ECLAC estimates.

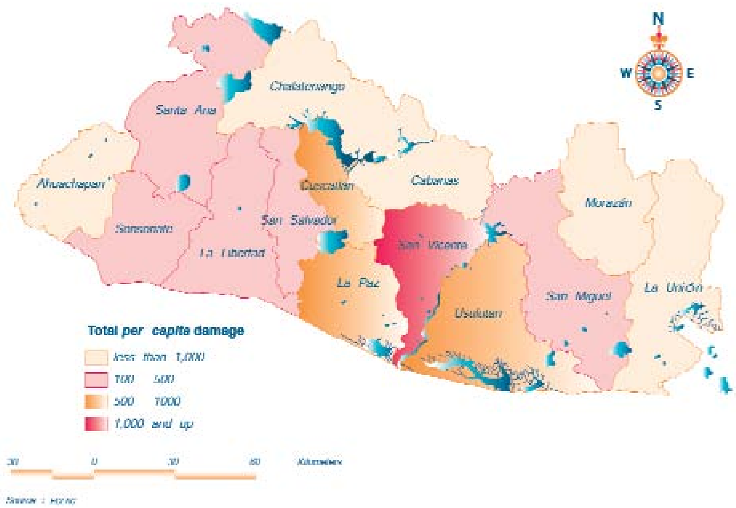
The preceding table shows that damages were most concentrated in the departments of San Vicente, La Paz and Cuscatlán, whose inhabitants sustained losses of between 1 500 dollars and 700 dollars, undoubtedly a very high percentage of their total assets. Inhabitants of the departments of Usulután, La Libertad and Sonsonate followed, in decreasing order of damage (see Table B and Map 1).

The geographic distribution of damage per inhabitant has both positive and negative implications. Most of the damage was sustained by the country's relatively more developed areas, which generally enjoy a greater recovery capacity than does the country's poorest departments (Cabañas, Morazán, Ahuachapán and La Unión). In other words, losses in human development did not greatly affect those departments where poverty is greatest (see Map 2).

Furthermore, reconstruction provides an opportunity to introduce mitigation measures that can include the provisioning of damage victims with housing and a means of production and income that is less prone to damage from future disasters.

5 United Nations Development Program (UNDP), Report on Human Development in El Salvador, San Salvador, 2001.

Map 1
GEOGRAPHICAL DISTRIBUTION OF DAMAGE CAUSED BY THE JANUARY AND FEBRUARY 2001 EARTHQUAKES IN EL SALVADOR
(Per capita loss in US per inhabitant)



We should note two negative aspects. First, the modest progress the country achieved in the recent past in human development indices has been erased in the departments most affected by the earthquakes. To put it differently, the geographical distribution of poverty has been modified by the disaster, with human development indices experiencing significant declines in the most affected departments. The new human development map for 2001 shows that the disaster pushed San Vicente, La Paz and Usulutan to join Cabañas, Morazán, Ahuachapán and La Unión in the country's lowest human development index category (see Map 3). Second, financial resources for reconstruction will have to be concentrated on the most affected departments, coinciding at least partly with areas where the greatest development investments are being made at the present time. This would entail a setback for poverty eradication in other relatively less developed regions.

Map 2

IMPACT OF JANUARY 13, 2001, EARTHQUAKE: SPATIAL DISTRIBUTION ON THE HUMAN DEVELOPMENT INDEX BEFORE THE EARTHQUEAKES

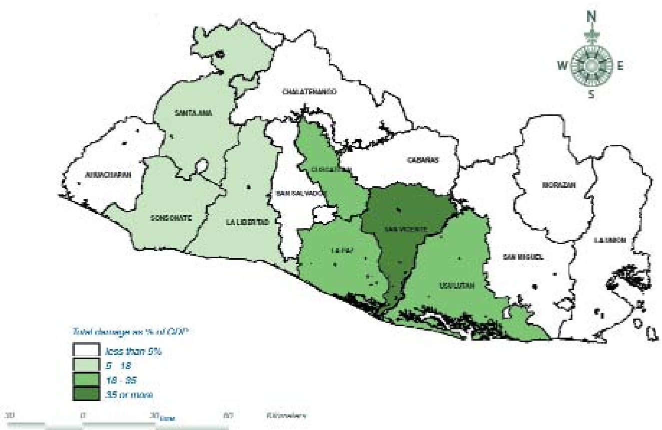
Source: UNDP, preliminary data from the 2000 report Human Development in El Salvador

The magnitude of damage –expressed as total damage as a percentage of GDP in the affected regions– was most severe in the departments of San Vicente (57%), La Paz (31%), Cuscatlan (22%) and Usulután (19%) (see Table B and Map 4) During a scant two minutes, the earthquakes caused the loss of a considerable portion of the annual GDP of these departments.

Map 3
IMPACT OF JANUARY 13, 2001, EARTHQUAKE: SPATIAL DISTRIBUTION OF THE HUMAN DEVELOPMENT INDEX (DHI) AFTER THE EARTHQUAKES

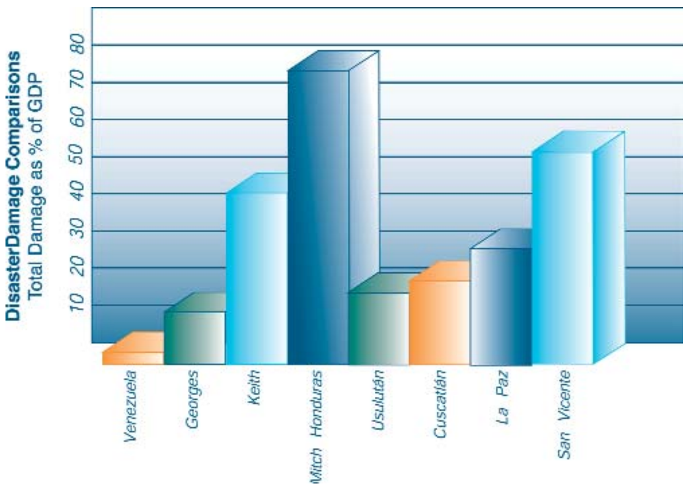
Source: UNDP, preliminary data from the 2000 report Human Development in El Salvador

Map 4
GEOGRAPHICAL DISTRIBUTION OF DAMAGES CAUSED BY THE JANUARY AND FEBRUARY 2001 EARTHQUAKES IN EL SALVADOR



Source : ECLAC

As the following figure indicates, the loss to GDP experienced in the hardest hit department (San Vincente) was greater than that registered in Venezuela from the floods of late 1999 or in the Dominican Republic in 1998 from hurricane Georges, and it is surpassed only by hurricanes Mitch in Honduras (1998) and Keith in Belize (2000).



By analyzing the absolute and relative earthquake-damage figures, we can identify several special disaster characteristics:

- A relatively high amount of damage, two-thirds of which corresponds to the private sector;
- Disruption and destruction of the highway transport infrastructure, thereby significantly increasing operational costs;
- Destruction or significant damage to housing and human settlements, especially in small towns and rural areas, thus aggravating existing deficits;
- Destruction or significant damage to education and health services, eroding the country's development efforts in these sectors;
- Damage to the production of micro, small, and medium-sized agricultural, industrial and commercial enterprises, while large-scale businesses in those same sectors were relatively unharmed;
- Significant damage to the environment, with considerable loss of land due to landslides and numerous hillsides that became unstable;
- A considerable concentration of damage in some departments, principally in the central part of the country;
- Significant losses in various departments, whether measured in per capita terms or in terms of the loss as a percentage of departmental GDP; and
- A reshaping of the poverty map, with several departments falling into the lowest human development index category.

However, the damage described above should also be considered within different contexts. In the first place, the property that was destroyed represents more than 40% of the country's gross annual formation of fixed capital, which provides an idea of the efforts that will be required for its replacement. Moreover, replacement costs will be notably higher than the value of the destroyed assets at the time of the disaster and are estimated at no less than 1.94 billion dollars. Although some of the construction industry's capacity was idle at the time of the disaster, its capacity is limited. We estimate that it will take between four and five years to replace all lost assets, and the population will have to endure significantly lower living conditions throughout that period.

In the second place, damage to transportation infrastructure is increasing cargo and commuter travel times, the additional costs of which are estimated at around 358 million dollars. Said costs will eventually have to be absorbed by the users, with the corresponding impact on the cost-of-living index. Similarly, despite emergency assistance received from the international community, the unforeseen costs incurred by the government both in the emergency and in reconstruction will result in increased fiscal deficits.

In the third place, production losses represent less than 3% of the country's exports, which might give the impression that the country's production capacity is virtually intact. Nonetheless, a good part of lost production is that of micro and small enterprises, earmarked for domestic consumption. Apart from a loss of income for those population sectors, this might result in shortages of various products on the domestic market, which would have to be imported.

In the fourth place, some of the damages caused by the disaster that occurred in El Salvador affect Central America as a whole, thus making this a subregional tragedy. With some parts of the Pan-American Highway left impassable, cargo and commuter traffic must take longer alternate routes, resulting in delays and increased transport costs for intra-regional trade. In addition, foreign tourists canceled reservations throughout Central American in the erroneous belief that damages widespread. Finally, the regional transformation and modernization strategy that the Central American countries have presented to the international community with the purpose of seeking partners to combat poverty will have to be modified to assign a greater priority to disaster vulnerability and disaster impact reduction so that Central America does not become less attractive to foreign investors.[6]

6 See Jovel, Roberto, et al., *Transformation and Modernisation of Central America in the XXI Century,* General Secretariat of the Central American Integration System (SG-SICA), San Salvador, January 2001.

IV. MACROECONOMIC EFFECTS OF DAMAGE

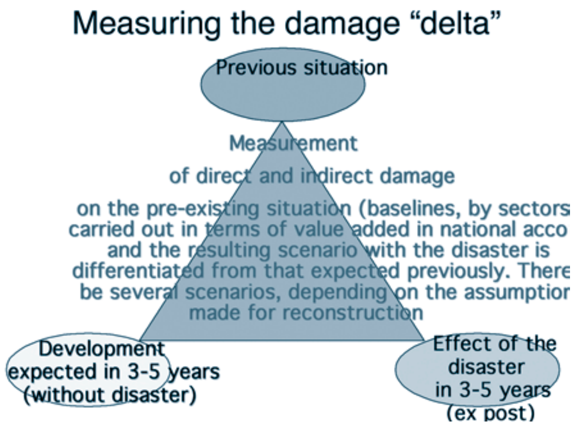
This chapter deals with the estimation of the quantifiable effects of the disaster on the main macroeconomic variables and aggregates (GDP, national income, investment and gross capital formation) and on the fundamental economic gaps (balance of payments, balance of public finances and inflation). The impacts will be measured in the short term (in the year or cycle in which the disaster occurs) and in the medium term (a period to be determined case by case according to the magnitude of the damage and the estimated time needed for a return to "normal" conditions). The macroeconomist will elaborate this chapter on the basis of the reports prepared by the sectoral experts. An accompanying task is to verify the consistency of different estimates by comparing the evolution of macroeconomic variables with that obtained by piecing together sectoral, regional or partial information. The macroeconomist should also form a view of the economic performance and the behavior of the main aggregates expected prior to the disaster. Finally, and most important, the macroeconomic assessment provides a basis on which to estimate the financial and technical cooperation that the international community is expected to contribute during the rehabilitation and reconstruction processes. This chapter contains five sections. The first provides a basic understanding of the steps involved in the macroeconomic assessment of the disaster damage. The second describes the functions of the macroeconomist. Section three refers to the establishment of the baseline, that is the pre-disaster situation and the performance expected during the year of the disaster in the absence of it. Section four deals with the assessment of the situation following the disaster. The last section details the general economic effects, the effects on economic growth and income and those on the fiscal and external accounts. For the situation following the disaster, the use of future reconstruction scenarios is introduced based on the capacity of the economy to absorb external resources and its project delivery capacity.

1. Macroeconomic assessment

The macroeconomic assessment should provide a summary of the damage that offers an overview of the full magnitude of the disaster's socio-economic impact, both for the country's economic development as a whole and for each of its main variables.[1] It should determine and specify the sectors or areas in which the effects were most severe and the period of time for which they will continue to be felt. Consequently, it should include, not only the disaster's effects on the economic growth rate, income, the external sector, public finances, employment, price levels and inflation, but also possible damage to natural resource endowments.

1 This summary must be presented in a uniform and comparable manner (in the same currency units). It must will take into account the possibility that a disaster's impacts might produce net benefits to society, rather than harm or loss. If such benefits are considered significant, their value should be calculated and subtracted from total estimated damage.

The overall assessment essentially measures a “delta” value, that is, the difference between the situation expected in the period before the disaster happened and the situation that the affected country or region is expected to experience as a result of the direct and indirect damage (see the following chart).



