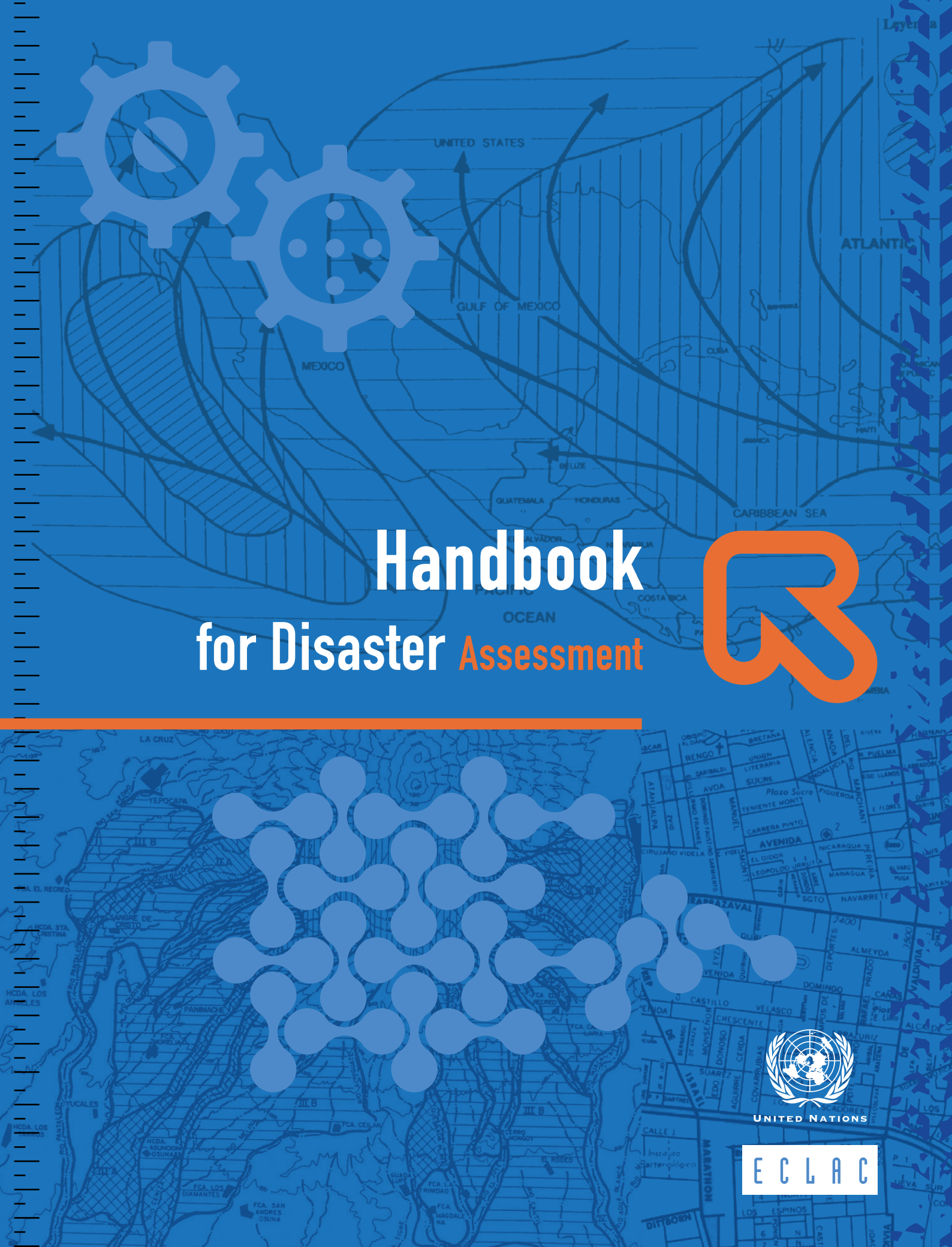
Handbook for Disaster Assessment



Handbook
for Disaster Assessment

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Contents

Foreword

The Economic Commission for Latin America and the Caribbean (ECLAC) has been a pioneer in the field of disaster assessment and in the development and dissemination of a disaster assessment methodology. Its approach involves estimating the effects of a disaster on assets (damage) and economic flows (losses and additional costs) and takes account of the economic, social and environmental impacts of disasters.

ECLAC studies in this area respond to the need to estimate the financial costs of a disaster with a view to determining the amount of sector-specific funding needed for recovery and reconstruction efforts (including risk-prevention measures) to restore a country or a region to its pre-disaster situation.

Since the earthquake that struck the Nicaraguan capital Managua in 1972, ECLAC has taken part in more than 90 assessments of the social, environmental and economic effects and impacts of disasters in 28 countries in the region (including 15 of the 20 most devastating disasters to hit Latin America and the Caribbean in the past 40 years) which were responsible for around 310,000 deaths and affected the lives of 30 million people, and caused damage estimated at US$ 213 billion (at 2000 prices).

In 1991 the experience gained by ECLAC in disaster assessment was compiled in the first edition of its disasters manual, coordinated by Roberto Jovel. The World Bank subsequently adopted the ECLAC methodology in countries outside Latin America and the Caribbean, and it has now been used in 40 countries on other continents, mainly Africa and Asia. A second edition was published in 2003, under the supervision of Ricardo Zapata, which helped transmit this methodology and other relevant expertise to governments in the region.

The methodology is again updated in this third edition, entitled *Handbook for Disaster Assessment*, which was prepared as a joint effort between various divisions of ECLAC and with the active collaboration of the Pan American Health Organization (PAHO). The project was partially funded from valuable contributions from the Japan International Cooperation Agency (JICA) and the United Nations Development Account Programme.

This new handbook strengthens procedures for estimating the effects and impacts of disasters and provides an integral accounting approach to bring them together into a coherent picture, distinguishing between losses and additional costs and with due account of linkages between different sectors of the economy. It also addresses cross-cutting issues such as gender and the environment.

The first section of the handbook covers conceptual aspects of disasters and the basis for the methodology for estimating their effects. Section II concerns how to quantify the effects of disasters on the various sectors in society, while the third section deals with quantifying the effects on infrastructure and the fourth focuses on the production sectors. The final section discusses the cross-cutting consequences of disasters, such as their impacts on macroeconomic variables, the different effect they have on men and women owing to underlying gender relations in society and their specific environmental consequences.

We believe that this handbook, like its previous editions, will prove to be an invaluable reference tool for policymakers, experts and civil society in what is a vulnerable region, susceptible to the vicissitudes of nature. It is of vital importance that this condition of the region, quite apart from its identity, is recognised in policymaking in the relevant fields.

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Part I
Methodological and conceptual aspects

I. Disasters and the measurement of their effects and impact

A. Introduction

Disasters are a consequence of natural phenomena unleashing processes that lead to physical damage and the loss of human lives and capital, while also disrupting the lives of communities and individuals and the economic activity of the territories affected. Recovery from such events requires action by governments and, in many countries, external resources without which it would probably not take place.

When formulating and estimating the financial requirements of a recovery and reconstruction strategy, it is essential to have quantitative information on the effects and impact of the disaster and estimates of the economic cost it represents. A general description of the impact of disasters and quantification and valuation of the damage, losses and additional costs they entail provide a gauge of what resources are essential for re-establishing the functionality of economic and social activities and for making the investments needed to enhance the resilience of physical, economic and social infrastructure against future such events, with a view to reducing vulnerability in the long term.[1]

The methodology of the Economic Commission for Latin America and the Caribbean (ECLAC), the first edition of which was published in 1991, offers a way of going about the estimation of the economic impact of natural disasters in order to support reconstruction and risk reduction efforts. It was first used in 1972 when the impact of the Managua earthquake was estimated, and over 90 reports have now been produced in 28 countries of the region.[2] The studies carried out have not only provided monetary estimates of sectoral damage and losses and the potential macroeconomic effects, but also reflect the diversity of the impact scenarios that tend to arise in the wake of a disaster. Some aspects that are important for differentiating the repercussions of a disaster, both immediately and in the short term, are: the scale of the impact in economic, spatial and demographic terms, the value of the capital exposed to damage, the institutional development of countries and the size and resilience of the economies affected.

Most of the disasters studied by ECLAC have been of climatic (meteorological and hydrological) or geophysical origin. Between 1972 and 2011, they were responsible for 309,742 deaths, with a further 30 million or so people

1 These concepts are explained in chapter II.
2 The methodology has also been applied in 40 countries in other regions.

affected, and their total economic effect amounted to approximately US$ 213 billion in real terms,[3] comprising US$ 150 billion in damage and US$ 63 billion in losses.[4]

The sectoral impact of a disaster has been found to differ depending on the type of hazard giving rise to it, its intensity and the characteristics of the subregion affected, something that is brought out by contrasting the relative distributions of damage and losses between social, production and infrastructure sectors.

Section B of this chapter discusses the origin and effects of disasters by characterizing different types of natural and socio-natural events and their close relationship with conditions of physical, social, economic and environmental vulnerability prior to their occurrence. Section C provides a typology of disasters based on the event giving rise to them, described in accordance with internationally available statistical data. Section D gives the sectoral profile of the disasters that have affected Latin America and the Caribbean. Lastly, section E discusses the short- and medium-term effects of disasters dealt with in the literature and the findings of ECLAC studies.

B. The origins of natural disasters

Natural disasters derive from a combination of two factors: (a) natural phenomena capable of unleashing processes that lead to physical damage and the loss of human lives and capital, and (b) the vulnerability of individuals and human settlements. These events disrupt the living conditions of communities and individuals and the economic activity of countries. While some originate in violent or unexpected phenomena such as earthquakes, others such as droughts are slow to develop or evolve but still negatively affect societies and economies and, depending on their intensity and duration, may eventually affect food supplies or essential services (ECLAC, 2004).

All nations are exposed to extreme natural events to a greater or lesser degree. Their effects do not always result in a disaster, however. This happens when a natural event meets conditions of vulnerability. Natural phenomena with the potential to cause destruction to a territory are identified as hazards.[5] Vulnerability is a precondition (which becomes manifest during the disaster) and at the same time an indicator of the exposure of capital and the ability of individuals, households, communities and countries to tolerate and recover from damage.

The destruction of physical assets and deterioration of the means of subsistence for much of the population are immediate and direct consequences of disasters. Nonetheless, there is a relationship between the extent of the impact and the problems suffered by countries in different spheres (social, political, environmental, sanitary, financial, etc.) that may impair their resilience and response capacity and negatively affect progress. The purpose of disaster risk management is to put advance measures in place to forestall negative effects and proceed effectively in the post-disaster recovery stage with mitigation actions that reduce future hazards.

There is no direct association between a natural phenomenon and the occurrence of a disaster. The former becomes a disaster hazard if a society is susceptible to its potential damage.[6] Floods, for instance, are a natural hazard when a society has a propensity to suffer social and economic losses and damage from them; in other cases, like that of the Nile, annual flooding is essential to the operations of the human settlements located on the banks (Andean Development Corporation, 2004; Gómez and Izquierdo, 2008).

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3 Damage and economic losses were originally estimated in millions of current dollars, but were converted into millions of real dollars at 2000 prices using the International Monetary Fund (IMF) global price index [online] http://www.imfstatistics.org/imf/. Hereinafter, figures in dollars refer to real dollars at 2000 prices.

4 See Bello, Ortiz and Samaniego (2012).

5 A physical event such as a volcanic eruption that does not affect human beings is usually treated as a natural phenomenon and not a natural hazard. Conversely, a natural phenomenon that occurs in a populated area is a dangerous event and thus constitutes a natural hazard. This latter concept is defined as those elements in the environment that are dangerous to man and caused by forces external to it (Burton, Kates and White, 1978).

6 Some studies of natural phenomena reveal significant differences in destructive potential, which depends on certain influences. These include intrinsic characteristics, such as type, intensity, duration and periodicity. Others are extrinsic circumstances of time and place. On top of this come multiple variables that contribute to a disaster occurring at a given time. It is preferable not to use the term disaster merely for a phenomenon that produces damage. Evaluation of the consequences and knowledge of the response capacity of the community affected are essential for ascertaining whether or not a disaster has taken place (USAID, 2007).

There are also cases where a community is confronted with different natural hazards occurring simultaneously or within a very short time of each other. This is illustrated by the situation that arose in the capital of El Salvador in 2005, when the eruption of the Ilamatepec volcano coincided with Tropical Storm Stan, and by events in Guatemala City in 2010, when Tropical Storm Agatha coincided with the eruption of the Pacaya volcano.

It is not easy to draw the line between a disaster hazard that is exclusively natural and one that is socio-natural in character. Studies of disasters suggest that a great many hazards are the result of interaction between natural events and environmental conditions that have been degraded by human action (Blaikie and others, 1994). A paradigmatic example of socio-natural hazards of this type are climate events and the environmental alterations expected as a consequence of global climate change induced by the atmospheric concentrations of carbon dioxide resulting from human activity. In other cases, environmental degradation results from the alteration of soils by deforestation, repeated monoculture or residential use, increasing the likelihood of landslides or flooding in the event of an earthquake or torrential rain.[7]

Besides environmental conditions that increase risk and trigger new hazards, analysis of disasters in different economic and social contexts has shown that they often arise not only because there is a natural hazard, but also because of the workings of social, economic and institutional processes such as poverty, social inequality, economic underdevelopment and warfare (ECLAC, 2000). This is confirmed when the consequences of disasters in economic and institutional contexts with a considerable social and economic response capacity are compared with those occurring in contexts that do not have adequate protection and prevention mechanisms to forestall, reduce or control damage. An example that illustrates these differences is the effective response to hurricanes by those living along the Miami coasts and the severe social and economic consequences these natural events bring in their wake in Central America, sometimes exacerbated by social conflict (Gómez, 2001).

Having reviewed and analysed disasters in very different economic and social contexts, Blaikie and others (1994) argue that while these originate in a natural phenomenon, the scale of the impact depends on the fragility of existing physical, social and economic conditions in the entities exposed to the damage. The theoretical and conceptual literature on disasters terms these conditions "disaster vulnerability" (see box I.1).

Box I.1
The concept of disaster vulnerability

Vulnerability is a concept that has been extensively studied in relation to disasters. Originally, it was identified with the geographical exposure of human settlements to natural hazards beyond human control (Cutter and others, 2009). Since 1970, economic and political elements have also been introduced into the disaster vulnerability concept, and institutional and economic fragility has been identified as one cause of the rise in disasters (O'Keefe and others, 1976).

There is now a consensus that vulnerability is a precondition and that natural phenomena are usually not the active element that determines disasters but the "trigger" for existing critical situations of insecurity and fragility that lead to a disaster (García, 1993). Consequently, disasters are not so much physical phenomena as social phenomena whose ill effects could be prevented and mitigated and their impact thus reduced or at least controlled.

Disaster vulnerability is thus constituted by the characteristics and circumstances of a community or system —by whatever makes them susceptible to the harmful effects of a hazard of natural origin. Vulnerability is usually taken to include potentially dangerous external processes, such as climatic and geographical exposure to natural hazards, and internal factors of economic, social, institutional and environmental exposure to damage, including shortcomings in disaster resilience and response capacity.

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of Piers Blaikie and others, At Risk: *Natural Hazards, People's Vulnerability and Disasters*, Routledge, 1994; Frederic Cuny, *Disasters and Development*, Oxford University Press, 1983; Susan Cutter and others, "Social vulnerability to climate variability hazards: a review of the literature", *Final Report to Oxfam America*, Hazards and Vulnerability Research Institute, University of South Carolina, Columbia, 2009; "Social vulnerability to environmental hazards", *Social Science Quarterly*, vol. 84, No. 2, 2003; "Revealing the vulnerability of people and places: a case study of Georgetown County, South Carolina", *Annals of American Geographers*, vol. 90, No. 4, 2000; Gilberto Gallopín, "Linkages between vulnerability, resilience, and adaptive capacity", *Global Environmental Change*, vol. 16, No. 3, 2006; Virginia García, "Enfoques teóricos para el estudio de los desastres naturales", *Los desastres no son naturales*, Andrew Maskrey (comp.), Red de Estudios de Prevención de Desastres en América Latina/Intermediate Technology Development Group (ITDG)/Tercer Mundo Editores, 1993; José Javier Gómez, "Vulnerabilidad y medio ambiente", paper presented at the international seminar "The different expressions of social vulnerability in Latin America and the Caribbean", Santiago, Chile, 20 and 21 June, Economic Commission for Latin America and the Caribbean (ECLAC), 2001; Phil O'Keefe and others, "Taking the naturalness out of natural disasters", *Nature*, No. 260, 1976; and United Nations, *Terminology on Disaster Risk Reduction*, Geneva, International Strategy for Disaster Reduction, 2009 [online] http://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf.

[7] Two disasters that illustrate this type of hazard are the partial destruction of the La Colina area of Santa Tecla in the Greater Metropolitan Area of San Salvador when the 2001 earthquake triggered a landslide in a highly deforested area, and a landslide that brought down 20,000 cubic metres of earth in the Villatina area of Medellín, Colombia, in 1987.

The studies carried out by Blaikie and others (1994), Cutter and others (2000, 2003 and 2009) and García (1993) are in agreement regarding the factors of vulnerability that repeatedly contribute to disasters: poverty, which is closely related to a country's level of economic development; urban expansion into areas at high risk of flooding and landslides; lack of building standards and financial precautions against disasters; heavy economic dependence on agriculture that is highly exposed to climate variations and hurricanes; increasing degradation of the environment, both locally and globally; and the presence of large-scale processes that range from the deforestation of particular territories to climate change, which is responsible for the rise in the sea level and major shifts in rainfall patterns all over the globe. Annan (1999) has also emphasized the importance of these factors in determining disaster risk, pointing out that they are themselves just one more consequence of the unsustainable development prevailing in many countries (see box I.2).

Box I.2
An increasing vulnerability to natural disasters

Human communities will always have to face natural hazards, whether floods, droughts, storms or earthquakes. But today's disasters owe as much to human activities as to the forces of nature. Indeed the term "natural" is increasingly misleading.

Ninety per cent of disaster victims worldwide live in developing countries, where poverty and population pressures force growing numbers of people to live in harm's way —on flood plains, in earthquake-prone zones and on unstable hillsides. The vulnerability of those living in risk-prone areas is perhaps the single most important cause of disaster casualties and damage.

Unsound development and environmental practices exacerbate the problem. Massive logging operations and the destruction of wetlands reduce the soil's ability to absorb heavy rainfall, making erosion and flooding more likely. Many scientists believe that the recent upsurge of weather-related natural disasters is the product of increased global warming, much of which is caused by human activity.

Above all we must never forget that it is poverty, not choice, that drives people to live in risk-prone areas. Equitable and sustainable economic development is not only a good in its own right, but also one of the best forms of disaster insurance.

Source: Kofi Annan, "An increasing vulnerability to natural disasters", *The International Herald Tribune*, 10 September 1999.

C. Disaster types and the geographical areas affected

While disasters arise out of a complex web of effects generated by natural phenomena interacting with existing conditions of social, economic and environmental vulnerability, they are usually classified by the characteristics of the natural hazard giving rise to them, in respect of the type of phenomenon, the way it appears (unexpectedly, as with earthquakes, or with warning, as with hurricanes) and its duration (short, medium or long).

One of the classifications most often used is the United Nations International Strategy for Disaster Reduction (UNISDR, 2009), which groups disasters into four categories, depending on whether they arise from: (1) internal earth processes, (2) external earth processes, (3) hydrometeorological hazards or (4) biological hazards (see box I.3).[8]

The first group covers geophysical phenomena arising from the internal processes of the earth, such as earthquakes, tsunamis and volcanic eruptions, which human beings cannot usually predict or prevent. The second group is usually classified as geophysical as well, but the phenomena it comprises, such as landslides, collapses and sometimes flooding and mudslides, are hazards that could be avoided and are often associated with man-made alterations in the environment, such as deforestation on hillsides or excavations and earth movements in sloping areas for the siting of new residential developments.

[8] Another frequently used classification is that of the Emergency Events Database of the Centre for Research on the Epidemiology of Disasters (EM-DAT/CRED), which distinguishes five groups of natural phenomena (geophysical, meteorological, climatological, hydrological and biological), with disasters being broken down into 12 types and 30 subtypes. This classification has the advantage of providing greater differentiation of disasters originating in meteorological, climatological and hydrological phenomena, three hazards with very different consequences. The EM-DAT/CRED classification is also used for the natural disaster database of the same name, which is the most exhaustive international disaster database.

The third group is associated with changes in air and ocean temperature responsible for the formation of weather phenomena such as hurricanes and tornadoes, and the precipitation and climate variations that sometimescause extreme flooding, storm surges, droughts and other hydrological phenomena. This group includes the recurrent hazards caused by the atmospheric and oceanographic changes that occur cyclically in the Pacific over periods of three to eight years, known as El Niño-Southern Oscillation. These cause changes in sea temperature that in turn alter rainfall patterns and produce flooding and droughts, mainly in coastal countries (in Latin America, this means particularly the Andean and Meso-American countries).

Box I.3
Classification of disasters by originating phenomenon type

1. Disasters caused by dynamic processes within the earth:
   - **a) Earthquakes** - Movements of the earth's crust that produce powerful distortions in the rocks within the earth, with an accumulation of energy that is suddenly released as waves that shake the earth's surface.
   - **b) Tsunamis** - Movements of the earth's crust beneath the ocean so that high waves form and spread.
   - **c) Volcanic eruptions** - The movement of material (magma), ash and gases from the interior of the earth to the surface.
2. Disasters caused by dynamic processes on the earth's surface:
   - **a) Landslides** - Caused by sudden or gradual changes in the composition, structure, hydrology or vegetation of a sloping area of land.
   - **b) Collapses** - The collapse of a section of land that has become unstable or of a man-made structure.
   - **c) Avalanches** - Masses of snow sliding downhill.
   - **d) Debris flows** - Flows of large volumes of mud, water, ice or rocks caused by a lake bursting its banks or a slippage of snow.
   - **e) Huaycos** - Mud and rocks washed away by rain and turning into a flash flood of muddy water that runs at great speed along dry gullies where little water normally flows, sweeping stones and tree trunks with it.
3. Disasters caused by hydrometeorological phenomena:
   - **a) Floods** - Slow or violent incursions of water from rivers, lagoons or lakes as a result of heavy precipitation or the bursting of dams, causing considerable damage. They may be slow or gradual on level ground and violent or sudden in steep mountainous areas.
   - **b) Droughts** - Lack of moisture in the atmosphere as a result of irregular or inadequate rainfall or poor use of ground water, reservoirs or irrigation systems.
   - **c) Frosts** - Atmospheric phenomena caused by low temperatures and causing damage to plants and animals.
   - **d) Storms** - Atmospheric phenomena caused by electrical discharges in the atmosphere.
   - **e) Hail** - Precipitation in the form of solid drops of ice.
   - **f) Tornados** - Hurricane-force winds that move in a gyratory pattern at high speeds.
   - **g) Hurricanes** - Winds that exceed 24 km/h as a consequence of interaction between warm, moist air from the Pacific Ocean and cold air.
4. Disasters of biological origin:
   - **a) Plagues** - Calamities produced in crops by certain animals.
   - **b) Epidemics** - The spread of infectious diseases among large numbers of people in particular places.

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of United Nations, *Terminology on Disaster Risk Reduction*, Geneva, International Strategy for Disaster Reduction (UNISDR), 2009 [online] http://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf.

Biological disasters result from the proliferation of agents such as bacteria, viruses and toxins that can kill or disable people, harm animals and crops and damage the environment. Some examples of biological hazards are cholera, dengue, yellow fever, Ebola virus and Marburg virus.

Classifications are usually limited in order to properly capture the differences between natural and socio-natural disasters and do not clearly reflect chain reactions or the cumulative effects that tend to arise in major disasters or when consequences carry over from earlier events (Gómez, 2001). However, their use has made it possible to systematize information on disasters and the production of statistics on geographical exposure, making a substantial contribution to the identification of global impact patterns.

Disaster statistics are mainly based on information from governments, humanitarian aid organizations and, in some cases, newspapers. Internationally, the three most important data sources[9] are the EM-DAT International Disaster Database, compiled by the Centre for Research on the Epidemiology of Disasters (CRED) and the United

[9] Other sources of data on disasters are: the Global Disaster Identifier Number (GLIDE) system, an open standard that is easy to access and free of charge for anyone interested in disaster information; the Inter-American Development Bank (IDB) indicators of disaster risk and risk management, which provide country-by-country reports with relevant statistical data on natural disasters; the DesInventar disaster information management system, a conceptual and methodological tool for constructing databases of losses, damage or effects caused by emergencies or disasters, covering 28 countries; and Preventionweb.net Disaster Data & Statistics, an information system that uses EM-DAT/CRED, the United Nations International Strategy for Disaster Reduction (UNISDR), Munich Re and DesInventar as its primary sources.

States Office of Foreign Disaster Assistance (OFDA), and the databases of the insurance companies Munich Re[10] and Swiss Re.[11]

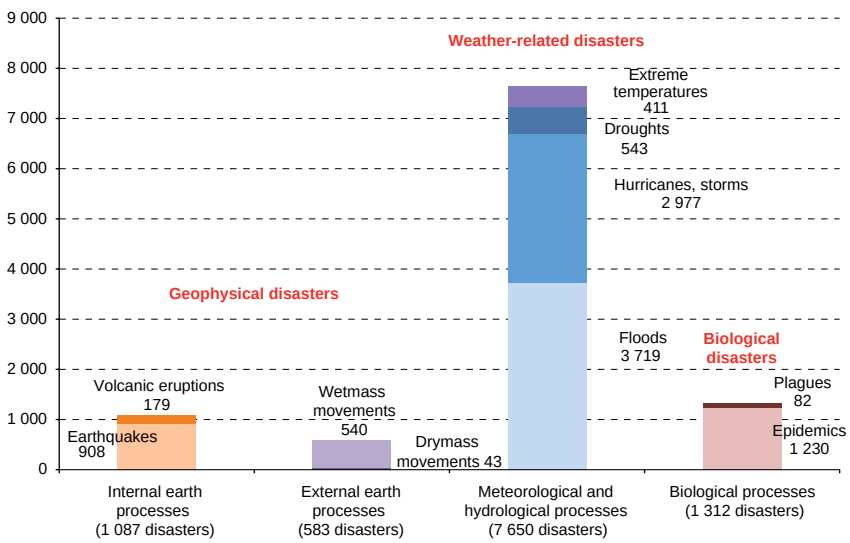
Disaster inclusion criteria differ from source to source (see box I.4). The EM-DAT International Disaster Database has the widest geographical coverage and the most detailed information about the type of hazard giving rise to the disaster. However, none of the sources has adequate indicators for a thorough analysis of the economic and social effects and impact of disasters. For this, recourse has to be had to case studies controlled for hazard type and geographical region, like those carried out around the world by different academic research centres (Benson, 1997a, 1997b and 1997c; Benson and Clay, 2000 and 2001; Murlidharan and Shah, 2001). ECLAC carries out many of these studies in Latin America and the Caribbean (ECLAC, 1991, 2000 and 2010a; Zapata and Madrigal, 2009).

According to the data available in the EM-DAT classification, most disasters around the world between 1970 and 2011 were of meteorological and hydrological origin (7,650), most being caused by floods (3,719) and hurricanes and storms (2,977). Earthquakes and volcanic eruptions were responsible for 1,087 disasters (see figure I.1).

Disasters affected every region of the planet in that period, but Asia was the most exposed of any continent with 4,185 of the 10,632 events recorded. It was followed by the American continent, including the Caribbean, and Africa, with 2,537 and 2,109 disasters, respectively (see figure I.2a).

In the Americas, including the Caribbean, the subregions most exposed to disasters were North America and South America, where 29% and 33%, respectively, of all disasters took place (see figure I.2b). In these subregions, as elsewhere in the Americas, meteorological and hydrological events were the main causes of disasters. Flooding was the main cause of disasters in South America, including Brazil, and Central America, while in North America, the Caribbean and Mexico it was hurricanes, which were also the second-greatest cause of disasters in Central America (see table I.1).

Figure I.1
Distribution of disasters worldwide, by originating event type, 1970-2011
(Number of disasters)

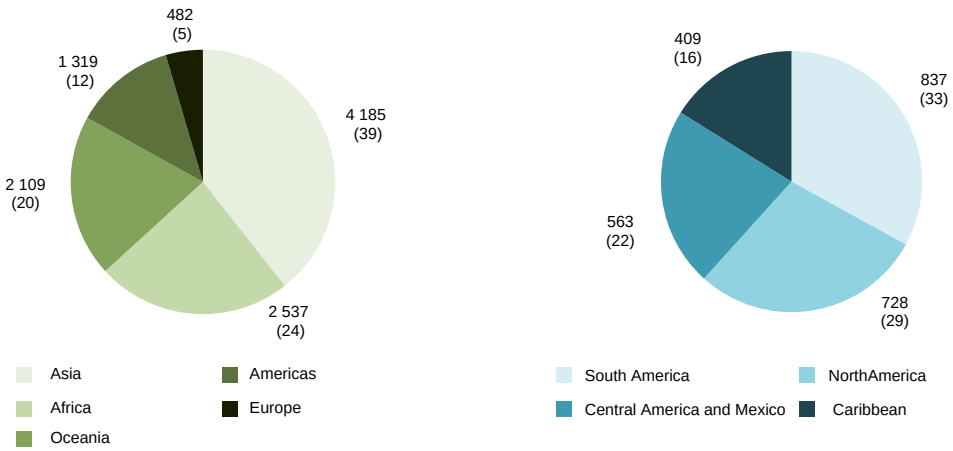


Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of data from the Centre for Research on the Epidemiology of Disasters (CRED)/United States Office of Foreign Disaster Assistance (OFDA), EM-DAT International Disaster Database.

[10] Munich Re has developed the NatCatService database [online] http://www.munichre.com/en/reinsurance/business/non-life/georisks/natcatservice/annual_statistics.aspx.
[11] Swiss Re has developed Sigma [online] http://www.swissre.com/sigma/.

The Latin America and Caribbean region is highly exposed to meteorological and hydrological phenomena, but at the same time all areas of the continent are exposed to geophysical phenomena (earthquakes and volcanic eruptions), which were responsible for about 367 disasters in the region between 1970 and 2011.

Figure I.2
Distribution of disasters worldwide, by region affected, 1970-2011
(Absolute numbers and percentages)



Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of data from the Centre for Research on the Epidemiology of Disasters (CRED)/United States Office of Foreign Disaster Assistance (OFDA), EM-DAT International Disaster Database.

The areas most exposed to earthquakes and volcanic eruptions are the Pacific seaboards of Central America, Mexico and South America located in the so-called "ring of fire". About 10% of disasters in the South American subregion and 12% in Central America between 1970 and 2011 were due to earthquakes and about 5% to volcanic eruptions (see table I.1). In Mexico, earthquakes were responsible for 12% of geophysical disasters and volcanic eruptions for 4%.

Mass movements, landslides and avalanches were primarily responsible for disasters of geophysical origin in South America, including Brazil (see table I.1).

Table I.1
The Americas: disasters by region and originating event type, 1970-2011
(Percentages)

Hazard		North America	Central America	Mexico	Caribbean	South America
Geophysical	Earthquakes	3.4	11.5	12.2	2.4	9.8
	Mass movements	0.5	4.4	5.1	1.2	13.4
	Volcanic eruptions	0.3	5.2	4.1	2.0	3.7
	Total	4.3	21.0	21.3	5.6	26.9
Meteorological and hydrological	Hurricanes and storms	64.6	23.0	38.1	57.9	8.1
	Flooding	24.5	38.3	27.9	27.6	45.9
	Droughts	1.6	7.1	3.6	4.9	5.7
	Extreme temperatures	3.7	1.4	7.6	0.0	5.0
	Total	94.4	69.7	77.2	90.5	64.8
Biological	Epidemics and plagues	1.4	9.3	1.5	3.9	8.4
	Total	100.0	100.0	100.0	100.0	100.0

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of data from the Centre for Research on the Epidemiology of Disasters (CRED)/United States Office of Foreign Disaster Assistance (OFDA), EM-DAT International Disaster Database.