There may be more than one ex - post disaster effects scenario, and several post-disaster alternatives may be identified according to the local capacity for recovery; the amounts of external assistance received; the overall macroeconomic, fiscal and commercial goals set in pre-disaster programmes; the developing country’s capacity to carry the debt required by the process; and any commitments that it might have with international financial institutions.

2. The functions of the macroeconomist and the preparation of the assessment

The chapter written by the macroeconomist will normally be based on the reports prepared by the sectoral specialists. Nevertheless, she or he must also work in the disaster area to gather data (sectoral, regional data) and assessments related to the disaster’s macroeconomic effects. To this end, he or she should contact the macroeconomists at the ministries or government bureaus with economic functions and the financial, tax and national planning authorities. He or she should also request relevant information from academics and specialized independent analysts. When the data is vague and unreliable, the macroeconomist must rely on his or her judgment to arrive at an estimate and choose the sources for his on her figures and estimations.

Discrepancies and consistency problems are likely to arise because the data gathered comes from different sources and may be expressed in different economic units. For example, discrepancies may arise between public sector figures for national accounts data and the balance of payments. To overcome these difficulties, the macroeconomist must establish an audit trail.

An audit trail provides detailed information on the nature of the damage, its incidence and the estimated value of the damage. It is part of a meticulous approach to deriving estimates that allows for the simplification of tasks and the verification of the estimates should a figure be challenged. It includes the adoption of alternative methods for estimating the value of the damage, and it uses objective and precise criteria as a basis for the definition and adoption of decisions and priorities that will guide the rehabilitation and reconstruction programs. The audit trail should also ensure that there is no double acounting in the sectoral assessments, i.e. that effects in one sector that also have an effect on another should not be counted in both. For example, damage to rural roads will have to be clearly distinguished in the farming sector to ensure that it is not duplicated in the assessment made by the transportation and communications sector.

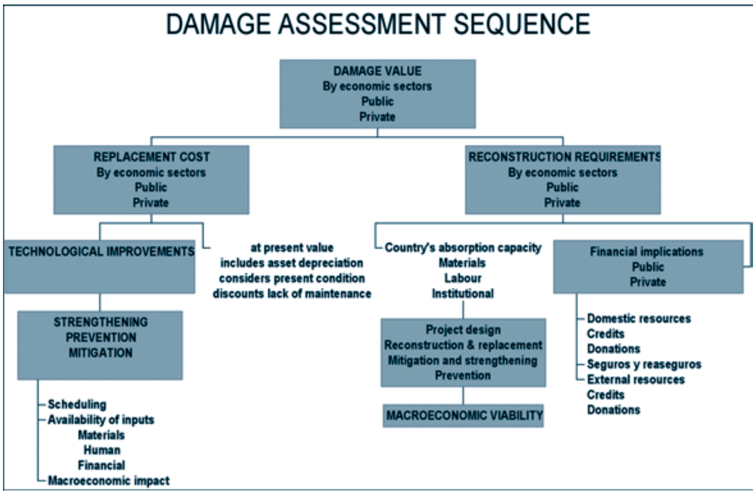
Quick rules of thumb that allow one to check the consistency of macroeconomic data are to use fiscal statistics to estimate government consumption in the national accounts; to review data on exports and imports from the national accounts to make it compatible with the balance of payments; to check the quality of the investment data; to compare the growth of nominal GDP with the growth rate of financial assets; to compare consumption and receipts from domestic taxes; and to compare GDP growth and imports.

The assessment report normally includes an introduction with a brief description of the phenomenon's characteristics and the magnitude of its impact. The macroeconomist also plays an important role in the preparation of the introduction.

A general recommendation is that direct damage be consolidated after it has been quantified in terms of physical magnitudes and that the macroeconomist analyze the criteria and prices used for setting the monetary value. This will make it possible, where necessary (especially in countries with high inflation), to make assessments at replacement values (or to adjust those that have already been made at purchase cost so that they are shown at replacement value). This is essential for determining the financial requirements of restoring the destroyed or damaged assets.[2]

The following chart illustrates the assessment sequence.

2 The introductory chapter to this manual contains the criteria for assessing direct damage, as well as a discussion of the advantages and disadvantages of using purchase versus replacement costs. Some flexibility is called for. It is sometimes useful to show both, since one indicates the cost of the loss and the other the replacement value, which takes into account any technological improvement thought desirable when replacing the destroyed assets. Furthermore, since the reconstruction process should not recreate the prior vulnerability, which was often the cause of the seriousness or magnitude of the damage, the reconstruction value will include elements of reinforcement and improvement above and beyond the replacement value.



The overall assessment should show the net results, that, is the difference between the negative and positive effects. A recovery in the construction sector, for example, is a phenomenon that is noticed relatively soon and can, to some extent, counteract the fall in the levels of activity forecast for most production sectors.

Another of the basic aims that should guide the work of the macroeconomist in the field is to form his or her own view on the economic performance forecast before the disaster occurred and on the way in which that performance would have been reflected in the major aggregates, both for the year in which the disaster occurred and for the following year or years.

The macroeconomist is therefore responsible for compiling and consolidating data on the impacts in the different sectors. In addition to the summary of direct damage (to capital) and indirect damage (the flows which will cease to exist) mentioned in the preceding paragraph, the macroeconomist should included an estimate of the economy's financial requirements and the financial and technical aid expected from the international community during the restoration and reconstruction process. That process normally runs for two years, but if the impact is great, it may be extended to as many as five.

The macroeconomic analysis may be called by different names, such as "effects on economic development" or "the phenomenon's repercussions on the economy". Where appropriate, the expression "in the short term" or "in the medium and short term" may be included, depending on how far into the future the effects of the disaster are projected. Such projections are generally limited to a maximum of five years, although destroyed urban service infrastructure, farmland, woodlands and the environment can take longer to replace. Similarly, the investments needed to replace production capacity and certain plantations can take more than five years to mature. These factors should be reflected in the report.

3. The situation before the disaster

As already mentioned, one of the macroeconomist's tasks will be to obtain a comprehensive understanding of pre-disaster economic trends, including its main problems, and the salient features of the economic policy that was being implemented. This background information is necessary for understanding the phenomenon's effects on the country's economy and the key areas of its economic policy, as well as the new challenges being set for the economy. Central banks, the country's economic, tax or finance ministries and its departments or ministries of planning, together with international financial bodies and ECLAC itself, prepare annual reports or have the information needed to provide an understanding of the topic.

Familiarity with the pre-existing situation can only be obtained by identifying the baselines on which the country's economy functions: those elements which are central to the economy's development -its engines of growth and the constraints imposed by the present development model (without assessing or making value judgments on it). It is also necessary to identify the most significant features of the situation prior to the disaster: the part of the cycle in which the event occurred; the seasonal nature of the activities in the country and its main sectors; and its capacity for risk exposure and for responding to external conflicts, including its ability to carry debt, the amount and importance of domestic savings and the strength and importance of flows of foreign direct investment.

This involves obtaining macroeconomic databases from the national authorities, academics and the country's economic advisors (establishing whether there are any econometric models for the economy and any input-output tables or tables of weights for intersectoral linkages). These sources can help the macroeconomist understand the estimates or projections for the situation expected before the disaster, whether scenarios or short- or medium-term projections. On the basis of frequently sketchy information and interviews, a projection should be prepared of economic growth expected before the disaster occurred and how this would have been reflected in the main aggregates: economic growth, inflation, exports, imports, balance of payments, external debt and so on. This preliminary projection will be of great assistance not only for the macroeconomist's own work, but also for that of the other members of the assessment team.

The following are usually among the most important information sources for assessing these tendencies: projections of economic growth for the year (sometimes half-yearly or even quarterly projections are prepared by planning offices or ministries or by central banks); the fiscal budget adopted and budget estimates for the following months made prior to the occurrence of the natural disaster (Ministry of Finance); and other macroeconomic statistics that are generally compiled by Institutes of Statistics; including crop growth index, trends in the manufacturing industry, monthly inflation trends and urban unemployment surveys. By extrapolating on the trends shown by these statistics during the months for which they are available, the macroeconomist will be able to estimate what annual performance would have been had the disaster not occurred.

It is more difficult for the macroeconomist to obtain global assessments of how the economy is developing in the affected 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, if this type of information were available, it would greatly help the macroeconomist to describe the situation and the disaster area's economic outlook.

It is necessary to analyze trends in the external sector's main aggregates, namely, exports, imports, external financing, levels of international reserves and external debts. Trends in the prices and supply of the chief export products must also be taken into account when projecting the level of exports prior to the disaster. The estimated cost of servicing the debt is another important element, since the feasibility of making payments must be considered in the light of new post-disaster financial conditions and requirements.

This is also the case with other major macroeconomic aggregates: public finances (including the foreseeable deficit before the disaster occurred) and trends in the consumer price index and employment are among the most important.

The projections for the disaster period and for one or two years (there may be more than one pre-disaster scenario) for the main macroeconomic variables should be used to prepare a GDP series at current prices, forecasting development for at least five years from the disaster period. A constant price series (with the base year used by the country and expressed in the local currency and in dollars) is also required for the same variables. In both cases, macroeconomic data from the assessments made by international bodies and especially by ECLAC itself should be compiled before the mission in order to identify the intertemporal comparisons needed.

Finally, the exchange rate to be used for the assessment should be set. In the case of sudden events, the exchange rate for the appropriate period (whether a quarter, month, week or day) should be established; for longer-lasting events (droughts or disasters that last for several months, such as El Niño), an average for the event's duration should be determined.

4. The performance observed after the disaster

The disaster will affect the different sectors in varying degrees and will thus be reflected in the macroeconomic performance of the economy as a whole. The following table illustrates the potential impact –and possible timeframe– of an event's consequences.

Table 1

ECONOMIC IMPACTS FOLLOWING A NATURAL DISASTER ON A SMALLER ECONOMY

Economic impacts following a natural disaster on a smaller economy			
Variable	Year of event	Year after	Subsequent years
GDP	Immediate drop in GDP growth	Rise in GDP growth from reconstruction	Slow down in second and third year
Exports of goods	Reduction in the rate of growth	Return to previous levels	Continuation of year after
Imports of goods	Considerable increase in rate of growth	Return to pre-disaster level	Further drop, possibly caused by reduced incomes
Tourist arrivals	Considerable drop	Some recovery	Recovery continued
Cruise ship arrival	Considerable drop		
External debt	Increase in rate of growth	Drop of the rate of increase to below pre-disaster levels	

The role of the macroeconomist and of the sectoral specialists is preeminent here. The purpose is to identify actions and events occurring during the emergency that have an impact on the economy's aggregates: emergency imports of food, medicines and other essential goods; the magnitude of the aid donated in solidarity by the international, local and national communities; state expenditure (at the national and local levels) to combat the disaster,[3] and expenditure incurred by the private sector, either in support of the victims or to provide post-disaster goods and services until essential services are restored. This is particularly important with regard to public services (drinking water, electricity, telecommunications and telephone services), especially when, as is increasingly the case.

Similarly, with support from the sectoral specialists, the macroeconomist an should attempt to quantify the effects of the disaster on the education, health and other public infrastructures, many of which, if they have not been catastrophically damaged, are used as shelters and centers for storing and distributing aid. These expenditures must be specifically accounted for, in addition to any damage suffered by the health and education sectors themselves.

3 Including military expenditure, such as, transportation, personnel mobilization and space at army premises; use of installations, vehicles and personnel belonging to the different agencies mobilized by the official emergency response bodies (committees, national and local emergency offices, etc.); and resources from national disaster funds, when these form part of the state's budget.

During the event, resources are received not only in the form of altruistic aid (whether requested or not), but also from other sources. Registers exist of aid agencies, such as the Red Cross and other international bodies. The United Nations also publishes regular bulletins with information about the progress of the disaster, emergency needs and very short-term consequences. At the request of the affected country, a consolidated request for support is prepared. All such international information can be found at www.reliefweb.org, a Web site that should be consulted before the assessment is begun. As well as making it possible to complete the data needed to identify the expenditure incurred during the emergency (which has to be shown in the consolidated summary of damage), the systemization of this information will also facilitate its inclusion when measuring the disaster's impact on external variables, public finances and the currency.

a) General economic effects

The idea under this heading is, above all, to present a summarized appreciation of the disaster's economic repercussions throughout the economy. The specialist should gather data on the repercussions for capital assets (direct damage) and for the flows that will cease to exist (indirect damage), as well as on the secondary effects on the main macroeconomic variables mentioned. This mainly consists of a summary and analysis of the table data, which shows damage to physical infrastructure and natural resources, as well as to the production of goods and services that will cease to exist. It also includes increased import requirements resulting from the disaster. It usually covers a period of two years, but can be extended to five if the disaster's magnitude so merits. If relevant, it includes alternative scenarios of later developments and specifies the assumptions underlying each one.