Box I.4
Sources of international data on disasters

The three main sources of global data on disasters are the EM-DAT International Disaster Database, NatCatService and Sigma.

EM-DAT is a worldwide database maintained and supplied with data since 1988 by the Centre for Research on the Epidemiology of Disasters (CRED), a collaborating unit of the World Health Organization (WHO) belonging to the University of Louvain, which has been collecting country-level data on natural and technological disasters since 1900. In January 1999, a collaboration began between CRED and the United States Office of Foreign Disaster Assistance (OFDA), a unit belonging to the United States Agency for International Development (USAID), with the goal of completing EM-DAT and validating its contents. Since then, the two units have maintained a single database.

For a disaster to be included in EM-DAT, at least one of the following conditions must be met: 10 or more fatalities, 100 or more people affected, declaration of a state of emergency, application for international assistance. The variables recorded for each disaster are: the date the disaster began and ended, the type and subtype of natural event giving rise to it, the number of fatalities, the population affected and the total damage caused by the disaster in millions of dollars at current prices.

The Munich Re insurance company maintains the NatCatService database, and the Swiss insurance company Swiss Re is responsible for the Sigma database. These databases classify event types by different criteria, and so are not strictly comparable with EM-DAT.

The Sigma database records an event as a natural catastrophe if the number of dead or disappeared is greater than 20, the number of injured is greater than 50 or the number affected is greater than 2,000, or if total damage or insured damage exceeds a certain sum.

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of World Bank, *Natural Hazards, Unnatural Disasters. The Economics of Effective Prevention*, Washington, D.C., 2010.

D. Sectoral profile of loss and damage estimates

On the basis of the database of reports on disaster losses and damage studied by ECLAC between 1972 and 2011, Bello, Ortiz and Samaniego (2012) estimated that of the total sums involved by these events, approximately US$ 150 billion (at 2000 prices) was for damage and US$ 63 billion for losses.[12] Most of these disasters were weather-related (meteorological or hydrological) events and geophysical events (mainly earthquakes), which were responsible for 309,742 deaths and affected some 30 million people.

The largest damage estimates were for the earthquakes in Managua (1972) and Mexico City (1985), at US$ 25.833 billion and US$ 25.217 billion, respectively. The highest estimated losses were from the disasters caused by El Niño in Peru, at about US$ 7.6 billion, followed by the Managua earthquake at US$ 6.3 billion.

Analysis of the results of the estimates presented by these authors reveals major differences by sector in the total estimates and the separate loss and damage estimates, which also differ by originating event type and region affected. To show the pattern of disaster costs, the authors took for the analysis a classification that distinguishes as far as possible between the natural event giving rise to the disaster and the characteristics of the subregion in terms of its exposure to natural phenomena, considering spatial and climatic aspects and the population sizes of human settlements for this purpose.[13]

The greatest weather-related disaster damage was caused by extreme precipitation in Central America and by the climate alterations of El Niño in South America, at US$ 3.023 billion and US$ 2.82 billion, respectively. Next came the effects of La Niña in South America, which caused damage amounting to US$ 1.455 billion (see table I.2).

At the sectoral level (see box I.5), the damage caused by weather-related disasters was mainly in the production sector (51.2%) and the infrastructure sector (27.0%). Only 20.1% of damage was in the social sector (see table I.3).

[12] The estimates, which were originally expressed in millions of current dollars, were converted into millions of dollars at constant 2000 prices using the world price index produced by IMF [online] http://www.imfstatistics.org. Accordingly, in this chapter, all references to dollars refer to dollars at constant 2000 prices.

[13] The distinction between phenomena is based on the characterization of the main events causing disasters. The subregions chosen are Central America, Mexico, the Caribbean and South America, four regions that differ in their climate exposure, population size, territory, impact conditions and vulnerability. While earthquakes, volcanic eruptions and landslides are among the main hazards in much of Latin America and the Caribbean, the countries of Central America and the Caribbean are more vulnerable because of the small size of their territories and economies. Mexico, Central America and the Caribbean are in the hurricane zone. The Caribbean islands, most of them small, are affected every year by storms and hurricanes blowing up in the Atlantic. Mexico and Central America are exposed not only to Atlantic storms but also to the recurrent cyclones of the Pacific. In some countries of Central America, storms do not just affect the coastline but cross the whole territory, as happened with Hurricanes Joan and Cesar in Nicaragua and Hurricane Mitch, which affected all the countries (Bello, Ortiz and Samaniego, 2012).

The greatest economic impact on the production sector was from El Niño events in Central America, at 85.6%, followed by the same phenomenon in South America, at 68%. For the Caribbean, the impact profile indicates that the hurricanes and storms mainly affected production (farming and fishing, manufacturing, commerce and services, including tourism), where 45.4% of all damage occurred. It was followed by the social sector, which accounted for 30.2% of the total (see table I.3).

Table I.2
Latin America and the Caribbean: estimated disaster losses and damage, by event type and subregion
(Millions of dollars at 2000 prices)

Origin of the disaster/region of occurrence	Damage	Losses	Average damage	Average losses
All disasters	**140 019.20**	**70 367.89**	**1 609.42**	**748.59**
All weather-related disasters	**60 854.82**	**40 748.08**	**845.21**	**522.41**
Hurricanes and storms-Central America	12 129.63	5 973.75	551.35	271.53
Hurricanes and storms-Caribbean	16 143.47	8 352.73	807.17	417.64
Hurricanes and storms-Mexico	887.95	2 085.68	295.98	695.23
El Niño-Central America	3 542.69	1 065.10	885.67	266.27
El Niño-South America	20 205.44	17 522.53	2 245.05	1 946.95
La Niña-South America	2 464.53	1 183.90	821.51	394.63
Extreme precipitation-South America	4 084.13	2 911.22	680.69	485.20
Extreme precipitation-Caribbean	252.80	188.44	126.40	94.22
Extreme precipitation-Mexico	1 144.17	1 283.00	381.39	427.67
Extreme precipitation -Central America	0.00	181.72		30.29
Drought-Central America				
All geophysical disasters	**78 851.66**	**22 551.44**	**6 065.51**	**1 879.29**
Central America	49 384.88	11 758.28	7 054.98	1 679.75
South America	2 683.53	4 709.21	1 341.77	2 354.61
Caribbean	3 203.40	2 453.47	1 601.70	2 453.47
Mexico	23 579.85	3 630.48	11 789.93	1 815.24
All mixed disasters	**312.71**	**497.95**	**156.35**	**248.98**
Central America	312.71	497.95	156.35	248.98
All biological disasters	**0.00**	**6 570.42**		**3 285.21**
Epidemics	0.00	6 570.42		3 285.21

Source: O. Bello, L. Ortiz and J. Samaniego, "La estimación de impacto económico y social de los desastres naturales en América Latina, 1972-2010", Santiago, Chile, Economic Commission for Latin America and the Caribbean (ECLAC), unpublished, 2012.

The damage caused by La Niña in South America mainly affected the social sector, at 47.7%. The scale of the damage to the social sector was due to the fact that La Niña events in the subregion involve heavy rainfall that causes flooding and landslides, heavily affecting residential and public services infrastructure. A case that illustrates the extent of the housing impact of the climate alterations caused by these events was the flooding resulting from the torrential rains of 2010-2011 in Colombia, where damage to housing represented 77% of all damage in the social sector and 66% of all the damage caused by the flooding.

Environmental damage not captured by the other sectors does not show a definite distribution pattern by event type and subregion affected. As can be seen in table I.3, only damage from disasters caused by hurricanes and storms in Central America was substantial, at 6.9% of all damage.

Average damage from geophysical disasters was much greater than that estimated for weather-related disasters, at US$ 6.745 billion as against US$ 1.079 billion, with the highest averages being for Mexico and Central America, where it is estimated that the damage from earthquakes averaged US$ 12.648 billion and US$ 7.114 billion, respectively (see table I.2).

Table I.3
Latin America and the Caribbean: distribution of damage estimates, by sector, event type and subregion
(Percentages of damage)

Origin of the disaster/region of occurrence	Production sector damage	Social sector damage	Infrastructure sector damage	Environmental damage	Other damage	Total
All disasters	**39.4**	**53.5**	**5.6**	**1.2**	**0.3**	**100.0**
All weather-related disasters	**64.6**	**24.2**	**8.3**	**2.6**	**0.2**	**100.0**
Hurricanes and storms-Central America [a]	49.1	28.9	11.6	10.4	0.0	100.0
Hurricanes and storms-Caribbean [b]	61.8	28.2	8.3	1.6	0.0	100.0
Hurricanes and storms-Mexico	54.7	36.9	7.7	0.7	0.0	100.0
El Niño-Central America	70.1	4.2	25.1	0.2	0.4	100.0
El Niño-South America	85.2	10.8	3.6	0.0	0.4	100.0
La Niña-South America	13.2	84.5	1.1	1.2	0.0	100.0
Extreme precipitation-South America	48.8	39.1	11.0	0.5	0.5	100.0
Extreme precipitation-Caribbean	31.6	1.6	66.7	0.0	0.0	100.0
Extreme precipitation-Mexico	67.1	27.4	5.1	0.4	0.0	100.0
Extreme precipitation -Central America						
Drought-Central America	..	..	..	..	..	..
All geophysical disasters	**20.1**	**75.9**	**3.5**	**0.1**	**0.3**	**100.0**
Central America	21.5	73.4	4.5	0.2	0.4	100.0
South America	32.0	64.5	3.5	0.0	0.0	100.0
Caribbean	11.3	79.6	6.6	0.1	2.4	100.0
Mexico	17.1	82.0	0.9	0.0	0.0	100.0
All mixed disasters	**18.0**	**56.7**	**10.3**	**15.1**	**0.0**	**100.0**
Central America	18.0	56.7	10.3	15.1	0.0	100.0
All biological disasters	**..**	**..**	**..**	**..**	**..**	**..**
Epidemics	..	..	..	..	..	..

Source: O. Bello, L. Ortiz and J. Samaniego, "La estimación de impacto económico y social de los desastres naturales en América Latina, 1972-2010", Santiago, Chile, Economic Commission for Latin America and the Caribbean (ECLAC), unpublished, 2012.
[a] Sectoral estimates of damage for Tropical Depression 12-E in Honduras do not include damage in the education and health subsector, as the figures in the report are not consistent with the overall estimates. In the report, furthermore, only total estimates are presented for the same event in Honduras and Nicaragua.
[b] Sectoral estimates of damage caused by Hurricane David in Dominica in 1979 are for the infrastructure sector alone.

Box I.5
Sectoral classification of damage and losses

Bello, Ortiz and Samaniego (2012) classify estimates of economic damage and losses from disasters using the sectoral breakdown proposed by the ECLAC estimation methodology for the final recapitulation of the impact of a disaster. The impact studies coordinated by ECLAC between 1972 and 2011 usually distinguish four sectors: social, infrastructure, economic (production) and environmental. With this methodology, the monetary value of damage to the social sector includes that affecting social infrastructure, a category which includes housing, health and education infrastructure, urban facilities such as parks and public recreation areas, and damage to public buildings. What is calculated in the infrastructure sector is the monetary value of damage to transport and communications, electricity generating and distribution and water and sanitation infrastructure. For the economic sector (called the production sector in many reports), estimates are made of the damage caused by the event in the agriculture and forestry, industrial, mining, and commerce and services sectors. In addition to the monetary value of damage in each sector, sectoral losses are estimated. The environmental damage and losses included in the final recapitulation are an estimation of the effects on ecosystems (water, soil, woodland and fauna) not included in any of the other sectors. Where estimates of impact on women are concerned, the estimates available have been added, depending on their composition, to the other subsectors, mainly manufacturing, commerce and services and, in the agriculture subsector, backyard economies.

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of *Handbook for Estimating the Socio-Economic and Environmental Effects of Disasters* (LC/MEX/G.5; LC/L.1874), Mexico City, ECLAC subregional headquarters in Mexico, 2004.

Where geophysical disasters are concerned, average damage in the Caribbean subregion has been put at US$ 2.979 billion, owing essentially to the Haiti earthquake of January 2010.[14] The average for South America is US$ 1.436 billion, mainly owing to the estimates for the earthquakes in the Colombian coffee-growing zone in 1999 and Ecuador in 1987, the damage from which was put at US$ 1.74 billion and US$ 1.132 billion, respectively (see table I.2).

Disasters of geophysical origin, mainly earthquakes, have had a substantial effect on the social sector, where 73.7% of all damage is estimated to have occurred. Impacts were much smaller in the production and infrastructure sectors, at 19.4% and 6.5% of damage, respectively. The greatest impact on the social sector is estimated to have been caused by the geophysical events studied in Mexico and the Caribbean, with 76.4% and 79.3%, respectively, of all damage being in this sector (see table I.3).

In Central America, damage to these sectors shows a pattern similar to the one consolidated for the region as a whole, with an estimated 73% of total damage being in the social sector, 22% in the production sector and 5% in the infrastructure sector. In South America, as in the rest of the subregions, capital damage from geophysical events, mainly earthquakes, chiefly affected the social sector (60%). The impact on the production sector was substantially greater there than in the other subregions, however (30%). In the Caribbean, conversely, damage in the infrastructure sector was more to the fore, as its share of 14% was more than double that estimated for the sector in Central America and South America and far above the 7.7% or so estimated for Mexico (see table I.3).

Average loss estimates, like damage estimates, are usually higher for geophysical than for weather-related events. If the latter are analysed, the highest average loss estimate is for El Niño in South America, at US$ 1.899 billion (see table I.2).[15]

Average losses from geophysical disasters in the Caribbean are estimated at US$ 2.453 billion, followed by those in South America and Mexico, with estimates averaging US$ 2.334 billion and US$ 1.813 billion, respectively.

Total losses, unlike total damage, are mainly concentrated in the production sector (70.2%), with lower shares for infrastructure (15.8%) and for the social sector, in which they account for a much smaller portion (12.6%) than damage does (see tables I.3 and I.4).

For weather-related events, the highest concentrations of losses were in the production sector in South America: 85.5% of El Niño losses were in this sector. Production also suffered serious losses from extreme precipitation in Mexico, 81.5% of which were in the sector.

Hurricanes and storms in the Caribbean subregion and disruptions from El Niño and La Niña in South America likewise caused disasters with major impacts on the production sector. In the first case, losses accounted for a share of 81.9% and derived from the impact of storms and hurricanes on tourism in the Caribbean islands, which is commerce- and services-intensive (see table I.4). In the second case, 83% of losses derived from the effects of El Niño and La Niña on agriculture.

With the exception of the estimated losses caused by extreme precipitation in Mexico and El Niño in South America, losses are put higher in the infrastructure sector than in the social sector in all regions, with the largest share being recorded for the Caribbean (38%), owing to the heavy flooding and landslides of 2003 in the Dominican Republic.[16] In Central America, the share of losses from drought in the infrastructure sector was about 32.3%, mainly because of the drop in hydroelectric output caused by events of this type throughout the subregion. Not only did recurrent droughts have a substantial effect on the infrastructure sector in Central America, but storms and hurricanes and El Niño effects also generated losses in the sector exceeding a fifth of the total.

Analysis of geophysical disasters shows that losses in the region as a whole were concentrated in the production sector (55.6%) and the social sector (29.5%). In South America, the production sector accounted for 94% of the total. In Central America and the Caribbean, conversely, the greatest losses were in the social sector, at 51% and 40%, respectively.

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[14] Damage and loss estimates were carried out for two earthquakes in the Caribbean subregion: the one in Haiti in 2010, the damage from which was put at US$ 2.66 billion, and the one in Antigua and Barbuda in 1974, with damage estimated at US$ 544 million.

[15] The largest losses in the subregion were in Peru and were associated with the 1982-1983 El Niño event.

[16] Precipitation in the Dominican Republic in November 2003 left the ground saturated, increasing the amount of run-off and causing rivers and dams to overflow, with severe flooding in the district of Bajo Yaque, which stretches from the Taveras dam to Monte Cristi, and in the district of Bajo Yuna.

Regarding losses caused by permanent or temporary disruptions to environmental services that cannot be assigned to the production, infrastructure or social sectors, the situation, as with damage, is that the estimates do not present a clearly defined pattern by geographical area and type of event originating the disaster. Although the comparison generally brings out the importance of losses of this type from storms and hurricanes in Mexico (4%) and geophysical events in the Caribbean (14%), the largest share for such losses (32.6%) was when these meteorological phenomena coincided with earthquakes in Central America (see table I.4).

Table I.4
Latin America and the Caribbean: distribution of estimated losses, by sector, event type and subregion
(Percentages of total losses)

Origin of the disaster/region of occurrence	Production sector losses	Social sector losses	Infrastructure sector losses	Environmental losses	Other losses	Total
All disasters	**60.48**	**12.94**	**18.53**	**1.29**	**6.76**	**100.00**
All weather-related disasters	**68.38**	**6.52**	**19.44**	**0.98**	**4.67**	**100.00**
Hurricanes and storms-Central America [a]	52.46	15.88	23.85	4.01	3.80	100.00
Hurricanes and storms-Caribbean [b]	74.27	6.13	15.43	0.43	3.74	100.00
Hurricanes and storms-Mexico	82.23	2.26	9.99	3.04	2.48	100.00
El Niño-Central America	63.77	13.23	22.38	0.00	0.62	100.00
El Niño-South America	72.33	3.13	19.49	0.00	5.05	100.00
La Niña-South America	72.35	6.90	16.58	0.01	4.15	100.00
Extreme precipitation-South America	46.61	6.98	34.58	1.75	10.09	100.00
Extreme precipitation-Caribbean [c]	43.67	18.11	38.22	0.00	0.00	100.00
Extreme precipitation-Mexico	78.35	12.86	3.87	0.77	4.15	100.00
Extreme precipitation-Central America Drought-Central America	66.42	0.00	26.49	0.00	7.09	100.00
All geophysical disasters	**40.38**	**27.05**	**18.51**	**1.55**	**12.50**	**100.00**
Central America	24.64	42.56	23.25	0.00	9.54	100.00
South America	91.47	2.16	3.21	0.06	3.09	100.00
Caribbean [d]	26.54	40.35	19.00	14.12	0.00	100.00
Mexico	34.46	0.13	22.67	0.00	42.73	100.00
All mixed disasters	**26.70**	**21.88**	**15.09**	**31.28**	**5.04**	**100.00**
Central America	26.70	21.88	15.09	31.28	5.04	100.00
All biological disasters	**83.47**	**3.23**	**13.29**	**0.00**	**0.02**	**100.00**
Epidemics	83.47	3.23	13.29	0.00	0.02	100.00

Source: O. Bello, L. Ortiz and J. Samaniego, "La estimación de impacto económico y social de los desastres naturales en América Latina, 1972-2010", Santiago, Chile, Economic Commission for Latin America and the Caribbean (ECLAC), unpublished, 2012.
[a] There are no sectoral loss estimates for the disaster caused by Hurricane Fifi in Honduras. Sectoral estimates of damage for Tropical Depression 12-E in Honduras do not include damage in the education and health subsector, as the figures in the report are not consistent with the overall estimates. In the report, furthermore, only total estimates are presented for the same event in Honduras and Nicaragua.
[b] No sectoral loss estimates are available for the disaster caused in Dominica by Hurricane David in 1979.
[c] No sectoral loss estimates are available for the disaster caused in Grenada by extreme precipitation in 1975.
[d] No sectoral loss estimates are available for the 1974 disaster in Antigua and Barbuda.

E. The overall impact of disasters

With regard to the overall impact of disasters and their secondary effects on countries' welfare, some authors and international organizations (ECLAC/IDB, 2000; UNISDR, 2011b) maintain that they are a major obstacle to progress, while others argue that there is no compelling evidence for this, as causes and effects are numerous and complex and difficult to quantify in many contexts.

Hochrainer (2006) studied 85 disasters in 45 countries and found that the economy was affected for the first year and subsequent growth did not make up the lost ground. Murlidharan and Shah (2001) examined the effect of disasters on medium-term economic growth and concluded that it was negatively affected, with disasters leading to higher external debt, budget deficits and inflation. Albala-Bertrand found that there were no major long-term impacts from disasters in developed countries and that the effects on developing countries faded out after two years, despite some adverse impacts on income distribution. His conclusion is that disasters are "a problem of development, but essentially not a problem for development" (Albala-Bertrand, 1993).

From the ECLAC standpoint (ECLAC, 1991, 2000 and 2010a; Zapata and Madrigal, 2009), going by the reports on the disasters studied, there are a variety of impact scenarios that usually arise some time after an event of this type. Aspects that are important for differentiating the effects are the scale of the immediate impact of the disaster in economic, social, spatial and demographic terms, the size and resilience of the economies affected and the macroeconomic sensitivity of the country at the time a catastrophe occurs.

The conclusion from analysis and follow-up of disasters is that, even once the reconstruction phase has begun, disaster vulnerability remains in all countries, but it is in less economically developed nations that this situation, which is present on many levels, not least because of the frequency of disasters, is increasingly the cause and effect of these. This is a serious obstacle to countries' sustainable development and, specifically, to fulfilment of Millennium Development Goals as important as reducing extreme poverty by 2015 (UNDP, 2004). Faced with the urgent need to recover from the damage wrought by Hurricane Mitch in 1998, for example, Guatemala postponed the social measures agreed to in the peace accords following the end of the armed conflicts in 1996, and similar situations arose in other Central American countries such as Honduras and Nicaragua.

The situations studied show that some disasters, such as the 1985 Mexico City earthquake, the earthquake in the coffee-growing zone of Colombia and the 1999 mudslides in the Venezuelan state of Vargas had huge and devastating effects on part of the population in terms of the number of victims and the destruction of housing and sanitary infrastructure, but their overall impact on the totality of economic activity and the whole population of the countries concerned was generally small. Conversely, disasters whose effects were confined to a specific geographical area, like the Managua earthquake of 1972, inflicted a similar level of economic damage to those cited above but had a substantial negative effect on the Nicaraguan economy (ECLAC/IDB, 2000).

Other disasters in the region have affected very extensive geographical areas or entire countries, particularly small ones, with devastating repercussions for the whole population and many production activities. Disasters with these characteristics have mainly occurred in the small islands of the eastern Caribbean because of hurricanes, such as Luis and Marilyn in 1995 and Lenny in 1999. A similar situation arose in Central America because of Hurricane Mitch, which affected much of the territory of Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua in 1998.

In addition, the damage caused by new events often compounds that from earlier disasters which have not been fully recovered from and cannot be because essential institutional resources and capabilities are not available. Some extreme cases illustrating such a recurrent situation have occurred in Honduras, where highway and agricultural infrastructure is frequently affected by hurricanes and flooding.

There are other cases where natural phenomena have produced changes in environmental conditions, reducing opportunities for exploiting natural resources such as fisheries and agricultural land for long periods. In Peru, certain pelagic species disappeared from the Pacific Ocean seaboard for a time because of the El Niño events of both 1972-1973 and 1982-1983, and this impaired the fishing activities of coastal communities, which were severely affected and forced to find other livelihoods. These communities relocated to other geographical areas where they turned mainly to informal work in Ecuador, Peru and the Plurinational State of Bolivia. Much the same happened after Hurricane Mitch in Central America, when rain heavily eroded the soil and destroyed oil palm and banana plantations, which took several years to grow back.

In addition to capital damage, the resultant economic losses and the macroeconomic and social effects of these, disasters have had effects that are impossible to measure and value, such as trauma resulting from panic and the stress of living through a catastrophic experience, the disruption to normal everyday life from moving home and changing work and school and the loss of dietary nutrition resulting, for example, from droughts and flooding, whose long-term effects on the health and intellectual development of children have yet to be evaluated.

At the same time, it is important to stress that positive effects have been identified. For example, reconstruction work has included unplanned investments, giving rise to more employment and increased consumption. These investments have improved infrastructure in a number of cases, reducing vulnerability to further catastrophes.

Disasters have major social impacts that are manifested in different dimensions of human development and poverty.[17] The empirical evidence seems to indicate that disasters negatively impact anti-poverty efforts. In their review of poverty studies, Dercon and Shapiro (2007) argue that few of these deal with the relationship between disasters and the likelihood of exiting or returning to poverty. They discuss the research of Elbers, Gunning and Kinsey (2002), Lybbert and others (2004) and Dercon (2005), who, using longitudinal data for Zimbabwe, Ethiopia and Ethiopia, respectively, find that disasters are an obstacle to individuals overcoming poverty. These studies use household panel data, which might introduce some econometric problems associated with measuring errors or with attrition or reduction of the longitudinal sample. Rodríguez Oreggia and others (2013) set out to solve these problems by using municipal-level data for Mexico and find that certain social indicators such as the Human Development Index (HDI) and a number of poverty measures underperform in municipalities where disasters have occurred. These conclusions are based on the difference-in-differences estimator.

[17] UNISDR (2009) deals with the subject of disaster risk and poverty in the context of climate change.

II. Methodological aspects: damage, losses and additional costs

A. Introduction

Since 1972, ECLAC has used its experience of studying disasters in the countries of Latin America and the Caribbean to develop what is now the most widely used methodology for measuring the demographic, social, economic and environmental effects and impact of disasters. By the effects of disasters are meant the destruction of physical assets (damage) and disruptions to economic flows (losses and additional costs). The impact of a disaster is defined as the consequences of the effects caused by the event (reduction in economic growth and loss of personal well-being, among other things). This methodology is based on the compilation of sectoral information to estimate the effects at this level so that aggregation can then take place.

The practical consequence for public policies is that damage estimates provide guidance for the replacement and rebuilding of destroyed assets, while estimates of losses and additional costs can orient the design of sectoral interventions aimed at bringing about recovery.

The region's countries recognize the importance of measuring the economic impact of disasters, and in some, such as Mexico, this is now standard procedure (Bitrán, 2000). However, the limited availability of damage estimates and particularly of loss estimates in the main international disaster information sources mentioned in chapter I suggests that quantification of this type is not carried out systematically in most of the countries. The data available are still too unreliable and incomplete to allow the monetary effects of disasters to be measured.

Despite the lack of information and the difficulties encountered, in response to which the methodology has been evolving, ECLAC, the World Bank and other regional and international bodies have carried out exhaustive economic assessments of total and sectoral damage and losses in many countries, including some on other continents.

Between 1972 (when the effects and impact of the Managua earthquake were estimated) and 2010, ECLAC produced about 90 estimates of disaster effects and impact with the corresponding reports in 28 countries of the region at the request of the countries and international financial organizations. Fifteen of the events studied were among the 20 most lethal disasters in the region between 1972 and 2010.

Section B of this chapter presents and characterizes the concept of damage, section C details the concepts of losses and additional costs and section D lays down guidelines for forming the estimation team.

B. Damage

1. Definition

Damage means the effects the disaster has on the assets of each sector, expressed in monetary terms. These occur during the event giving rise to the disaster. Depending on the sector, assets may include:

(a) Physical assets such as buildings, installations, machinery, equipment, means of transport, storage facilities, furnishings, irrigation systems, dams, road systems and ports.

(b) Stocks of final and semi-finished goods, raw material, materials and spare parts.

Two pieces of information are needed to set a monetary value on damage: the physical scale of the effect, and a price to convert it into a value. Information about the former, as detailed in each chapter, is gathered from different sources and from a visual inspection of the affected assets. The diversity of assets means that effects are expressed in different physical units. In the case of a highway, for example, the physical unit might be the number of kilometres affected or destroyed; in the housing sector, the number of permanent and makeshift houses destroyed; in the case of a wine-making business, the destruction of a tank where fermentation is carried out to obtain the wine. Some valuation criterion has to be used to arrive at a monetary estimate of such damage, and this handbook will use the replacement price (current price before the disaster) of an asset equivalent to the one destroyed. For the examples cited, these could be the average price per kilometre of highway charged by contractors in the area where the disaster occurred, the average price of a home similar to those destroyed in the area where the event took place, and the price of a tank with similar characteristics to the one affected.

2. The baseline

Damage is measured relative to a baseline or pre-disaster situation. This is constructed using information existing prior to the disaster on the assets of the different sectors in the affected region, which is compiled during the estimation process. The ideal information would include a listing of the different asset classes. In the case of the housing sector, for example, information would be sought on the number of homes in the affected area before the disaster, and a classification would be carried out of these homes and of furnishings for each of the groups established.[18]

3. Institutional agents

Accounting, conceptual and public policy data that are important for quantifying damage can be obtained by differentiating the wealth impact experienced by different institutional agents such as households, public- and private-sector enterprises and the different branches of government as a result of the event. It should be noted that:

- Households are essentially the users (owners or renters) of homes and owners of household items.
- The different branches of government own their administrative installations, educational and hospital buildings and the road network, among other things.
- Private- and public-sector firms that produce goods own administration and production facilities, machinery and equipment and inventories of different products.
- In the case of electricity firms, the assets of utility firms include generating facilities, transmission systems, distribution system assets and administrative buildings.

It is important to bear this in mind, because what is essentially meant by the effects on a sector is the impact on one or more institutional agents. A helpful way of presenting damage is to differentiate between that affecting the public sector and the private sector, and to specify what percentage was insured in each case, when this information

[18] The possible sources from which this information might be obtained are listed in the chapter on the housing sector.

is available. To complement this, classifying damage by institutional sector provides a better estimate of the fiscal financial effort that might be involved in the asset replacement process. This would have to focus on the proportion of public-sector assets that are uninsured and the percentage of uninsured private-sector assets deemed to be a policy objective.[19]

The institutional agent affected by the destruction of assets will not necessarily be the one financing restoration, owing to the possibility of public-sector action. For example, reconstruction of a municipal school may be financed by the central government and not by the owner responsible for the asset, in this case the municipal government.

4. Disaster as a local phenomenon

The quantification of damages must be circumscribed to a specific territorial area, the region affected. Accordingly, presentation by province, department or region is recommended, depending on the political and geographical division employed in the country concerned. Although it is true that a disaster can affect a whole country (in the region, for example, hurricanes have affected entire Caribbean islands), this is the exception rather than the rule.

5. Damage and reconstruction funding

The damage estimate is the approximate replacement value of the assets affected in each sector. This is not the same as reconstruction funding, as the latter might incorporate elements of risk reduction and resilience against future events, an example being construction on a different site that is less exposed to hazards. It could also include quality and technology improvements. These new characteristics obviously raise the cost of construction above that of merely replacing what has been damaged. Relocation could entail land purchases, while improving resilience would entail stricter building standards and perhaps even elements like early warning systems.

Replacement costs should not include the costs of dealing with existing deficiencies in the affected area (such as housing deficits), as these did not result from the event whose impact is being estimated.

6. Damage and the capital stock

It is important to stress that the amount of damage is not the same as the effects on the capital stock. The two concepts differ because anything totally or partially destroyed may have been fully written down and thus no longer form part of the capital stock. Consequently, it is to be expected that once written-down assets are replaced, the capital stock of the economy, both residential and non-residential, will rise to levels higher than those obtaining before the natural disaster. It is the responsibility of sectoral groups to gather information on the approximate year in which different types of capital items were built or manufactured.

It is very helpful to ascertain whether the institution that deals with the national accounts of the country holds capital stock series. In the past few years, ECLAC has estimated these series for both residential and non-residential capital stock in 16 countries of Latin America.[20] If the country where the effects and impacts of the disaster are being estimated does not have these series, one way of capturing this is to use the depreciation criterion employed in the construction of such series in the references cited and to classify capital stock into two categories: the part that was fully written down, and the part that was not.

[19] An additional factor is that after a disaster the insurers may be slow to settle claims due to the volume received. In these cases, there needs to be an assessment of which agents the public sector will support.

[20] See Aravena, Jofré and Villareal (2009), Aravena (2010) and Hoffman (2000). The countries are Argentina, the Bolivarian Republic of Venezuela, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, the Plurinational State of Bolivia and Uruguay.

7. Summary

The monetary value of damage must be estimated by sector.[21] Given that damage is local, it is suggested that this calculation should be carried out using the political and geographical division of the country affected. To improve the relevance of damage estimates to public policy decision-making, the best course would be to total up damage affecting the private and public sectors separately, determining in each case what percentage of the affected assets were insured, if this information is available. In the private sector, it is suggested that damage to firms be separated from damage to households. In the public sector, the right course would be for damage suffered by public-sector enterprises, state governments, municipal governments and central government to be presented separately.