This analysis is essential for designing restoration and reconstruction programmes and for orientating any international aid that might be needed. To this end, it is often necessary to show amounts in domestic currency (at the prices in the period when the assessment was made) and in dollars. The text should also include a summary of the effects (with a breakdown) on economic growth, population income level, employment, inflation, exports and imports and public finances.

A summary table showing the main economic indicators and the way in which the disaster affected them supports the relevant analysis. The sectoral specialists provide the macroeconomist with their estimates of indirect damage to production and services for the present and the following year and of the implications for the external sector. This damage is assessed at current prices in the year when the disaster occurred. This information is entered in the first two columns of Table 2. The last two columns indicate the ratio of value - added to the gross value of production. In Appendix XVI, as in the previous chapters dealing with specific sectors, an example is included to illustrate the contents of the macroeconomic overall impact assessment.

Table 2

SECTOR	EXTERNAL IMPACT	MACROECONOMIC IMPLICATIONS WEIGHTED BY ECONOMETRIC MODELS AND INPUT-OUTPUT TABLES WHEN AVAILABLE	
		GROSS VALUE OF PRODUCTION	VALUE ADDED
PRODUCTION SECTORS			
Farming (including livestock, fishing, forest resources)			
Industry			
Commerce			
Services			
- Finances and banking			
- Tourism			
- Personal and other non-industrial			
INFRASTRUCTURE			
Water (drinking, irrigation, drainage, sanitation, and waste disposal)			
Energy (generation, transmission, distribution)			
- Electricity			
- Others (oil, gas, etc.)			
Transportation and communications			
SOCIAL ASPECTS			
Education			
Health			
Housing and human settlements			
Cultural heritage			
Social conditions (social fabric: employment, etc.)			
ENVIRONMENTAL ASPECTS			
TOTAL			
FISCAL IMPLICATIONS (for the public sector)			
- Income			
- Expenditure			

The cost of the impact in terms of direct and indirect damage will be assessed sector by sector by means of the assessment methods described or suggested for each sector. Available sectoral weighting methods will be applied to these values to identify delta (D), or “damage” expressed as the difference between the expected value without the disaster (Va) and the value produced by the weighted sectoral assessment (Vb).

DAMAGE "DELTA"

The difference between the expected results with and without the disaster are expressed as follows:

> D = Va - Vb, where Va is the variable's initially expected condition (sectoral, weighted) and Vb is the value discounting the disaster's effect.
>
> Direct damage shows the losses of capital assets and is calculated as follows:
> K = Ka - Kb, which measures the loss of capital, where this is assessed from the identified direct damage, sector by sector.

The indirect effects, in terms of output/income affected by the event, is expressed as:

> DY = Ya - Yb, which measures the lost output/income.

Generally speaking, it is assumed that the capital/income-output relationship is not substantially altered by the disaster. Nevertheless, if sufficient information is available, it could be assumed that there have been changes in this relationship as a result of the disaster and the reconstruction processes. This is one of the elements that might motivate the suggestion of alternative scenarios.

b) The effects on economic growth and income

The aggregate that best reflects variations in the general level of economic activity is gross domestic product (GDP). Accordingly, the macroeconomist should estimate the disaster's effects on this variable's growth rate and the extent to which they modify the GDP forecasts made before the disaster. As stated, these estimates are generally relevant for a period of one or two years beyond the disaster year.

A clear distinction should be made between nominal and real magnitudes. GDP is generally obtained in nominal values and is transformed into a real magnitude. Thus the impact "delta" should be made in real terms (real magnitudes expressed in the prices of the base year normally used in the country) in order to obtain an appreciation of the disaster's real effects on the economic growth rate . One common problem of a statistical nature is explicitly distinguishing between the nominal and real value of the major aggregates that make up internal supply (gross domestic output by branches of activity) and demand (expenditure on public and private consumption and capital formation) at the time of the disaster occurred.

The macroeconomist must therefore consult national experts in order to select the most appropriate and reliable price index (whether the implicit price deflator of GDP, the wholesale price index or the cost of living index), so that the figures are expressed at constant values. This conversion is essential for the correct appreciation of the magnitude of the losses in GDP or income resulting from the disaster and their effect on the forecast growth rate. It is important to make clear that once this adjustment has been made, the data for the year, or for the two or more subsequent years, should be expressed, as far as possible, in constant disaster-year prices. In other words, the effect of inflation should be removed. This is important because the purpose at this point is to estimate the disaster's effects on the real growth rate.

The forecast aggregate demand and supply information obtained is to be modified according to the damage calculations supplied by the sectoral specialists, by applying these the deflators recommended by the Central Bank or corresponding economic authority.

The preceding calculation is used to make a preliminary estimate of the disaster's impact on the sector's GDP makeup. When the impact of reconstruction programmes is taken into account, the assessment might show that the disaster has a positive effect on GDP. Once the macroeconomist is in possession of the gross values of the damage obtained by the sectoral specialists, he or she must convert them to value - added so that they can be incorporated into GDP. This can be done by identifying the ratio of value-added to gross production value for all economic sectors and branches of activity. The above information is generally obtained from an input-output matrix that is recent enough for the ratios to be valid, or considering appropriate ratios.

The projections and forecasts about post-disaster development are made first for the disaster year and then for the following year(s). The number of years to be considered will vary in accordance with the relative impact of the event given the size and level of development of the economy and the economic cycle. These projections may be made for several alternative scenarios. The assumptions applicable to each case must be specified. There is not much literature on the subject, and, to obtain an approximate estimate of the impact, it would be prudent to consider the models used by the country's analysts or by analysts at international institutions. All these models must be subject to a set of endogenous and exogenous variables and, for the purpose of simplification, certain assumptions must be made for each case. The methodological and taxonomic development of each model is not shown here. This task has to be carried out on a case-by-case basis in order to decide which type of model or models are to be employed.

i) The measurement of GDP. Generally, GDP data is obtained on the basis of real sectoral data. In some cases, the distinction should be made between GDP at market prices and at factor costs. GDP data is sometimes obtained at factor costs, while the macroeconomists needs GDP at market prices. The relationship between value - added and final demand is shown in the following table.

Gross domestic product as net contribution to income	Gross domestic product as net final demand
- Gross value - added to basic prices o Remuneration paid to wage earners o Other taxes less production subsidies o Fixed capital consumed o Surplus of exploitation/mixed income - Taxes less production subsidies	- Household final consumption expenditure - Final consumption expenditure by non-profit institutions serving households (individual) - Government's final consumption expenditure o Collective o Individual - Gross fixed capital formation o Gross fixed capital formation o Variations in stock levels o Purchases minus disposal of valuable objects - FOB exports - Minus FOB imports

Alternative ways to calculate GDP

- As the sum of value - added (the production approach) - GDP estimated at consumer purchaser's prices (GDPbp). This is the sum of gross production in each sector at producer prices (GPpp) minus each industry's intermediate consumption at purchaser's prices (ICbp), plus customs duties and other import taxes (Im):

  GDP = total industrial production at basic prices
  GDP = PBpp - ICbp + Im

This approach makes it possible to calculate the value - added to each industry's basic price by subtracting each industry's intermediate consumption at purchaser's price from its production at basic price.

- As the sum of primary incomes (the income approach). With this approach, GDPbp is equal to the sum of employees' remunerations (Er), indirect taxes net of subsidies (Tin), fixed capital consumed (CKF), net exploitation surplus (NES) and customs duties and other import taxes (Im):

  GDPbp = Er + Tin+ CKF + NES + Im

- As net final demand (the expenditure approach). In this process GDPbp is equal to the sum of final consumption (FC), gross fixed capital formation (GFKF), variation in stock levels (E) and exports (X), minus imports:

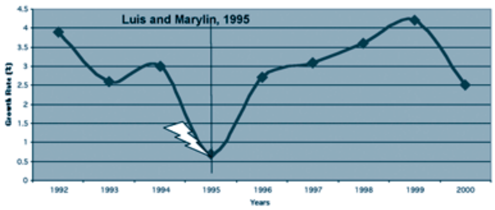
  GDPbp = FC + GFKF + E + X - M

- The commodity flow approach. The national accounts system combines three approaches (production, income and expenditure) to calculate national accounts statistics. Since it balances the supply and use of each output by means of supply and use tables, it is possible to make a uniform crosscheck at a very detailed level to ensure that the figures are consistent.

Therefore, the input-output matrix preparation methodology can be used for calculating GDP at purchaser's prices (GDPbp) and measuring it either as the sum of value - added or of primary incomes, or as net final demand. With the assistance of the input-output tables or the sectoral weightings, it is possible to identify the way in which damage in one sector is reflected in others. Losses are accounted for at replacement cost and the damage scenario is defined. Changes in basic balances -external sector, fiscal deficit, internal balance (prices, exchange rate, etc.- should be highlighted.

The past performance of economies following a major disaster are exemplified by the situation experienced in the Caribbean after two major hurricanes, Luis and Marilyn, as is illustrated by the following graph.

Eastern Caribbean
GDP growth
1983 - 1999



Source: Eastern Caribbean Central Bank

ii) The use of several future scenarios. The first scenario (quantification and impact of the event without taking later reconstruction activities into account) serves as a basis for alternative reconstruction scenarios. These scenarios are based not on replacement values, but on reconstruction costs, the emergency reconstruction priorities sector by sector and the reconstruction strategies that begin to emerge in the weeks following the disaster.

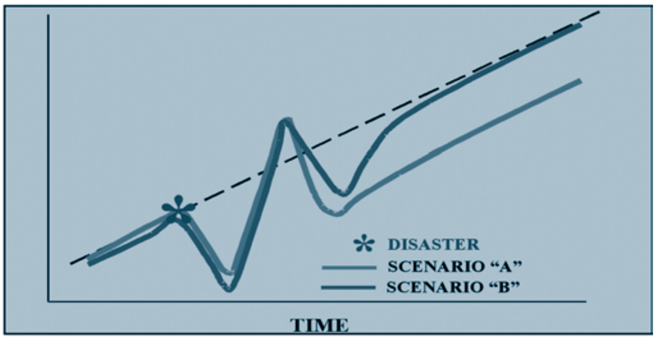
The various scenarios should specify the assumptions made about two core elements: the economy's capacity to absorb external resources and its project delivery capacity. These scenarios should also include assessments of the way that key economic variables will behave in the event of a significant increase or diversion of resources for reconstruction taking into account interest rates, debt capacity and the availability of production inputs and means (raw materials, capital goods, internal savings, labor, etc.).

The effect on income refers to connections that might be established with the impact on employment. This is extremely important for calculating the impact of a disaster that slows or closes down income - generating activities. The estimate of the impact on income also includes an assessment of the disaster's effect on inflation and the available sources of supply. The calculation of the effects on the population's income is another way of analyzing the problem of the disaster's consequences on the level of activity (and for that reason it should not, of course, be added to them). It is sometimes useful to singularize effects when they encompass a defined stratum of the population (especially the lowest deciles), in order to facilitate the design of reconstruction-related occupational absorption programmes, whether in rural or urban areas. Clearly, these assessments will be closely related to those made about the disaster's effects on employment. These phenomena sometimes affect the population's real income if inflexible supply, caused by temporary interruption to the supply channels, exacerbates inflation. The example that accompanies this chapter (taken from the assessment of the macroeconomic impact of the El Salvador earthquakes in 2001) shows the type of analysis and macroeconomic assessment results expected. The following table and figures illustrate the way in which the results should be presented at the end of the exercise.

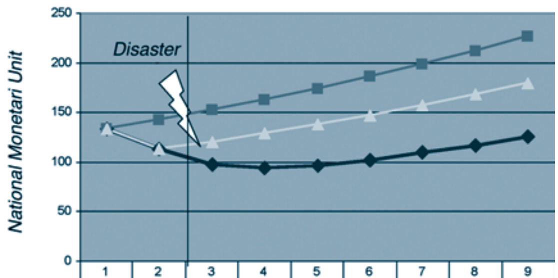
MACRO / GLOBAL IMPACT (CURRENT VALUE AND CONSTANT VALUE)	EX ANTE SITUATION (CURRENT PERIOD)	EX POST SITUATION (CURRENT PERIOD)	SHORT-AND MEDIUM - TERM PROJECTIONS (INCLUDING ALTERNATE SCENARIOS)
1. GDP			
EXTERNAL BALANCE			
- Exports			
- Imports			
A - BALANCE OF TRADE			
B - CURRENT BALANCE AND CAPITAL ACCOUNT			
- Net credits (including service and repayment)			
- Net donations			
- Net private transfers			
- Other income (payments fom insures and reinsurers)			
2. FISCAL BALANCE			
- Income			
- Expenditure			
3. CAPITAL ACCOUNT			
- Gross capital formation			
- Domestic investment			
- Foreign direct investment			

Based on a consistency model, different reconstruction scenarios may be estimated. The model that produced the second figure is based on particular features of a smaller economy and on the empirical evidence available for smaller economies before and after a disaster.

THE EFFECT OF DISTASTERS ON THE GROWTH OF A NATIONAL ECONOMY



NATIONAL INCOME BEFORE AND AFTER A DISASTER: SLOW OR FASTERCOVERY ADJUSTMENT AS COMPARED TO TREND



	1	2	3	4	5	6	7	8	9
Slow reconstruction efforts	133.687	112.722	98.0169	94.3167	96.7038	102.345	109.345	117.128	125.279
Trend	133.687	142.83	152.599	163.035	174.186	186.098	198.826	212.424	226.952
Fast reconstruction	133.687	112.722	120.431	128.668	137.467	146.869	156.914	167.645	179.111

Periods (Years)

c) Effects on the external sector and the balance of payments

When making their assessments, the sectoral specialists will have included among the disaster's secondary effects those that affect the current account of the balance of payments and, where relevant, the external financial requirements for the reconstruction process.

The macroeconomist will need to have estimates of the balance of payments for the economy as a whole, as well as a projection for the disaster year (and, if possible, for the following year, too). This information must be supplemented with information on other external-sector basic magnitudes (e.g., the total amount of external debt, the effect of debt servicing and the level of international monetary reserves).

The data required for estimating the effects of the disaster on the balance of payments are as follows: a pre-disaster estimate of the balance of payments for the year in which the disaster occurs; and the balance - of - payment accounts for the preceding five years, using the most detailed data possible (i.e., IMF, Fifth Manual). The balance of payments comprises three components: flows of goods and services in and out of the country; unilateral transfers that are the counterpart of real resources or financial claims that are provided or received; and changes in resident's claims on, and liabilities to, non-residents that arise from economic transactions.

Possible effects on the balance of payments

a) Flows of goods and services

Decrease in export merchandise (a result of the destruction of output and capacity or of diversion to the internal market).

Decrease in service earnings, which arises out of losses to the merchant fleet, tourism and other infrastructure.

Increase in imports that are indispensable during the restoration phase (fuel; foodstuffs to replace lost harvests and production of staple food; additional inputs).

Decrease in import value due to tariff reduction.

Disaster related insurance and re-insurance.

b) Unilateral transfers

Unilateral transfers received from the rest of the world will increase (donations and grants; remittances).

Unilateral transfers provided to the rest of the world will decrease (profit and interest repatriation).

c) Changes in resident's claims

Changes in resident's claims should be estimated 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 expert should also consider in the calculation additional external financing needed to confront a possible worsening of the current account deficit. The performance of the balance of payments for Dominica (in US dollars) following hurricanes Luis and Marilyn (1995) illustrates such an assessment.

Dominica: Balance of payments (US dollars. Millions) 1993-1997					
	1993	1994	**1995**	1996	1997
Goods	-118	-129	**-143**	-129	137
Services	48.9	36.4	**34.5**	64.9	84.0
Income	-17.3	-29.9	**36.0**	-53.2	-46.5
Transfers	23.5	19.1	**21.2**	27.5	28.3
Capital transfers	26.3	23.2	**52.3**	57.4	60.8
Financial account	53.9	80.5	**78.9**	26.6	14.2
Foreign direct investment	35.7	61.1	**146.1**	48.1	57.0

Source: Eastern Caribbean Central Bank

d) The effect on public finances

A natural disaster affects the budget. The budget is a financial programming exercise projecting how the government plans to spend revenue. It presents certain expected levels of receipts and certain expected levels of expenditures. Public sector operations may be reported on a cash flow or accrual basis. Central government revenues should be shown on a cash basis. Revenues on an accrual basis may include commitments by their parties that cannot be honored.

The presentation of fiscal accounts on an accrual basis depends on the need to reconcile fiscal with other financial and economic variables, the importance of the floating debt as a source of finance and the availability of data. Public sector operations are carried out in the context of a fiscal year. The fiscal year does not necessarily coincide with the calendar year. Adjustments are needed to make fiscal figures compatible with other figures such as the national accounts.

Possible budgetary effects due to the disaster include the following:

Reduction in current revenues due to decreases in tax revenues: the tax base, tax rates, tax holidays (reductions in import duties) and non-tax revenues;

Reduction in capital revenues due to destruction and damage;

Variations (probable increase) in current (operating) expenditures: increases in operating outlays, increases in transfers and decreases of interest on public debt; and

Increase in capital expenditures: increase in direct investment, capital transfers and financial operations.

The financial impact of the disaster can be analyzed by rearranging the fiscal components in a presentation that shows the gap between central government operations and their financing. It is important to take into account the influence of the rest of the general government accounts and in particular that of state enterprises on the budget. The relations between state enterprises and the central budget are captured in current expenditures under transfers. Enterprises can be classified into those engaged in production; in providing certain services; in marketing commodities; and in producing, importing, and refining petroleum products.

As an example of such a budget impact on a very small economy, Antigua and Barbuda reported increased import tax revenues following hurricanes Luis and Marilyn in 1995 despite a reduction in import tariffs.

Antigua and Barbuda: Central Government Budget Balances
(EC Dollars) Millions, 1993 - 1997

	1993	1994	**1995**	1996	1997
Tax revenue	255.0	281.0	**283.0**	323.0	327.0
Domestic taxes	44.8	62.0	**53.3**	59.9	63.4
International trade taxes	140.5	156.2	**160.6**	181.6	187.5
Import duties	44.0	47.1	**46.0**	54.6	56.8
Current expenditure	274.4	275.4	**290.6**	314.6	324.3
Capital expenditure	2.4	2.8	**4.2**	5.0	3.7

e) Employment

The reports on the social and economic sectors should include estimates that make it possible to appreciate the overall effects on the level of employment derived from: the effects of the destruction of production capacity or social infrastructure, and from the occupational requirements created during the emergency and the rehabilitation process. These effects on employment not only have implications for household incomes and national output, but they increasingly affect people's mobility and migratory flows, both within the country (between the most and least affected regions) and to neighboring and more distant nations. Such shifts often have significant social and political implications.

f) Prices and inflation

Inflation data should be readily available from the Central Bank on a monthly or at least quarterly basis. It is a key variable for the IMF and for countries that have programmes with the IMF. However, price surveys leading to the construction of a price index are generally carried out in urban areas. Therefore, the analyst may be confronted with a paucity of pricing data for the countryside when assessing a natural disaster that has affected a sector such as agriculture.

Although the macroeconomist cannot be expected to measure the general levels of inflation before and after the disaster, he or she should at least express an opinion (based on the sectoral analyses) about the effect that supply constraints (due to destruction of crops, manufactured goods, trading channels, transportation routes, etc.) could have on the price of particular goods and services that will be supplied by alternative means. An assessment of the influence of these variations on general price levels and on relative prices must be made and included in the description of the general effects of the disaster.

g) The use of models

As already mentioned, the models to be used will preferably be those generally employed by analysts in the country in question. Examples will now be given of two generic models and the tools that are needed when adapting these models to specific cases. The behavior of investment deserves a separate discussion. The effects on investment are not clear from the damage assessment; they will vary according to the availability and quality (amount, terms and conditions, internal/external mix and public/private participation) of resources for the reconstruction process. The use of models allows for the introduction of different scenarios and constraints. In Appendix XVII, two models are briefly described as an illustration of how they can be useful for measuring short- and medium-term impact and designing reconstruction strategies.

Models are alternative methods that macroeconomists can use to process and analyze the information received from the sectoral specialists and the country's economic authorities. Past experience of disaster assessments suggests that estimates of impact on GDP and on the GDP growth rate are made by positing different scenarios, not just one unvarying course of action. It should be remembered that estimates of impact on the GDP growth rate made using the input-output matrix and the GOV and VA ratios are only approximations of reality and that in practice, many countries in the region lack an up-to-date or relatively recent input-output matrix. Therefore, estimates made using this instrument can be unreliable or fail to reflect the magnitude of sectoral impacts.

From the point of view of macroeconomic policy, the key question is this: How much money does the government need to finance the reconstruction costs, and how quickly can it obtain it while remaining within the framework of sustainable fiscal policy? At this point in the assessment it is important to identify the underlying public sector deficit, that is the deficit excluding reconstruction costs. The next step is to determine how the underlying deficit was expected to be financed: for example, by loans from multilateral institutions, by issuing bonds, or both. If loans are obtained, information on the maturity, grace periods and interest rate (generally expressed in terms of LIBOR rates plus x basis points) should be obtained from the country's authorities, and a medium- and long-term debt plan should be drawn up. Once this information has been obtained, two scenario modes can be proposed:

a. Probable financing structure and

b. An occurrence probability associated with each financing structure. With the first mode, there can be as many scenarios as there are financing structures defined. To simplify matters, no more than three scenarios should be used, each one set out in roughly the following way:

Scenario A (pessimistic): this assumes that the government contracts loans for the amount needed to repair the damage and pay the estimated replacement costs over a period of several years (e.g., five) without overheating the economy or throwing the system out of balance. The related expenditure is also distributed over the same period because of the limits on the economy's absorptive capacity. It is assumed that the loans will have a long-term maturity period (e.g., 20 years), a grace period of several years (e.g., five) an interest rate equivalent to the LIBOR plus a moderate number of basis points (e.g., 150).[4]

Scenario B (probable): this assumes that the government contracts loans for the amount needed to repair the damage and pay the estimated replacement costs over the same period suggested in the previous example (five years). The disbursements of the loans contracted at the end of the disaster year are paid on the same terms as in Scenario A, but it is assumed that the financing is raised by issuing special disaster bonds with a longer maturity period (e.g., seven years) and an interest rate of LIBOR plus a sufficient number of basis points (e.g., 280) to make it an attractive investment.

Scenario C (optimistic): This assumes that the government borrows more money in order to improve and strengthen the infrastructure of the affected area by incorporating vulnerability reduction programmes in the reconstruction process. The loans are contracted on the same terms as in Scenario A.

With the second mode, each scenario is associated with a probability distribution that, as in the preceding mode, can be distinguished by the occurrence probability allocated to the three scenarios. An occurrence probability of 50 percent is assumed for the probable scenario and 25 percent each for the pessimistic and optimistic scenarios.

In every case, it is important to check whether the reconstruction expenditure is expected to create faster economic growth, especially if it is assumed that a good part of the additional expenditure will be reflected in the volume of imports. In short, projections should be made for the planned reconstruction period based on the total underlying deficit:

Total underlying deficit = net financing need plus debt amortization = gross financing need minus disbursements of existing debt = fiscal financing gap

The above information can be used to make a "sensitivity analysis" by distinguishing between the overall fiscal deficit in each of the proposed scenarios and the underlying position. The analysis can be extended to include public debt and debt servicing, the financial gap and the balance of payments.

4 The periods and the points added to the interest rate will be adapted in each case to the affected country's financial conditions and risk rating, to the magnitude of the debt and to the economy's capacity to absorb the required reconstruction.

APPENDIX XVI
MACROECONOMIC EFFECTS
OF THE EARTHQUAKES IN EL SALVADOR IN 2001

1. Summary of damage

Total damage is the equivalent of 12.1 percent of 2000's GDP. It is also the equivalent of 43.5 percent of exports, 29.3 percent of imports, and 42.3 percent of gross fixed capital formation. These figures highlight the challenges facing public finances and the external sector.

2. The situation before the earthquake

General features

El Salvador's GDP grew by 2 percent in 2000, marking the third consecutive year of falling growth rates.[5] To a large extent, this performance was associated with a slack export sector, where a fall in international coffee and sugar prices combined with a rise in fuel prices to worsen the terms of trade. A slowdown was also experienced in the construction and trade sectors, as well as in agriculture for domestic consumption.

Public finances weakened in 1999; together with the external sector, this constituted the most vulnerable area of the economy. The deterioration occurred in spite of efforts to apply a conservative fiscal policy in spending, as well as measures aimed at broadening the taxpayer base and reducing tax avoidance and evasion. Some of the government's basic assumptions about the economic situation before the earthquake are shown in Table 1.

At the close of 2000, a central government fiscal deficit of 2.3 percent of GDP was reported; this was slightly higher than in 1999. For 2001, without the effect of the earthquake, the fiscal deficit had been estimated at 2.8 percent. Had the trend in revenue collection continued, the fiscal deficit was expected to come under more pressure, largely because of the government's obligation to pay more than a billion dollars in pensions over the next five years. Income from customs duties was also expected to fall as a result of free trade agreements entered into by the country.