Lastly, another classification that provides a useful damage breakdown is one that works out separate replacement percentages for imported goods and locally produced goods. Given that this process will not normally be completed in a year, the best way of determining the impact on the trade balance is to carry out a projection for the number of years and amounts per year required for assets to be replaced.

C. Losses and additional costs

1. Definition

Losses and additional costs are disruptions to flows resulting from a disaster. Because they have different financial implications, it is necessary to differentiate the following:

(a) Losses: goods that go unproduced and services that go unprovided during a period running from the time the disaster occurs until full recovery and reconstruction is achieved. Examples include a reduction in the size of future harvests because of the flooding of farmland or prolonged droughts, a decline in industrial production because of damage to plant or lack of raw materials or inputs such as water and electricity, and revenues forgone by utility firms because their services have been interrupted or reduced.

A distinction must be made between two situations that have different implications as regards the re-establishment of flows: whereas in some cases goods and services are not produced because the destruction of assets prevents this, in others the disaster only delays the production process. When the economic impact from the torrential rains of 2010-2011 in Colombia was estimated, for example, losses were registered in the operation of mines and quarries because output from coal mines in the Guajira and Cesar departments fell.[22] The disaster delayed mining activities but did not destroy coal reserves in open-cast mines. The loss was only apparent, as production was merely deferred, and there might ultimately be a loss or a gain depending on coal prices at the future time these seams are worked.

Forgone or delayed production is a gross value. It is important to spell this out because, as will be seen later, this concept includes intermediate consumption and could be overestimated.

Losses are a more complex concept than damage. They are not a tally of obvious, tangible things (destroyed bridges, destroyed or damaged homes and so on). Calculating them means setting a value on production that will be forgone, which will obviously have an impact on GDP, employment, the public finances and the external accounts. They are a dynamic measure of flows. This being so, the consequences of a disaster cannot be accounted for at the time they arise; their economic repercussions will persist for a certain time, which may vary from case to case. This means that losses are hard to measure fully at the time valuation is carried out (a few weeks after the disaster). At that time, it is not always obvious whether the short-term

[21] It is important to have information by sector that provides a basis for estimating this monetary value, i.e. the physical volume of the assets affected (number of hospitals destroyed, number of schools affected, kilometres of highway destroyed, machinery destroyed, etc.).

[22] See ECLAC/IDB/DNP (2012).

losses are over or if they will continue, or what type of effect there will be in the medium term, especially when it is worth observing this separately for a particular sector that has been affected (agriculture or transport, for example).

(b) Additional costs: outlays required to produce goods and provide services as a result of the disaster. These represent a response by both the public and the private sectors, which may take the form of additional spending or a recomposition of spending. This can happen within a sector, as when the health-care sector redirects planned infrastructure spending to purchases of medicines so that the pharmaceutical sector indirectly benefits and the construction sector loses out. Recomposition also takes place between sectors, as when the government decides to reduce technological development spending in order to direct the funds to emergency assistance (food, shelter and so on), or when households forgo recreational spending and use the money to restore housing infrastructure. For some specific sectors (like agriculture in the case of flooding), it may be important to carry out a more detailed analysis of the impact right along the production chain.

A number of considerations make it important to distinguish between the two types of flow disruptions:

(i) Goods cease to be produced and services provided as a result of the disaster combined with the vulnerability of economic activity in the affected area, while additional spending or a recomposition of spending are a public policy decision or private-sector response to the event.[23]

(ii) The flows explained in (a) are obtained by comparing the outlook after the disaster with a baseline represented by the evolution each sector would have had if the disaster had not occurred. These are both hypothetical situations that rely on a number of assumptions, as does any estimate derived from them. Conversely, additional costs or a recomposition of spending are outlays that are in fact made as a consequence of the event.

(iii) For the reasons discussed in the previous point, national accounts treat these flows differently. Additional expenditures are a temporary increase in a sector's intermediate consumption made with a view to restoring goods production or service provision there, the result being a decline in its value added. The portion of additional expenditures that is spent within the country translates into an increase in the output of another sector (examples of this are detailed in chapters IV, V, VII, IX and X). Conversely, losses are a gross value for production forgone relative to a hypothetical situation, and as such are not registered in the system of national accounts.

2. The baseline

Losses are calculated as the difference between a situation that has not occurred, which is the evolution the sector was assumed to be going to have before the disaster, and another situation that has not occurred either, the behaviour that will take place after the disaster. To avoid losses being overestimated, the baseline must be estimated from the best information available and in a way that is consistent across sectors.[24] It is suggested that the most recent projection of the economy, disaggregated by sectors, should be used to establish the baseline. This forecast needs to be revised in the light of recent economic trends.

Most countries in Latin America and the Caribbean have improved their statistics a great deal in the last 40 years. Currently, 15 Latin American countries (Argentina, the Bolivarian Republic of Venezuela, Brazil, Chile, Colombia, Costa Rica, the Dominican Republic, Ecuador, El Salvador, Mexico, Nicaragua, Panama, Peru, the Plurinational State of Bolivia and Uruguay) have quarterly accounts and a set of monthly variables for which long series exist.[25] These series and their behaviour in the event of a shock offer information that should not be neglected either in the construction of the baseline or in expectations of the aftermath of the event.

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[23] A well-known author in the field of disaster literature, Albala-Bertrand (1993), uses the concept of a disaster situation to refer to the way a disaster presents itself in reality. What this means is that it is a mixture of two inseparable sets of events: the impact of a disaster, with all its effects on the economy and society, and society's response, with its own effects. In purely analytical terms, the final outcome of a disaster situation is the net effect of the negative impact of the event and the positive effects of the response.

[24] It is harder to calculate a baseline for losses than for damage because assumptions have to be made.

[25] See [on line] http://websie.eclac.cl/infest/ajax/cepalstat.asp?carpeta=estadisticas

3. The post-disaster scenario

The information gathered by the group carrying out the estimation has to be used to construct projections of the post-disaster situation for each sector. This situation depends on the scale of asset destruction, which in turn, together with financing potential and the productive capacity of the construction sector, determines how long it will take to restore production. It is suggested that this time should be expressed in months and the monthly flow of forgone production or sales estimated. Some additional complexities in this exercise, relating to changes in regional spending and production, are touched on in the next section.

4. Disaster as a local phenomenon

One characteristic of natural disasters is that they often only affect a specific area, region or department.[26] Territorially speaking, where the place matters, instruments must be available for approaching them in terms of local (metropolitan, regional, departmental, provincial or state) economies, defining the specific, dramatic and intense character of the event for these areas' inhabitants. As described by Albala-Bertrand (1993), these events are spatially delimited and indirectly affect the rest of the economy through the links between the local system and the national one. The stronger the links, the greater the transmission potential. The true scale of a disaster at the local economy level, which is where the greatest impact may be felt in practice, cannot be appreciated when the effect is measured by some national economic gauge such as GDP.

The scope for bringing out the local dimension is often limited by the availability of data. However, seven countries in Latin America (Brazil, Chile, Colombia, Ecuador, Mexico, Peru and the Plurinational State of Bolivia)[27] have subnational accounts, and other countries of the region may have them in the near future.[28]

Another aspect of the local character of these events concerns the disaster situation mentioned earlier and may involve redistribution of spending between a country's regions. For example, much of the assistance needed to deal with the emergency may be raised in other regions or departments, with the result that sectoral activity is not disrupted at the national level but is at the regional level. If the local character of the disaster is not reflected, merely measuring the aggregate impact will mask the effect on the regional economy.[29]

5. Losses, additional costs and financial needs for recovery

Financial needs for recovery are the costs of different supply and demand policies that, together with reconstruction, help the economy return to normal. Supply policies include in particular the amounts required to restore provision of and access to basic services for the population (health care, education, temporary housing, transport, water and sanitation, electricity). The disaster may cause the operating costs of these sectors to rise above normal (i.e. pre-disaster) levels during the period in which infrastructure is being rebuilt and disaster-damaged equipment replaced, when for example temporary facilities are used to provide certain services. These amounts are part of the additional costs. Then there are the amounts required to provide inputs and working capital so that production levels can be restored (in the production sectors of agriculture, stockbreeding, fishing, industry and trade). These amounts are part of the losses.

Demand policies include the funding required to implement temporary programmes, such as food-for-work or cash-for-work programmes, designed to provide a minimum income to those who have lost earnings or even been left workless. These amounts are part of the losses.

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26 Exceptions to this are some hurricanes that have affected small islands in the Caribbean.

27 See [on line] http://websie.eclac.cl/infest/ajax/cepalstat.asp?carpeta=estadisticas

28 For example, in estimating the impact of the torrential rains in Colombia (ECLAC/IDB/DNP, 2012), the effect of the disaster on economic activity was estimated from the sectoral structure of GDP in the different departments of the regions affected.

29 One market where the national aggregate conceals the true social dimension of the impact is the labour market, as this has a markedly regional character, especially in rural areas. After a disaster, the short-term behaviour of employment will depend on the dynamizing effects of reconstruction programmes. Those who lost their work in the sectors worst affected by the disaster will not necessarily be the ones employed in the new jobs created in the construction sector. This is another situation that exemplifies the redistributive effects of events of this type.

6. The effects of losses on macroeconomic variables

Disruptions in flows could have effects on different macroeconomic variables such as GDP, employment, the public finances, the balance of payments, inflation and the exchange rate. Given the local character of most disasters, these effects could be downplayed.

It is suggested that sectoral experts should report to the mission's macroeconomic team on the possible effects on certain variables, but estimation of the impact on these variables should not be carried out simply by aggregating sectoral information, as this can result in major errors.

D. Organizing the estimation team

When a disaster occurs, the national government of the affected country usually receives support from the international community to deal with the emergency. This includes producing estimates of the effects and impact with a view to orienting the restoration and reconstruction process in the different economic and social sectors that have experienced the effects of the event.

Those responsible for coordinating resources to meet humanitarian needs during the emergency phase are normally the country's own emergency agencies, supported by the United Nations and other international organizations, both public and private. It is now normal practice for the community or country affected to undertake the most urgent measures to meet humanitarian needs, with friendly countries and international organizations quickly providing additional assistance, both directly and through non-governmental organizations (NGOs). Private- and public-sector agents are involved in this effort, along with many local, regional and international NGOs and social welfare organizations.

The methodology presented here can and should be incorporated into the institutional skillset of the various public-sector bodies that lead, coordinate or regulate the economic sectors analysed in the wake of a disaster so that local actors, coordinated by the national government, can apply it should the need arise. This is also important because the impact estimation team that arrives in the country will need to work alongside professional and specialist personnel at the national level and in the regions affected, since in addition to the information these can provide, there will be a need for their guidance on the practicalities of information gathering.

This handbook has been written on the basis that it is the government of the affected country that carries out estimation of the effects and impact. The sectors included in the estimation will be the ones revealed by evidence of various kinds to have been the worst affected by the disaster. It is assumed that a group of specialists will be set up for each sector, in which the national institutions most relevant to the sector will be represented. Box I.1 presents some general guidelines for when these estimates are produced by an ECLAC team.

It has been found in practice that a team's success in producing high-quality estimates of a disaster's effects and impact largely depends on its opportunities for obtaining information that is qualitatively and quantitatively accurate, up to date and suited to the requirements of the methodology.[30] It is helpful to employ a variety of methods for obtaining information that can be contrasted and analysed. Some of these will now be detailed.

[30] What has been found in practice with impact estimations is that the reports prepared by public and non-public bodies on the sectors requiring analysis are often unusable because the data are consolidated in a way that does not match the ECLAC methodology (damage and losses are mixed together, for example).

Box II.1
The ECLAC mission

Once the national government has put in a formal application for support with the estimation of the economic and social effects of a disaster, ECLAC and other United Nations agencies mobilize teams of suitable specialists for the work required to produce the most diligent possible analysis of the damage and losses suffered by the different sectors indicated in the introduction to this chapter.

After receiving the support request but before forming the team and organizing the logistics for the mission, the mission head and coordinator for the request carries out a reconnaissance and concludes operating agreements with the national government and its departments, and with United Nations bodies in the affected country. This will ensure that information and practical support are forthcoming for the team of specialists and that the work will be carried out successfully. This mission will establish which sectors are worst affected in the disaster zone, helping to clarify the profile required of sectoral specialists. It is also recommended that the national accounts expert should be included in this first visit so that contact can be made with the institution responsible for the issue and so that the statistics available on the affected area and their weight in the national sample can be ascertained with a view to estimating the different variables.

The mission comprises a head who will act as team coordinator and will be responsible for drawing up a working timetable and ensuring it is kept to, monitoring progress with the gathering of data from the various sectors, and ensuring these are consistent with the methodology. The mission head is also responsible for detecting obstacles in the information-gathering process so that they can be surmounted and for reviewing the substantive aspects of the work. Sectoral experts, chosen in consideration of the sectors affected, will also form part of the mission. These will be specialists with technical and economic knowledge of each sector (civil engineers, doctors, demographers, gender experts, agricultural engineers, etc.) and will be responsible for carrying out the estimation. They will work closely with the economist responsible for the macroeconomic analysis and the national accounts expert; among other reasons, this is because it is vital to specify which institutional sectors the costs of restoration and reconstruction will fall on and to arrive at an accurate estimate of losses and additional costs, with this work being oriented by the national accounts framework.

It is not possible in advance to determine or generalize about what occasions might merit the use of this methodology to carry out an impact estimation, as this will depend on each individual case, in view of the type of phenomenon giving rise to the disaster, its scale and its geographical extent. Generally speaking, experience indicates that it is not advisable to start an impact estimation until the emergency response phase is well advanced, both so as not to interfere with rescue and salvage operations and so as to ensure that sufficient quantitative information is available on the effects and that there is access to the affected areas so that damage and losses can be quantified. Given that the involvement of substantive personnel from the national level and the affected areas will always be required to complement the outside mission team, a time must be set for the evaluation when these local staff are no longer involved in rescue and humanitarian aid work or when they or their families are no longer in the position of victims if, as often happens, they have been personally affected.

Nor is it advisable, however, to delay the start of the estimation work for too long, as the findings it produces could be crucial when it comes to initiating investment plans and projects and organizing internal and external support for reconstruction work.

As noted in the chapters on the different sectors, the gathering of appropriate statistical data on the pre-disaster situation and of qualitative data on national institutions and those of the affected territory is a stage of great importance in the process of estimating the effects and impact of a disaster. For this reason, it is advisable to ensure that the work is as far advanced as possible before the visit to the affected country begins. This can be done by consulting the websites of the emergency management agency, ministries dealing with social affairs, production, infrastructure, the environment and especially finance, institutes of statistics, public offices in general, and international organizations and NGOs operating in the country. It is absolutely vital to understand the organization and workings of the national body that keeps the national accounts and to identify the officials responsible for this work, as the specialists in each sector will have to interact with them as they go about estimating losses and additional costs (see section C).

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

1. Strategic informants

Regardless of whether the emergency and restoration organization is centralized or decentralized, the person in charge of carrying out the estimation for a sector will need to have in place from the start a network of national bodies, national and international agencies, research centres and key persons capable of providing the information being sought and invested with enough authority to request and obtain documents and reports on the disaster. Although time is usually short, use must be made of documented facts and data and direct observation or whatever can be gleaned from verbal reports or situation summaries prepared by different sources. Without the support of such strategic informants it becomes difficult to judge the accuracy and reliability of information and make sense of divergent or contradictory opinions.

2. Long-distance interpersonal communication

Often there is no choice but to resort to the telephone, Internet or radio to obtain information from remote and inaccessible areas. Because one of the first measures must be to re-establish communications, one or other of these is very likely to be in operation. It is important always to be very precise when requesting information by these means and then to examine it carefully, comparing it with the independent sources available.

3. Reconnaissance missions

Given that the process of estimating a disaster's effects and impact is organized or requested by the national government, it is important for the groups of specialists to plan their reconnaissance missions so that they are carried out after an initial desk assessment of the data obtained from the relevant sources. In this way, additional information not available from the sources consulted previously can be collected and the accuracy of the data gathered can be checked. In isolated or inaccessible areas, field inspections will often be the only method available for obtaining data. Local reconnaissance will always be useful, for three reasons: (a) it provides data that are essential for assessing the quality of the sources to be employed throughout the estimation process, (b) it enables the sectoral groups to rank the effects of the disaster by their own criteria, and (c) major damage not included in other sources can be identified.[31]

4. Cartography

Maps are a vital aid, so efforts must be made to obtain them right from the start. Maps prepared with information on the effects of the disaster are particularly useful, although care must be taken to see that the maps used are current (up to date) at the time of the estimation.

5. Images obtained from remote sensors

Images obtained from remote sensors, especially those from satellites, can be very helpful. There are some drawbacks to their use, however. First, while satellite imagery can be employed with advantage to assess disasters caused by phenomena such as flooding, hurricanes, landslides, earthquakes, eruptions, forest fires and oil spills, it does not yet seem feasible to identify infrastructure damage in this way. For example, a building may look intact from the air, yet have internal structural damage that necessitates demolition. It will be possible to overcome this limitation when a detailed geographical referencing system is available.

Another problem is that the cost of buying images is too high for most developing countries, which means that their use might be restricted to more developed countries or to situations where some developed country decides to provide the affected country with images free of charge.

Aerial photography, when available, can be a powerful tool. However, this is true when it forms part of an aerophotogrammetric system and all the elements required to properly interpret the nature and scale of much of the damage can be found. It is advisable for the specialist to carry out the estimations and calculations in close collaboration with the personnel specializing in aerophotogrammetric analysis.

6. Questionnaires

Questionnaires are a very useful method of obtaining data in the restoration and reconstruction phases. It is important to emphasize, however, that this information must be treated with care; questionnaires are not the same as surveys, as they usually have no set of specifications clarifying basic elements such as the sampling technique, survey error and

[31] This often happens when damage in the social sector and among the population is being assessed, but it holds true for all sectors. It can happen that infrastructure damage is more prominent in official reports because it is more obvious and concentrated, while the impact on agriculture, for example, goes unremarked because it is more spread out over the territory. Gaps in centralized information can be remedied by air or land reconnaissance or reports from local bodies and organizations.

expansion factors for reaching the target population. One example of a survey carried out in the months following a disaster that does meet all these technical requirements is the one conducted after the 2010 earthquake in Chile.[32]

If the estimation of effects and impact coincides with these stages and the government or other bodies have already applied questionnaires, these can be a source of information on particular effects of the disaster. There are three types of surveys that can be very helpful: (i) those carried out by different government departments and agencies for a rapid appraisal of the damage (such as a simple visual inspection of the number and condition of homes damaged or ruined) or partial aspects of it (such as the number of victims and the morbidity structure, as ascertained by some government health-care department); (ii) those with greater coverage that are conducted using more systematic procedures and provide comparable and accurate data for the pre-disaster stage (including surveys of employment and unemployment in the main cities, which are very valuable instruments for a number of aspects of the damage assessment process, analysed later as an integral part of the secondary data analysis); (iii) rapid appraisal surveys, carried out particularly during the reconnaissance missions (these should be conducted when no better sources are available). A special case are the surveys needed to ascertain differential effects on women, as there is no other means of obtaining information about the additional productive workload placed on them or about lost assets and income in household economies. Whenever possible, a field survey must be carried out among women living temporarily in shelters. Useful though these sources are, care must be taken about biases resulting from very small samples that are not systematic or replicable.[33]

7. Secondary data analysis

This is the analysis and use of publications, documents and reports prepared by different institutions or individuals. In the immediate aftermath of the disaster, documents will be scarce and will include the findings of partial surveys carried out by government departments and international organizations and the internal reports of the institutions most involved in the emergency and restoration stages.[34]

Whatever the specific assessment methodology employed, it must reflect values that contrast a post-disaster situation with a pre-disaster situation. Furthermore, information from the stage prior to the disaster will be the starting point for assessing its effects. Without such information, it will not be possible to carry out an accurate impact assessment. Where disasters are concerned, there is a need to obtain reliable and accurate data on the physical characteristics of the affected territory and its population (size, distribution, density, economic, cultural and ethnic characteristics, and so on). When the assessment is carried out by government institutions and international organizations, it is advisable for use to be made as far as possible of official sources or documents based on these, with figures published by competent agencies. Particularly useful are population and housing censuses and sectoral censuses (agriculture and stockbreeding, manufacturing and mining, etc.). Statistical yearbooks and the publications of offices of statistics and censuses can also be recommended, as can the publications of research centres in the country and surveys carried out by official bodies, universities or other institutions of recognized competence.

8. Unofficial information sources

From the day of the disaster onward, the press will be publishing reports that can be useful as a reference source for identifying possible strategic informants and useful documents, and as a guide to areas and types of damage not covered by the analyses conducted. These data should be taken as a reference and not used directly in quantitative estimates without first being checked.

32 Several chapters of the present handbook refer to the processing of this survey by Contreras (2012).
33 See chapter XVII on disaster impact estimation with a gender perspective.
34 For those carrying out the estimation, these analyses are secondary only in the sense that they themselves have not produced them, which does not mean they are not important.

Part II
Social sectors

III. Affected population

A. Introduction

One of the first tasks in estimating the effects and impacts of a disaster is to define the geographical area affected by it. This task should involve close cooperation between the sector specialists in the assessment group and the official authorities, because the process of defining the affected area should be a single procedure undertaken at the outset, before embarking on the estimation process. Thus, identifying the population affected by the disaster, which stems from the definition of the impacted land area, will serve as basic information for all sectors.

Accurately estimating the population affected –where all tangible and intangible effects of the disaster come together –is essential for attaining an overview of the event and for estimating the damage caused in each social sector, such as education, health and housing. It provides an independent criterion against which the consistency and coherence of the other estimations can be measured; and, above all, it constitutes the starting point from which to direct national and international relief efforts and to set priorities for rehabilitation and reconstruction plans and programmes.

B. Definition of the affected geographical area and population

Estimating the effects of the disaster must begin with a definition of the affected area, after which the dimensions and characteristics of the affected population can be identified. In other words it is necessary to establish the number of inhabitants; ascertain their previous socioeconomic conditions; and, if possible, form a judgment as to their post-disaster situation, so as to obtain an overall idea of the intangible effects that might affect the conditions governing their conditions or standard of living. It is common to encounter discrepancies both in the concept and in the measurement of the population affected by a disaster, so the population specialist will almost invariably need to make his or her own estimates. For that purpose, it is advisable to start work based on a broad view of the affected area and population affected, and then narrow it down. Nonetheless, in countries where emergency or disaster management agencies have a well-developed institutional framework, this task may already have been completed and the affected area and population identified, before the start of the estimation. In any event, this should be corroborated and discussed by the various groups of the team making the estimations.

1. Affected area

The strategy for defining the affected area varies according to the type of phenomenon that caused the disaster and the availability of information. The best way to illustrate this is through examples.

Example 1. When confronted by contradictory versions of the area and population affected by an earthquake occurring in a Central American country, population specialists resolved the situation following these steps:

(i) Mark on a political/administrative map the entire area in which the population "felt" the earthquake (broadest concept). In terms of the Modified Mercalli Intensity Scale, this is equivalent to intensity V or higher.

(ii) Then, reduce the marked territory to areas that reported victims or damage, reconciling partial official and unofficial figures: data obtained from a full analysis of press content since the day of the disaster, and data obtained from a reconnaissance by land of some of the affected zones

(iii) Some of the zones marked in this way were practically inaccessible or contained populations that were very dispersed, or for which the latest census data were unreliable. Zones suffering only minor damage were omitted and conjectural estimates were made on the remainder (inevitable adjustment considering the time available for completing the damage assessment).

(iv) Based on the census data, the political/administrative unit of lowest level of aggregation for which population data were available was chosen; the area was defined and adjustments and projections were made as necessary to arrive at a definitive estimation of the population affected by the earthquake.

Example 2. In another similar experience, in this case an earthquake affecting the area and population of relatively inaccessible high Andean zones, it was decided that estimations were needed of the population most seriously affected by the disaster and its location. This task was made more difficult by two facts: the affected zone was rural and the population was scattered; and it had been impossible to obtain maps reflecting the current population situation.

In this case, the following steps were taken:

(i) Material was obtained from the Cartography Department making it possible to identify these small clusters of disperse mountain dwellers sufficiently accurately.

(ii) With this and other information on material losses and the number of people made homeless, the specialist was able to estimate the damage and the affected population in hamlets, villages and cities accessible by land. Reconnaissance missions to neighbouring locations, chiefly to confirm the authenticity and accuracy of the figures, also made it possible to classify the proportion of the population most affected in those localities.

Although it was impossible to reach large areas close to the epicentre, the evidence compiled in the most densely populated settlements indicated a rough but clear graduation, whereby the damage diminished as one moved further away from the epicentre.

(iii) Taking the population figures as a reference, two circles were drawn around the epicentre. The radius of the first circle corresponded to the distance to the most affected settlement among those located furthest away from the epicentre. The radius of the second corresponded to distance to the furthest village in which the seismic wave had been felt. Knowledge of the characteristics of rural housing also made it possible to estimate the number of inhabitants and the location of the population most seriously affected in the first circle. This population, both urban and rural, was estimated on the basis of another group situated in the second circle.

2. Affected population

The strategy for estimating the population of the affected area will vary according to the following factors: availability of up-to-date information on the population at a disaggregated level, whether census or projections; unforeseen demographic changes in some of the areas, which invalidate the assumptions implicit in the projections; and the time that has elapsed between the date of the disaster and the latest available census.

The older the latest census, the greater will be the assumptions on which the estimation will need to be based, and hence, the riskier the projection.

When working with more aggregate levels, there are fewer risks in the estimation than when working with more disaggregated data. If the disaster occurred very soon after the census, the official version of the census data will probably be simply accepted, given the need for rapid assessment —particularly if no relevant post-census demographic events have occurred in the disaster area (large migratory movements, opening up of colonization zones, etc.).

As noted above, many countries have emergency response units (civil protection and others); and when the mission is undertaken to assess the impact of an event in a given country, this national entity probably already has the necessary information (geographical definition of the impact, consolidated reports of fatalities and injuries, population living in shelters and displaced, and so forth). Moreover, there are generally a number of civil society and international organizations in the country, compiling information on the affected population; and this is very useful for the quantitative and qualitative estimation, and for defining the impacted area. All of these sources, particularly the national risk and disaster management agencies, should be consulted and made use of to reach a more precise conclusion as to the affected area and the population living in it. In conjunction with those sources, and depending on the degree of uncertainty attaching to the information compiled, the work can be complemented with data processing and map work.

The most frequently used data will come from the latest available population and housing censuses, and also from the population estimations and projections obtained from these and other sources, such as official and academic publications. These data can be complemented with information obtained from household surveys and from vital or administrative records.

The following are possible approaches based on specific scenarios:

Case 1. Annual population projections at a disaggregated (e.g. municipal) level are available, the disaster has occurred no more than five years after the most recent census, and there have been no important demographic changes in the affected area since the most recent census.

In this case, once the geographical area has been defined (identification of the affected municipalities), the projected population for the year can be taken directly, or it can be estimated for the date of the disaster using the following exponential growth formula:

$Pd = Po * e^{rt}$ (1)

where:

Pd = the population on the day of the disaster

Po = the most recent official estimate of the population

r = the annual exponential growth rate for the year or period in which the disaster occurs

t = the length of time in years between the initial projection date used to calculate r and the time of the disaster

Example: An assessment is made that a disaster that occurred on 10 November 2000 affected 15 municipalities with a projected population of 3,590,000 on 30 June 2000 and 3,695,000 on 30 June 2001.

$P_{(10/11/2000)} = P_{(30/06/2000)} * e^{rt}$

Using formula (1) the growth rate, r, can be calculated as follows:

$r = [\ln(Pd/Po)]/t$

$r_{2001\text{-}2000} = [\ln(P_{(30/06/2001)} / P_{(30/06/2000)})]/1$

$r_{2001\text{-}2000} = 0.02883$

If

t = date of the disaster minus initial date of the population estimate

t = (11 November 2000 – 30 June 2000)/365

t = (134)/365= 0.36712

then,

$P_{(10/11/2000)} = P_{(30/06/2000)} * e^{rt}$

$P_{(10/11/2000)} = 3628199$

If significant changes had occurred in any of the affected areas (significant emigration or immigration flows before the disaster and after the census, for example), appropriate adjustments to the projected population figures and new projected totals would need to be made before undertaking the estimate shown above.

Case 2. The disaster has occurred five or more years after the most recent census, and, therefore, projections at a disaggregated level may not be updated or do not exist.

In this case, once the geographical area has been defined (municipalities, communes or districts), either a projection of the population should be done or the available estimates should be analysed to determine whether there is any evidence of municipalities whose population has increased or declined to a greater degree than that observed in the preceding inter-census period. Once the new adjusted totals for the population of the affected area have been calculated, the procedure shown in case 1 should be followed.

If there is no disaggregate population projection or if the existing one is out of date, it will be necessary to make a projection of the population in the affected area. It is possible that projected information is available for a larger geographical area. In this case, the population of the affected area should be projected by applying the growth rate for the population of the larger administrative unit (department, province or state) in which the area is located for the year or period that includes the date of the disaster.

Example: An estimate is required for the population of the area affected by a disaster that included 20 districts of department X on 15 January 2001.

According to the census taken on 30 June 2000, the population figure for the area was 1,536,000. According to projections, the population of department X will grow at a rate of 1.89% during the period 2000-2005.

In this case, the estimated population of the affected area on the day of the disaster is calculated as shown below, using formula (1):

$P_{(15/01/2001)} = P_{(30/06/2000)} * e^{0.0189} * 0.54110$

$P_{(15/01/2001)} = 1551789$

In the previous example, it is assumed that no sudden demographic flows have occurred in the corresponding districts or municipalities, or that they were confined to displacement directly within the impact area. If this is not the case, it will be necessary to make separate projections for those municipalities or districts whose population growth or decline was greater than expected before continuing with the rest of the procedure. Additional sources of information (e.g., school rolls, new building permits and other administrative records) are necessary for such estimates, which involve specific methodologies.

C. A disaster's impact on a population

Since the population may be affected in different ways and to various degrees depending on the source of the disaster and its consequences, it can be broken down into primary, secondary and tertiary categories.

1. Primary affected population

This category includes people affected by the direct effects of the disaster and consists of the dead, the injured and the disabled (primary trauma victims), those displaced and living in shelters, and those who suffer material losses as a direct and immediate consequence of the disaster. This segment is made up of people who were in the affected area at the time the disaster occurred.

2. Secondary and tertiary affected population

The secondary population affected by the disaster is defined as people who were within the boundaries of the affected territory but suffer other consequences of the disaster. These include individuals who lose their job owing to the destruction of the firm in which they worked, and tradespeople from the territory in question who lose income because they worked in marketing activities related to agricultural harvests that were destroyed.

In slowly evolving disasters, such as droughts or floods, secondarily affected people often take refuge in institutional or informal shelters. It is useful to keep a separate record of such people since this information may provide an early warning of significant internal migration flows.

The tertiary affected population consists of people who suffer indirect consequences from the disaster but who were not living in the area defined as disaster-affected. Examples of this population category are people affected by the collapse of water supply systems several kilometres away (see chapter X).

To estimate the secondary and tertiary population one needs a baseline for the total population living in the affected zone when the disaster struck. This can use demographic data obtained from censuses and surveys using the Retrieval of data for small areas by microcomputer (REDATAM) program (see appendix 1), developed by the Latin American and Caribbean Demographic Centre (CELADE)-Population Division of ECLAC.[35]

3. Assessing the direct and indirect effects on the population

Each sectoral assessment measures, in monetary terms, all damage and losses sustained by the affected population. Damage to personal property is usually recorded in the housing sectors, while damage and losses in production are included in the assessments of the impact on productive sectors. The monetary loss due to deaths caused by a disaster may be high. From a methodological standpoint, it is possible to analyse such losses and allocate a monetary value to them. Nonetheless, it was decided not to do so, since the purpose of this handbook is to estimate the damage and losses caused by a disaster that affects the economic performance of the country or region. Furthermore, loss of life is considered a permanent cost to society that cannot be replaced or recovered.

The most widely recognized impact on disaster victims is the deterioration in their living standards. The physical environment becomes degraded and affects other dimensions. Thus, normal access to education, health care and food is interrupted; the network of social contacts at work and human settlements are weakened, endangering social capital within and between communities; communications, culture, and recreation possibilities are also reduced; people's security and confidence in their way of life are threatened; and the loss of homes and belongings reduces normal living standards.

Other, unquantifiable effects on the population include psychological harm and societal change, the solidarity or generosity shown in confronting the disaster, the despair of those who do not receive aid and many similar intangible costs or consequences.

Disasters also produce psychological after-effects. Episodes of depression, anxiety, fatigue, nervousness, irritability, loss of appetite, sleep disturbances and psychosomatic symptoms, such as diarrhea and headaches, have been observed and measured both during and after the emergency stage.[36] Psychiatric interpretations of disaster effects suggest that damage of this nature may have significant short- and long-term effects.[37] On the other hand, sociological research shows that while disasters produce significant stress, victims do not seem to behave in a dysfunctional way: profound pathologies are not common, psychological damage eventually disappears, and recovery is speedy.

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35 CELADE has over 50 years' experience in working on these issues. The institution fulfils the following tasks: (i) it provides advanced training in the application of demography to the study of economic and social problems and to development planning; (ii) it promotes demographic research adapted to the socioeconomic realities of Latin American countries; (iii) it establishes standard demographic data and research techniques, to ensure comparability between countries; and (iv) it generates a system for the exchange of information on population issues (see www.eclac.cl/celade/Antecedentes50.htm).

36 See appendix 2, which is based on Contreras (2012).

37 The Pan American Health Organization (PAHO) has prepared a guide that responds to growing concerns among governments, non-governmental organizations and the international community regarding the mental health care of the population during emergencies and disasters (See PAHO, 2002).

Few events reveal societal inequalities better than the destruction caused by a disaster, especially in developing countries. The devastation suffered by the poorest people is so disproportionate that it becomes obvious where the cause lies: one is vulnerable because one is poor. It is not unusual for disasters to be followed by, sometimes sweeping, societal changes. There are well-documented cases in which the effects of a hurricane or a storm have triggered a situation that led to the independence of an Asian country; or African governments that fell from power as a result of rescue and assistance actions deployed during a cruel and lengthy drought; or countries that experience relatively long periods of social and political unrest caused by the demands of population groups rendered homeless.

To an even greater degree than intangible effects and psychological damage, the effects that cause societal change defy precise identification and measurement when making a quick damage assessment.

Direct and indirect demographic effects can be estimated from the partial or isolated effects of disasters on the components of population growth (mortality, fertility and migration), or from the aggregate effect on population growth itself.

Direct effects on mortality rates refer to deaths that were an immediate consequence of the disaster and are included in the fatalities report. However, there are indirect effects that lead to loss of life in the short or medium term. In the short term, deaths, both in temporary shelters and elsewhere, may occur as a consequence of the increase in acute respiratory ailments and infectious or parasitic diseases caused by the disaster. In the medium term, the deterioration in living conditions caused by the disaster may still be felt beyond the period immediately surrounding the event, as a result of increased vulnerability and the deterioration of health, housing, and basic utility infrastructure in general.

To estimate the specific demographic impact on the mortality rate by age and on the average life expectancy of the population, it is necessary to determine the age and sex structure of direct fatalities (and indirect ones, if feasible). Estimated life expectancy is calculated with the aid of a life expectancy table. The same table is then used to obtain a different average life expectancy figure by adding the additional fatalities caused by the disaster to each age and sex group. The difference between them is the number of years lost as a result of the event.

It is not as easy to calculate the indirect effects on fertility. In the short run, and depending on the scale of the disaster, and particularly its period of impact, the fertility rate may decline, owing to a combination of various situations that discourage marriages and cause a temporary drop in the frequency of sexual relations. But there might be an effect whereby it recovers in the long term, as has been observed in the case of wars or other great crises. Sudden disasters, such as earthquakes or hurricanes, have substantial effects on the fertility rate only if the primary affected population is significant, thereby reducing the number of women of fertile age.

The impacts of disasters on migration are clearer to see; nonetheless, population specialists are likely to find them it hard to estimate.

Disasters give rise to temporary population displacements owing to the destruction of property (land, homes, etc.). Other medium-term effects may be more significant. Changes in the structure of production and employment levels have a significant destabilizing effect, and become opportunities for seeking a new job or emigrating abroad. These impacts cannot be assessed immediately after the disaster, but only through an analysis at a later date.

The impacts on demographic growth can be estimated once the effects on the three previous components are known. Given the difficulties mentioned above regarding fertility and migration, this methodology can be used to estimate the impact of the disaster on demographic growth by taking loss of life into account, based on the census projection.

D. The availability and use of demographic information

When starting to estimate the impact of the disaster, the team of specialists generally finds it difficult to judge which information is the most reliable.

Problems arising from the scarcity of adequate and up-to-date data are frequently compounded by the inconsistency of information provided by different institutions, problems accessing the information, and differing

degrees of quality, depending on the variable in question and the geographical unit under study. Some of these problems are mentioned below, and possible strategies for resolving them are suggested.

The obstacles include the following:

• Difficulties in assessing the quality of the basic information on the number of deaths and people left homeless.

In many cases, the information on the number of victims tends to be collected by different institutions, which often results in duplication. Moreover, the number of people classified as disappeared, which is often added to the number of fatalities, can be exaggerated because it is difficult to revise the figure when a person thought to have disappeared reappears.

Another serious problem arises in estimating the number of people left homeless, because the figure varies significantly according to whether the headcount is made during the emergency response or later in shelters. Moreover, the information is often collected without a breakdown by sex, age, ethnicity, or some other socioeconomic characteristic, which complicates subsequent in-depth analyses.

It is therefore suggested that estimates of the number of fatalities and people rendered homeless be reviewed and evaluated if the aim is to obtain the largest possible amount of information on the demographic, and also socioeconomic, characteristics of those affected.

• Inconsistencies in the data collected.

Following a disaster, aid agencies often perform censuses on the affected population, mostly through headcounts in shelters, on different dates and using different methods. This situation invalidates compatibility between the figures.

It is advisable to coordinate a single data collection activity, on a date as close as possible to the event. Given the cost and time that this activity may entail, it is advisable to do it in the shelters and collect a minimum set of useful data. The basic question set should contain the following at least:

- Name and surnames
- Sex
- Age
- Education level
- Presence of the family group in the shelter; membership and relationship in the single or two-parent family group [38]
- If a member of the family has died, ascertain sex, age and relationship.
- Current health status (presence of acute respiratory conditions, or diarrhea or a contagious disease)
- Property damage suffered by the family (housing, domestic belongings, food, means of microenterprise production, livestock, others)

[38] When consolidated, these data make it possible to ascertain the number of single-parent families, which in turn provides information on the number of single heads of household, men and women, affected. That makes it possible to design actions to support those families in terms of employment, credit, housing, health and education.

Appendix 1

Use of computational and cartography tools to obtain demographic data

(a) Redatam

Estimating the primary affected population is clearly relatively simple, based on available reports of deaths, injuries, displacements and people accommodated in temporary shelters. As noted above, to identify the rest of the affected population —secondary and tertiary— ne needs a baseline for the total population that was living in the zone when the disaster struck.

This is where the first estimations and projections start to be prepared; but a sound foundation is needed to apply the projections. For this purpose, work begins with the population censuses (although the dates of these are prior to the disaster), and household surveys are also used in larger administrative areas. Obtaining population data is easier if the affected area is very extensive, in other words if it covers an entire region or province. In the case of more disaggregated zones, it is more difficult to obtain detailed information, and demographic data can obtained from censuses and surveys through the Redatam program developed by CELADE-Population Division of ECLAC. The program can be freely obtained at www.redatam.org.

Redatam and its applications aim to facilitate the production of population indicators based on varied data sources, thus supporting decision-making for different geographical levels, ranging from the entire country down to the local entity. The characteristics of this program make it suitable for identifying the population and its specific features. The user can define whole areas or small units such as a set of aggregate districts, a group of urban blocks or an entire rural sector. Based on the selection, and using the basic information (censuses, surveys), it is possible to determine not only the characteristics of the population that was living in those areas, but also the characteristics of their housing.

These results are used to project the population or to estimate its growth at the date of the disaster, using the formulas described above.

(b) Availability of cartographic data

The countries of the region are increasingly using digital cartography to represent and study the physical and socioeconomic aspects of the territory and the population living in it. The analysis of a natural disaster should use the cartography that best represents the aspect to be studied, depending on the sector analysed (transport, crops, housing, coastline, morphology, human settlements, villages, cities etc.). In many cases, this basic national cartography comes from national geographical institutes, but it is also possible to find maps of the smaller political/administrative divisions in each country's national statistical office. In addition, sector-level maps can be found in the respective ministries. At the local level, a territorial information system may have been created in the municipalities themselves. These resources jointly represent a rich source of territorial information, because they not only have the basic cartography but also contain a lot of sector-level data. Another source of digital cartography is the Google Earth web tool, which combines the power of Google searches with satellite images, maps, land areas and 3-D buildings, to make a lot of geographical information on all countries available to any user.

The process of disaster assessment includes determining what material and basic cartography is available and how up to date it is.

Appendix 2 [39]

Although the population exposed to a natural disaster experiences human and material losses, the potential psychosocial impacts also need to be analysed. In the post-earthquake survey carried out in Chile in 2010, the Davidson Trauma Scale (DTS) was used, which uses measurements ranging from 0 to 136 points. To determine the population displaying post-trauma stress three months after the occurrence of the disaster, the cut-off point was set at 40 points.[40]

Table A.III.1 shows that in the zones affected by the earthquake that struck Chile on 27 February 2010, roughly 11.8% of the population over 18 years of age reported suffering from post-traumatic stress. The largest proportion of those displaying the symptoms are women. Table A.III.2 shows that the effect is slightly greater in the rural zone.

Table A.III.1
Chile: population over 18 years of age displaying post-traumatic stress symptoms
(Percentages)

Region	Men	Women	Total
Valparaíso	4.1	10.4	8.4
Libertador B. O'Higgins	11.9	26.7	21.5
Maule	11.5	23.8	19.7
Biobío	15.8	28.1	24.0
Araucanía	4.8	14.5	11.2
Metropolitan	2.9	8.0	6.4
Total	6.6	14.4	11.8

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of O. Larrañaga and R. Herrera, *Encuesta post terremoto: principales resultados. Efectos en la calidad de vida de la población afectada por el terremoto/tsunami*, Santiago, Chile, United Nations Development Programme (UNDP)/ Ministry of Planning of Chile, 2010.

Table A.III.2
Chile: population over 18 years of age displaying post-traumatic stress symptoms, by zone
(Percentages)

Region	Urban	Rural	Total
Valparaíso	8.5	7.2	8.4
Libertador B. O'Higgins	21.8	20.7	21.5
Maule	19.1	21.1	19.7
Biobío	25.5	16.6	24.0
Araucanía	12.8	8.1	11.2
Metropolitan	6.4	3.2	6.4
Total	11.5	14.3	11.8

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of O. Larrañaga and R. Herrera, *Encuesta post terremoto: principales resultados. Efectos en la calidad de vida de la población afectada por el terremoto/tsunami*, Santiago, Chile, United Nations Development Programme (UNDP)/ Ministry of Planning of Chile, 2010.

[39] See Contreras (2012).
[40] See Larrañaga and Herrera (2010).

An analysis of the impact by 2009 income level shows that people in the lower income quintiles were more likely to display post-traumatic symptoms. Table A.III.3 shows that 13.6% of the population in the lowest income quintiles had such symptoms, compared with 8.9% of the population in the top income quintile.

Table A.III.3
Chile: population over 18 years of age displaying post-traumatic stress symptoms, by 2009 income quintile [a]
(Percentages)

	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Total
Valparaíso	9.6	8.4	9.8	7.5	7.0	8.4
Libertador B. O'Higgins	22.9	21.6	27.7	21.2	15.7	21.5
Maule	25.2	22.9	19.3	17.6	16.0	19.7
Biobío	29.7	25.4	27.6	21.8	17.8	24.0
Araucanía	13.6	12.1	9.2	14.0	8.0	11.2
Metropolitan	6.5	8.5	7.5	5.4	4.7	6.4
Total	13.6	13.6	13.4	10.9	8.9	11.8

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of O. Larrañaga and R. Herrera, *Encuesta post terremoto: principales resultados. Efectos en la calidad de vida de la población afectada por el terremoto/tsunami*, Santiago, Chile, United Nations Development Programme (UNDP)/ Ministry of Planning of Chile, 2010.
[a] Total household per capita income in 2009, by region.

This is reflected in the higher demand for mental-health assistance. In the Maule region, one of the worst affected zones, consultations rose by roughly 17% in February 2010 compared to the same period in the previous year (see table A.III.4).

Table A.III.4
Chile, Maule region: primary care mental-health consultations

Year	January	February	March	April	May	June
2008	9 487	9 581	10 408	12 360	10 134	12 446
2009	10 330	9 128	12 376	12 794	12 182	13 836
2010	12 650	10 713	12 068	15 046	14 088	14 083

Source: Alberto Minoletti, "Sistematización de la experiencia de protección y cuidado de la salud mental del a población afectada por el terremoto y maremoto del 27 de febrero de 2010 en las regiones V a VIII de Chile", Santiago, Chile, Pan American Health Organization (PAHO)/World Health Organization (WHO), 2010.

It is also important to take account of the effect of the natural disaster on pregnant women and on the development of the unborn child. International evidence shows that alterations during the intra-uterine period have an impact on the child's development and his or her long-term performance. Torche and Kleinhaus (2011) analysed the effect on pregnant women exposed to the earthquake in Tarapacá, Chile, in 2005, considering the weight of the child at birth and his or her gestational age. They found evidence that the number of premature and low-birthweight babies increased significantly in the affected zone, compared to the number recorded in other parts of the country.

IV. Education

A. Introduction

The education sector encompasses educational services provided by either the public or the private sector, at all levels and for any profession. The activities in question may be oral or written, and may be broadcast by radio and television or through other media. The sector also includes adult education imparted by the various institutions of the general education system at different levels, including basic literacy programmes, among others. It embraces military schools and academies and prison schools at their respective levels.

B. Damage

Disaster damage in the education sector involves the destruction or partial impairment of its various assets: buildings, furnishings and equipment, books and other education material. The procedure for estimating damage in this sector is as follows:

1. Compilation of pre-disaster information to ascertain the sector's assets

This includes:

- Buildings. The number of buildings and the number of classrooms in the sector in the affected area, classified by:
  - Urban or rural.
  - Public or private ownership. Publicly-owned buildings can be grouped according to the government level (national, departmental or municipal) that finances them.
  - Education level (primary, secondary or middle, technical-vocational, university).
  - Size, in terms of both the number of students enrolled in each school and the number of teachers working in them.

It is also important to obtain information on the quality of the premises, based on the type of construction materials used (for example, adobe, wood, brick, concrete), the age of construction and its state of repair.

- Furnishings and equipment. The furnishings category includes tables, cupboards, desks and chairs. Equipment includes computers, audio and projection equipment, instruments and other items used for educational purposes (for example, instruments and materials in laboratories and manual workshops, and sports implements) which are generally itemized in inventories.
- Education materials. These include textbooks, exercise books and other utensils.

Information on the number of buildings can be obtained by consulting national public and private organizations. The information will need to be verified and completed in meetings held with institutions such as: [41]

- The Ministry of Education
- Regional and municipal governments
- Other institutions responsible for coordinating different education levels
- Religious entities and private-school associations

2. Estimating the damage

An estimate needs to be made of the number of education facilities affected in each of the categories mentioned, that is, urban and rural, public or private ownership, and education level. This information may come from the aforementioned institutions if they have already worked on this task. It is advisable to contact different agencies because the sources may vary for each education level.

To estimate the damage to buildings, valued at the cost of replacing them with characteristics similar to those of the original design, information is required on the extent of surface area destroyed or damaged, the age of the building,[42] and the construction cost per square metre for a given type of building.

The damage can be estimated using a scale running from zero (no damage) to four (total destruction). To express these damage levels in value terms, the average construction cost per square metre needs to be obtained for the different types of buildings, as previously defined, in the affected area prior to the disaster. As the value might differ between rural and urban zones, it is important to ensure that the square-metre construction cost used is not a national average or local historical averages.

Next, these updated average costs for the affected localities are multiplied by the number of square metres of building damaged, and by the levels indicated on the aforementioned scale. This procedure must be applied to each type of facility.

Replacement cost must also be used to estimate the damage to furnishings, equipment and education material. If an itemized inventory of these assets is not available, recent information on the equipping of new schools of different sizes and types similar to the schools affected can be used.

Lastly, the total damage can be estimated by adding together the damage estimates for all asset categories.

C. Losses and additional costs

In this sector, the affected flows include a reduction in output, measured in terms of the number of hours or days of classes taught. Additional costs include all outlays needed to restore the education service. The steps to be taken in valuing these categories are as follows:

41 The team estimating the impact of the disaster should ideally include officials from these institutions.
42 See point 6 of chapter II for a discussion of the importance of this information.

1. Compilation of pre-disaster information

The aim is to ascertain various characteristics of the flows of the sector in the affected zone, including time series of the following variables:

- Number of students by education level.
- Number of teachers by education level.
- Number of classes taught by education level (this indicator may be hard to obtain, but it is important, as will be seen below).
- Average costs of private education at the different levels.

This information must be compiled with a breakdown between public and private, particularly focusing on those relating to the current year.

The information may be obtained from the institutions mentioned in the previous section. The national statistical office will need to be added to the list of sources, along with family expenditure and budget surveys, and surveys undertaken to define the CPI consumption basket.

2. Estimation of flows

As a result of a disaster, the sector's gross output value may vary for the following reasons:

(a) Lower production

This is hard to measure, because in most of the region's countries the national accounts of the education sector are based on input costs, in other words employee compensation and intermediate consumption, rather than production indicators, as explained in box IV.1.

Box IV.1
Public and private education in national accounting

Public education

Public education, or education provided by non-profit institutions, does not have market prices. As such, the gross "output" value (GrOV) must be calculated from the sum of its costs, pursuant to international recommendations on national accounting.[a] The fundamental costs are divided into intermediate consumption (IC) and compensation of employees (CE).

GrOV=IC+CE (1)

Intermediate consumption includes costs such as public utilities, maintenance, transport, paper, and printed material. Compensation of employees includes wages and salaries, plus other staff emoluments and social security contributions.

In national accounting, gross value added (GVA) is defined as:

GVA=CE+Iin+GOS (2)

where:

Iin: Taxes on production and imports net of subsidies; GOS: Gross operating surplus. The two latter concepts relate to market activities carried out by productive agents, which is not the case of public education, so:[b]

GVAPublic Educ. =CE (3)

Private education

The production account of the activity "private education" quantifies the education service provided at an economically significant price; in other words, it is market production, supplied to the household sector as consumers.

The gross output value is calculated in the same way as for public education, but value added is calculated using (2) instead of (3).

Appendix 1 illustrates these concepts as they are implemented in most countries of the region.

Source: Economic Commission for Latin America and the Caribbean (ECLAC).
[a] See Eurostat (2001).
[b] This is a detail to take into account because, in national accounting, gross value added and compensation of employees appear in different accounts (production account and income generation account, respectively), so their "linear allocation" might be surprising.

To understand this, a comparison can be made with the agriculture sector, for example, specifically with the maize growing subsector. On the production side, the gross output value can be estimated by multiplying the number of metric tonnes harvested by the product's price. From another standpoint, this would be equal to the value of the

inputs used, in other words intermediate consumption plus factor payments. In the case of the education sector, the gross output value is estimated by the second method only; the first cannot be used because there are no volume indicators, and in the case of public education there is no market price.

This second method has the problem, as noted in appendix 1, that if employees continue to be compensated in the public sector, a disaster would not affect the sector's gross output value. This could be seen as paradoxical, and would explain why, in the system of national accounts, the effects of a disaster on the education sector will not be captured. In contrast, if overtime is paid or additional teachers are hired during the period in which classes are recovered, the sector's gross output value could even increase. Accordingly, it is advisable to use relevant volume indices when estimating the impact on education.

For that purpose, the output of this sector can be defined as the "quantity of teaching received by the students, adjusted to allow for the quality of the services provided for each type of education." [43] One way to make this definition operational is to use the number of hours for which students receive classes as an indicator of the quantity of education received. In this sector, it is important to distinguish between output and outcome. The first relates to the transfer of knowledge, whether successful or not, while the second refers to the knowledge that is actually acquired by the students.

Note that, following a disaster, output could fall either as a result of a reduction in the number of hours of classes taught, or because of a reduction in their quality. If, for example, it is decided to shorten the school year, this would mean fewer hours of classes, and therefore less output. In terms of quality, this is incorporated in the definition of output[44] so it can be used to calculate the drop in production. This is so because, although following the disaster the hours or days of classes lost can be recovered, which would leave output unchanged, it is reasonable to suppose that those hours of classes given under suboptimal conditions —for example, in temporary schools, in confined premises and more concentrated schedules to accommodate the institutions affected, or by the fact of recovering the weeks lost in other classes and other circumstances— are of inferior quality than those given prior to the event.[45] For example, in appendix 2, the data obtained from a processing of the post-2010 Chilean earthquake survey show the percentages of students who report having started classes one or two months after the normal start of the school year, with a breakdown by affected region, education level, type of education, and income quintile. The data also report the number of students who transferred to another school, and the percentage of schools that moved to another site following the event (Contreras, 2012). Each of these events–postponement of the school year and change of school, with the staffing allocations that this could imply; use of alternative premises for educational establishments–and others provide a less-than-optimal setting for the education process, so its quality will be reduced, adversely affecting the relationship between output and outcome.

Two consequences of these arrangements relate, first, to the reduction in the length of class hours (for example, the normal 45 minutes are cut to 30), and hence its higher cost; and, second, to an increase in the grade failure rate. The first is calculated on the basis of the value of the class hour, which increases as the number of minutes is reduced (33.3% in the example given). The second effect mentioned aims to project the increase in the grade repetition rate based on a comparison of historical data. In this case, relevant indicators are those held by education entities on the per student cost at different education levels. Repetition constitutes a 100% increase in the cost per student, which, in the case of public education is borne by the State, and in private education by families.

The argument made in the foregoing paragraph raises the need to make a quality adjustment, which requires investigating which solutions have been implemented to organize the education process in the area in question: reduction of class time, extra classes and others. For this purpose, it is useful to have data on the percentage of the student population that experience a delay in classes (the number of days lost), or who transfer to another school; or the percentage that continued in the same school but on a different operating site, with a consequent reduction in teaching time.

Obviously, there is no single method for estimating the loss of quality. This should be done jointly with the national accounts expert of the macroeconomic group and with the statistical institute of the affected country, because,

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43 See Eurostat (2001).

44 The "measurement" of quality is a controversial topic owing to the number of indicators that could be used, which can be either outcome- or output-based.

45 In addition, a large proportion of the students might be living in shelters or temporary housing.

despite estimating education output by the cost of its inputs, these institutions might have certain unpublished quality-adjusted production indicators. Eurostat (2001) should be consulted for a review of different indicators, with the aim of making the quality adjustment and thus estimating the impact of a natural disaster on production in the education sector.

In summary, the reduction in the number of class hours received needs to be accounted for both in terms of the shorter school year and the reduction in quality.

(b) Additional costs

These costs could result in higher intermediate consumption of both public and private education for different reasons, including:

(i) The outgoings that have to be made to restore the education service in temporary premises, while the school buildings that were destroyed are being rebuilt. These costs could include temporary rental of premises or the installation of tents or mobile schools. To estimate these expenses, the following methodology is suggested:

- Ascertain how many temporary schools have been set up and how many have been rented.
- Ascertain the rental amount per establishment.
- Estimate the number of months for which such premises are likely to be operating.
- To obtain the total outlays, multiply these three values, and include the purchase of furniture and the education material needed for teaching activities,[46] which should be proportional to the number of classrooms set up.

(ii) The expenses that have to be incurred to convert schools that were used as temporary shelters for people affected by the event. This damages the facilities in question because they were not designed for such purposes. The repairs in question normally include works such as replacing windows and sanitary services, repainting walls, and purchasing or repairing furniture.

The sum total of these expenses represents the increase in the sector's intermediate consumption. It is important to maintain accounts by type of school (private or public) and by government level to which it is attached (municipal, departmental or national). The source of financing also needs to be recorded. As emphasized in chapter II, the domestic component of this intermediate consumption is positive for other sectors of the economy, such as construction. This will be illustrated in appendix 1.

The example described in appendix 1 also clarifies the difference in treatment between public and private education; the sources to be consulted and also the procedure for consistently recording the increase in intermediate consumption and, in the case of private education, the consequent drop in operating profits.

D. Financial needs for recovery and reconstruction

As noted above, education is a service provided by both the public and private sectors, so the latter could need financial support from the former to undertake recovery and reconstruction tasks.

1. Financial needs for recovery

The financial needs of recovery consist of the sum total of the costs of various policies that aim to seek the sector's operating costs over and above the cost under no-disaster conditions, during the period in which the infrastructure is being rebuilt and the equipment damaged by the disaster is being replaced, when temporary facilities are generally used to provide the service.

[46] If the furnishings and/or educational material were not destroyed, the costs of transferring them to provisional education facilities need to be accounted for.

Restoring the service is a top priority, even if in temporary facilities, since education is a basic service and its resumption shows that life in the locality is returning to normal.[47] Moreover, in many countries, schools are used as centres for distributing assistance, which may include special post-disaster vouchers, and thus form part of social policy.

Important information to collect and consolidate includes the number of students whose schools were affected by the disaster. It is also necessary to identify the number of classrooms that were not damaged and which could rapidly be recovered.

The recovery process should include:

- Rapid repairs to schools that display nonstructural damage or were used as shelters.
- The rental of sites to set up temporary schools.
- The establishment of temporary makeshift schools in tents or mobile homes.
- The institution of a double shift, a temporary increase in the number of students per class or a combination of both measures so as to serve the needs of students whose schools were damaged.

The first three involve additional financial costs; in the first case, associated with all the expenses that have to be incurred for the repairs, purchase of replacement furniture and educational material; the second and third involve outgoings relating to the rental or purchase of tents and the purchase of school furniture and education materials. The main impact of the last alternative is the reduction in the quality of education, owing to a higher student/teacher ratio.

The need for provisional facilities to have school canteens should not be neglected, since this is important for monitoring both the nutrition and the health of the school population after the event.

2. Financial needs for reconstruction

The financial needs for reconstruction are equivalent to the estimated value of the damage caused to existing assets, plus the additional cost of making quality improvements, renewing technology and adopting measures to reduce disaster risk. The latter could include stricter regulations on school design and construction, the relocation of certain assets to safer zones, and the implementation of flood protection and other similar works. Accordingly, the cost of the reconstruction needs will invariably be higher than the value of the damage caused to existing assets.

Given the importance of young people and human capital formation to society, all possible efforts should be deployed to ensure that the new buildings which replace those destroyed incorporate all elements of disaster-risk reduction, to make them less vulnerable to future events. This could include the reinforcement of structures and the stabilization of zones affected by landslides, and the installation of early-warning and evacuation systems in school premises. Such risk-prevention elements should also be included in buildings that were in the affected area but escaped damage.

In cases where schools have to be relocated, there will be additional expenses to cover:

- The cost of the land where the new school premises will be built.
- The cost of installing and providing water, sewerage, electricity, telecommunications services, etc., when these are not already available at the chosen site.
- The cost of transporting furnishings and education materials.

[47] One significance of this is the support provided to the adult female population affected by the disaster, who will be able to resume their economic activities and thus their income (see the chapter on gender).

Appendix 1
Damage, losses and additional costs of a disaster and the national accounts

A. Pre-disaster situation

In a "small" country of 14,483 inhabitants, 20% of its population attend school. Two types of education are distinguished in terms of the governing entity: publicly-run education and privately-run education.

School enrolment had been growing at a sustained pace, mainly among children of primary- and secondary-school age. It was not possible to obtain any gender statistics or an urban-rural breakdown.

The total student population is 2,886 in the three levels. The enrolment is distributed 32.2% in privately-run institutions and 62.8% in publicly-run schools,[48] as shown in table A.IV.1).

Table A.IV.1
Data on educational facilities, teachers and students, by management sector

	Public management			Private management		
	Establishments	Teachers	Students	Establishments	Teachers	Students
Primary schools	4	50	680	3	35	420
Secondary schools	6	75	854	5	52	386
Universities	2	30	423	1	16	123
Total		155	1 957		103	929

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

1. Aggregates of the public education sector

Intermediate consumption, which includes fungible goods or services used to provide the education service, is calculated from the administrative records kept by the Ministry for the Public Budget for publicly run establishments.[49] Intermediate consumption is expressed in monetary units (MU).

Tables A.IV.2 and A.IV.3 provide breakdowns of expenditure in the public education system; nonetheless, in addition to consumption and wage items, several others need to be recorded: thus, "interest paid" is classified as property rental paid, and "grants" in current transfers, etc.

[48] Mixed management regimes are not included, such as public education establishments that are privately run, or those operated by foreign foundations, religious congregations, etc. Nonetheless, the treatment should be similar to the public management regime.

[49] Care should be taken to avoid allocating to "intermediate consumption" expenditure accounts that only share the characteristic of being "non-wage".

Table A.IV.2
General expenses, institutions under public management
(Monetary units)

Water	1 800
Electricity	2 600
Telephone	3 200
Internet	1 500
Maintenance	4 000
Printing	1 200
Paper	3 600
Markers	1 580
Transport	1 600
Total inputs	21.080

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

The source noted above provided the item compensation of employees (consisting of the budgetary items wages and salaries, other staff payments, and social security contributions).

Table A.IV.3
Compensation of employees, institutions under public management
(Monetary units)

Primary schools	1 800
Secondary schools	2 500
Universities	1 400
Total	5 700

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

The gross output value of schools run by the state sector is estimated using the method described above in box IV.1.

Table A.IV.4
Production account for the publicly managed education sector
(Monetary units)

Uses		**Resources**	
Intermediate consumption	21 080	Gross output	26 780
Gross value added	5 700		
Total uses	26 780	Total resources	26 780

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

The second account, income generation of public education, only includes the "identity" employee compensation = value added, for the reason noted above.

Table A.IV.5
Income generation account for the publicly managed education sector
(Monetary units)

Uses		Resources	
Compensation of employees	5 700	Gross value added	5 700
Net taxes on production and imports			
Gross operating surplus	0		
Total uses	5 700	Total resources	5 700

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

2. Aggregates of the private education sector

Private education can be analysed through the accounting statements of privately run schools, which in several cases are set up as non-financial corporations, and in others operate as de facto companies, although they are often subject to some control.

The sources used are the balance sheets filed with the entity that supervises non-financial companies, some oversight office of the Ministry of Education or, ultimately, the National Tax Office.

Intermediate consumption is calculated from those sources and from the "General expenses" item. As in the case of public education, the production account and income generation account are both evaluated. The difference between the two subsectors lies in the valuation of gross output, which, in the private education service, is equal to its sales (for services, there are no inventories of what is produced— in this case education).[50]

Table A.IV.6
General expenses, institutions under private management
(Monetary units)

Water	2 340
Electricity	3 380
Telephone	4 160
Internet	1 950
Maintenance	5 200
Printing	1 560
Paper	4 680
Markers	2 050
Transport	2 080
Total inputs	27 400

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

50 "Education" does not include activities whose main purpose is leisure, even if they use the name "school".

Table A.IV.7
Compensation of employees, institutions under private management
(Monetary units)

Primary schools	2 400
Secondary schools	4 500
Universities	2 200
Total	9 100

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

In this calculation, the sequence is the reverse of that followed for the income generation account in the state sector (employee compensation was known, which was obtained from the following account and were equivalent to value added). In this account, gross value added is a balance (common procedure), namely the difference between gross output value and intermediate consumption (see table A.IV.8).