5 According to official estimates in December 2000.

Table 1

SELECTED ECONOMIC INDICATORS

	1999	2000	2001 (before the earthquake)
Targets			
Real GDP (%)	3.4	2.0	3.5 - 4.5
Inflation (%)	-1.0	4.3	2.0 - 4.0
Assumptions			
Coffee crop 1999/2000 (hundreds of millions of pounds)	3.2	-.-	-.-
Coffee crop 2000/01 (hundreds of millions of pounds)		2.9	3.2
Coffee exports (hundreds of millions of pounds)	2.5	3.1	2.6
Average price of exported coffee (dollars per 100 pounds)	99.0	96.5	75.0
Exports of goods FOB (millions of dollars)	2,500.4	2,981.9	3,603.1
Imports of goods CIF (millions of dollars)	4,119.9	4,908.1	5,782.0
External inflation (%)	2.6	3.7	2.0- 3.0

Source: El Salvador Central Reserve Bank.

In the private sector in 2000, the highest growth was to be found in the transport and communications (6.2%), banking and insurance (5.1%) and manufacturing (4.5%) sectors. In the external sector, exports of goods and services increased by 17.3 percent and imports by 18.1 percent, taking the deficit on the trade balance of goods and services to 26 percent. The current account deficit was the equivalent of 3 percent of GDP, compared with 2 percent in 1999. Before the earthquake, it was estimated that the deficit in 2001 would be reduced to 2.5 percent, because of expected improvements in exports of maquila products (especially textiles) following the broadening of the Caribbean Basin Initiative.

Trade deficits continued to be offset by family remittances, which totaled 1.751 billion dollars in 2000. In addition, the Central Reserve Bank had amassed net international reserves of almost 1.9 billion dollars, the equivalent of four and a half months of that year's imports.

December-to-December inflation in 2000, measured by the national consumer price index (CPI), was close to 4.3 percent, reversing the previous year's -1 percent. Before the earthquake, a December-to-December inflation rate of 3 percent had been projected for 2001.

In late November 2000, the Monetary Integration Project was announced. When it came into effect on January 1, 2001, the prevailing exchange rate, which had been in effect since 1994, was set at 8.75 colóns to the dollar. Other currencies were allowed to circulate freely alongside the colón, and the dollar was made the unit of account for the financial system. Prior to the earthquake, the government had hoped that this process would promote the flow of capital and increase foreign direct investment.

It is important to emphasize that the macroeconomic mechanisms used to adjust to external shocks (e.g., the January 13 earthquake) in a dollarized scenario are totally different from those used in a national currency scenario. In the former scenario, adjustments can be made through fiscal measures and through the labor market; in the latter, it can be made by modifying the nominal exchange rate. A dollarized scenario calls for strict control of public finances, together with greater external resources and considerable flexibility in the labor market.

3. The accumulated effects of the two earthquakes: post-earthquake projections for 2001 and the following years

The assessment of the macroeconomic effects of the second earthquake for 2001 and the following years uses the estimates contained in the document on the 13 January disaster to focus on the impact on growth, inflation and the deficit, both in the current account of the balance of payments and in public finances.

Some post-earthquake projections of the most probable 2001 macroeconomic scenario measure the role of economic policy and, as a result, the future reconstruction challenge.

The earthquake's main impact on the GDP growth rate, in terms of the GDP percentile structure, was on the social (40 percent), infrastructure (32 percent) and production (20 percent) sectors . The most badly affected part of the social sector was housing. In infrastructure, roads suffered the most damage, and their restoration and reconstruction may raise the country's low level of public and private investment. In the production sectors, the greatest damage was caused to small and micro - businesses, many of which have begun to recover on their own initiative, although many others will disappear permanently or will only be revived with the assistance of directed credit programmes to provide them with working capital and inventory capital.

Table 2 shows overall supply and demand at current prices. The post-earthquake projection column includes the increase in imports that might occur because of reconstruction work.

Table 3 shows overall supply and demand at constant 1990 prices. The projection for 2001 was estimated by the Central Reserve Bank for a pre-earthquake scenario with 4.5 percent growth in GDP. All post-earthquake estimates were made by ECLAC and show a GDP growth rate of 4 percent in the first year (2001), with stronger growth in 2002 and 2003.

In short, the conclusion is that an earthquake in a small open economy like that of El Salvador puts increased pressures on public finances, since the additional expenditure, added to import requirements (especially for construction and housing) can culminate in simultaneous internal and external deficits. These will turn the adjustment process into a cause of higher unemployment rates, unless the international community provides additional financing. Such new funding must be provided on concessionary terms to ensure that the increase in the country's foreign debt does not increase its external weakness.

When added to those contracted after the previous earthquake, the new loans provided by multilateral institutions to lessen the fiscal gap caused by the magnitude of the reconstruction expenditure (an estimated 336 million dollars for this event) a total of 1.94 billion dollars.[6] It is considered that reconstruction will call for average annual investments of 390 million dollars over the next five years (a total of 1.9 billion dollars)

Table 2

OVERALL SUPPLY AND DEMAND AT CURRENT PRICES
(Millions of dollars)

	1999 Preliminary	2000 Projection rev. Dec.	2001 Projection pre-quake	2001 Projection post-quake	Percentage of GDP		
					2000	2001 before	2001 after
Overall demand	149,779.1	163,730.2	180,767.7	182,163.7	141.6	145.0	146.8
Consumption	104,605.4	111,988.5	121,514.9	121,503.2	96.8	97.5	97.9
Private	93,624.4	100,411.5	108,649.9	108,569.6	86.8	87.2	87.5
Public	10,981.0	11,577.0	12,865.0	12,933.6	10.0	10.3	10.4
Gross domestic investment	17,741.6	19,574.9	21,310.2	22,588.3	16.9	17.1	18.2
Fixed capital formation	17,618.9	19,436.2	21,083.3	22,406.1	16.8	16.9	18.1
Private	14,376.1	16,011.2	17,148.1	18,216.4	13.8	13.8	14.7
Public	3,242.8	3,425.0	3,935.2	4,189.8	3.0	3.2	3.4
Inventory variations	122.7	138.7	226.9	182.2	0.1	0.2	0.1
Export of goods and services	27,432.1	32,166.8	37,942.6	38,072.2	27.8	30.4	30.7
Overall supply	149,779.1	163,730.0	180,767.6	182,163.7	141.6	145.0	146.8
Imports of goods and services	40,693.6	48,062.9	56,108.5	58,108.5	41.6	45.0	46.8
Gross Domestic Product	109,085.5	115,667.1	124,659.1	124,055.2	100.0	100.0	100.0
Farming	11,725.9	11,806.7	12,414.4	12,086.2	10.2	10.0	9.7
Mining and quarrying	435.2	461.7	499.3	499.3	0.4	0.4	0.4
Manufacturing industries	24,545.9	27,092.3	29,476.9	29,412.6	23.4	23.6	23.7
Water and electricity	2,020.4	2,350.9	2,551.8	2,444.5	2.0	2.0	2.0
Construction	4,773.6	5,037.0	5,484.0	5,799.8	4.4	4.4	4.7
Commerce, hotels, and restaurants	20,740.6	21,462.6	22,857.8	22,632.3	18.6	18.3	18.2
Transportation, storage, and communications	9,209.3	9,955.6	10,858.2	10,858.2	8.6	8.7	8.8
Banking, insurance, and other financial institutions	4,606.9	4,952.7	5,417.8	5,417.8	4.3	4.3	4.4
Real estate and business services a/	4,544.3	4,704.7	5,000.9	5,050.9	4.1	4.0	4.1
Housing rentals	8,634.9	9,027.4	9,649.4	9,699.4	7.8	7.7	7.8
Community, social, personal, and domestic services b/	7,191.5	7,751.1	8,143.1	8,034.7	6.7	6.5	6.5
Government services	8,071.2	8,491.7	9,084.5	8,898.5	7.3	7.3	7.2
Minus							
Attributed banking services	4,506.6	4,845.4	5,225.4	5,225.4	4.2	4.2	4.2
Plus							
Customs duties and VAT	7,092.4	7,418.1	8,446.4	8,446.4	6.4	6.8	6.8

Source: ECLAC, preliminary estimates based on figures provided by the Central Reserve Bank.
a/ Includes leasing and use of non-residential properties; professional legal, accounting, and audit services; preparation of data, computer services, architectural services, and advertising.
b/ Includes private education and health services, entertainment services (cinema and television) and other services such as veterinary services; trade, professional, labor, and religious associations; electrical and motor vehicle repair shops.

6 Plus the sum of 112 million dollars needed for the reconstruction of housing whose loss was reported after 31 January, but before the second earthquake.

Table 3

OVERALL SUPPLY AND DEMANDS AT CONSTANT PRICES

	1999 Preliminary	2000 rev. Dec.	2001 Projection pre-quake	2001 Projection post-quake	Relative changes 2000/99	Relative changes 2001/00 pre-quake	Relative changes 2001/00 post-quake
Overall demand	84,898.5	89,439.8	96,081.2	97,100.6	5.3	7.4	8.6
Consumption	55,411.1	56,273.4	58,777.6	58,776.9	1.6	4.5	4.4
Private	50,710.6	51,557.7	53,749.1	53,720.7	1.7	4.3	4.2
Public	4,700.5	4,715.7	5,028.5	5,056.1	0.3	6.6	7.2
Gross domestic investment	10,594.8	11,149.5	11,957.8	12,630.6	5.2	7.2	13.3
Fixed capital formation	10,488.3	11,054.0	11,670.8	12,400.2	5.4	5.6	12.2
Private	8,829.3	9,421.4	9,851.4	10,463.2	6.7	4.6	11.1
Public	1,659.0	1,632.6	1,819.4	1,937.0	-1.6	11.4	18.6
Inventory variations	106.5	95.5	287.0	230.3	-10.3	200.5	141.2
Exports of goods and services	18,892.6	22,016.9	25,345.8	25,693.2	16.5	15.1	16.7
Overall supply	84,898.5	89,439.8	96,081.2	97,100.6	5.3	7.4	8.6
Imports of goods and services	29,015.1	32,455.2	36,550.4	37,855.7	11.9	12.6	16.6
Gross Domestic Product	55,883.4	56,984.6	59,530.8	59,244.9	2.0	4.5	4.0
Farming	7,205.1	7,145.9	7,403.0	7,207.0	-0.8	3.6	0.9
Mining and quarrying	242.6	249.9	262.3	262.4	3.0	5.0	5.0
Manufacturing industries	12,655.3	13,225.8	14,109.9	14,079.8	4.5	6.7	6.5
Water and electricity	350.2	354.3	374.4	358.6	1.2	5.7	1.2
Construction	2,176.6	2,126.5	2,243.4	2,373.1	-2.3	5.5	11.6
Commerce, hotels, and restaurants	10,940.9	11,030.8	11,370.7	11,259.9	0.8	3.1	2.1
Transportation, storage, and communications	4,554.8	4,836.6	5,124.8	5,124.2	6.2	6.0	5.9
Banking, insurance, and other financial institutions	2,098.4	2,205.2	2,337.5	2,337.3	5.1	6.0	6.0
Real estate and business services a/	1,811.4	1,838.6	1,893.7	1,912.5	1.5	3.0	4.0
Housing rentals	4,719.4	4,790.2	4,876.4	4,901.2	1.5	1.8	2.3
Community, social, personal, and domestic services b/	2,889.7	2,928.3	2,982.1	2,942.0	1.3	1.8	0.5
Government services	3,093.1	3,099.3	3,145.8	3,081.2	0.2	1.5	-0.6
Minus							
Attributed banking services	1,825.6	1,918.7	2,005.0	2,005.1	5.1	4.5	4.5
Plus							
Customs duties and VAT	4,971.5	5,071.9	5,411.7	5,410.9	2.0	6.7	6.7

Source: ECLAC, based on official figures

a/ Includes leasing and use of non-residential properties; professional legal, accounting, and audit services; preparation of data, computer services, architectural services, and advertising.

b/ Includes private education and health services, entertainment services (cinema and television) and other services such as veterinary services; trade, professional, labor, and religious associations; electrical repair shops and workshops for motor vehicles, watches, jewelry, etc.

In other words, the effect of the second earthquake was to further strain not only public finances, but also domestic savings and investment capacity. Such a significant increase in reconstruction expenditure will only come about if external resources can be obtained on preferential terms through loans made mainly by the Central American Bank for Economic Integration (CABEI), the Inter-American Development Bank (IDB) and the World Bank.[7]

7 According to the Central Reserve Bank and the IMF, the preferential terms for these loans are a 20-year period, a 5-year grace period and an annual interest rate of 7.5 percent (LIBOR). This suggests that there will be no significant rise in short-term debt during the three years following 2001.