Table A.IV.8
Production account for the privately managed education sector
(Monetary units)

Uses		**Resources**	
Intermediate consumption	27 400	Gross output value	38 322
Gross value added	10 922		
Total uses	38 322	Total resources	38 322

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

The accounting records also show that private education has not received subsidies and has paid 450 MU in indirect taxes. Wages and other wage-related payments are shown in table A.IV.9. These data on indirect taxes and compensation of employees are transferred to the income generation account, from which the balance referred to as gross operating surplus (GOS) is obtained, the main components of which include the return on capital invested, or gross profit.

Table A.IV.9
Income generation account for the privately managed education sector
(Monetary units)

Uses		**Resources**	
Compensation of employees	9 100	Gross value added	10 922
Net taxes on production and imports	4 500		
Gross operating surplus	1 372		
Total uses	10 922	Total resources	10 922

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

B. Occurrence of a disaster and estimation of its effects and impact

A natural disaster has occurred in the country, and education is one of the sectors affected. The mission specialist compiles the information described below, in conjunction with the national authorities. Several buildings suffered fallen masonry and damage to electrical installations, which led the government to suspend classes until further notice. As a result, more than 20% of the population (about 300 teachers and 2,886 students) halted their activities. An initial estimation shows that the disaster caused damage amounting to 12,000 MU, of which 8,000 MU occurred in public institutions and 4,000 MU in private schools.[51] Everything is to be recovered in the current year. This assumption is important because, in this example, the damage is considered as additional cost.

1. Impact on public education

Based on the conventional national accounts methodology, these effects are described as follows:

Table A.IV.10
Production account of the education sector: impact on publicly managed institutions
(Monetary units)

Uses		Resources	
Intermediate consumption	21 080	Gross output value	26 780
Intermediate consumption, differential	8 000	Gross output value, differential	8 000
Intermediate consumption, subtotal	29 080	Gross output value	34 780
Gross value added	5 700		
Gross value added, differential	0		
Total uses	34 780	Total resources	34 780
Differential	8 000	Differential	8 000

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

As shown in Table A.1V.10, the increase in intermediate consumption causes an equal increase in production, because the gross output value is obtained as the sum of costs. As wage-earners pay has not been changed, the value added remains unaltered. If the teachers in the sector have not worked on other support tasks, but have maintained their pay despite classes being suspended, there would be a reduction in productivity.

On the other hand, if, in the immediate future, extra schooling is required to enable the student population to recover the suspended classes, and if this is unpaid, there would be a recovery of productivity and a "current transfer in kind" across households (from teachers to students). In contrast, if overtime is payable for those recovery tasks, there will be an increase in government production, as a counterpart of the value added.

The income generation account remains unchanged.

[51] In this case we will not consider the origin of the funds to finance these additional expenses, because we are focusing on the differential effect on the sector's accounts.

Table A.IV.11
Income generation of the education sector: impact on impact on publicly managed institutions
(Monetary units)

Uses		Resources	
Compensation of employees	5 700	Gross value added	5 700
Compensation of employees, differential	0	Gross value added, differential	0
Net taxes on production and imports			
Gross operating surplus			
Total uses	5 700	Total resources	5 700
Differential	0	Differential	0

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

2. Impact on private education

In the case of privately run institutions, the damage was estimated at 4,000 MU. In addition, following the disaster, the schools cease to receive the monthly fee but continue to pay compensation to their employees; in other words, they assume the operating costs after the disaster. This is included as part of intermediate consumption.

Table A.IV.12
Production account of the education sector: impact on privately managed institutions
(Monetary units)

Uses		Resources	
Intermediate consumption	27 400	Gross output value	38 322
Intermediate consumption, differential	4 000		
Intermediate consumption, subtotal	31 400		
Gross value added	10 922		
Gross value added, differential	-4 000		
Gross value added, subtotal	6 922		
Total uses	38 322	Total resources	38 322
Differential	0		

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

This reveals the difference with respect to public education; in this case, expenses are recorded directly in intermediate consumption, without a symmetric contribution in production, which means that this additional expense is absorbed by value-added. In other words, the natural phenomenon caused this variable to decrease by an amount equal to the additional costs generated by the disaster.

Table A.IV.13
Income generation of the education sector: impact on privately managed institutions
(Monetary units)

Uses		Resources	
Compensation of employees	9 100	Gross value added	10 922
Net taxes on production and imports	450	Gross value added, differential	-4 000
Gross operating surplus	1 372		
Gross operating surplus, differential	-4 000		
Gross operating surplus, subtotal	-2 628		
Total uses	6 922	Total resources	6 922

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

The gross operating surplus, which initially was positive in the amount of 1,372 MU, now reports a negative value of -2,628 MU when the expenses caused by the disaster are taken into account.

To summarize, the impact of the damage would be 12,000 MU; value added in the public sector is unchanged, but value-added in the private sector is reduced by 4,000 MU.

Appendix 2 [52]

The damage to educational establishments makes it necessary to postpone classes or generates abnormal situations for the education process, which could lead to fewer teaching hours and lower quality education.[53]

In the specific case of Chile, the post-2010 earthquake survey shows that students suffered a delay in starting classes, and in some cases they had to transfer to another school or move into temporary premises (Larrañaga and Herrera, 2010). The zone-by-zone analysis reported in table A.IV.14 shows that the largest proportion of students starting classes late because of the earthquake were living in rural areas. This could be because construction quality in rural zones tends to be poorer than in urban areas, which directly intensifies the impact of natural disasters on the corresponding infrastructure.

Table A.IV.14
Chile: students for whom the start of classes was postponed as a result of the earthquake or tsunami, by urban or rural zone
(Percentages)

Region	Urban	Rural	Total
Valparaíso	6.4	4.3	6.2
Libertador B. O´Higgins	12.7	13.7	13.0
Maule	71.3	78.2	73.2
Biobío	79.2	82.3	79.6
Araucanía	7.6	4.8	6.8
Metropolitan	9.3	10.1	9.3
Total	23.1	37.1	24.5

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of Dante Contreras, "Efectos microeconómicos de los desastres naturales", Santiago, Chile, Economic Commission for Latin America and the Caribbean (ECLAC), 2012, unpublished.

In the unaffected regions, only 1.0% report having had the start of classes postponed or classes interrupted as result of the disaster.

Table A.IV.15 shows that the impact of the disaster cut across all school levels in the affected zone; but, table A.IV.16 shows that public education facilities had the highest percentage of students entering classes as from April (the earthquake occurred in February), which could be a reflection of the quantity and quality of resources and infrastructure in those schools.

Table A.IV.15
Chile: students for whom the start of classes was postponed as a result of the earthquake or tsunami, by education level
(Percentages)

Region	Preschool	Primary	Secondary	Higher	Total
Valparaíso	6.9	5.2	6.3	8.3	6.2
Libertador B. O´Higgins	11.2	11.3	12.7	21.4	13.0
Maule	67.4	74.6	75.3	72.3	73.2
Biobío	79.9	79.5	81.4	77.1	79.6
Araucanía	11.1	4.1	5.9	13.0	6.8
Metropolitan	9.1	8.3	10.6	10.0	9.3
Total	24.6	24.6	24.7	24.1	24.5

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of Dante Contreras, "Efectos microeconómicos de los desastres naturales", Santiago, Chile, Economic Commission for Latin America and the Caribbean (ECLAC), 2012, unpublished.

[52] This appendix is based on Contreras (2012).
[53] The analysis considered the population of 0-24 years of age that reported attending some educational establishment in 2010.

Table A.IV.16
Chile: students for whom the start of classes was postponed as a result of the earthquake or tsunami, by type of education
(Percentages)

Region	Public [a]	Subsidized private [b]	Private [c]	Total
Valparaíso	6.2	6.0	6.7	6.2
Libertador B. O´Higgins	15.3	6.3	17.4	13.0
Maule	76.8	68.4	68.8	73.2
Biobío	83.3	75.9	76.4	79.6
Araucanía	7.6	4.5	9.9	6.8
Metropolitan	10.1	9.3	8.4	9.3
Total	29.4	21.0	21.0	24.5

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of Dante Contreras, "Efectos microeconómicos de los desastres naturales", Santiago, Chile, Economic Commission for Latin America and the Caribbean (ECLAC), 2012, unpublished.
[a] Institutions administratively attached to the municipalities, the National Board for Nursery Schools (JUNJI) and the INTEGRA Foundation.
[b] Subsidized private, corporations of delegated administration, other schools receiving a state subsidy.
[c] Unsubsidized private, nursery schools, or crèches at the mother or father's workplace, university affiliated to the Council of Rectors, private university, professional institute, technical training centre.

Based on the income levels prevailing in 2009, table A.IV.17 shows the proportion of students starting classes late is broadly homogeneous across household income brackets; nonetheless, the wealthiest quintile reports a smaller percentage.

Table A.IV.17
Chile: students for whom the start of classes was postponed as a result of the earthquake or tsunami, by 2009 income quintile
(Percentages)

Region	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Total
Valparaíso	5.2	5.0	11.9	6.0	3.3	6.2
Libertador B. O´Higgins	18.6	12.1	9.8	13.3	8.1	13.0
Maule	72.0	76.0	71.6	82.2	64.4	73.2
Biobío	84.3	81.6	75.7	77.0	76.8	79.6
Araucanía	5.7	9.6	4.6	8.9	5.6	6.8
Metropolitan	9.6	9.4	12.3	8.5	5.4	9.3
Total	25.4	24.7	24.9	25.6	20.9	24.5

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of Dante Contreras, "Efectos microeconómicos de los desastres naturales", Santiago, Chile, Economic Commission for Latin America and the Caribbean (ECLAC), 2012, unpublished.

While natural phenomena cause delays or interruption to classes, it is also likely that a proportion of students will have to change school, owing to the partial or total destruction of existing facilities, or even the destruction of roads giving access to them. In the case of Chile, table A.IV.18 shows that just 4.0% of the total number of students in the affected regions reported having changed school as a result of the natural disaster, although this figure was higher in rural areas.

Table A.IV.18
Chile: students reporting having changed school as a result of the earthquake or tsunami, by urban or rural zone
(Percentages)

Region	Urban	Rural	Total
Valparaíso	1.5	2.8	1.6
Libertador B. O´Higgins	6.8	7.5	7.0
Maule	7.8	12.5	9.1
Biobío	7.1	6.9	7.0
Araucanía	1.3	2.3	1.6
Metropolitan	2.9	1.3	2.9
Total	3.7	6.1	4.0

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of Dante Contreras, "Efectos microeconómicos de los desastres naturales", Santiago, Chile, Economic Commission for Latin America and the Caribbean (ECLAC), 2012, unpublished.

Of students who said they were attending classes in the unaffected zones, just 2.4% moved to another school as a result of the earthquake or tsunami.

Following a natural disaster, infrastructure damage means that some schools become partially or totally unusable, so alternative solutions have to be found to avoid further delay to the start of classes. Table A.IV.19 shows that 10.9% of students reported that some other institution was housing their school.

Table A.IV.19
Chile: infrastructure currently housing the educational institution
(Percentages)

Region	Same premises as in 2009	Other solution [a]	Total
Valparaíso	93.5	6.5	100
Libertador B. O´Higgins	89.2	10.8	100
Maule	86.7	13.3	100
Biobío	89.9	10.2	100
Araucanía	90.2	9.8	100
Metropolitan	87.8	12.2	100
Total	89.1	10.9	100

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of Dante Contreras, "Efectos microeconómicos de los desastres naturales", Santiago, Chile, Economic Commission for Latin America and the Caribbean (ECLAC), 2012, unpublished.
[a] Sharing premises with another school, government buildings, private spaces, modular school, tent school, other.

V. Health

A. General considerations

The health sector is that set of values, standards, institutions and agents engaged in the production, distribution and consumption of goods and services, the principal or exclusive objectives of which are to protect and promote the health of individuals and population groups. The activities that these institutions and agents pursue are geared to: (i) promoting health and preventing illness; (ii) curing illnesses and reducing premature mortality; (iii) providing care to persons suffering from chronic diseases that require medical attention; (iv) offering care to persons with limitations in terms of health, disability or temporary incapacity who require medical attention; (v) delivering and administering public health services; (vi) delivering and administering health programmes, health insurance and other arrangements for financial support; and (vii) health-related research and training.

1. Health functions

Health functions are classified as follows:

(i) Curative care services: their purpose is to alleviate the symptoms of illness or injuries, to reduce their severity or to provide protection against exacerbation and complications, which can threaten life or normal functions.

(ii) Rehabilitation services: these are targeted at improving and maintaining functionality for persons with disabilities, with a view to ensuring the best possible quality of life and their inclusion in the community and society.

(iii) Palliative and long-term care services: these comprise a broad range of medical and personal care services to alleviate pain and suffering, and to provide support in daily activities for patients with a degree of chronic dependency.

(iv) Auxiliary health-care services: this heading includes services that are not directly linked to any of the three functions described in the previous paragraphs. They cover services that the patient consumes directly during independent contact with the health system. They include laboratory services, diagnostic imaging, and assisted transport for sick or injured patients.

(v) Medical products: this item comprises products that are not related to curative services, rehabilitation and long-term care. It includes products that are consumed directly by the patient through independent contact with the health system, or purchased by the patient when they are not available through care services. It

encompasses pharmaceutical products and other perishable medical goods as well as therapeutic devices and other non-perishable medical products.[54]

(vi) Public health and prevention services: the purpose of these services is to avoid or reduce the number or severity of illnesses or injuries, through primary and secondary prevention. Primary prevention refers to specific health measures for avoiding illness and risk factors; they are designed to confine epidemic outbreaks, reduce the number of new cases, anticipate emergencies and reduce the severity of illnesses, through vaccination for example. Secondary prevention encompasses specific measures for the detection and early treatment of illnesses, for example medical screening procedures. Health and prevention services include the following:

- Information, education and counselling: strategies and methods to ensure that individuals, families, groups, organizations and communities play an active role in protecting and maintaining their own health by changing their practices and habits.
- Immunization programmes: these are intended to prevent the development of disease, before or after exposure, through the use of pharmaceutical products such as vaccines. They include resources for specific campaigns and for running ongoing programmes.
- Programmes for early detection of diseases: these involve a set of organized activities among at-risk groups, for actively seeking out a disease in its initial phase, before symptoms appear. They include early detection studies, diagnostic tests and medical examinations for communicable and non-communicable diseases.
- Programmes for monitoring health conditions: these involve watching for specific conditions such as pregnancy, monitoring specific age groups (infants, schoolchildren), and specific health fields (reproductive health, oral health, etc.).
- Epidemiological surveillance and risk and disease control programmes. These include surveillance of epidemic outbreaks, patterns of non-communicable diseases and injuries, and research into control activities.
- Disaster preparedness and emergency response programmes: these consist of measures for providing appropriate responses in the event of a humanitarian emergency. They include the capacity to acquire and distribute resources swiftly, as well as readiness to manage and refer large numbers of victims.

(vii) Governance, administration and financing of the health system: this includes the formulation and implementation of government health policies, standards-setting, regulation, certification, supervision of providers, funds management; as well as monitoring and evaluation of resources. These services are provided by public and private entities, by non-governmental organizations, and by private medical insurers.

2. Health providers

A distinction should be made between primary and secondary providers. Primary providers are those whose principal activity is to provide services and deliver goods for health care, such as doctors' offices, health establishments, laboratories and other relevant units. Secondary providers offer health services in addition to their main activities, for example: convalescent homes, businesses and organizations that offer on-site health-care services for their workers; shopping centres that include health posts, prisons, and so forth.

For purposes of this handbook, only the following primary providers will be considered:

(i) Hospitals: general, specialized and mental health hospitals.

(ii) Outpatient centres: doctors' and dentists' offices, offices of other health-care professionals, and outpatient centres.

(iii) Auxiliary services: patient transportation, emergency rescue, clinical laboratories, pathology laboratories, forensic medicine laboratories, emergency care centres, diagnostic imaging centres, and treatment and rehabilitation units.

[54] Note that what are considered here are the functions of the health sector in the broad sense, as a health ministry would understand them. It is not the intention to propose an impact assessment for each function within the health sector. Clearly, the function described under (iv) will involve the commercial sector and that under (v) the commercial and manufacturing sectors, while that under (vii) would fall within public administration.

(iv) Retailers and other suppliers of medical products: pharmacies (including those within hospitals serving outpatients primarily) and other providers.

(v) Preventive health providers: public health institutes or departments, epidemiological surveillance and disease control centres, infectious disease institutes, health promotion organizations and others.

(vi) Providers of health-care financing and administration: health ministries, social security, regional or local health units, health regulatory or supervisory agencies and other organizations.

B. Damage

The physical assets of the health sector include buildings with all their furnishings, specific equipment, patient transportation vehicles, as well as inventories of medicines, vaccines and medical inputs. Once damage has been estimated, it is important to detail the percentage of losses that will require imports.[55]

Damage to physical infrastructure can involve structural elements (beams, pillars, structural flooring, load-bearing walls, foundations, etc.) as well as non-structural or architectural elements (partitions, doors, windows, non-structural roofing and floors, interior and exterior walls, perimeter fences and so forth) and vital service connections (water, electricity, gas, oxygen, telecommunications systems).

These impacts may occur during the event, as in the case of earthquakes, or afterwards, as in the case of landslides following torrential rains in preceding days. In the case of slow-building or long-duration events, such as El Niño or La Niña climate phenomena, damage can occur over an extended period of time.

For the purposes of estimating damage to physical infrastructure, health providers' facilities are classified as:

(i) Buildings destroyed with no possibility of repair, and which must therefore be reconstructed after demolition and removal of rubble.

(ii) Buildings with serious damage that can nevertheless be repaired.

(iii) Buildings with minor damage.

To estimate the value of damage to physical infrastructure,[56] the following procedures will be used, depending on the case:

1. Buildings totally destroyed

(i) Count the number of buildings that have been totally destroyed and must be rebuilt.

(ii) Record the name of the building, its geographical location or address, its handling capacity, and its floor area in square metres.

(iii) Consult the project or infrastructure offices or the national construction association to determine the average cost per square metre of a new building with characteristics similar to the one destroyed, as of the time of the disaster.

(iv) Multiply the floor area in square metres by the cost per square metre of a new building, and record this figure as damage incurred. The figure thus calculated represents the cost of replacement with a building similar to the previous one. It does not include any improvements, or relocation to a safer zone. These two aspects are considered in the section of this chapter dealing with reconstruction.

(v) Add up the damages and losses for each health provider's building, differentiating by financing agent whenever possible.

[55] Appendix 1 presents a detailed example of the estimation of damage, losses and additional costs in the health sector.

[56] Note that estimates of damage to health facilities must be performed individually for each building, consistent with its specialized nature; one cannot resort to the definition of types of establishment as is done in the housing sector.

2. Buildings partially destroyed

(i) Count the number of buildings that have suffered serious or minor damage. Table V.1 illustrates how the health facilities of various providers of the Ministry of Health and Social Assistance of El Salvador that were affected by Hurricane Stan were identified.

(ii) Record the name of the building, its geographical location or address, and identify the affected elements and their dimensions, either in square metres (walls, roofs, cladding etc.), in linear metres (piping, perimeter fence etc.), or in units (doors, windows etc.).

(iii) Consult the infrastructure or physical resource services of the health ministry for the unit cost of repairing the affected elements. Ensure that the average cost of repair includes all elements such as materials, labour and administrative costs. In general, any intervention with respect to structural and non-structural elements will require a technical study of greater or lesser complexity, particularly for major repairs.

(iv) Calculate the cost of repairing each building: this will be equal to the total obtained from multiplying the dimensions of the affected elements by their unit costs.

(v) In some situations where detailed information is not available, the cost of repairs may be deemed equivalent to a percentage of the replacement value of the asset affected.

(vi) Add up the total cost of repairs needed for the health provider's building, differentiating them by financing agent.

It is also important to record damage to the contents of health facilities, for example the destruction of biomedical equipment and furnishings crushed during an earthquake, the destruction of medication inventories through water damage, or the deterioration of vaccines through loss of refrigeration as a result of power cuts during a disaster. In some cases, the affected items may be repaired and in other cases they will have to be replaced because of severe deterioration, physical contamination, or environmental exposure.

Estimating damage of this kind requires verification of:

(i) Biomedical equipment intended to be used on human beings for purposes of prevention, diagnosis, treatment and rehabilitation. Includes equipment and instruments used in care services.

(ii) Industrial equipment for hospital use, such as generators, sterilization equipment, boilers, refrigeration and air-conditioning equipment.

(iii) Computers and communications equipment that are part of the establishment's information and communications system.

(iv) Furnishings for administrative and operational use.

(v) Drugs and medical supplies, including vaccines and personal protection equipment used by health providers.

(vi) Vehicles for transporting victims and patients.

(vii) Equipment used for public health interventions, communications and coordination in the case of emergency or disaster.

For estimating the value of damage to health facility furnishings, equipment, vehicles, drugs and medical supplies, the following calculation procedure is used:

(i) List all goods damaged in each health sector facility affected, using as a basis for comparison the inventory of resources in place prior to the disaster. Distinguish those goods that can be repaired from those that must be replaced. It is recommended that goods be grouped according to the types listed in the previous paragraph. Consider also the contents of buildings destroyed, for which furnishings, equipment and other goods must be replaced.

(ii) Seek information on the cost of repairing the affected good, or its replacement cost. In this case, use the value shown in the inventory or data from health sector equipment projects.

(iii) Multiply the number of goods affected by their cost of repair or replacement, for each locale, and add up the repair and replacement costs to obtain the value of damage to the contents of health facilities.

(iv) Present the information differentiated by financing agent, public or non-public.

Table V.1
El Salvador: suppliers of the ministry of public health and social assistance affected by Hurricane Stan, by department, 2005

Departments	Hospitals			Health units			Casas de Salud		
	Total	Affected	Percentages	Total	Affected	Percentages	Total	Affected	Percentages
Total	23	4	17	323	91	28	142	3	2
Ahuachapán	1	-	-	21	2	10	6	-	-
Chalatenango	2	-	-	37	18	49	10	-	-
Cuscatlan	2	-	-	15	3	20	15	-	-
La Libertad [a]	1	-	-	28	15	54	7	-	-
La Paz	1	-	-	24	3	13	11	1	9
Morazán	1	-	-	25	1	4	11	-	-
San Miguel	3	-	-	36	2	6	21	-	-
San Salvador [b]	4	2	50	35	24	69	28	-	-
San Vicente	1	-	-	17	2	12	3	-	-
Santa Ana [c]	3	-	-	32	2	6	7	-	-
Sonsonate	1	1		19	13	68	11	2	18
Usulután	3	1	33	34	6	18	12		

Source: Economic Commission for Latin America and the Caribbean (ECLAC), "Efectos en El Salvador de las lluvias torrenciales, tormenta tropical Stan y erupción del volcán Ilamatepec (Santa Ana) octubre del 2005 y Perfiles de proyecto" (LC/MEX/R.892), Mexico City, ECLAC subregional headquarters in Mexico.
[a] Plus one administrative building.
[b] Plus six administrative buildings.
[c] Plus one administrative building.

A special item should be included for the monetary quantification of donations received from national and international organizations, consisting of biomedical equipment, public health inputs, medical furnishings, vehicles, radio communication equipment and other supplies used to maintain or strengthen care in the services network of the disaster zone or in nearby facilities to which persons requiring care may be referred.[57]

C. Losses and additional costs

Losses and additional costs occur subsequent to the disaster event and represent changes in the health sector's economic flows. These may appear at varying intervals after the disaster and can be more difficult to identify in a quick assessment. Additional losses and costs can occur from the time of the disaster until recovery and reconstruction of the sector.

The flows altered by the disaster are of two kinds: changes in output and additional costs.

1. Changes in output

If infrastructure and the contents of health sector buildings are destroyed or rendered unusable, and if access and resources are restricted during the emergency, this can lead to a decline in the programmed and anticipated quantity of health services provided, thereby reducing revenues from direct payments, particularly for private health providers.

"Output" or production in the health sector[58] is defined as the quantity of health care, quality-adjusted. The quantity of health care received by patients must be measured in terms of complete treatments.

[57] Such items constitute transfers in kind and can be disaggregated between national and international sources.
[58] See Eurostat (2001).

The definition of complete treatments is subject to debate.[59] There is general agreement that indicators of the volume of service provided by the sector should be used to establish this output. For example, some countries use: (i) the number of outpatient consultations; (ii) admissions or hospitalizations (patient days); (iii) emergencies. It is important to confirm the volume indicators used in this sector in the country concerned, in order to apply them in estimating the impact and thereby be able to draw upon any available historical series. This will require making contact with the institution responsible for preparing national statistics, and specifically the officials who keep the health output account.

Most countries in the region do not in fact apply this definition, and output is measured by way of inputs.[60] As was stressed in chapter II, this approach does not capture the impact of a natural disaster, and thus output should preferably be measured along the lines indicated in the previous paragraph. It must be remembered, furthermore, that public health has no market price.

Estimating disaster impacts in the health sector is complicated by the fact that, given the kind of service it provides, the sector has a leading role to play both in responding to the emergency and in supporting recovery, which must be achieved as quickly as possible. This means that much of the care normally provided in the hospitals affected must now be managed in makeshift facilities. The estimate of the impact on output must try to determine the difference between what was expected and the new, post-disaster situation, including the emergency response and the reestablishment of services through temporary facilities and, later, recovery and reconstruction.

The definition of output in the health sector, as in the education sector, includes the quality dimension. Accordingly, to measure the disaster correctly, to the possible reduction in volume must be added an adjustment for quality, because a consultation or an emergency treatment performed in a temporary hospital is not the same as one provided in an established hospital. So, both volume indicators and the respective quality adjustment should be considered with the mission's national accounts specialist.

The definition of output is patient-focused and does not distinguish between the public and private sectors. It is desirable, however, to differentiate the two sectors in estimating the effects of the disaster. If the disaster renders a private hospital unusable, demand for its services will likely be transferred to the temporary facilities established by the public sector. In this case, the private sector will suffer a proportionately greater impact than the public sector.

In this respect, the change in the value of output must be assessed as follows:

(i) Review the average quantity of non-free care provided in the affected health institutions, compared to the quantity programmed and to records for the same period in previous years when there was no disaster, epidemic or health crisis.

(ii) Obtain information on the volume of care projected in the affected hospitals for the year of the disaster. This will constitute the baseline. If the information is not available, data from the previous point can be used.

(iii) Obtain information on the volume of care provided in temporary hospitals in the disaster area, and adjust these volumes for quality.[61]

(iv) Obtain information on the number of patients diverted to unaffected hospitals, and their cost and financing.

(v) Compare the total volume of care programmed before the disaster (ii) in the affected hospitals (iii and iv). This will show whether there has been a decline in the volume of care provided vis-à-vis what was expected according to the record from previous years. Take the volume of paid care not provided and multiply it by the unit cost of the service. Note that this unit cost will be increased by some of the additional costs described in the following section.

(vi) An indirect estimate can be made by quantifying the difference between the average value of revenues in previous years or that programmed prior to the disaster, and revenues during the emergency.

[59] For details, see Eurostat (2001).
[60] See chapter II for a detailed example of the recording and processing of the health sector in the national accounts.
[61] It is suggested that the health expert should work together with the national accounts specialist on this process.

2. Additional costs

The additional costs relate to unforeseen expenses for meeting health needs during and after the emergency. As was stressed in chapter II, the sum of the additional costs is the counterpart to the output estimate, and therefore should not be added to that estimate. The recording of these costs is very important for determining the fiscal effort and the private effort. Information should be obtained, working together with the macroeconomic expert, on the sources of financing for all these additional expenses.

The estimate considers the value of care for those injured in the disaster and the cases of diseases that may be linked to the event. In the latter situation, the number of cases considered will be those in excess of epidemiological estimates.

It is assumed that additional outlays for the recovery of the injured will include unplanned health sector expenses on personnel (overtime and new hirings) and investment in medical equipment and inputs, as well as other measures to respond to the additional, unanticipated demand generated by the disaster.

Generally, expenditure on auxiliary health services and on medical inputs and drugs will be channelled through health providers with public or private financing. However, injured persons may pay for such goods and services out of their own pocket, and consequently a sample survey of the affected population is recommended to determine the percentage that had to pay the providers directly, and the type of expenditures involved, in order to estimate private loss in these items. If such sampling is impossible, insurance institutions or large-scale hospital service providers can be asked for a rough estimate. These costs will now be discussed.

(a) Outpatient care

This represents emergency care and outpatient consultations provided through hospitals and first-level care facilities.

In the case of emergency care, two alternative situations may occur: one in which primary trauma victims are few and localized, and are treated by the health services in the area affected, for which reason the information will generally be centralized and there should be no difficulty in estimating the costs of care. The alternative situation is one in which large numbers of injured overwhelm the local health-service capacity and the victims are diverted to facilities outside the disaster zone, which may generate problems in gathering information. No imputation should be made for victims not registered by health-care providers.

Estimating the value of emergency outpatient care involves the following:

(i) Record those direct or primary victims of the disaster who received care from health providers in the critical emergency stage or during the event. This type of care can include general or specialized consultation, diagnostic and therapeutic procedures, and observation. Emergency periods, it must be recalled, can vary depending on the type of event, from hours or days for earthquakes and tsunamis to weeks or months for droughts or El Niño/La Niña phenomena. The cost of transporting victims from the site of the event to the health facility or from one facility to another with greater capacity, or vice versa (referral and counter-referral) must be added if necessary.

(ii) Seek information for calculating the cost of care. It is advisable to use the rates charged by the institution where the victim was treated: the rates reported by the health provider or those corresponding to public or private insurance costs in the affected area.

(iii) Multiply the number of victims by the unit cost of emergency care. Remember that the cost may be simple (consultation only) or aggregate (consultation, procedures, observation).

(iv) Add up the total cost for the victims treated, differentiating by financing agent.

Failure to take steps to reduce the potential risk of epidemics from biological, environmental and social factors may result in an increase in illnesses (pre-existing or not) in the affected area, as well as an increase in psychosocial problems associated with the emergency, and these will require attention from health providers.

In this case, outpatient consultations would show an increase in cases of communicable diseases and mental health problems associated directly with the emergency, for which the following steps must be taken:

(i) Review the records of such health problems over the period in question for at least the latest three years in which there was no disaster emergency.

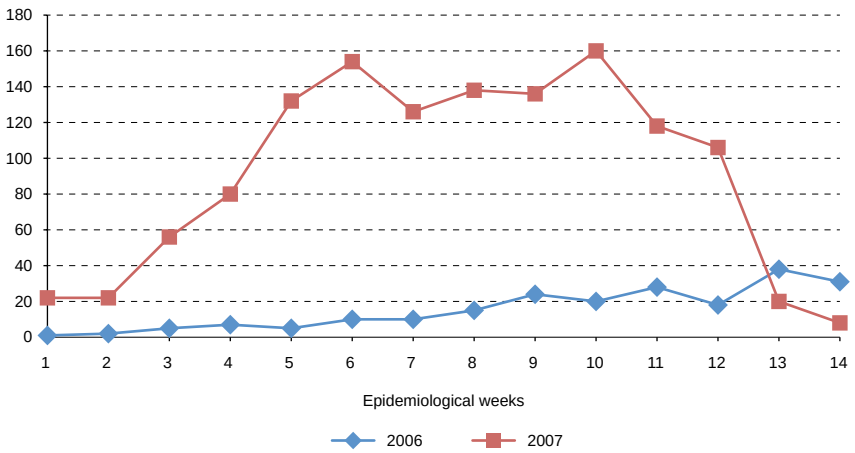
(ii) Determine whether there is a difference between the average number of cases recorded in those years and the number of cases handled during the emergency. If there is a difference, this may be attributed to the event, and it will be taken as the basis for calculation.

(iii) Multiply the number of cases attributable to the emergency by the unit cost of the outpatient consultation.

(iv) Add up the total cost of cases handled, differentiating by financing agent.

For example, following the El Niño phenomenon of 2007 in the Plurinational State of Bolivia, a 553% year-on-year increase was recorded in cases of classic dengue fever in the Department of Santa Cruz de la Sierra, as well as cases of severe dengue fever (serotypes 2 and 3) with a mortality rate of 14%.