We considered it useful to present three scenarios based on the estimated damage caused by both earthquakes. They are based on the following increases to the economy's historical investment rates: Scenario 1) 150 million dollars in the first year and an average of more than 400 million dollars a year for the following four years until reconstruction is completed; Scenario 2) an average of 380 million dollars for five years; and Scenario 3) 400 million dollars in the first year and an average of 375 million dollars a year for four years.[8] This will determine the level of public expenditure and investment. It will depend on the terms of the country's debt in the next few years and its feasibility will be associated with the national productive structure's ability to expand. The length of time that the reconstruction phase lasts is another factor that might change, and with the cumulative effect of the second earthquake, it could easily continue for more than five years

Table 4

SUMMARY OF MAIN ECONOMIC INDICATORS IN THREE RECONSTRUCTION SCENARIOS FOR 2001 AFTER THE EARTHQUAKES OF 13 FEBRUARY

	Scenario 1 (pessimistic)	Scenario 2 (probable)	Scenario 3 (optimistic)
Real GDP growth	3.0%	3.5-4.0%	4.0-5.0%
Inflation	4.3%	3.0%	3.0%
Fiscal deficit	5.0-5.5%	4.8-5.0%	2.7-3.0%
Current account deficit/GDP	4.0%	3.5%	2.5%
Public debt/GDP	35%	33%	32.3%

Source: prepared by ECLAC All the scenarios assume that loans will be made on preferential terms, especially with regard to interest rates and grace periods: 7½ percent annual interest over 20 years with a five-year grace period.

Pessimistic Scenario: prepared on the basis of 150 million dollars for reconstruction in 2001, with a further 1.750 billion dollars in 2002-2005. Although real GDP growth is greater than in 2000, the reduced flow of resources for reconstruction in 2001 would not be enough to give a boost to the production sector and would cause a marked deterioration in the main economic indicators.

Probable Scenario: prepared on the basis of 380 million dollars for reconstruction in 2001 and 1.520 billion dollars in 2002-2005. This scenario would double 2000's GDP growth rate and reduce annual inflation. New reconstruction work and higher imports would increase the fiscal and current account deficits, respectively. It is estimated that the underlying deficit would be 2.7 percent of GDP, while reconstruction expenditure would be 2.1 percent of GDP, for an overall deficit in 2001 of 4.8 percent of GDP.

Optimistic Scenario: prepared on the basis of 400 million dollars for reconstruction in 2001 and 1.5 billion dollars in 2002-2005. Under this scenario, GDP growth would increase, inflation would be lower than in 2000 and the fiscal and external sector accounts would be kept at prudent levels.

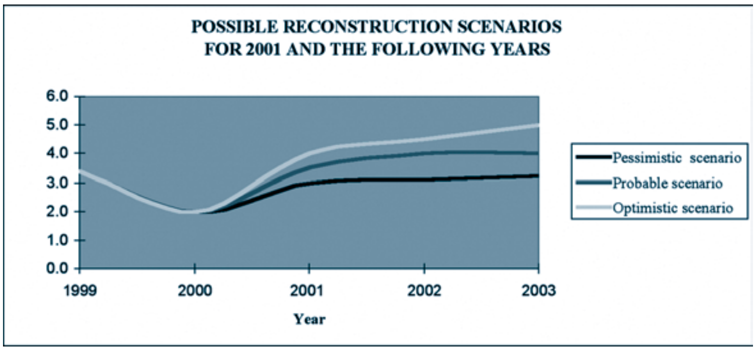
8 Changes in interest rates and reconstruction loan conditions could cause changes in the cost of servicing the fresh debt. The concessions obtained may not only favour a swifter reconstruction process, but also create fewer pressures on the basic macroeconomic balances.

These scenarios are of assistance in measuring possible impacts on the main economic indicators. However at the time of preparing the second assessment, it was still not possible to specify the amount of aid that might be received, the financing that would be available for 2001, when disbursement and implementation will take place or whether these loans would be made on the preferential terms mentioned previously.

This assessment does not include the effect of the possible use of alternative means of partially financing reconstruction, such as the sale of concessions or shareholdings in privatized businesses. Another possible source of financing should be increased domestic savings and tax revenues. This would lessen the strain produced by increased public expenditure –both current spending (in the emergency and for immediate rehabilitation) and investment spending (during the five or more years that reconstruction is expected to last).

Figure 1 shows GDP growth rates for each of these three scenarios.

Figure 1



As noted, the costs of reconstruction are over 1.9 billion dollars. This adds to the challenge already posed to economic policy by the first earthquake. Additional resources and appropriate management of public finances are needed to finance the national reconstruction plan and, at the same time, keep international reserves at an adequate level, control debt servicing costs and avoid further risks of macroeconomic instability.[9] All this has to be done without producing any negative effects on production capacity and employment, which have already been harmed by the earthquakes.

9 These funds could be generated by a basket that could be made up of concessionary loans from multilateral bodies, bond issues, own resources and fiscal measures designed to broaden the taxpayer base and improve tax collection and the efficiency of the revenue authorities. The recent amendment to the tax code, which tackles the country's traditional problems of tax avoidance and evasion, might make tax collection more efficient.

Surveys of business activity carried out after the two earthquakes, together with the expectations of different business sectors, do not conclusively support the view that an increase in tax revenues can be obtained in 2001.[10] Their stated perception was that internal demand could fall unless there were a recovery in income and employment. In addition, a potential increase in demand for resources for reconstruction could reduce demand in other areas. Reconstruction would bring a relative increase in current expenditure that could have a negative effect on the forecast rates of growth in social and capital expenditure, precisely because of the costs incurred during the emergency stage of the earthquakes and the financing of the 2001 "winter plan" (emergency measures to provide temporary housing and stabilize hillsides before the start of the rainy season).

In any of these possible reconstruction scenarios, the public sector deficit would be financed by the new loans, even in a scenario in which the Central Bank continued amassing international currency because of the potential increase in family remittances. The previous situation will be aggravated the more that reconstruction is financed by increasing the level of medium- and long-term debt. In the probable scenario, the overall cost of debt servicing could reach 33 percent of annual GDP, which is a reasonable level.

4. The impact on employment

Since the impact of the second earthquake was more localized than the first one, the effects on employment are more directly related to damage caused to the productive sectors of San Vicente, Cuscatlán and La Paz (especially small and micro - commerce). It is believed that the second earthquake had a much lower impact on the agricultural and maquila sectors, and damage was concentrated on rural and semi-urban sectors that used their homes as production centers. Consequently, the figures contained in the first assessment can be used as a basic reference, since they do not forecast changes in the major relationships and magnitudes caused by the second earthquake.

According to figures provided by the Coffee Council of El Salvador, more than 8 900 jobs have been lost as a result of the second earthquake, 43 percent of them in the San Vicente department; 13 percent in La Paz; 9 percent in Cuscatlán and other departments, such as San Salvador. Also, according to figures provided by the Chamber of Agriculture (CAMAGRO), more than 400 Lake Ilopango fishermen were affected.

Because a large number of the people engaged in these family, small, and micro - businesses are women, this population group will be particularly affected.

10 The surveys were undertaken by the El Salvador Foundation for Economic and Social Development (FUSADES), the National Private Enterprise Association (ANEP) and the El Salvador Chamber of Commerce and Industry.

The impact on employment was once again concentrated on small and medium-sized enterprises. The second earthquake increased the unemployment rates in San Vicente (7.3%), Cuscatlán (6.9%) and La Paz (6.3%). It also put more jobs at risk in these departments and destroyed production enterprises.

The first earthquake was responsible for the loss of 484 jobs in coffee plantations and 630 in coffee processing plants. Both figures were increased by the second earthquake (see above).

APPENDIX XVII

TWO EXAMPLES OF MODELS APPLICABLE FOR ESTIMATING THE IMPACT OF DISASTERS AND FORECASTING THEIR SHORT- AND MEDIUM-TERM CONSEQUENCES

Model A

Basic theoretical assumptions:

This is a simplified and improved version of the model used mainly by the International Monetary Fund (IMF) to estimate the impact of a natural disaster on GDP and the main macroeconomic variables.[11] The underlying assumption of Model A is based on empirical observation. This shows that although natural disasters usually have a very severe negative impact on the rate of economic growth in the immediate aftermath (a year, say), the growth rate tends to recover relatively quickly in the succeeding period. It is assumed that, other things being equal, the swiftness and size of the recovery in growth rate is a direct function of the capacity to replace the assets destroyed by the disaster and, more generally, of the reconstruction process itself.

In this model, it is assumed that the higher growth rate in the years following a natural disaster does not necessarily replace or return the well - being lost in the disaster within the medium (three to five years) or long (eight to ten years) terms. This is related to the conditional convergence hypothesis of growth theory, which postulates that the poorest countries (with less capital stock) tend to grow more quickly than developed countries (with greater capital stock).[12]

The first assumption in this model is a function of added production for the entire economy at a general level; a different function may be adopted, depending on the type of disaster and the type of economy. For the sake of simplicity, a Cobb-Douglas function with constant scale returns is assumed:

$$Y = AK^{\alpha}L^{\beta}$$

where:

$$y = \frac{Y}{L} \quad 0 \prec \alpha \prec 1 \quad k = \frac{K}{L}$$

Y is the product of GDP, K is the capital stock, L is the labor stock and A is a technological parameter that includes a trend variable as well as variables of external competitiveness and of human capital accumulation levels (total productivity of the factors).

The estimate is made using an error correction model that identifies the growth determinants with panel regression results from the Cobb-Douglas production function described above. The structural factors affect the technological variable and the macroeconomy, while prospects explain deviations from the long-term trend.

11 Some of the improvements to the model were proposed in the course of ECLAC's damage assessment of the earthquakes in El Salvador at the beginning of 2001. The IMF's original model has no error correction mechanism and the GDP growth rate is plotted from estimates of expenditure and the magnitude of the fiscal gap.

12 Robert Barro and Xavier Sala-i-Martin (1995), Economic Growth.

The model makes it possible to include information about long-term balance factors and also allows the information to be given an important role in specifying the dynamic structure. It also identifies the long-term determinants of total factor productivity in a context of balanced relationships provided by a technological production function. Short-term deviations are the result of factors that have been triggered when the long-term balanced relationship has not been fulfilled. Their magnitude is explained by stationary variables.

In general, the model sets certain requirements about the way in which the variables and the parameters are grouped. At the same time, this functions as a test of the reliability of the results and provides information about the growth trend and the nature of the economic cycle.

The following is a brief explanation of the error-correction model:

- A fundamental characteristic of co-integrated variables is that their short-term deviations tend to diminish in the long term. Therefore, it seems reasonable to suppose that there must be a co integration relationship between, for example, two variables Y_t and X_t:

$$Y_t = \beta X_t + \varepsilon_t \qquad (1)$$

- There will probably be short-term imbalances between the variables, which the following VAR model of autoregressive vectors could explain (unless they are white noise, short-term changes can be estimated using an ARMA model):

$$\Delta X_t = \Sigma^n{}_{i=1}\alpha_{11}(i)\ \Delta X_{t-1} + \Sigma^n{}_{i=1}\alpha_{12}(i)\ \Delta Y_{t-i} + \varepsilon x_t \qquad (2)$$

$$\Delta Y_t = \Sigma^n{}_{i=1}\alpha_{21}(i)\ \Delta Y_{t-1} + \Sigma^n{}_{i=1}\alpha_{22}(i)\ \Delta X_{t-i} + \varepsilon Y_t \qquad (3)$$

However, since the variables function over a long term, the previous VAR does not include this knowledge and might not correctly identify the way that they should behave in the short term. Therefore an error correction model should be included:

$$\Delta X_t = \alpha_S(Y_{t-1} - \beta X_{t-1}) + \Sigma^n{}_{i=1}\alpha_{11}(i)\ \Delta X_{t-1} + \Sigma^n{}_{i=1}\alpha_{12}(i)\ \Delta Y_{t-i} + \varepsilon X_t\ (4)$$

$$\Delta Y_t = \alpha_L(Y_{t-1} - \beta X_{t-1}) + \Sigma^n{}_{i=1}\alpha_{21}(i)\ \Delta Y_{t-1} + \Sigma^n{}_{i=1}\alpha_{22}(i)\ \Delta X_{t-i} + \varepsilon Y_t\ (5)$$

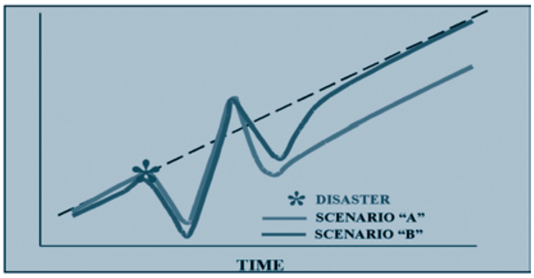
With this correction, a differential between the short and long-term variables should be corrected when the value of the variables t-1 to t is changed, provided there is equilibrium between the variables. For example, if Y_t rose in relationship to X_t in t-1, then in equation (4), X_t in t would be expected to rise ($\alpha_x>0$). In equation (5) Y_t would be expected to fall ($\alpha_y<0$) in t.