Figure V.1
Plurinational State of Bolivia, Department of Santa Cruz: epidemiological curve of confirmed classic dengue cases in epidemiological weeks 1 to 14. El Niño phenomenon, 2006 and 2007



Source: Economic Commission for Latin America and the Caribbean (ECLAC), *Alteraciones climáticas en Bolivia: impactos observados en el primer trimestre de 2007* (LC/MEX/L.792), Mexico City, ECLAC subregional headquarters in Mexico, 2008.

The valuation assessment must include services rendered by providers with a permanent presence in the zone, and by others that arrive in response to the disaster, such as field hospitals or mobile units deployed by the country or by national or foreign organizations involved in humanitarian assistance.

It should be checked whether the disaster has resulted in acute episodes of chronic diseases, such as asthma or hypertension, or allergies that should be incorporated in the estimate.

(b) Hospital admissions

After receiving attention through outpatient consultations or at the emergency units, some of those affected by the disaster may be admitted to hospital, to intensive care units or regular wards for diagnosis and medical or surgical treatment.

The value of hospital admissions must therefore be added to the costs quantified earlier. They are estimated as follows:

(i) Number of patients admitted to intensive care units, surgery rooms or regular wards. The primary reference are those cases having been confirmed previously as emergency or outpatient consultations resulting from the disaster, and having been admitted to one of the services described. Depending on the specific situation, the

number of patients admitted directly for surgery or therapy without having been evaluated by the emergency services or through outpatient consultation should be verified.

(ii) Determine the total cost of care for each patient, considering the number of days hospitalized, the diagnostic procedures and the medical or surgical treatment performed; drugs and patient-day cost in hospital or intensive care services.

(iii) Add up the total costs for patients admitted, differentiated by financing agent.

These curative services may be provided in general or specialized hospitals, and they may be provided through admission to hospital, day-hospitalization, outpatient care, or home care.

(c) Emergency response programme

The cost of managing and transferring multiple victims from the disaster zone to care facilities must be evaluated. These services are often very costly in sudden-onset events such as earthquakes and tsunamis, because these generate the greatest numbers of injuries and are likely to cause severe damage to health facilities, meaning that patients must be evacuated over great distances. In the 2007 earthquake that hit Pisco (Peru), for example, more than 90% of hospital beds in the disaster zone were destroyed, and some 1,200 victims had to be airlifted to hospitals in Lima, 250 km away.

The monetary valuation of patient transfer must consider the cost of transport by land, air, river or sea, taking the unit cost of transfer as the reference point: for example, the cost of ambulance use, the hiring of helicopters or airplanes, or the value of commercial air tickets (allowing four or more seats per patient).

Another item that must be evaluated is the 24-hour functioning of the emergency operations centre, as needed to maintain control over the situation. An estimate of this value will be based on overtime pay for personnel, additional purchases of materials and inputs, and other actions such as supply management (Logistics Support System (LSS) and Humanitarian Supply Management System (SUMA).[62]

Lastly, the estimate must include the cost of strategies to expand victim care capacity rapidly, by setting up temporary or modular field hospitals and purchasing services from public or private providers. In the emergency phase of the 2010 earthquake in Chile, for example, freight containers were adapted for use as medical consultation facilities, and were outfitted with beds. Pre-fabricated victim care facilities were also constructed to temporarily replace collapsed buildings and thus maintain and expand care capacity.

(d) Other services

There is also the question of whether the health sector will have to provide longer-term rehabilitation services to deal with the effects of injuries or illnesses among the affected population. Here account must be taken of the cost of the service, the number of patients using it, and the quantity of care required. These services may be provided through day-patient hospitalization, outpatient care, and home care.

For example, because of the nature of the injuries inflicted, victims of the 2010 earthquake in Haiti required immediate rehabilitation that included post-surgery care and immobilization to prevent complications, as well as the promotion of patients' functional independence and autonomy, counselling for next-of-kin, and psychological support to patients and their families.

(e) Prevention and public health services

The actions taken during the emergency to prevent or mitigate the effects of the disaster on public health in the affected zone must be identified and valued.

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[62] The main objective of the LSS and SUMA systems developed by the Pan American Health Organization is to improve the administration of humanitarian assistance by strengthening national capacities to manage supplies so as to ensure adequate and timely delivery of services to the population most affected. See [online] www.lssweb.info and www.disaster-info.net/SUMA/english/index.htm.

(i) Information, education and counselling

This includes broadcasting information through various media such as radio, television and the written press, to allay rumours and to inform the population about the measures being taken to prevent diseases that could spread as a result of the disaster. The valuation will be based on the health sector activities included in the communications plan or those carried out in response to the event, considering communications strategies, the number of activities, the scope of intervention, duration and cost: for example, the cost of hiring a firm to print educational materials or a contract for radio or television time to broadcast health messages.

With regard to education and counselling, the kinds of activities that the health sector is performing in the disaster zone may take the form of home visits, counselling, or some other form used in the country. The estimate will be based on the volume of activities, at unit cost, broken down by public and private sector. If this information is not available, the overall cost of interventions will be used.

(ii) Immunization programmes

In countries that have vaccination programmes in place and broad immunization coverage, special measures in this regard should not be a technical priority at the emergency stage. However, an immunization programme requires careful evaluation, as it may sometimes be necessary to administer vaccines to the general population at risk, as in the case of yellow fever or hepatitis A, or selectively as in the case of measles among children, or anti-tetanus vaccine for people with dirty wounds or those engaged in rescue work or rubble removal. If immunization campaigns are required, the valuation must consider the number of persons for each type of vaccine, the number of doses required and the unit cost per dose and application, and the unit cost of application must also be differentiated by type of vaccine.

(iii) Early disease detection programmes

These interventions will include active detection of cases among the population in shelters and among persons at risk in the affected zone. Calculation of the cost of these programmes must consider:

- Unit cost of diagnostic tests and medical exams, or of screening strategies.
- Number of exams, tests or services performed.
- Multiply the unit cost by the number of exams, tests or services performed.
- To this total must be added the numbers and cost of the equipment or health personnel mobilized in the field for identifying disaster-related cases of diseases and the cost of other interventions performed in the shelters and at the community level.

(iv) Programmes for monitoring health conditions

Check whether there has been a requirement for additional resources, not planned prior to the disaster, for implementing or reinforcing programmes to monitor the health of pregnant women, infants and schoolchildren, reproductive health, mental health and other programmes in the affected zone. If necessary, the unanticipated costs of operating these programmes during the emergency must be valued.

(v) Epidemiological surveillance and risk and disease control programmes

In emergency situations, the health sector will place emphasis on greater surveillance to detect the appearance or spread of diseases in the disaster zone. This may require the use of resources additional to those budgeted in order to strengthen or implement the epidemiological surveillance system and to perform diagnostic work in public health laboratories.

The estimation will take into account the following:

- Overall cost of actions not planned prior to the disaster, for active surveillance in existing establishments and temporary services, sentinel surveillance, community surveillance and investigation of rumours. For example, the cost of mobilizing epidemiological evaluation teams can be determined from the unit cost and the number of teams deployed.
- Cost and quantity of laboratory tests for diagnosis and study of disaster-related cases.

In the event of outbreaks of foodborne diseases, food-safety-related interventions by the health sector must be valued. This includes sanitary inspections of places where food is prepared and handled, such as community kitchens

and public markets. Although the delivery of food to the affected population is not the responsibility of the health sector, it may be involved in monitoring the quality of food deliveries and overseeing nutritional requirements according to age, sex and the special needs of vulnerable groups (pregnant women, children, and sick or elderly persons).

The activities involved in environmental risk surveillance are described in the chapter on water and sanitation, environment and epidemics.

D. Financial needs for recovery and reconstruction

1. Financial needs for recovery

Given the type of services it provides, the health sector must see to the immediate recovery of its facilities and services damaged by a disaster, at the same time as it addresses the public health emergency: the two phases cannot be separated. For this reason, adequate conditions for consultation, intervention, general treatment and hospitalization must be promptly restored even if facilities have been damaged to varying degrees. This will require, first, a solid health sector organization and institutional structure built up in normal times, which must include risk management and the emergency preparedness in order to guarantee services, in particular the financial and logistics services needed to quickly supply field hospitals and inputs for treatment and hospitalization, train and deploy professional teams of varying rank and specialization, and ensure coverage of food supplies and related inputs.

2. Financial needs for reconstruction

In light of the importance of the health sector, priority should be given to launching the reconstruction of permanent hospital facilities and replacing temporary hospitals, including all possible improvements needed to make health structures resistant to disaster. It is also essential to ensure that the private sector follows these guidelines.[63]

The need for a strategy of "rebuilding better" is particularly pressing in the health sector because hospitals must be able not only to withstand disasters but also to provide uninterrupted service in their aftermath. This is what the Pan American Health Organization (PAHO) calls "safe hospitals"[64] and it means that the physical building structures, vital connections, basic services and, most importantly, the organization of staff to provide care at these times are such as to maintain a high level of efficiency in the services offered in disaster situations. Health facilities which have not been destroyed but whose operating capacity has been damaged must be reinforced as necessary to guarantee their proper functioning in case of future disasters.

Lastly, for purposes of estimating medium- and long-term recovery costs, there should be a separate inventory of facilities that have not been damaged but may need to be relocated to safe zones, or may require structural protection or reinforcement against the risk of a future natural event, which would further increase reconstruction costs.

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63 The public sector may need to offer financing facilities to the private sector so that the latter can rebuild as quickly as possible and to better construction standards.

64 The "safe hospital" concept does not mean that the physical structure's integrity is 100% guaranteed after a disaster such as an earthquake, hurricane or explosion, as it may in fact suffer considerable damage. What is important is to ensure that, despite the damage, the hospital's critical areas can continue to function and provide adequate medical care to disaster victims.

Appendix 1
Disaster-related damage, losses and additional costs and the health sector national accounts

To bring greater clarity to the discussion of disaster-related losses and how they relate to the national accounts system, an example for the health sector is presented below. Various chapters of this handbook contain similarly framed examples. The information on which those examples are based is assumed to have been obtained by sector experts during the impact estimation mission.

The framework of the national accounts as it relates specifically to the health sector is described first, showing the coverage, the institutional sectors providing health services, and their principal accounts. Next, a hypothetical example of a pre-disaster situation is presented, followed by a detailed recording of the post-disaster situation, highlighting the interaction between sectors. Appendix 1 also presents a basic glossary of national accounts terminology.

A. Coverage: the institutional sectors that provide health services

The production frontier for this sector includes all institutional units of the economy whose activities and products relate to the provision of health services for prevention, cure and rehabilitation. It includes units of the general government that have technical and policy responsibility for the sector's activities.

B. Production and intermediate consumption by institutional sector

1. General government

This includes institutional units with the primary function of providing non-market individual and collective health services. In other words, it covers health services provided to the community free of charge or at nominal prices that do not cover production costs.

The information sources for these statistics are the ministries of finance and health, or the units providing the service. These institutional units are grouped into three subsectors: central government, local government, and social security funds (see box 1).

The gross output value (GrOV) on a non-market basis is obtained by totalling the costs incurred to generate it:

- Compensation of employees (CE).
- Intermediate consumption (IC).
- Other taxes on production (OTP).
- Consumption of fixed capital (CFC).

GrOV health/gov = CE+IC+OTP+CFC

Intermediate consumption consists of current expenditures or inputs consumed during the period. It should be noted, first, that the institutional units of government providing non-market health services do not pay taxes on

their production. As to the recording of CFC, this involves complexities that exceed the limits of this exercise, and often go beyond the information available in practical applications.[65] Thus:

GrOV health/gov = CE + IC

The gross value added (GVA) of this institutional agent is:

GVA health/gov = GrOV health/gov – IC = CE

Thus, gross value added in this case is equal to employee compensation.

2. Non-profit institutions serving households (NPISH)

In most countries there are institutions whose social purpose is to deliver non-market health services. Examples are the services provided by the Red Cross or by hospitals managed by benevolent associations. Their output value is calculated in the same way as that of the government institutions sector, by totalling their costs, i.e. the total of employee compensation and intermediate consumption.

GrOV health/NPISH = CE + IC

NPISH are non-market producers. Their balance sheets and financial statements are normally available.

3. Households

This institutional sector comprises:

(i) Households as "own-account producers of health services". This refers to health professionals who operate independently. Their output is equal to the sale of health services, or to their declaration of income on own account. Note that this is market production. Intermediate consumption is similar to that in the previous cases.

GrOV health/hhd = sale of services (own-account income)

Box A.V.1
Non-market production

Non-market output may be produced for two reasons:

(a) It may be technically impossible to make individuals pay for collective services because their consumption cannot be monitored or controlled. The pricing mechanism cannot be used when transaction costs are too high and there are market failures. The production of such services has to be organized collectively by government units and financed out of funds other than receipts from sales, namely taxation or other government incomes.

(b) Government units and NPISH may also produce and supply goods or services to individual households for which they could charge but choose not to do so as a matter of social or economic policy.

The most common examples are the provision of education or health services, free or at prices that are not economically significant, although other kinds of goods and services may also be supplied.

Source: Economic Commission for Latin America and the Caribbean (ECLAC), *on the basis of System of National Accounts, 2008 [online]* http://unstats.un.org/unsd/nationalaccount/docs/SNA2008.pdf.

This category includes physicians, dentists, psychologists, medical and dental assistants; physiotherapists and the like; mid-level nursing personnel; traditional medicine practitioners and healers; home nursing assistants. The information sources for this sector may come from tax records or from surveys of household expenditure or living conditions.

[65] "6.240. Consumption of fixed capital is the decline, during the course of the accounting period, in the current value of the stock of fixed assets owned and used by a producer as a result of physical deterioration, normal obsolescence or normal accidental damage. The term depreciation is often used in place of consumption of fixed capital but it is avoided in the SNA because in commercial accounting the term depreciation is often used in the context of writing off historic costs whereas in the SNA consumption of fixed capital is dependent on the current value of the asset." *System of National Accounts, 2008 [online]* http://unstats.un.org/unsd/nationalaccount/docs/SNA2008.pdf.

(ii) Households as consumers. These are households that use medical services purchased at market price, or received for nominal value or free of charge.

4. Non-financial companies

These are clinics, hospitals and other units constituted as companies that provide such services. They are normally referred to as "market producers", as they offer health services against payment of a market price, which usually covers production costs and yields a profit.

GrOV health/cos = sale of health services

Information sources are the balance sheets and financial statements that are generally compiled in a company's taxation or control office. It must be determined whether satellite health accounts are prepared in the country – Latin America has seen significant advances in this respect. Note the difference vis-à-vis the manner in which the gross output value of non-market producers is estimated.

Box A.V.2
System of National Accounts 2008

Government units

22.20. In addition, there may be government entities with a separate legal identity and substantial autonomy, including discretion over the volume and composition of their expenses and outlays and a direct source of revenue, such as earmarked taxes. (The terms expense, outlays and revenues are commonly used in the presentation of government accounts.) Such entities are often established to carry out specific functions, such as road construction or the non-market production of health or education services. These entities should be treated as separate government units if they maintain full sets of accounts, own goods or assets in their own right, engage in non-market activities for which they are held accountable at law and are able to incur liabilities and enter into contracts in their own right. Such units are often referred to as extrabudgetary units because they have separate budgets and any transfers from the main budget account are supplemented by their own sources of revenue. Budgets vary widely among countries and various terms are often used to describe these units.

22.17. Government units typically make three different kinds of final outlays:

The first group consists of actual or imputed expenditures on the free provision to the community of collective services such as public administration, defence, law enforcement, public health, etc. that are organized collectively by government and financed out of general taxation or other income.

The second group consists of expenditures on the provision of goods or services free, or at prices that are not economically significant, to individual households. These expenditures are deliberately incurred and financed out of taxation or other income by government in the pursuit of its social or political objectives, even though individuals could be charged according to their usage.

The third group consists of transfers paid to other institutional units, mostly households, in order to redistribute income or wealth.

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of *System of National Accounts, 2008* [online] http://unstats.un.org/unsd/nationalaccount/docs/SNA2008.pdf

C. Supply-use balances

The equivalence between the supply and use of health services in an economy is described by means of accounting identities:

GrOV/health = EFC/households + EFC/individual government + EFC/collective government

Where:

GrOV/health = output of health services

EFC/households health = household expenditure on final consumption of health services

EFC/individual government = expenditure on final individual consumption by general government

EFC/collective government = expenditure on final collective consumption by general government.

D. Numerical example

1. Initial situation

In a small country of 15,000 inhabitants, 5% of the population has private health insurance. In the health sector there are three types of units: publicly run units, non-profit institutions serving households (NPISH), and privately run units.

Social protection has increased in recent years: 60% of the population receives health care in public institutions; 20% in NPISH; and 10% in private facilities. The remaining 10% has no services. 20% of the population is rural. Hospital facilities, expenditures on inputs and remuneration are shown in table A.V.1.

Table A.V.1
Health facilities, remuneration, inputs and revenues by management sector

	Facilities			Government expenditure		Annual non-profit institutions serving households expenditure		Private		Insurers		
	Government	Non-profit institutions serving households	Private	Compensation of employees	Inputs	Compensation of employees	Inputs	Inputs	Compensation of employees	Inputs	Compensation of employees	Indemnity
Hospitals	4	2		1 000	200	400	50				50	450
Clinics	2	3	3	100	100	150	100	300	50	10		
Private doctors' offices			400					30	25			
Total				1 100	300	550	150	330	75	10	50	450

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Table A.V.2
Health Unit revenues
(Monetary units) [66]

	Private fees	Private clinic charges	Partial government payments	Partial non-profit institutions serving households payments	Government rate	Donations to non-profit institutions serving households	Insurers
Hospitals			150	250	900		
Clinics		400					
Private doctors' offices	800					450	
Premiums							250
External reinsurance							250
Total	800	400	150	250	900	450	500

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

The production and income generation accounts for the publicly managed health sector are presented, in accordance with the previous definitions, in tables A.V.3 and A.V.4. As noted earlier, production is calculated as the total of costs: intermediate consumption plus compensation of employees. However, it must be noted that the resources side of the production account includes an item for partial household payments, which corresponds to symbolic fees for some health services that public establishments may charge.

66 In all the examples relating to the national accounts in this handbook, the values are expressed in monetary units (MU).

Table A.V.3
Production account for the publicly managed health sector
(Monetary units)

Uses		Resources	
Intermediate consumption	300	Non-market production for own use	1 250
Gross value added	1 100	Household partial payments	150
Total uses	1 400	Total resources = gross output value	1 400

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Table A.V.4
Income generation account for the publicly managed health sector
(Monetary units)

Uses		Resources	
Compensation of employees	1100	Gross value added	1100
Net taxes	0		
Gross operating surplus	0		
Total uses	1100	Total resources	1100

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

The same methodology is used for non-profit institution serving households (NPISH): see tables A.V.5 and A.V.6.

Table A.V.5
Production account for the NPISH health sector
(Monetary units)

Uses		Resources	
Intermediate consumption	150	Non-market production for own use	450
Gross value added	550	Household partial payments	250
Total uses	700	Total resources =gross output value	700

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Table A.V.6
Income generation account for the NPISH health sector
(Monetary units)

Uses		Resources	
Compensation of employees	550	Gross value added	550
Net taxes	0		
Gross operating surplus	0		
Total uses	550	Total resources	550

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

When it comes to private medical practice, as this represents a service, production is equal to sales. By contrast, for the production of goods one must take the final inventory of finished products and subtract the initial inventory.

Table A.V.7
Production account for the privately managed health sector
(Monetary units)

Uses		Resources	
Intermediate consumption	300	Sales	1 200
Gross value added	900		
Total usos	1 200	Total resources = gross output value	1 200

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

These companies earn a gross profit, which is recorded as the gross operating surplus (GOS).

Table A.V.8
Income generation account for the privately managed health sector
(Monetary units)

Uses		Resources	
Compensation of employees	75	Gross value added	900
Net taxes	0		
Gross operating surplus	825		
Total uses	900	Total resources	900

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

2. Disaster situation

Assume that the country has been hit by a disaster that has affected health sector assets and flows. These impacts are examined by institutional sector.

(a) Health activities in the government sector

The group of sector specialists that is estimating the effects and impacts of a disaster will collect the following information on the change in flows, damage to assets, and financial assistance in this sector:

(i) Increased demand for health-care in public-sector establishments boosts inputs for those establishments by 120%.

(ii) The personnel complement is increased by 30%.

(iii) Public health establishments have suffered minor damage, in the amount of 1200 MU, which must be repaired during the year of the disaster.

(iv) The government must lease private dwellings to establish dispensaries, at a cost of 120 MU.

(v) The "symbolic co-payment" must rise by 20%.

(vi) The government receives external assistance of 300 MU.

(vii) One hospital, with a value of 3,000 MU, has been destroyed and will have to be rebuilt starting next year.

Information items (i) to (v) are used to record the impact in the health sector production and income generation accounts (see tables A.V.9 and A.V.10). Items (i) to (iv) represent additional costs; item (vi) is recorded in the distribution accounts as explained in subsection 3, while item (vii) is explained in section 4.

Table A.V.9
Production account for the publicly managed health sector: impact
(Monetary units)

Uses			Resources	
Intermediate consumption, initial		300	Gross output value, differential	1 980
Intermediate consumption, differential		1 680	Household partial payments	30
Increased inputs	360			
Infrastructure repairs	1 200			
Housing rentals	120			
Intermediate consumption, final		1 980	Gross output value, initial	1 400
Gross value added, initial		1 100		
Gross value added, differential		330		
Gross value added, final		1 430		
Total uses, initial		1 400	Total resources, initial	1 400
Total uses, differential		2 010	Total resources, differential	1 400
Total uses, final		3 410	Total resources, final	3 410

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Table A.V.10
Income generation account for the publicly managed health sector: impact
(Monetary units)

Uses		Resources	
Compensation of employees	1 100	Gross value added	1 100
Compensation, differential	330		
Net taxes	0	Gross value added, differential	330
Gross operating surplus	0		
Total uses, final	1 430	Total resources	1 430

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

The short-term negative impact implies an increase of 1,680 MU in inputs and of 330 MU in wages. The increase in intermediate consumption reflects expenditures on construction (to repair hospital facilities) and rent, as well as the increase in medical inputs. The counterpart of intermediate consumption is the production occasioned by construction (infrastructure repairs), real estate activities (housing rental) and sales or imports of medical inputs.

(b) NPISH health activities

The disaster assessment team will gather the following information on changes to flows, impact on assets and financial assistance in this sector:

(i) The event sparks an 80% increase in care volume and, consequently, in inputs.
(ii) Repairs to facilities cost 350 MU.
(iii) The NPISH hire additional health workers in the amount of 120 MU.
(iv) Medical volunteers perform work valued at 50 MU.
(v) Institutions receive a government transfer of 25 MU.
(vi) International agencies transfer 350 MU to these institutions.

Items (i) to (iii) are used to record the impact on the production and income generation accounts: see tables A.V.11 and A.V.12. These are additional costs. Items (iv) to (vi) are recorded in the distribution accounts, as explained in subsection 3. The increase in output, calculated as the sum of costs, reflects the increase in intermediate consumption explained by the repair to buildings and the increase in medical inputs. The other component of the gross output value, value added, rises because of the hiring of additional personnel.

Table A.V.11
Production account for the NPISH health sector: impact
(Monetary units)

Uses		Resources		
Intermediate consumption, initial		150	Gross output value, differential	590
Intermediate consumption, differential		470	Household partial payments	0
Additional workers	120			
Infrastructure repairs	350			
Intermediate consumption, final		620	Gross output value, initial	700
Gross value added, initial		550		
Gross value added, differential		120		
Gross value added, final		670		
Total uses, initial		700	Total resources, initial	700
Total uses, differential		590	Total resources, differential	590

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Table A.V.12
Income generation account for the NPISH health sector: impact
(Monetary units)

Uses		Resources	
Compensation of employees	550	Gross value added	550
Compensation, differential	120		
Net taxes	0	Gross value added, differential	120
Gross operating surplus	0		
Total uses, final	670	Total resources	670

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

(c) Private-sector health activities

The group of specialists for this sector, who will be estimating the effects and impacts of a disaster, will gather information on the change in flows, the impact on assets, and financial aid in this sector:

(i) Medical consultations rise by 20%, which is added to the value of production.

(ii) Doctors work as NPISH volunteers, for a value equivalent to 50 MU.

(iii) Damage to doctors' offices, repaired during the current year, amounts to 400 MU.

Table A.V.13
Production account for the privately managed health sector: impact
(Monetary units)

Uses			Resources	
Intermediate consumption, initial		300	Sales	1 200
Intermediate consumption, differential		400	Sales, differential	240
Repairs to doctors' offices	400			
Intermediate consumption, final		700	Gross output value, initial	1 200
Gross value added, initial		900	Gross output value, differential	240
Gross value added, differential		-160		
Gross value added, final		740		
Total uses, initial		1 200	Total resources, initial	1 200
Total uses, differential		240	Total resources, differential	240
Total uses, final		1 440	Total resources, final	1 440

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Table A.V.14
Income generation account for the privately managed health sector
(Monetary units)

Uses		Resources	
Compensation of employees	75	Gross value added	900
Compensation, differential	120		
Net taxes	0	Gross value added, differential	-160
Gross operating surplus	825		
Gross operating surplus, differential	-160		
Total uses, final	740	Total resources, final	740

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

In this case, gross value added has declined because the increase in invoicing is not sufficient to finance repairs, and as a result gross profit has declined by 160 monetary units.

3. Distribution transactions

Distribution operations sparked by the disaster in the health sector managed by the government are recorded in the accounts for each institutional sector.

(a) Government

The information compiled by the mission shows the following changes in the distribution accounts for this sector:

(i) The government receives external assistance, which is posted to the Secondary Income Distribution Account, in the item for current transfers received from the rest of the world: 300 MU.

(ii) The government delivers aid to NPISH: this is posted to the secondary income distribution account, in the item for current transfers paid to the NPISH account: 25 MU.

(b) NPISH

The information compiled by the mission shows the following changes in the distribution accounts for this sector:

(i) Institutions receive a transfer from the government: this is posted to the secondary distribution of income account, in the item for current transfers received from government: 25 MU.

(ii) Institutions receive a transfer from the rest of the world: this is posted to the secondary distribution of income account, in the item for current transfers received from government: 350 MU.

(iii) NPISH receive voluntary work by doctors: this is posted to the account for redistribution of income in kind, in the item for social transfers in-kind received from households: 50 MU

(c) Households

Information compiled by the mission shows the following change in the distribution accounts for this sector:

(i) Delivery of voluntary work to NPISH: this is posted to the account for redistribution of income in kind, in the item for social transfers in-kind delivered: 50 MU.

4. Changes in assets

Destruction of the hospital represents damage amounting to 3,000 MU. The hospital will be rebuilt in subsequent years. In the current year, this is reflected in the other changes in the volume of assets account, changes in liabilities and in net worth, as disaster-related losses, under the item "changes in net worth due to other changes in volume of assets", which has an impact on the country's wealth.

5. Impacts in other sectors as a consequence of the health impact

(a) Construction sector

There is a positive impact in the construction sector, as summarized in table A.V.15.

Table A.V.15
Growth in output, construction sector
(Monetary units)

Government	Infrastructure repairs, differential	1 200
NPISH	Infrastructure repairs, differential	350
Households	Repairs to doctors' offices	400
	Construction sector output	1 950

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

If the technical coefficient of construction (the ratio of raw materials to the value of production) is 40%, the increase in value added is 1,170 MU.[67]

(b) Chemical products industry and inputs for health establishments

The industry producing chemical products and inputs for health establishments will see its output rise, as shown in table A.V.16. In addition, real estate activity will be boosted by 120 MU, through the leasing of dwellings for dispensaries.

[67] This value is obtained by multiplying the technical coefficient, 0.4, by the gross output value, 1,950 MU.

Table A.V.16
Growth in output, chemical industries and hospital inputs
(Monetary units)

Chemical products industries	Increased inputs	360
Real estate activity	Increased output	120
	Gross output value	480

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

As illustrated in this example, disruption to the health sector can have a positive impact in other sectors.

6. National accounts and health sector

Government final consumption, health. Resources geared to operational functions of public entities to cover compensation of employees and the purchase of supplies and services for an objective directly related to health.

General government final consumption expenditure (GFCE). Government incurs expenses in generating a broad range of goods and services for final consumption, and it finances them through taxes or other budgetary revenues. They are delivered to the community in general or to individual households either free of charge or at affordable prices. Within the coverage relating to collective services, these refer primarily to civilian security and national defence, maintenance of law and order, legislation and regulation, public health maintenance, environmental protection, research and development, etc. Individual services include education, health, culture and recreation.

Household actual final consumption. This represents goods or services for final individual consumption acquired by households through expenditure or through social transfers in kind from government and from non-profit institution serving households (NPISH).

Actual final consumption. Actual final consumption of households is defined as the sum of expenditure on final consumption by resident households, plus social transfers in-kind from government (=individual consumption expenditure by government) plus social transfers in-kind from NPISH (= individual consumption expenditure by non-profit institution serving households).

Actual final consumption by general government is defined as collective consumption expenditure by government.

Production for own final use. This consists of goods and services produced and retained by the owners of enterprises who produce them for their own use, either for own final consumption or as own gross fixed capital formation.

Production. The activity performed under the control and responsibility of an institutional unit that uses labour, inputs and capital goods to obtain other goods and services.

Non-market health producers. Non-market producers are those that provide health services free of charge, or at insignificant prices that do not cover their costs of production. This category includes the general government sector, which is classified into the subsectors of central government, local government, and social security; and NPISH.

Characteristic health products. These are services that contribute directly to health prevention, cure and care.

Current transactions. These are economic transactions conducted by agents in the normal course of their activities.

Distributive transactions. These relate to the generation, distribution and redistribution of income.

Social transfers in-kind. Expenditures by government or NPISH on goods or services produced by market producers that are provided directly to households, individually or collectively, without any further processing constitute final consumption expenditures by government or NPISH and not intermediate consumption. The goods and services in question are treated as social transfers in-kind and enter into the actual consumption of households.

VI. Epidemics

A. Introduction

1. Diseases and epidemics

This chapter examines the health-sector impact of an epidemic. As with any other disaster, its economic and social impact can be estimated with the methodology described in the various chapters of this handbook. A disaster of this kind does not involve the destruction of physical capital, and therefore the estimation of its impact considers only additional costs and losses. The outbreak of a serious epidemic can damage the economy and people's livelihoods, both in the country that is the scene of the outbreak and in other parts of the world. Globalization has brought with it greater mobility for persons and products, and epidemics are now more readily transmitted between countries and continents.

The Centre for Research on the Epidemiology of Disasters (CRED)[68] at the University of Louvain defines an epidemic as "either an unusual increase in the number of cases of an infectious disease that already exists in the region or population concerned, or the appearance of an infection previously absent from a region." The term is used in public health work to refer to the fact that the disease strikes a larger-than-expected number of people.

As this definition implies, there are levels of incidence that are considered normal for any disease. At any given time, it can be expected that a certain number of persons will be affected, but when the number of patients exceeds that figure, the situation becomes an epidemic (as the number of cases is greater than expected).

When an epidemic occurs all around the world, or over a very wide area, crossing national borders and generally affecting a great number of persons, it becomes a pandemic (Last, 2001). In its etymological origin, this word means "a disease of all the people". A pandemic typically occurs with the appearance of a new virus for which there is no type of immunity. On the other hand, if an epidemic persists in the same zone over a long period of time it is considered endemic. This is the case with malaria in many countries.

There is evidence that human activities are having an impact on the global climate, with serious repercussions for public health. According to the World Health Organization (WHO), the consequences of global warming pose a risk to health, associated with water and food shortages, changes in the distribution of infectious diseases, and diseases that emerge from the alteration of ecosystems.[69] Some of the most common among these diseases are the following:

[68] CRED maintains the EM-DAT International Disaster Database, the world's most exhaustive inventory of natural disasters.
[69] See 10 Facts on Climate Change and Health, [online] www.who.int/features/factfiles/climate_change/en/.

(a) Influenza

Influenza is a viral disease that infects animals and, through constant mutation of the viruses, can sometimes take on a form that spreads readily among humans.

This is an acute contagious viral infection, characterized by inflammation of the respiratory tract. It generally occurs in seasonal epidemics (seasonal influenza) or occasionally in pandemics (pandemic influenza). Transmission of infection occurs at short range, primarily via droplets and occasionally through contact. To date, there is no evidence to suggest that the infection is airborne-transmitted among humans in health-care settings (WHO, 2007).

In 1997, the avian influenza A (H5N1) virus demonstrated for the first time a capacity to infect humans, following outbreaks on commercial poultry farms in Hong Kong, China. This virus is considered very infectious and is associated with high rates of severe illness and mortality. The main risk factor for contracting a zoonotic infection from the A (H5N1) virus is direct contact or close exposure to infected poultry.

Influenza A (H1N1) first appeared in Mexico in mid-March 2009. A new subtype of the H1N1 strain of the virus was discovered that had not circulated previously among humans, and consequently there was no natural immunity. This influenza affected primarily persons who were extremely elderly, pregnant, obese, or with pre-existing illnesses.

(b) Cholera

The bacterium *Vibrio cholerae*, which causes cholera, has sparked a number of epidemics in Latin America and the Caribbean. From 1991 to 1994, it spread through South America, beginning in Peru, triggering 1.04 million cases and close to 10,000 deaths in that subregion.

In October 2010, the bacterium appeared in Haiti and by July 2011 a total of 419,511 cases had been reported: of these, 222,359 patients were hospitalized and 5,968 died,[70] among a population that was already vulnerable because of the January 2010 earthquake.

(c) Dengue

Dengue is a systemic and dynamic infectious disease transmitted by mosquitoes (*Aedes aegypti and Aedes albopictus*), and it is found around the world. It is caused by any one of four viruses for which mosquitoes are vectors. With more than a third of the world population living in areas at risk for transmission, and as there is no vaccine to prevent dengue infection, this is the leading cause of illness and death in the tropics and subtropics. Some 100 million people are infected every year.[71]

Dengue has reached endemic levels in various parts of the world, and it remains a public health problem in Latin America and the Caribbean. Its progress has been promoted by climate patterns favourable to the proliferation of *Aedes aegypti*, even during unexpected times of the year. Because of progressive re-infestation by the vector mosquito, dengue has become a severe problem not only for health but also for the economy in many countries of the region.

(d) Yellow fever

Yellow fever is an acute and infectious viral disease caused by a virus transmitted by *Aedes aegypti* and other mosquitoes of the genera Aedes, Haemagogus and Sabethes, which generally thrive at less than 1,300 m above sea level. Characterized by an acute onset, general discomfort and fever, severe cases can result in death through generalized haemorrhaging.

In 2008, Paraguay suffered an outbreak of this disease in urban areas, 34 years after the last reported case. The reappearance of yellow fever may be related to the fact that, over the past 60 years, there has been a significant ecological change in Paraguay's rural areas, primarily as a result of intensive deforestation, associated with other factors such as extension of the agricultural frontier. It is also believed that the more than 5,000 forest fires reported in 2007 may have caused the displacement of the vector to other zones (PAHO, 2007).

[70] See [online] www.paho.org/hq/index.php?option=com_content&view=category&layout=blog&id=3119&Itemid=3467&lang=en.
[71] See Center for Disease Control and Prevention, United States Agency for International Development (USAID) [online] http://www.cdc.gov/dengue/.

2. The socioeconomic impact of epidemics

Epidemics have a direct impact on public health and on people's lives, and it can potentially generate losses in the productive and services sectors, such as industry, employment, trade, tourism, transportation and education. The country affected must incur additional costs to respond to the emergency, to diagnose and treat the sick, costs that represent a greater burden for low-income countries.

Thus, the dengue epidemic recorded in the first half of 2009 in the Plurinational State of Bolivia, which was concentrated primarily in the Department of Santa Cruz, entailed additional costs amounting to US$ 8.97 million in medical care, fumigation and information campaigns.

In 2002 and 2003, the severe acute respiratory syndrome (SARS)[72] spread in just a few months from Asia to the Americas and Europe. According to WHO, it infected 8,098 persons (including a significant number of health workers), of whom around 800 died. The health sector found itself dealing with an illness for which there is no cure.

3. The effects of epidemics on the health sector

Health emergencies and epidemics have a direct effect on the health sector, leading within a short time to mounting demand for outpatient and hospital care, and placing strain on available equipment and supplies. In such a situation, the health sector needs to take steps to reduce the appearance of new cases, to lower the number of severe and fatal cases, and to prevent exposure of the uninfected population. These steps include public health interventions, emergency care, and expanded health services. The fundamental effect is a temporary increase in additional costs for the sector.

The influenza A (H1N1) pandemic is a good example of how a health disaster can have a negative impact on a country's economy, especially in the health sector. According to estimates by the Secretariat of Health of Mexico of fallout from the 2009-2010 epidemic, the cost in gross terms amounted to more than 9.573 billion pesos, of which over 57% corresponded to medical care outlays, while the remainder include the costs of laboratory tests for confirming cases, anti-influenza vaccination, attention in patient information and referral modules, and educational and social communication campaigns.

Box VI.1
Recommendations during the evaluation

It is important for estimation of the effects of the epidemic on the health sector to be conducted in permanent coordination and communication with the local technical services of PAHO/WHO, so as to involve them in the evaluation and subsequent monitoring of recovery projects.

The evaluation should start with a meeting with the PAHO/WHO office, where the objectives and methodology for estimating the effects on the sector will be explained and facilities requested for conducting interviews with management and operational staff of the areas involved in dealing with the epidemic; field visits to the principal patient care centres, including temporary facilities set up specifically for the emergency; and to gain access to the information needed to produce the estimates.

Upon completing its work, the evaluation mission should deliver the preliminary estimates to the PAHO/WHO office at another meeting, in which the national authorities may also participate, if relevant.

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

[72] This syndrome constituted the first severe infectious disease outbreak of the twenty-first century. From 12 March 2003 until 1 July of that year, WHO issued recommendations for travellers to areas where there was local transmission. The list included the Philippines, Hong Kong (China), Mongolia, Singapore, Taiwan, Vietnam and various localities of China such as Beijing, Guangdong, Hebei, Hubei. Jilin, Jingsu, Shaanxi, Shanxi and Tianjin. The only city in North America that was included on the list was Toronto, Canada. For further data, see http://www.who.int/csr/sars/en/. It can be assumed that SARS and the travel alerts it generated had an economic impact, with particularly important losses in tourism, commerce and industry. Many people cancelled their tourism and business travel plans out of fear and uncertainty over the transmissibility of this previously unknown pathogen.

B. Estimated losses and additional costs

As noted above, an epidemic does not involve the destruction of an economy's physical capital, which would constitute damage. It is only the losses and additional costs that need to be estimated, that is, the changes in economic flows resulting from the emergency response itself and the activities performed in subsequent months to control the epidemic.

Evaluation of the health sector effect includes the following stages:

(i) Definition of the pre-emergency baseline

(ii) Development of the emergency scenario

(iii) Estimation of the additional costs

(iv) Summary of the total effect on the health sector

1. Pre-emergency baseline

It is useful to have a baseline that includes information on the behaviour of the disease in question during the years preceding the epidemic, as well as any prevention and control measures that the authorities may have taken. It is also important to appreciate the functioning and scope of the health services and the action taken by the public health sector prior to the emergency – for example, vaccination coverage in the case of a disease such as yellow fever that can be prevented by immunization, and public access to health services.

One of the first parameters to be defined for the evaluation is the time horizon, taking the epidemiological week as the unit of measurement. The evaluation period, then, is taken as the time elapsing between the initial epidemiological week and the end of the epidemic. It must be recalled that some diseases, such as influenza, come in waves that may reappear with an interval of several months.

2. Emergency scenario

This will be based on information gathered during interviews and field visits, and through interaction between local specialists and those of the mission, obtaining in this way a complete overview of the epidemic's effects on the health sector.

Interviews should be scheduled with officials in strategic areas who are leading the effort to control and record epidemiological events, to finance them and to provide medical care for patients. They will include representatives of the health ministry, social security institutions and private health service providers. The purpose here is to facilitate access to all the information needed for a complete estimate of the expenses involved in responding to the emergency.

Following are some of the most common items on which information should be sought:

(i) Registry of suspected and confirmed cases.

(ii) Outpatient care (consultations and emergency care) and hospital care (hospital wards and intensive care).

(iii) Diagnostic studies (laboratory tests, imaging and so forth).

(iv) Acquisition of additional resources:

- Medications and inputs
- Medical equipment and furnishings (hospital, laboratory and so forth)
- Human resources
- Mobile units for patient care, vaccination and epidemiological surveillance

(v) Reinforcement of hospitals, laboratories and other facilities used to deal with emergency.

(vi) Medical resources available for treating patients in accordance with the specific disease in question:

- Health units (including mobile units)
- Health personnel (medical and paramedical)

- Hospital beds
- Intensive care beds
- Mechanical ventilators or other life-support equipment
- Medications and inputs
- Vaccines

(vii) Patient information and referral modules

(viii) Vaccination (number of vaccines purchased and administered)

(ix) Education and social communication campaigns

(x) Per diems and other travel expenses for providing emergency care in remote areas

For all the items listed that involve activities, interventions and procurement of resources, it will be important to know both the quantity and the associated costs. Account should be taken of those items that correspond to inputs, medications or materials that require special storage and distribution conditions, such as refrigeration in the case of certain vaccines and drugs. In the case of vaccines, the number of vaccines purchased must be determined, as well as those that were distributed and actually used, together with the costs associated with their acquisition, storage, transportation and application. The information collected will need to be integrated and classified in order to estimate the expenses generated under each item.

As part of the emergency scenario, the mission must determine how the health sector is responding, what types of actions it is taking to prevent and deal with cases, and the public health activities that are underway in the affected area. The health sector must be considered to include the public and private institutions that comprise it, as well as the health authorities as a whole, covering both the local authorities in each of the affected regions and those at the federal or national level.

For purposes of recording and projecting all the expenses flowing from the epidemic, the mission, in consultation with the country's authorities, will determine the duration and scope of the public health measures for controlling and preventing the appearance of new episodes of the epidemic, as well as the activities and the type of care that will be performed in the health services to address the emergency and to prepare for any in the future.

3. Estimating the additional costs

In the event of an epidemic, the health sector will face extra expenses in caring both for people who fall ill and for those who may require preventive measures or care to avoid contagion and illness. The expenses involved in activities for these purposes during the emergency are additional costs and will be recorded as such for estimating the impact. As well, it will be necessary to record revenues forgone as a result of care services that are not provided or are postponed because of the emergency. As already discussed, the national component of these additional costs will have a positive impact in other sectors. The external component will have a negative impact because it may involve increased imports.

The estimate of the health-sector impact of the emergency will be based primarily on the identification and evaluation of additional costs. Such an estimation for the health sector as a whole must recognize that outlays for epidemic prevention and control may be incurred either by the national or local authorities (the latter distinguished by state, district, region, department, municipality or commune, depending on the terminology used in each country).

Additional costs should be estimated for the public and private health sectors separately. The sectors may also be classified as public and non-public, including in this last item NGOs, United Nations agencies, programmes and funds, professional colleges, private providers and so forth.

The additional costs that may arise are associated with:

(i) Greater costs incurred through personal care services (beyond the sector's ordinary budget), i.e., medical treatment of persons infected with the disease, which will require extra provision of medications and medical supplies, additional personnel, extension of working hours, and reinforcement of services.

(ii) Higher operating costs for public health services (beyond the sector's ordinary budget) involved in reinforcing surveillance systems, prevention measures and epidemiological risk control.

(iii) Other unforeseen costs involved in coordinating and managing supplies (e.g. payment of customs duties).

Each of these items is detailed below, highlighting the most important aspects to be considered in estimating them.

(a) Personal health services

This includes the resources invested to provide care to persons who become ill during the emergency, as well as a projection of the cases that are likely to appear in the weeks following the impact estimate.

Personal medical care services are usually divided into outpatient (or ambulatory) and in-hospital care. Outpatient care[73] is usually provided in the external or emergency consultation areas, while hospital care covers general hospitalization and the critical care areas (pediatric, intermediate and intensive).

In emergency situations, most patients turn directly to the emergency services, where an initial assessment of their health status is performed. If their condition is not serious, they will generally be given medication and referred to outpatient consultation, where the progress of their disease will be monitored and, if the severity of the illness so dictates, they will be referred for hospital admission.

Outpatient care includes the value of the medical consultation and the means of clinical diagnosis, as well as delivery of the initial or complete dose of the necessary medication. Emergency room care entails a greater cost, as the facility will have medical equipment and specialized health staff to care for and stabilize patients in a critical state. Emergency room costs are generally calculated on the basis of a maximum stay of 24 hours, during which a patient's condition will be stabilized and monitored to decide whether the person should be discharged or admitted to hospital. If possible, differentiated costs should be applied to patients who have received care in these two areas.

Patients who are admitted to hospital will be given a bed in a regular ward or placed directly in the intensive care unit. In the latter case, as their condition stabilizes, patients will be moved to a ward bed until they have recovered sufficiently for discharge.

The estimate of health intervention costs may vary considerably, depending on the methodology and the medical protocols applied in each country, region or institution. However, the cost components are generally divided between fixed and variable costs, and consequently this handbook stresses the importance of incorporating both components.

Fixed costs are those that a health establishment incurs year in and year out, regardless of the volume of demand. They include infrastructure costs, capital costs (equipment, instruments and furnishings), utility and service costs (electricity, water, property taxes and maintenance), as well as the cost of human resources (when this is fixed) (Avila-Figueroa and others, 2002). Variable costs, on the other hand, are additional costs relating typically to inputs, such as drugs and curative materials and diagnostic studies, laboratory tests and imaging. They are specific to each intervention and their consumption level depends on the demand for that intervention.

Outpatient care costs are estimated on the basis of the number of patients served and the unit cost of the consultation (fixed cost), plus the variable costs, which include diagnostic studies and specific medications for the illness in question. The cost of hospital care will be based on the number of patients admitted to hospital wards and to intensive care units. The estimate will consider fixed costs (cost per bed-day in wards or intensive care units) and days of stay, as well as variable costs associated with in-hospital care.

On occasion, when the demand for hospital services exceeds installed capacity, it may be necessary to outfit additional medical care spaces and to purchase extra resources.[74] In such situations, the cost of the extra space, the equipment and furnishings, vehicles and additional human and physical resources must be considered.

[73] This includes care in any type of health establishment, as well as care offered by the members of field brigades or teams (mobile units).

[74] For example, during the influenza A (H1N1) epidemic in Mexico, intensive care units in public hospitals were overwhelmed and emergency areas and hospital wards were set up with ventilation and other life-support equipment for seriously ill patients.

These contingencies are financed to a large extent by reallocating budgets or drawing down unspent funds. Consequently, the strategies followed for covering the supply and demand gap in patient care must be reviewed. These activities may include:

(i) Using more of the available space in institutions.

(ii) Arranging for alternative sites such as shelters, schools, churches, rest homes, hotels or community centres.

(iii) Acquiring medical equipment, furnishings, materials and inputs.

(iv) Outfitting or renting mobile units.

(v) Contracting additional health personnel or extending working hours.

When additional inputs and medications are acquired for an emergency, care must be taken to avoid the double accounting that would result from recording them in the cost estimate for medical care and also under the heading of additional expenses.

Use of additional resources must take account of demand and the stocks of all resources that can be used in patient care. To this end it is important to obtain as much information as possible on the resources (beds, staff, equipment and so forth) available in public and private health institutions.

Special care must be taken to identify the expenditures that will have to be made for importing drugs, equipment and other components from abroad, so that the impact on the external sector of the economy can be subsequently measured.

For countries of broad geographical dimensions with widely scattered population centres, it is best to conduct a detailed analysis of outpatient care and hospital admissions by administrative level (region, department, province, or other denomination). Account must also be taken of the costs in terms of transportation equipment and paramedical personnel involved when patients who are seriously ill or located in isolated communities with only rudimentary health facilities must be transferred to other regions with more sophisticated health services.

In addition to recording the additional costs entailed in an epidemic, it is also important to quantify and identify the means for financing them, whether this involves budgetary reallocation or additional resources. In this respect, it is useful to identify the government body that has provided the additional resources.[75]

Box VI.2
Recommendations for estimating the value of medical care

The value of medical care includes suspected and confirmed cases registered during the epidemic. There should be no imputation as to the number of cases expected, except as necessary to make forecasts for the weeks or months following the evaluation.

The presentation of results must differentiate between ambulatory and hospitalized patients, and the latter category must be subdivided into those treated in regular hospital wards and those placed in intensive care units.

Whenever possible, the specialist should review the care manuals or protocols to reconcile their provisions with actual field observations and to make projections.

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

The following table illustrates the estimation of total medical care costs, using the example of Mexico during the influenza A (H1N1) epidemic (2009-2010), when an estimated 367,523 patients were treated. In this case, the costs are differentiated by institution involved.

[75] See chapter XVI on estimating the fiscal impact.

Table VI.1
Mexico: estimated total costs of medical care during the influenza A (H1N1) epidemic, 2009-2010
(Mexican pesos at 2010 prices)

Institution	No. of cases treated			Unit cost (pesos per person)			Total cost (pesos)		
	Outpatients	Hospital admissions		Outpatients	Hospital admissions		Outpatients	Hospital admissions	
		Regular ward	Intensive care		Regular ward	Intensive care		Regular ward	Intensive care
Mexican Social Security Institute (IMSS)	169 054	15 028	1 116	5 687	38 309	289 352	961 410 098	575 707 652	322 916 832
"Seguro popular" health insurance programme (SPS)	121 631	19 964	1 483	1 380	15 529	121 613	167 850 780	310 020 956	180 352 079
Social Security and Social Services Institute for State Workers (ISSSTE)	10 296	2 168	207	1 880	16 028	149 289	19 356 480	34 748 704	30 902 823
Private hospitals	8 260	768	40	2 501	150 000	750 000	20 658 260	115 200 000	30 000 000
Other	16 302	1 123	83	1 880	16 028	149 289	30 647 760	17 999 444	12 390 987
Subtotal	325 543	39 051	2 929	13 327	235 893	1 459 544	1 199 923 378	1 053 676 756	576 562 721
TOTAL								2 830 162 855	

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of estimates from the Economic Analysis Unit (2011); Secretariat of Health, for information on the "Seguro popular" health insurance programme; Mexican Social Security Institute (IMSS); Social Security and Social Services Institute for State Workers (ISSSTE); Ministry of Naval Affairs, Petróleos Mexicanos (PEMEX); and others.

(b) Public health interventions

The purpose of such interventions is to monitor the behaviour of the disease, to identify the causal agent, to halt or delay the propagation of the disease, and to reduce morbidity and mortality by controlling epidemiological and environmental risks. The type of intervention will depend on the disease that causes the emergency.

(i) Surveillance and identification of cases

This includes activities to implement or strengthen the disease surveillance system. The investment made by the sector and the support received from national and international organizations for surveillance in existing establishments as well as sentinel surveillance must be estimated.

The estimate will value the investment incurred for taking samples among the symptomatic population that visits the health services and for analysing them in public health laboratories and establishments, as the basis for distinguishing probable and confirmed cases of the disease. The estimate is based on the unit value of the examination and the total number of samples analysed, regardless of the percentage of confirmations. If other, more specialized examinations or studies are required, their costs must also be incorporated into the estimate.

(ii) Vaccination

In cases where it is feasible and the disease-specific vaccine is available, vaccination is performed with a view to confining propagation of the disease and thus reducing the demand for health services as well as the potential for complications among at-risk groups. It also allows people to continue with their daily activities, thereby avoiding greater social disruption and reducing the economic impact of the epidemic.

Calculation of the cost of the vaccination programme must take into account the number of persons to be immunized, the number of doses per person and the cost of each dose. It must also consider costs of distribution and the training of personnel in handling and administering the vaccine.

The following table shows the vaccination costs during the influenza A (H1N1) epidemic in Mexico (2009-2010), for which 30 million doses were purchased. This was a one-dose vaccine, and the estimate included the cost of the vaccine as well as its administration in all cases.

Table VI.2
Mexico: estimated vaccination costs during the influenza A (H1N1) epidemic, 2009-2010
(Mexican pesos at 2010 prices)

Influenza A (H1N1) vaccines	Total cost
Secretariat of Health (12.9 million doses)	1 254 402 133
Mexican Social Security Institute (IMSS) (9.97 million doses)	1 052 752 795
Social Security and Social Services Institute for State Workers (ISSSTE) (1.99 million doses)	177 359 570
Other (5.16 million doses)	503 242 984
TOTAL	2 987 757 481

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of estimates from the Economic Analysis Unit (2011); Secretariat of Health, for information on the "Seguro popular" health insurance programme; Mexican Social Security Institute (IMSS); Social Security and Social Services Institute for State Workers (ISSSTE); Ministry of Naval Affairs; Petróleos Mexicanos (PEMEX); and others.

(iii) Chemical prophylaxis

The purpose of prophylactic administration of medications to the public and to health personnel is to mitigate the impact of the epidemic, to keep the health services running, and to slow the propagation of infectious agents. The monetary estimate will be based on the unit cost, the quantity of doses necessary, and the number of persons to be protected, to which will be added the costs of distributing and delivering drugs to beneficiaries during the emergency phase.

(iv) Non-pharmacological measures

The effectiveness of these public health measures in slowing the propagation of the epidemic will depend on the agent's transmission characteristics. The measures that may be considered, depending on the type of the epidemic, include patient isolation and quarantine, as well as recommendations concerning hand-washing and respiratory hygiene. They also include bio-safety measures to prevent public health workers from developing the disease when they are responding to an emergency. These measures include the use of personal protection devices (for nose, mouth and eyes) and frequent hand-washing.

The cost of implementing the non-pharmacological measures in the health emergency response plan must be estimated. Examples of these measures include the purchase and distribution of inputs such as antibacterial gel and face masks for use in medical units, government offices, public facilities, schools and so forth.

The health sector may also recommend that other sectors adopt measures to reduce inter-personal contact, such as closing schools and public places, or restricting nonessential domestic air travel into areas affected by the emergency. The costs involved in adopting such recommendations will be charged to the corresponding sector.

Box VI.3
The influenza A (H1N1) epidemic in Mexico (2009)

The influenza A (H1N1) epidemic in Mexico that began in March 2009 provides an example of non-pharmacological measures. With a view to safeguarding public health, both for citizens and foreigners, the Mexican government declared a state of "health contingency" and took a series of prevention and social segregation measures that were subsequently reinforced by individual state governments as the epidemic spread. Those measures included temporary closures of schools, churches, sports stadiums, theatres and cinemas, restaurants, bars, cabarets, nightclubs and discotheques, as well as sanitary surveillance at the country's airports, designed in particular to identify and isolate outward-bound passengers who showed symptoms of the disease.

As the number of suspected cases continued to rise, some states (Chiapas, Tabasco, Quintana Roo and Yucatán) launched a search for cases in the schools. This involved a student screening exercise, as a result of which some 40 schools in that region were closed. When classes resumed, a three-step procedure was instituted: (i) students were screened upon arrival at school; (ii) the schools were cleaned and reconditioned three days before classes resumed; and (iii) the student screening process and the health situation in the schools were subjected to special surveillance and monitoring. The losses and additional costs associated with these segregation and surveillance measures were imputed to the education, commerce and transportation sectors, as appropriate.

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

(v) Controlling environmental risks

A value must be calculated for vector control, insect and rodent surveillance, the destruction of vector reproduction sites, the local application of pesticides, protection of domestic water supplies, and distribution of repellents or barriers (e.g. mosquito nets) to reduce human contact with the vector.

Depending on the type of health emergency, other measures will be taken for monitoring water quality or tracking soil, water and air contamination. Foodstuffs may also be analysed in emergency situations caused by mass food poisoning.

(vi) Social communication

Another set of additional costs that must be quantified relates to keeping communication channels open for advising the public on health measures that will slow propagation of the disease or reduce its complications. This component may include radio, television and other mass media announcements, and the printing and delivery of flyers, brochures, posters and other social communication materials for distribution to the community.

Having a proper communication plan in place will help ensure timely and efficient care, by optimizing use of available capacity in light of the severity of the symptoms in each case. For example, adequate information and referral of patients can avoid overloading health services, especially the hospitals, with patients who have only minor symptoms and who could be treated in lower-level facilities or could stay at home to recover.

(c) Other costs

These may include the cost of coordination, supply management (for example via the Logistics Support System (LSS) and the Humanitarian Supply Management System (SUMA))[76], transport of medical inputs, or customs duties on donated imports, depending on the type of health emergency.

4. Total impact on the health sector

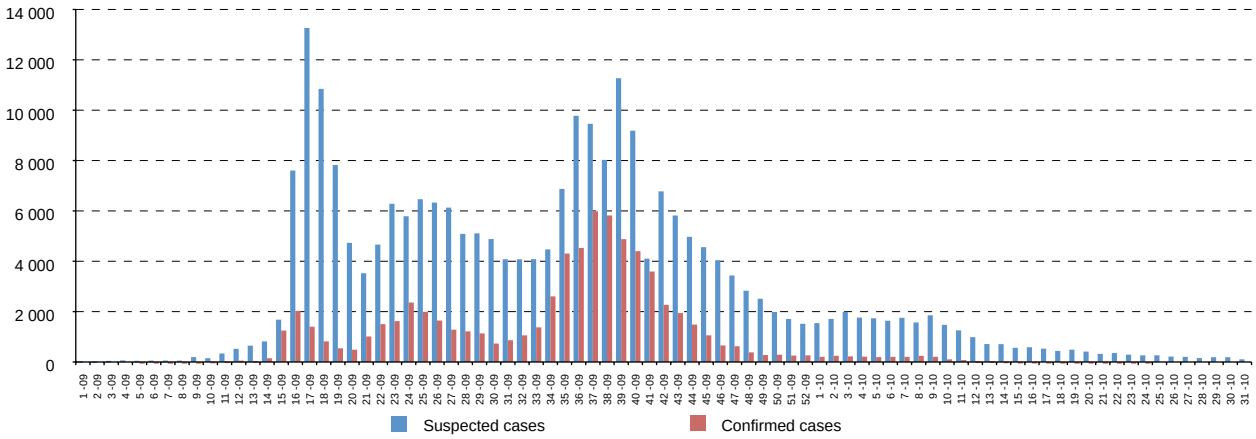
As a result of the estimation exercise, a consolidated information table can be prepared, showing the main expenditure items and the value of the different kinds of interventions performed during the emergency.

The impact of the epidemiological emergency includes the additional costs incurred by the health sector, as estimated according to the previous sections. At the end of the mission, the sector specialist should present a report containing a table summarizing those costs, disaggregated if possible by geographic or administrative unit (and for all sectors) as well as by the fiscal year or period and by public/private sector.

With regard to the influenza A (H1N1) epidemic in Mexico (2009 and 2010), figure VI.1 shows suspected and confirmed cases by epidemiological week, while table VI.3 summarizes the economic impact on the Mexican health sector. It will be seen that the greatest expenses were incurred during 2009, when the outbreak of the epidemic in epidemiological week 11 triggered efforts to provide medical care for patients and to control the spread of the disease. Of all the patients who showed symptoms during the entire course of the epidemic, some 90% were treated in that year, and it was in that year that 93.7% of additional costs to the health sector were incurred.

[76] This is a software tool distributed by PAHO for monitoring international humanitarian assistance in emergencies and disasters. The system is now widely used around the world to facilitate the definition and management of special supplies for responding to epidemics and pandemics, and for controlling and administering inputs, drugs and donated materials.

Figure VI.1
Mexico: suspected and confirmed cases by epidemiological week during the influenza A (H1N1) epidemic, 2009-2010



Source: Economic Analysis Unit, on the basis of figures from the Directorate General for Epidemiology, Secretariat of Health, 2011.

Table VI.3
Mexico: summary of health sector impacts of the influenza A (H1N1) epidemic, 2009-2010
(Thousands of Mexican pesos at 2010 prices)

Component	Year		Subtotal	Total
	2009	2010		
1. Personal care services				
1.1 Medical care				
• Outpatients	1 127. 09	72. 83	1 199. 92	2 830.09
• Hospital patients	742. 53	311. 08	1 053. 61	
• Intensive or intermediate care patients	401. 00	175. 56	576. 56	
1.2 Additional resources				
• Medical equipment	663. 08		663. 08	2 650. 93
• Antiviral drugs	416. 99		416. 99	
• Medical inputs	1 570. 86		1 570. 86	
2. Public health interventions				
2.1 Surveillance and identification of cases (laboratory tests)	356. 38	21. 79	378. 17	3 906. 88
2.2. Vaccination (seasonal influenza and influenza A (H1N1)	3 370. 51		3 370. 51	
2.3. Social communication and service in information modules	147. 26	10. 94	158. 20	
3. Other costs				
• Contribution to most seriously affected states	179. 07		179. 07	185. 19
• Disability premiums	1. 83	4. 29	6. 12	
ANNUAL TOTALS	8 976. 60	596. 49		9 573. 09

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of estimates from the Economic Analysis Unit (2011); Secretariat of Health, for information on the "Seguro popular" health insurance programme; Mexican Social Security Institute (IMSS); Social Security and Social Services Institute for State Workers (ISSSTE); Ministry of Naval Affairs; Petróleos Mexicanos (PEMEX); and others.

VII. Housing

A. Introduction

The term housing refers, strictly speaking, to any building intended to serve as a dwelling for individuals or families. However, the "housing sector" necessarily includes certain elements of urban infrastructure and equipment, such as for the delivery of basic utility services: water, sanitation and electricity. For this reason, an estimate of the impact of any natural event on the housing sector must consider the availability of essential water, sewage, electricity and gas services. For example, even if the dwelling itself (walls, roof and floor) is not damaged, drinking water will often be polluted as a result of flooding, and this can have serious implications for the health of residents. In estimating the impact of a disaster on this sector, then, damage to these types of infrastructure must also be considered. Public buildings and public spaces also form part of the housing sector, but should be examined separately.

B. Damage

Damage in this sector covers: (a) the total or partial destruction of dwellings and their equipment (furniture, electric appliances, sanitary facilities, and equipment in general) as well as the indoor components of water, sanitation, electricity and communications facilities; (b) the total or partial destruction of public buildings; and (c) the total or partial destruction of public spaces.

The following procedure is suggested for estimating the damage:[77]

1. Compiling information on the pre-disaster situation

The assessment team must have a clear picture of the housing sector prior to the disaster: number of dwellings and their principal characteristics, such as type and condition. An up-to-date and detailed diagnostic assessment of recent developments in the housing sector and related services can be useful for understanding any previous deficiencies, in order to compare the initial situation with that generated by the disaster. Such an assessment, usually easy to obtain, will reveal details of deficits, both quantitative (availability of dwellings in relation to the number of families present) and qualitative (wall, floor and roofing materials), as well as the availability and status of water, lighting and sewage services.

[77] Most of the explanation in this chapter focuses on housing, given its importance.

It is also important to have knowledge of existing housing policies, in particular with respect to social housing, and the latest information on substandard or precarious dwellings in the affected zone, which are typically inhabited by families in the lower income quintiles. Such information will be very useful in the preparation of subsequent reconstruction plans.

This information can be obtained from sources such as:

(i) The population and housing census, the household survey, and statistical bulletins and yearbooks available from national statistical offices or agencies.

(ii) Information available from the construction industry association, the property registry, periodic housing surveys, and building permits and licenses.

(iii) Information available in the records of housing and urban development ministries or institutions, planning ministries or institutions, local governments and municipalities.

(iv) Municipal or national tax records, covering the levies that are paid on dwellings in most countries. Note that substandard dwellings may not be registered, and thus will not be taxed. Geo-referenced maps.

(v) Information obtained from those segments of civil society directly affected by the disaster.

The main sources of information will be found at the national level, but it is also useful to consult international sources for published analyses and studies. Much of this information is available online, or can be obtained from the agencies concerned. These sources include:

- United Nations statistical yearbooks or compendiums such as the *Statistical Yearbook for Latin America and the Caribbean* of ECLAC or the *Human Development Report* of the United Nations Development Programme (UNDP).
- Materials from international entities such as the Latin American and Caribbean Demographic Centre (CELADE)-Population Division of ECLAC, the Economic Commission for Latin America and the Caribbean (ECLAC), the United Nations Development Programme (UNDP), the United Nations Human Settlements Programme (UN-Habitat), the Inter-American Development Bank (IDB), the World Bank and the Andean Development Corporation (CAF).