Both α_x and α_y are known as the equilibrium adjustment speed. Either of the two may have a value of zero, but not both at the same time. Therefore if $\alpha_Y = 0$, we can conclude that the imbalance adjustments could only be corrected through X_t and also that if all the $\alpha_{21}(i)=0$, then there would only be Granger causality from Y_t to X_t and not vice versa.

This model is based on the work of J.M. Albala-Bertrand (1993), which proposes a macroeconomic model to measure the impact of a natural disaster.[13]

Under this model it is assumed that the effects of a natural disaster are geographically localized, and that only rarely do they have a negative impact on added output. In fact, at least in the short term, their effects on GDP seem to be positive. Basically, the model postulates that the effects of a natural disaster "are a problem of development, not a problem for development". The central argument is that even when the amount of total damage is large in relationship to GDP, this is not an obstacle to an economy's growth. The model distinguishes between disasters whose impact is immediate (earthquakes, floods) and those with a slow impact (droughts). It is not applicable to man-made disasters (wars, technological failures, etc.). Despite such arguments, ECLAC's experience over more than thirty years of disaster assessment in the developing countries of Latin America and the Caribbean shows that disasters are a problem both for and of development, in the sense that the response capacity and resilience to these events entail changes to existing structures and institutions. Otherwise, the positive effects of disasters on growth and output are constrained by the availability of resources budgeted for these events (disaster or prevention/mitigation funds). Where developing economies were suffering from shortages before the disaster, the resources allocated for attention and reconstruction not only compete with pre-existing development projects, but also add an extra burden that states cannot carry by themselves or that they are incapable of absorbing. The result is that after every disaster the gap between the level of growth expected and that achieved grows wider (see the following figure).

THE EFFECT OF DISTASTERS ON THE GROWTH OF A NATIONAL ECONOMY



Both in the model and analytically, a natural disaster consists of three elements: The impact of the disaster, the response to the disaster and the disaster's incidental interference. The analysis is centered on the disaster's impact on both growth and the loss of capital and output. A disaster is considered to be of great magnitude when the ratio of total damage to GDP is comparable to an economy's growth rate (for example, five percent). However, this parameter should be used with caution, since a smaller damage ratio can also imply severe economic effects if the damage is localized in a key area of economic activity.

13 For further information, see World Development, Vol. 21, Nº 9, pp.1417-1434, 1993.

This model assumes several rules for the behavior of disasters and their assessment, the last three of which are rendered questionable or invalid in the light of ECLAC's empirical observation.[14] If recent experience shows anything, it is that damage is not necessarily overstated for political reasons. On the contrary, there are many recent examples of countries which have attempted to minimize the damage in order to maintain strict macroeconomic or fiscal discipline or which, for electoral reasons, have denied the existence of negative impacts, especially on vulnerable social sectors. In cases like that of Hurricane Mitch, the stability of macroeconomic variables was severely strained. It also seems that disasters are happening more often and that their consequences are increasing with every one. This is especially so with hydro-meteorological disasters, which could be linked to climatic change.

Because of the above, in methodological terms, a model enabling the identification of the upper limit of the disaster's impact on output is considered useful. This is a five-part process. The following is assumed that at the time of assessment:

I. The emergency stage is either very advanced or has finished
II. Materials are available;
III. The capital stock lost cannot be replaced in the short term;
IV. All the losses are of capital stock. and
V. Capital stock is homogeneous

Given (IV) and (V):

$$\Delta K = D \Rightarrow \Delta K = Ka - Kb \qquad (1)$$

Where K is the capital, D is the damage or total loss caused by the disaster, b is the impact before the disaster and a is the impact after the disaster. Assuming that the overall capital-output ratio is the same as for the total damage ratio, then:

$$c = K / Y = \Delta K / \Delta Y \qquad (2)$$

where c is the capital-output ratio
$\Delta Y = Ya - Yb$ (daño esperado en el producto)
Y = producto (ingreso)

Solving (2) by ΔY y sustituyendo ΔK por D:

14 The model is based on six "rules" or assumptions:

Rule I: Specific localization. Disasters only affect a "geographically" or "economically" localized area of activity.

Rule II: Internal effect differentiation. Neither the disaster's magnitude nor the social vulnerability at a particular disaster magnitude are the same throughout the disaster area.

14 Corollary II(a): Local sectoral coexistence. In the disaster area, affected economic units will coexist internally, with unaffected units belonging to the same economic sector.

Corollary II(b): Disasters have a greater effect on the poorer sectors (or on the poorest units within the sectors) of society.

Rule III: Differentiated damage to capital stock. The different types of capital stock are not equally affected by disasters. In fact, the distribution pattern for capital loss depends on the type of disaster

$$\Delta Y = D/c \qquad (3)$$

Transforming (3) in growth rate and dividing both sides by Y:

$$y = d / c \qquad (4)$$

Where $\mathbf{y = \Delta Y/Y}$: output growth rate (fall) and $\mathbf{d = D/Y}$ is the total damage/output ratio.

Consequently, the expected fall in the output growth rate (y) is in direct proportion to the total damage/total output ratio (d) and in inverse proportion to capital/output ratio (c). If assumption (iv) is removed, then $\mathbf{\Delta K < D}$, since part of the damage corresponds to loss of output and not only to capital stock. This means that $\mathbf{\Delta K}$ is heterogeneous, and c must be revalued in accordance with the productivities of the different types of capital stock. Therefore, other factors must be included in (4) to set a realistic value for the bottom level and consequently for an interval of the expected fall in the output growth rate:

i. Not all disaster damage is to capital stock;
ii. As a rule, disaster damage is overestimated;
iii. Losses to capital stock are normally estimated at replacement cost;
iv. All types of capital stock are heterogeneous in terms of production;
v. Output growth does not depend exclusively on physical stock.

The first three factors affect the numerator in (4); the others affect the denominator. The resulting equation gives the bottom level of the expected reduction in the GDP growth rate. Removing assumption (iv) and incorporating factor (i):

$$D = D_1 + D_0 \qquad (5)$$

where $\mathbf{D_1}$ is total damage to capital and $\mathbf{D_0}$ is total damage to production. Restating (1):

$$\Delta K = D - D_0 = D_1 \quad (6)$$

Since the cost of capital is calculated at replacement cost (factor iii), depreciation is subtracted to assess the present damage or loss of productive potential resulting from the capital loss. If this were not done, the effect on capital loss would be overestimated. Therefore:

$$D_3 = \pi D_2 = \pi D_1 \qquad (7)$$

14 Rule IV: Overestimation of damage. It is assumed that the total amount of damage is overestimated for political and technical reasons.

Rule V: GDP stability and inflation. It is assumed that disasters do not have a strong negative effect on GDP and inflation.

Rule VI: Probability of disasters. Disasters are scarce and occur only occasionally.

Where $\mathbf{D_3}$ is the present cost of capital loss, **B** is the reciprocal of the rate of depreciation, and **T** is depreciation. For example, $\pi = 1 - \lambda$ and $\lambda = T/D_2$ Correcting $\mathbf{D_2}$ in (8):

$$\Delta K = D_3 = \pi D_2 = \pi D_1 \qquad (8)$$

Since capital is heterogeneous in all types of stock (factor iv) and (in accordance with rule III) the least productive types of stock are generally the ones most affected by disasters, the average capital/output ratio where there is capital loss would be greater (i.e., less productive) than the overall average. This differential impact is incorporated by multiplying **c** by a ratio that, if rule II applies, will be greater than 1. However, if empirical evidence makes this rule inapplicable, its value could be equal to or less than 1:

$$c_1 = \alpha c \qquad (9)$$

where $\mathbf{c_1}$ is the capital/output ratio corrected by factor (iv).

Since capital is heterogeneous in all types of stock (factor v) and, according to the composition of the capital losses, more or less productive than any type (rule II and corollaries IIa and IIb), the average capital/output ratio for capital loss will be different from the overall average. This is incorporated by multiplying $\mathbf{c_1}$ by a coefficient that will be determined for each case (greater than 1 if damage is caused to the least productive capital; otherwise, less than 1):

$$c_2 = \beta c_1 = \alpha\beta c \qquad (10)$$

Where $\mathbf{c_2}$ is the capital/output ratio corrected in accordance with factor (v).

Finally, since output does not depend exclusively on the contribution of capital, the contribution of the non-capital factors (factor v) is corrected by multiplying $\mathbf{c_2}$ by a actor greater than 1, such that:

$$c_3 = \gamma c_2 = \gamma\beta c_1 = \gamma\alpha\beta c \qquad (11)$$

Where $\mathbf{c_3}$ is the capital/output ratio multiplied by the contribution of the non-capital factor. When all the corrections are incorporated in to (4):

$$y = d_3/c_3 \qquad (12)$$

To state it in another way:

$$y = (\pi\varepsilon/\alpha\beta\gamma)\ (d - d_0)/c \qquad (13)$$

Since this is the lower limit of the expected fall in the output growth rate due to a natural disaster, the interval is expressed as:

$$d_3/c_3 \lesssim y < d/c \text{ (expected loss interval)} \qquad (14)$$

This model enables the estimation of how much investment (or expenditure) should increase to compensate exactly for the expected loss or damage to output. The model includes three additional assumptions:

vi. Since the main purpose of any post-disaster response is to replace capital (reconstruction investment), the contributions made to replace indirect losses (in flows) are limited;

vii. Although reconstruction investment represents autonomous capital expenditure, it nevertheless competes with alternative uses for the resources; and

viii. There has to be sufficient idle capacity in the economy, especially in the construction sector.

Therefore:

$$\Delta \mathbf{Y} = \mathbf{m}\ \Delta \mathbf{KIr} \qquad (15)$$

where **m** is the multiplier, **Ir** is reconstruction investment, **Y** is income (output), **Δ** is the variation and $\mathbf{m \geqslant 1}$. Dividing equation (5) on both sides by **Y**:

$$\mathbf{y} = \mathbf{m}\Delta\mathbf{v} \qquad (16)$$

where $\mathbf{v = Ir/Y}$ is the investment ratio. This means that when $\mathbf{m \geqslant 1}$, for each unit of variation in the investment ratio (v) the output growth rate (y) can be expected to increase by **m**.

If reconstruction work is expected to last for several years, then equation (14) can be made to equal (13) such that:

$$\Delta \mathbf{v} = \mathbf{d_3/mc_3} \text{ (compensatory investment ratio)}$$

The above represents the minimum increase in the investment ratio needed to fully compensate for the expected fall in output growth rate (capital lost or damaged) in the first year following the disaster. It is known as the compensatory investment ratio.

To calculate the minimum compensatory investment required, the following assumption is added to the model:

ix. The new capital is at least of the same quality as the lost capital. In fact, if mitigation and vulnerability criteria are included, it will necessarily be of greater quality.

At the end of the first year, the reconstruction investment ratio for that year $\Delta \mathbf{v_1}$ should be deducted from the damage or total capital loss ratio. The compensatory investment ratio for the second year will now be:

$$\Delta v_2 = \frac{d_3 - \Delta v_1}{mc_3} \qquad (17)$$

In this way, it can be generalized for the following year or derived as a geometrical series.

The series decreases and converges to zero as it tends toward infinity. The significant thing about this approach is that reconstruction can take place over several years without negative consequences for output or sacrificing funds for other development projects. Of course this will depend on the values of the multiplier **(m)**, the corrected capital/output ratio **(c_3)** and the corrected capital damage ratio **(d_3)**. With this, it is easy to demonstrate that the greater the value of the multiplier and the capital/output ratio, the smaller the value of **$1/mc_3$** and the nearer to unity the ratio r. The closer this ratio gets to **1**, the smaller the reconstruction investment required for any particular year.

In the first year, in addition to the investment expenditure, there is a part of total damage which corresponds to current GDP and which must be compensated for once only and at the same time. If the income multipliers are symmetrical and the disaster's impact tends to lead to contraction while the response to the disaster promotes expansion, then the same amount of additional expenditure will be needed to compensate for the loss of current income. Nevertheless, as the impact multipliers are expected to be lower than the response multipliers, compensatory expenditure is only a part of the loss of current income. Therefore, the amount of compensatory expenditure required in the first year would be:

$$\Delta e_1 = (m_1 / m_2)\, d_0 + \Delta v1 \qquad (18)$$

where e_1 is the total first year expenditure ratio, v_1 is the minimum compensatory investment ratio in the first year, d_0 is the current output loss ratio, $\mathbf{m_1}$ is the impact multiplier and $\mathbf{m_2}$ is the response multiplier.

V. EMPLOYMENT AND INCOME

1. Introduction

It is very difficult to quickly gauge a disaster's possible impact on employment and income. One must begin by using the available sources to determine the extent to which the labor force of the affected country or region's employment and income was at risk.

Then the analyst must use field studies to assess the post-disaster state situation of jobs and employment generation in the key sectors of the economy in the affected region. Later, he/she must determine the best time to conduct a much more precise and detailed evaluation while making sure that such painstaking endeavors are completed in time for the results to be delivered to policy makers in charge of drawing up repair and reconstruction plans and programme.[1]

Timely assessments are key to ensuring that policy makers can focus actions on the most affected areas and sectors. The dynamics of employment recovery are not simply a variable of indirect adjustment (i.e., a product of investment in reconstruction); to achieve the greatest impact, programs must take into account where, to what extent and which sectors have been affected. Such an approach is essential for stemming the migratory flows frequently sparked by delays in employment recovery. Such migration tends to contribute to expanding the poverty belts around urban areas and to rendering more precarious the options available to these population groups to undertake their own micro process of family reconstruction, a subject not covered in macroeconomic disaster analysis.

2. Estimation of the overall impact on vulnerable employment

A preliminary response to the problem requires an estimate of the population exposed to disaster damage in terms of employment vulnerability. An approximation may be obtained by comparing data on the economically active population (EAP) of the affected areas against the impact on housing and the population, and with such vulnerability indicators as those measuring poverty, unemployment, and female employment.

The procedure to be followed involves determining the dimensions of the percentage of primary and secondary affected population. This will allow the analyst to ascertain the exposed EAP (those suffering direct loss of employment, reduction in income or a future loss or reduction of income). The exposed EAP is estimated as the total EAP of the affected area, multiplied by the percentage of primary and secondary affected population

1 The timing of such research will depend on the extent of access to and communication with the affected area; furthermore, analysts should avoid bombarding disaster victims with multiple surveys and questionnaires during critical moments of the emergency period.

One must then determine the vulnerable EAP by combining the figure on exposed EAP and the percentage of total poverty or poverty index.

Later, it is necessary to determine the factors aggravating employment and income vulnerability. This requires information on the percentages of female employment, general unemployment and the damage to housing within the affected areas. The population's vulnerability is aggravated by such factors as the specific challenges faced by women workers employed outside the home, the difficulties in finding employment in the post-disaster situation and the economic burden of repairing and reconstructing housing.

The following table presents an example of an analysis of the global impact on employment and income, using the case of the January 13, 2001, earthquake in El Salvador to illustrate how to estimate the economically active population left vulnerable by a disaster.

Table 1

ESTIMATION OF THE ECONOMICALLY ACTIVE POPULATION VULNERABLE TO LOSS OF EMPLOYMENT AND INCOME IN EL SALVADOR AS A RESULT OF THE JANUARY 13, 2001, EARTHQUAKE

	Primary secondary affected popilation	Exposed EAP	Total poverty	Vulnerable EAP	Factors aggravating vulnerability[4]		
					EAP Women	Unemployment	Damaged housing
Departments	%		%		%	%	%
Usulután	96.1	120,230.0	55.8	67,088.0	36.5	8.7	71.3
La Paz	76.0	82,624.0	49.3	40,734.0	38.0	6.3	63.0
La Libertad	21.2	57,093.0	32.9	18,783.0	42.4	6.5	20.4
Sonsonate	21.4	37,151.0	60.5	22,476.0	37.6	7.2	25.9
San Vicente	55.9	33,117.0	39.9	13,213.0	32.3	7.3	64.4
Ahuachapán	21.0	22,884.0	60.3	13,799.0	28.2	8.5	14.3
San Miquel	12.8	22,226.0	44.6	9,912.0	36.4	6.5	11.7
San Salvador	2.0	16,920.0	28.4	4,805.0	45.1	7.0	2.7
Santa Ana	6.9	14,892.0	45.7	6,846.0	36.3	7.7	6.2
Cuscatlán	18.1	14,349.0	39.9	5,725.0	41.8	6.9	20.6
TOTAL		421,486.0		203,381.0			

Source: ILO estimates based on official information and the mission's own estimates.

The above table shows the vulnerable EAP broken down by affected geopolitical unit. The basis for these calculations includes the prior determination of the primary and secondary affected population (as described in the chapter on affected population in Section Two of this Handbook) and the use of the poverty index (usually available in official statistics offices or in the human development reports presented by the United Nations Development Program UNDP). Furthermore, one must obtain information on paid female employment and total unemployment, which is generally contained from in the aforementioned sources. Lastly, the employment analyst must work closely with the team's housing and human settlements specialists to acquire the housing damage assessment.

2 Identifies the sector of the EAP that might have been affected by lost employment, fall in income, and income susceptible to loss or reduction. Estimated as: Total EAP x % of primary and secondary affected population.

3 Identifies the sector of exposed EAP whose poverty serves as a drag on recovery. Estimated as: Exposed EAP x poverty rate.

4 The conditions of working women, the difficulty of finding employment and the economic burden of rehabilitating or reconstructing dwellings aggravate the situation of vulnerability.

3. Estimates of losses of employment and income at the sectoral level

Occasionally it is possible to obtain or develop coefficients linking the volume or value of production lost in each sector with the number of jobs involved, but time constraints usually make such analysis impossible. Therefore, indirect procedures must be used to estimate loss of employment in each affected sector or activity, together with the job implications of reconstruction activities, which tend to expand demand for both skilled and unskilled labor.

Let us look at some examples of how to calculate or estimate employment and income loss for typical productive sectors; the employment specialist need make only minor adjustments to apply the same methodology to other sectors.

a. Micro, small and medium-sized enterprises (MSMEs)

In developing countries, dwellings commonly accommodate a range of productive activities that generate income for their occupants. Therefore, references to “productive homes” are common.

Among the lowest-income population groups, such productive homes may serve as informal markets, wholesale stores, service establishments and so forth. Damage to housing may interrupt such productive activities and lead to the total or partial loss of stocks or product inventories; meanwhile, transportation costs may be greatly magnified when access roads have been blocked or severely damaged. In addition to the resulting loss of sources of employment or income, other population groups run the risk of relative income erosion under the impact of greater costs, reduced supply and price speculation on inputs and basic goods. Thanks to the timely distribution of food aid and relief supplies, price spikes and supply shortages generally do not appear until after the initial emergency stage, generally around the time reconstruction activities get underway. This means the affected population suffers a double penalty or loss as the cost of “family reconstruction” increases.

Estimating the loss of employment or income in this sector requires the availability of basic statistical information (normally available from business surveys of micro, small and medium-sized enterprises) regarding the number of people employed by type of enterprise and the relationship between the number of such enterprises and the housing accommodating them.[5] Sometimes business associations conduct rapid surveys in the aftermath of a disaster to determine the damage suffered by members; ideally, these must be properly directed or at least coordinated by the mission’s employment specialist. The final picture can be filled out by combining the resulting data with the information produced by the housing and human settlements specialist about the number of dwellings damaged or destroyed. To this end, it is necessary to determine the wages paid and estimate the time required for production to recover in each kind of enterprise. Obviously, the employment specialist must cooperate closely with the specialist in productive sectors to produce these estimates.

5 For example, 1.5 employees per subsistence and simple-accumulation microenterprise; 3.5 employees per broad accumulation microenterprise; 25 employees per small enterprise. Moreover, statistics show that in this case there is one such enterprise for every 20 dwellings.

Our estimate example yields the following results:

- An average of 1.82 jobs per establishment in the 11 820 housing units destroyed that housed enterprises = 21 500 lost jobs;

- Thirty percent of jobs lost per establishment in the 20 218 damaged housing units that accommodate enterprises = 11 040 lost jobs;

- An additional 25% of jobs put at risk in the damaged 20 218 units = 9 200 jobs at risk;

- In the 30% of the establishments destroyed that are to be rebuilt in a three-month period, workers lose an average of 1.5 months' wages/income. In the 40% of establishments to be rebuilt in six months, workers lose an average of 4.5 months' income; in the 30% of establishments that are to be rebuilt after six months, income is lost during the first six months while income falls an average of 25% in the succeeding year. At a rate of one legal monthly minimum wage of 144 dollars, lost income totals 16 254 000 dollars.

- Fifty percent of establishments damaged are repaired in the first six months, with an average loss of three months' wages per employee; the remaining 50% are repaired in the following six months, with an average loss of six months per worker. Combining these figures with the same legal minimum wage, we arrive at a total loss of income of 7 153 900 dollars.

The mission thus estimated that 32 540 jobs were lost and another 9 200 jobs are at risk, implying approximately 23.4 million dollars in lost income in the period of six to 18 months required for establishments to be repaired. The scope of the impact on women can be inferred as they accounted for 65% of those employed in the sector. The following table summarizes the results of the previous estimates, with losses broken down by geopolitical division.

Table 2

IMPACT ON THE EMPLOYMENT AND INCOME OF WORKERS IN MSMEs AFFECTED BY THE JANUARY 13, 2001, EARTHQUAKES IN EL SALVADOR

	Enterprises destroyed	Enterprises damaged	Jobs lost	Jobs at risk	Loss of wages, US$
Usulután	3,880	3,398	8,345	2,359	6,117,887
La Paz	2,853	3,668	7,557	2,137	5,485,730
La Libertad	1,985	1,633	4,936	1,396	3,624,167
Sonsonate	1,404	2,242	1,852	524	1,270,555
San Vicente	477	3,801	3,047	862	2,071,840
Ahuachapán	87	440	351	99	242,233
San Miguel	582	2,510	2,975	841	2,066,072
San Salvador	175	842	1,020	288	702,281
Santa Ana	128	156	335	95	242,935
Cuscatlán	229	1,265	1,257	355	864,864
TOTAL COUNTRY			32,540	9,200	23,407,920

Sources: 99 Survey of homes (unpublished), 1998 Directory of establishments, 2001 CONAMPYE report, and ILO estimates based on the mission's complementary figures.

b. Agricultural sector

The impact on employment in the agricultural sector comprises two factors. The first consists of losses in production and farmland, as well as damage to infrastructure. The second has to do with a combination of indirect factors, such as the farm workers losing access to housing when farm work is suspended or partially curtailed.

The number of jobs lost in each agricultural productive activity must be inferred from the shortfall in production resulting from the disaster. This information is normally obtainable from agriculture ministries.

The figures above must be combined with the estimated recovery period and the impact on wage levels for each activity.

It is not possible to directly measure the impact on wages, making it very difficult to arrive at an estimate of jobs at risk in this sector.

The El Salvador mission made the following job-loss estimates:

- Coffee picking, 2 015 jobs;
- Work in coffee processing plants, 630 jobs;
- Artisan fishing, 1527 jobs;
- Irrigation districts, 1 240 jobs; and
- Dispersed small irrigation systems, 215 jobs.

The following recovery estimates were made in line with the opinions of experts and local authorities:

- Twelve months for coffee picking, which in this case actually represents the period required for migrating other labor sectors, as non - disaster factors are expected to prevent a full recovery of activity;

- Six months for the repair of the coffee processing plants that were severely damaged, three months for those that were seriously damaged, and no impact for those that suffered less significant damage;

- Three months for the return of biomass to areas accessible to artisan fishermen, and to repair the sector's infrastructure; and

- Three months to repair irrigation districts and small irrigation systems.

Taking into account the wages paid in each activity, it was possible to estimate losses from the January 13, 2001, earthquake in El Salvador totaling 4 716 jobs and 2.9 million dollars in income (see the geopolitical distribution of these losses in the following table).

Table 3

EMPLOYMENT AND INCOME LOSSES IN THE AGRICULTURAL SECTOR CAUSED BY THE JANUARY 13, 2001, EARTHQUAKE IN EL SALVADOR

Department	Totals		Irrigation districts		Small irrigation		Coffee processing plants		Coffee plantations		Fishing	
	Jobs	1,000 US$	Jobs	1,000 US$	Jobs	1,000 US$	Jobs	1,000 US$	Jobs	1,000 US$	Jobs	1,000 US$
National total	4,716	2,859	1,840	795	235	102	630	467	484	836	1,527	660
Usulután	1,166	571	515	223			70	52	35	60	546	236
La Paz	7	12							7	12		
La Libertad	2,691	1,687	1,325	572	76	33	440	320	305	527	545	235
Sonsonate	549	282			45	19	50	43	18	31	435	188
San Vicente	9	16							9	16		
Ahuachapán	165	94			114	49	50	43	1	2		
San Miguel	1	2							1	2		
San Salvador	20	9					20	9				
Santa Ana	108	187							108	187		

Source: ILO and ECLAC estimates based on official figures and own calculations

The examples above, taken from two key economic sectors in a developing country, provide guidelines on how to estimate disaster-related employment and income losses. In light of the huge variety of effects produced by different disasters, employment specialists –in close cooperation with housing and productive sector specialists– should adapt the procedures outlined here to specific situations.