2. Estimating damage

(a) Housing

The estimate of damage in the housing sector is intended to establish the impact on the stock of:

(i) Dwellings (houses, apartment buildings, huts, temporary dwellings, collective or individual)

(ii) Furniture and equipment of housing units

Preliminary information on damage can be obtained from reports published by the competent authorities (that is, those with information and experience in the sector): emergency and disaster relief offices, government or municipal agencies involved in the sector (housing ministries, municipalities, town halls), professional and business organizations and associations, engineering and architecture firms, and national experts (or international experts who may be located in the country).

The data thus obtained must be confirmed through field visits. If there are no reports available, or if they are deemed inadequate, the mission will have to visit the regions, departments or provinces most affected by the disaster. Before planning such trips, however, the mission will have to identify the conventional official and private sources of local information, which can provide data, figures and other elements needed for preparing a proper evaluation.[78]

[78] In addition to available documents, reports and data, there may be satellite images produced by national or international institutions specialized in obtaining, analyzing and interpreting such images. The information they offer can be used to determine the built area, and the additional analyses can be very useful in establishing the pre-disaster baseline for comparison with the situation caused by the event or the phenomena encountered. Such graphic supports are important, for example, in the case of flooding, as they can help to identify the flooded zones and determine their extent and the height of the flood crest (see chapter III).

Information can be gathered from various sources simultaneously. What is important is to verify its reliability in each case and to conduct field reconnaissance and tests whenever possible and necessary.

Estimating damage requires knowledge of the degree of destruction of dwellings and their furnishings, as well as their replacement prices. It is best to prepare these estimates in consultation with the relevant national agents, such as experts from the construction association in the case of housing, and producers, distributors or merchants of domestic equipment (furniture dealers, white goods merchants, etc.) in order to value furnishings. Members of civil society should also be consulted. In any case, the assessments from these sources should be verified through field inspections.

In calculating damage, it is important to divide the affected dwellings into separate categories, in light of their quality, i.e. their structural aspects and their access to services. Housing quality in fact is one of the indicators used for calculating the multidimensional poverty index.[79] This will make it possible to identify the poorer households affected by the tragedy, recognizing that the average replacement cost of a dwelling is usually correlated with the income quintile of its inhabitants. This difference also appears in the furnishings and equipment of the dwelling. It is both useful and practical, then, to stratify damage to dwellings according to socioeconomic parameters.[80]

It will generally not be possible to conduct a detailed inventory of all units affected, and the mission will therefore have to extrapolate from its inspection of a representative set of dwellings and equipment damaged or destroyed. This will entail defining the type of damage to the various components of buildings. In light of the foregoing, the mission's work in evaluating damage and arranging for subsequent replacement or repair will be facilitated if the dwellings and public buildings are classified into three categories:[81]

- Buildings totally destroyed with no possibility of repair, including those with damage to structural elements (beams, pillars, structural flooring, load-bearing walls, and foundations).[82] In this case, the required action will involve total replacement of the element, additional reinforcement, or abandonment and replacement of the building.
- Buildings with serious damage that can nevertheless be repaired. This includes buildings with cracks, deformations or partial destruction, or a combination of these types of damage, for which repair and reinforcement projects will have to be planned.
- Buildings unaffected or with minor damage.

Information on dwellings must also be grouped according to the housing categories indicated above: houses, apartments, substandard dwellings, other type of dwelling. For each of these categories, the geographical location must be determined (urban, rural or peri-urban), as well as the construction materials used, the number of rooms per dwelling, and the ownership status (individual or collective, leased or owned, public or private).

This categorization will make it easier to estimate the pre-disaster value of the dwelling in unit terms (per square metre of construction or per housing unit). Special attention must be paid to the poorer households. The values to be applied should be obtained locally from reliable sources such as individual contractors, construction associations, housing funds, housing cooperatives, or non-governmental organizations (NGOs).

Another possible classification method is to group dwellings by income quintile: this can be useful for policy purposes as it reveals the housing impact on the most economically vulnerable families. Box VII.1 provides an example, using data from the post-earthquake survey in Chile (see Contreras, 2012).

79 See Alkire and Santos (2011).

80 The socioeconomic stratification can also be supplied by housing ministry officials at the regional, departmental or provincial level who, at the request of the expert, can conduct a survey or classification of damage to dwellings using this criterion. The information can be organized into percentages of dwellings in each stratum (as a minimum, categorizing them as substandard, social housing, middle-income and high-income). This will also be useful for placing a value on household assets or equipment, which must be consistent with each socioeconomic stratum.

81 This classification can be done more readily with the use of satellite maps for visualizing the most severely affected zones that will require priority attention from the authorities in terms of preparing detailed studies and defining needs for demolition and rubble removal.

82 This will depend on the nature of the disaster and the type of construction. For example, major flooding will destroy substandard dwellings, while better-quality buildings may not be destroyed but may suffer severe damage that renders them uninhabitable. It is important therefore to consider the degree of physical vulnerability of dwellings in accordance with their construction materials (CENAPRED, 2004).

Box VII.1
Earthquake in Chile, 2010: damage to dwellings by income quintile

According to data from the survey conducted after the 2010 earthquake in Chile, the percentage of damaged dwellings was greatest among the lower income quintiles (see Table 1). In geographical terms, as Table 2 shows, the greatest proportion of dwellings totally or partially destroyed occurred in the Maule and Bio-Bio regions, which are among the country's poorest.

Table 1
Percentage of damaged dwellings by income quintile and geographical area

Region	Quintile1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Total
Valparaíso	11.3	9.7	9.6	4.0	2.4	7.4
Libertador B. O'Higgins	12.5	15.9	14.1	11.2	7.5	12.2
Maule	26.3	27.4	18.7	18.2	2.8	20.7
Biobío	25.4	23.5	20.1	11.4	8.5	17.8
Araucanía	10.2	6.8	3.6	4.5	0.5	5.1
Metropolitan region	6.5	5.4	5.6	3.4	3.0	4.8
Total	12.0	11.1	9.7	6.3	4.6	8.8

Source: Dante Contreras, "Efectos microeconómicos de los desastres naturales", Santiago, Chile, Economic Commission for Latin America and the Caribbean (ECLAC), unpublished, 2012.

Table 2
Percentage of dwellings according to type of damage, by geographical area

Region	Serviceable	Reparable or destroyed	TOTAL
Valparaíso	4.9	52.8	7.4
Libertador B. O'Higgins	9.6	44.0	12.2
Maule	14.7	77.9	20.7
Biobío	15.6	65.5	17.8
Araucanía	2.8	33.6	5.1
Metropolitan region	4.0	16.2	4.8
	6.8	46.3	8.8

Source: Dante Contreras, "Efectos microeconómicos de los desastres naturales", Santiago, Chile, Economic Commission for Latin America and the Caribbean (ECLAC), unpublished, 2012.

The main categories of assets destroyed or affected, for purposes of damage evaluation, are:

(i) Dwellings

In order to estimate damage to dwellings valued at replacement cost (assuming characteristics similar to those of the original design), information is needed on the floor area destroyed or damaged and on the current average value per square metre of a dwelling with the given characteristics. That value refers not to a nation-wide average but rather to the average cost in the disaster zone (see table VII.1). The group performing the estimates must also collect information on the approximate age of the buildings.

In other words, when destruction is total the cost to be considered is that of replacement with a dwelling of equivalent quality. Once dwellings have been divided among the categories mentioned above, the replacement cost of each group is calculated by multiplying the number of dwellings by an average damage coefficient and by the cost per housing unit. This coefficient will take values between 0 and 1: if the dwelling is totally destroyed, the coefficient will be 1. This procedure is illustrated in table VII.1, detailing the damage to the housing sector from the La Niña phenomenon in the Plurinational State of Bolivia (ECLAC, 2008b).

Table VII.1
Plurinational State of Bolivia: value of damage to dwellings wholly or partially destroyed by the La Niña phenomenon, 2008

Department	Totally destroyed	Unit cost [a]	Total cost	Partially destroyed	Unit cost [a]	Total cost	Value of damage
Chuquisaca	208	25 760	5 358 080	412	8 597	3 541 964	8 900 044
La Paz	948	28 000	26 544 000	174	9 333	1 623 942	28 167 942
Cochabamba	164	23 125	3 792 500	233	7 708	1 795 964	5 588 464
Oruro	20	17 820	356 400			0	356 400
Potosí	12	17 820	213 840	66	5 940	392 040	605 880
Santa Cruz	689	27 500	18 947 500	217	9 187	1 993 579	20 941 079
Beni	6 144	24 050	147 763 200	13 933	8 017	111 700 861	259 464 061
Pando	1	17 820	17 820	84	5 940	498 960	516 780

Source: Economic Commission for Latin America and the Caribbean (ECLAC), *Evaluación del impacto acumulado y adicional ocasionado por La Niña, Bolivia* (LC/MEX/L.863/Rev.1), Mexico City, ECLAC subregional headquarters in Mexico, 2008.
[a] The unit cost of buildings destroyed was estimated from information on the value of a typical unaffected dwelling in each department. The unit cost for damaged dwellings was estimated at 30% of that for dwellings destroyed.

(ii) Household equipment

This item relates primarily to domestic appliances and equipment such as refrigerators, stoves, ovens, washing machines, dishwashers, heating and air-conditioning equipment, radios and television sets.

It excludes all equipment used in micro and small businesses[83] run from the home (and forming part of the "informal" urban or rural economy),[84] as these will be covered in the commercial, agricultural or industrial sector, as appropriate. The mission should work with the experts conducting the estimate in those sectors, as well as the gender experts, in order to appreciate the sex-disaggregated impact on home-based economic activities.[85]

It must be recalled that a household's equipment and its value will be different for each socioeconomic stratum.[86] Consequently, it is useful to determine all the assets for each stratum and their corresponding monetary value. For calculating replacement values, data can be obtained from commercial price lists.[87]

(iii) Furnishings

This heading includes furniture as such (beds, tables, chairs) as well as cooking and table utensils, clothing and such items as jewellery, books and toys.

As in the case of equipment, the estimation will be based on market prices, according to the dwelling category. It is important to note that the value of furnishings as well as of equipment is closely related to the average value per square metre.

As there will be little time available for evaluating damage and deciding which elements can be repaired, it is useful to define "degrees of damage" for furnishings: for example, 100% damaged (total destruction), 75%, 50% or 25% damaged.

83 Chapter XIV of this handbook contains a section on microenterprises.
84 In the Dominican Republic, for example, it was found that 76% of microenterprises headed by women are located in the home and that, while 10% pursue their economic activity outside the home (for example as street vendors), the home still serves as the base of operations and storage for supplies and inputs (ECLAC, 2008d).
85 See chapter XVII, which deals with the gender perspective.
86 The National Centre for Disaster Prevention (CENAPRED) in Mexico has developed a housing and household typology based on the quality of construction materials. This can be taken as an approximation of the socioeconomic stratification of housing (CENAPRED, 2004).
87 Information on damage to household equipment and its value has a gender connotation because, in general, it is women who perform the majority of household tasks, and such equipment makes for more efficient use of their time. For this reason, the gender perspective should be applied to the housing sector.

(iv) Other damage

There can be other damage such as to utility connections (water, sewage, electricity and gas). Although these are services delivered within the dwelling, they are not described here, as they fall under the heading of public works and infrastructure.[88] They are mentioned in this chapter because if the disaster has destroyed or disrupted access to these basic services, the dwelling may well be uninhabitable even if it has not suffered serious damage.

(b) Buildings of public use

These are generally few in number, in comparison with dwellings, and damage to such buildings is estimated individually. As with housing, the replacement cost will be estimated in light of the floor area and the cost of construction per square metre, and will then be depreciated by the appropriate factors.

For estimating furnishings and equipment the mission will need to work with the competent authorities to compile a specific inventory for each case, as the volume will be much greater than in the case of dwellings.

If the requirement is merely to repair the damage, this can be estimated either through detailed calculations for each case or by assigning a fraction or a percentage of the replacement cost.

This category may include buildings of a heritage nature (such as government buildings, town halls, cathedrals and universities). They may be only of local, regional or provincial importance, but they might also be of national or international significance, as is the case with buildings that have been declared part of the historic or architectural patrimony of the country or of humanity. The estimate of damages and losses to such assets, classed as cultural, is dealt with in another chapter of this handbook, because of their special character (see chapter VIII).

(c) Public spaces

These are green spaces, squares or parks for public use, damage to which is estimated on the basis of its extent, measured in square metres and the unit cost of the repairs or restoration needed to return them to their pre-disaster state. For parks or public squares, the estimate must also include the cost of repairing or replacing benches, lampposts and ornamentation of all kinds, such as planters and shrubbery.

C. Losses and additional costs

Losses in the housing sector relate to the interruption of accommodation services due to damage or destruction of the housing stock, making it temporarily or permanently uninhabitable.[89] The value of these services and implicit or explicit rents forgone, constitute losses, which can be estimated using the following procedure:

1. Compile pre-disaster information to establish a baseline for the estimate

This information can be obtained from various sources indicated above with respect to damage. To this must be added information from the national accounts with respect to the value of imputed rent.

[88] See chapters IX, X and XI of this handbook.

[89] Income forgone during replacement or reconstruction of dwellings that are used for micro or small businesses will be recorded under the productive sectors, and as most of these businesses are run by women, it will also be considered in the impact of the disaster on women. In effect, whatever the damage to the dwelling itself, what is important here is to assess the direct damage to the assets that generate income. For this purpose, close coordination with the gender experts will be necessary (see chapter XVII).

2. Interruption of services

This corresponds to the value of rents paid or imputed for dwellings rendered uninhabitable through destruction or damage. This calculation is done as follows:

(i) Obtain the cost of imputed rents forgone in the dwellings affected (partially or totally destroyed) and in those from which people had to be evacuated. This is obtained by multiplying the number of dwellings in those circumstances by the average implicit rent. In the case of rental dwellings, it is the actual rent that is taken into account.

(ii) Multiply the foregoing by the estimated number of months (or years) that it will take to rebuild the dwelling, in order to obtain the decline in rental income.

It will normally take several years to replace the stock of buildings, depending on financial constraints as well as on the capacity of the construction sector.

3. Estimating the additional costs

These will have a positive economic impact for various sectors, as shown in Appendix 1. They can be divided into two groups:

(i) Costs relating to the dwellings affected:

- Partial or no structural damage, requiring minor repairs and, in the case of flooding, all expenses involved in cleanup and mud removal.
- Total or irreversible structural damage, in which case all the costs of demolition and rubble removal must be counted.

(ii) Costs associated with the provision of temporary accommodation for persons whose homes were destroyed or had to be abandoned. These costs include the establishment of shelters or temporary homes, together with the costs of water and electricity supply, food and personnel costs. In some cases, it may be necessary to install water or power service. It is important to estimate how many families will require such accommodation, and for how long.

The sector that will finance these costs must be identified. For the public sector, the costs will be attributed to the government body making the expenditure. In addition, when temporary shelters and housing are established, all donations in kind from international humanitarian aid agencies must be recorded and a monetary value attributed to them.

D. Financial needs for recovery and reconstruction

The replacement or reconstruction of affected dwellings will involve different sectors of the economy, as explained in Box VII.2 and Appendix 1.

Box VII.2
Sectors of the economy that are affected when housing is damaged and destroyed

For the purposes of recording the economic flows arising from damage to dwellings, there are four sectors to be considered: real estate services, construction, land transport, and government.

1. Real estate activities (L68).[a] These include the services of lessors, agents or brokers in selling and buying or renting real estate and performing other services, on own or leased properties.
   When a dwelling has been destroyed, this results in a loss of profits corresponding to the imputed rental value of the dwelling. The calculation must consider the estimated number of months (or in some cases, years) that it will take to rebuild the dwelling, and this estimate will then be multiplied by the value of the imputed monthly rental at market prices.
2. Construction sector. Within this sector, the following activities can be affected:
   (i) Specialized construction activities (F43), specifically demolition and site preparation, which covers construction activities, including removal of existing structures. Freight transport of rubble and waste materials by road (H4923) can be recorded as part of intermediate consumption (costs) of the construction sector.
   (ii) Construction of residential buildings (F4100.1)
   (iii) Government production account. This is affected when, for example, the government temporarily provides shelter to persons who have lost their homes. In effect, the government is making an in-kind transfer to households.

The institutional sectors participating in the economic flows mentioned above are private non-financial companies, the government, and households. The value of construction output is calculated by multiplying the square metres actually built during the period by the unit price for each type of work.

Gross output value/total housing = physical construction m^2 x unit price m^2

Supply-use balances

The supply-use balance for services in this sector is described by accounting identities: thus, supply is equal to the gross output value, i.e. the output of construction products, while demand is equal to gross fixed capital formation (GFCF) of agents acquiring the buildings. In terms of final use of construction output, this is not consumed but rather accumulated, as it relates to capital goods. Moreover, these are the only goods that can be accumulated by the household sector as consumers (see table 1).

Table 1

Supply	Demand
Gross output value of construction	Gross fixed capital formation

Source: Economic Commission for Latin America and the Caribbean (ECLAC).
[a] This and the following codes are those assigned in the International Standard Industrial Classification of all Economic Activities (ISIC).

1. Financial needs for recovery

When a disaster strikes and dwellings are rendered uninhabitable, this marks the beginning of a process that starts with establishing temporary housing units and ends with restoring dwellings to their pre-disaster condition. The initial phase encompasses arranging all temporary accommodation, both those that are established and those set up in buildings designed for other purposes, such as schools and gymnasiums. The financial requirements for recovery include the resources needed to deal with all these phases.

Temporary housing consists of purpose-built structures or temporary shelters arranged in existing buildings that are normally used for other purposes. In the first case, the construction cost must be estimated, together with the related services such as water, sanitation and electricity. In general, these costs are estimated from the number of square metres and the unit cost of construction for each temporary dwelling, taken together with the number of households registered.

When shelters are set up in existing buildings such as schools, churches or sporting facilities, the cost is imputed to the corresponding sector rather than to the housing sector. In effect, the costs in this case arises from suspension of the activities for which the buildings were intended, the deterioration of infrastructure used for temporary accommodation, and subsequent rehabilitation or repair once the situation returns to normal.

Following the temporary housing phase, a study is carried out to determine whether recovery or reconstruction is needed. If it is recovery, all the costs of returning dwellings to their pre-disaster condition must be included.

2. Financial needs for reconstruction

Once the value of damage has been estimated, a strategy must be formulated together with reconstruction plans and programmes, or recommendations for adapting or modifying existing buildings. This strategy must include prevention and mitigation measures against similar events in the future, and it must take account of improved standards of quality, technology, design and construction, among others, for estimating the value of reconstruction needs, in addition to the value of the damage.

The programmes must take into consideration the conditions and characteristics of dwellings, the type of disaster, the most common types of housing construction in the affected zone, and any damage (structural and non-structural) suffered as a result of the event. It is also important to determine the location and the physical characteristics of the surroundings, such as the type of soil and local topography.

It is useful to identify national or international technical cooperation projects that may be needed for reconstruction programmes. Against this background, reconstruction recommendations can be prepared that address the following aspects:

(i) Investments needed to reduce the vulnerability of the dwelling and mitigate damage in the case of another extreme natural event. This may involve works to stabilize soils affected by landslides or subsidence, protection against flooding, or structural reinforcement.

(ii) Relocation, in cases where dwellings cannot be rebuilt or repaired, specifying the requirements for infrastructure works and urban services. This will generally involve the acquisition and servicing of lots for the relocation of dwellings that occupied vulnerable sites before the disaster. This cost does not include evacuations or transfers performed during the emergency phase.

The costs to be assigned to this heading also include those of housing construction, the value of the land on which the dwellings are to be built, and the cost of bringing in water, sewage, power and telecommunications services, as well as the cost of delivering property title and the outfitting of dwellings in the new location.

The administrative and institutional aspects for carrying out the works must also be established: these include community participation, technical support, personnel training, and interagency coordination.

Against this background, reconstruction programmes and their requirements in terms of time and funding must take into account the following aspects: availability of financial resources, institutional and organizational capacity, existing supplies of inputs, and the periods of time required.

Appendix 1

In a certain region of a country, 420 single-family dwellings have collapsed as a result of a natural disaster. The housing specialist does an inspection and estimates all the information provided below.

The cost of replacing the dwellings is 1.35 billion monetary units (MU). The collapsed dwellings have left 10,000 m^3 of rubble. The cost of removing this rubble is 150 MU per cubic metre.

As a provisional measure, the 420 homeless households (550 persons in all) are housed for three months in temporary shelters provided by the government. The operating cost of those shelters comprises a daily cost per person of 25 MU, plus 1,500 MU in monthly compensation of employees.[90]

After three months, 275 single-person households (50% of all the persons involved) move into rented homes, at a cost of 300 MU per month. The other 50% remain in the shelters for a further three months. Both the cost of the shelters and the rent paid for the housing constitute additional costs.

Table A.VII.1
Information compiled

Item		Number	Fixed assets (thousands of monetary units)	Persons	Unit price	Days	Expenses (thousands of monetary units)
A.	Intermediate goods	20	100				
B.	Operation			550	25	90	1 237.5
				275	25	90	618.8
C.	Monthly compensation of employees			50	1 500	180	450
D.	Private leases			275	300	90	900
E5.	Removal of rubble	10 000			150		1 500

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

1. Shelter operation — Government account (180 days)

As a result of the natural disaster, the government expands its production, providing shelter services to the families left homeless. As will be seen in table A.VII.2, the gross output value for this item is 2,306,300 MU, of which non-labour operating costs account for 1,237,000 MU in the first three months and 618,000 MU in the following three months, and shelter staff wages represent 450,000 MU. Intermediate consumption is equal to the non-labour operating costs of the shelters. As there is no market price for the shelters, the operating surplus is zero (see table A.VII.3). The government must record a transfer in kind to households, as a result of its provision of accommodation to homeless persons.

Table A.VII.2
Government production account
(Thousands of monetary units)

Uses		Resources	
Intermediate consumption	1 856.3	Gross output value	1 237.3 + 618 + 450
Gross value added	450		
Total uses	2 306.3	Total resources	2 306.3

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

[90] These are the costs of temporary reinstatement of housing.

Table A.VII.3
Income generation, government sector
(Thousands of monetary units)

Uses		Resources	
Compensation of employees	450	Gross value added	450
Net taxes on production	0		
Fixed capital consumption	0		
Net operating surplus	0		
Total uses	450	Total resources	450

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

2. Housing rental

Another sector involved is that of housing rental. The gross output value, at 94,500 MU, corresponds to the amount of rentals paid on behalf of the families housed in the shelters (see table A.VII.4). Intermediate consumption is found to be 23,600 MU, compensation of employees 10,000 MU, net taxes on production 3,000 MU, and consumption of fixed capital 4,000 MU. These data represent an operating surplus of 53,900 MU.

Table A.VII.4
Production account, real estate service providers
(Thousands of monetary units)

Uses		Resources	
Intermediate consumption	23.6	Gross output value	94.5
Gross value added	70.9		
Total uses	94.5	Total resources	94.5

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Table A.VII.5
Income generation, real estate sector
(Thousands of monetary units)

Uses		Resources	
Compensation of employees	10	Gross value added	70.9
Net taxes on production	3		
Consumption of fixed capital	4		
Net operating surplus	53,9		
Total uses	70,9	Total resources	70.9

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

3. Rubble removal

The third sector where production is affected by the collapse of dwellings consists of the private construction companies hired to remove the rubble. Their gross output value is equal to the total volume of rubble multiplied by the price per cubic metre for removing it. As with the previous point, information is available on intermediate consumption, compensation of employees, net taxes on production, and consumption of fixed capital. Based on this information, the following tables estimate the gross value added and the operating surplus.

Table A.VII.6
Production account, private construction companies (removal of rubble)
(Thousands of monetary units)

Uses		Resources	
Intermediate consumption	525	Gross output value	1 500
Gross value added	975		
Total uses	1 500	Total resources	1 500

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Table A.VII.7
Income generation, construction sector (removal of rubble)
(Thousands of monetary units)

Uses		Resources	
Compensation of employees	200	Gross value added	975
Net taxes on production	50		
Consumption of fixed capital	10		
Net operating surplus	715		
Total uses	975	Total resources	975

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

VIII. Culture and cultural assets

A. Introduction

Among the impacts that a disaster can leave in its wake is the total or partial destruction of the stock of cultural goods and assets, and interruption of the services they provide.

Estimating damages and losses to cultural and recreational assets is of great importance, given the role those assets play in the social and economic development of regions and countries. In fact, they serve as sources of income and of direct and indirect employment, while at the same time improving quality of life by fostering spiritual and intellectual growth and enriching human capital. Cultural properties are also the repository of the historic and artistic memory of human societies.

1. General considerations

For purposes of this methodology, cultural assets consist of:

(i) Cultural goods as such.[91]

(ii) Infrastructure (buildings and installations) of institutions that provide cultural services (libraries, workshops, theatres, sporting facilities and so forth), as well as entities related to cultural industries.[92]

(iii) Furnishings and equipment for cultural activities.

In order to estimate the effects of the disaster, it is best to begin by obtaining the most complete information possible on the cultural assets affected, through Internet searches, interviews with the authorities of ministries or departments responsible for culture and cultural heritage, museum directors, public agencies involved in culture and the arts, public and private entertainment enterprises, municipal and departmental bodies responsible for cultural heritage, artists' associations, culture officials and other relevant agencies.

[91] Cultural goods are those goods and services resulting from activities that involve some form of creativity, that communicate symbolic meanings, and that represent a form of intellectual property, at least potentially.

[92] Points (ii) and (iii) and their respective methodology for estimating damage are also applicable to public heritage buildings and facilities that perform functions for government, if they have been affected by the disaster.

B. Damage and losses to cultural goods as such

Placing an economic value on cultural goods can be a serious challenge, given their specific characteristics,[93] which can be described as follows: they transmit symbolic messages to the persons who consume them, they are experiential goods, they have the properties of public goods,[94] they are subject to intellectual property laws, creative work lies at the heart of their production process, and they embody or give rise to forms of value that cannot be fully expressed in monetary terms and may not be revealed either in real or in contingent markets (Throsby, 2002; Noonan, 2002; Vecvagars, 2006; Palma and Aguado, 2012).

Diagram VIII.1 illustrates the complexity involved in determining the economic value of a cultural good, because of its many facets and the fact that it may embody a use value (which can be traded on the market and will have a price) and a non-use value (which is not market-related).[95] The diagram summarizes the concepts that have been developed with respect to cultural issues, and may serve as guidance for the expert in understanding the characteristics of a cultural good. It is important to bear in mind those goods that, according to the United Nations Educational, Scientific and Cultural Organization (UNESCO), constitute cultural heritage.[96]

The following may be considered as "cultural heritage":

(i) Monuments, architectural works, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features, which are of outstanding universal value from the point of view of history, art or science.

(ii) Groups of buildings: groups of separate or connected buildings which, because of their architecture, their homogeneity or their place in the landscape, are of outstanding universal value from the point of view of history, art or science.

(iii) Sites: works of man or the combined works of nature and man, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological point of view (to which may be added the sacred sites of pre-Columbian cultures in Latin America).

In practice, the expert who is estimating the impact of a disaster on cultural goods will have to work together with specialists and professionals from public and private entities that are responsible for administering those goods, in order to determine their cultural value, and whether they are of local, national or world-heritage importance. The method used to estimate damages and losses will depend to a large extent on this categorization.

1. Estimating damage to a cultural asset

In estimating the value of damage to cultural properties partially or totally destroyed, the following considerations should be taken into account:

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93 The "culture economy" is a new area of economic specialization that began to emerge in the 1960s and that has now acquired great importance across a number of areas and issues such as cultural policy, the organization and management of cultural enterprises, the functioning of the art market, the construction of economic accounts for the sector, and other areas that require the development of new conceptual systems (Mourato and Mazzanti, 2002; Palma and Aguado, 2012; Herrero, 2009). The need to quantify the cultural sector's contribution to the economy has led to methodologies for establishing satellite accounts for culture within the national accounts. Considerable experience has been gained in the organization and management of such accounts over the last decade in Australia, Canada, France and the United Kingdom. In Latin America, Colombia and Chile have blazed the way, and Uruguay is following suit. Twelve Ibero-American countries are working on this issue under the Andrés Bello Convention (CNCA, 2007; Trylesinski and Asuaga, 2010; see [online] www.dane.gov.co).

94 This refers to the non-rivalry and non-excludability characteristics of a public good (Throsby, 2002; Noonan, 2002; Vecvagars, 2006). The first means that use of the good by one person does not necessarily preclude its use by others; the second means that it is difficult or impossible to prevent onlookers from enjoying a good, for example an architectural monument in a city.

95 As one of the most recent studies in Latin America notes, there is now no dispute as to the contribution of art and culture to economic activity, or as to their inclusion as a strategic sector within public policies. However, there is still controversy, even confusion, when it comes to delimiting the cultural sector. This extends to theoretical discussions, in the field of cultural studies, as to what constitutes culture and the cultural industry, and the limitations of current methodological tools (Aguado, 2010).

96 See the Convention Concerning the Protection of the World Cultural and Natural Heritage [online] http://whc.unesco.org/archive/convention-en.pdf.

(i) Determine whether the damaged portion or the complete property can be restored or replaced. This will require the knowledgeable opinion of architecture, archaeology and museology experts from the cultural and heritage institutions of the country affected as to the procedure by which the good was prepared or constructed (for example, a historic house, a colonial church, pieces of metal, stone or other minerals, pre-Hispanic textiles).

(ii) Determine the amount of money required for restoration or replacement.[97] This must reflect the economic value of the damage.

The particular feature of these properties is that they have a cultural value that is not confined to the total economic value of damage and loss (calculated as explained below), because it also comprises the non-use value represented by the components shown in the right-hand portion of Diagram VIII.1.[98]

As will be clear from the diagram, non-use values cannot be traded on the market, but form part of the total value of the cultural good and, depending on the importance of this set of values, a more exhaustive estimate may be needed.

Thus, when the damage to a cultural good so warrants,[99] the contingent valuation method (CVM) can be used as a way of measuring use and non-use values. These latter values, as noted earlier, have no market price or commercial substitute (Noonan, 2002). This is the method most frequently used for these purposes,[100] but it requires more work and resources and it demands careful preparation: it will in fact be very difficult to complete within the timeframe of a disaster assessment, and will likely have to be performed at a later date.

These studies require that surveys be conducted on the willingness to pay for the benefits of a particular good, or the willingness to accept compensation for the loss of those benefits. The following steps are involved here:

(i) Identify the property to be evaluated.[101]

(ii) Determine the method to be used for the survey (telephone, e-mail or face-to-face interview).

(iii) Design the questionnaire (structure and format, open-ended questions or multiple-choice responses).

(iv) Conduct the survey.

(v) Compile, process and analyse the data.

This method has been the subject of caveats from specialists in these matters, but as noted earlier it is one of the most widely used in various parts of the world, and there is consequently a certain reservoir of experience regarding the issues cited by the critics. The procedures and the results obtained from the many cases of application demonstrate their utility in estimating disaster-caused damage and losses to cultural properties.[102]

2. Estimating losses with regard to cultural assets

The losses in the case of a cultural good are directly related to its use values (see diagram VIII.1). Use value may be subdivided into direct (extractive or consumptive) and indirect (functional) use values. Direct use value refers to the revenues that a cultural asset can generate, for example in the form of rent.[103] This is the easiest value to estimate, because it has a market price, and it can be used as a parameter to measure disaster-related losses to a cultural asset. This category includes buildings of cultural or historical significance that can be used for hospitals, housing, or for

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97 In the case of textiles, for example, this amount may be the payment that will be made to the restorers for the entire process of analysing how the material was prepared and how the work was made; this can take a great deal of time.

98 Non-use values include *existence value*: people may regard the mere existence of the heritage item under consideration as being of value to themselves or to the community, even if they do not enjoy benefits from it at first hand; *spiritual value*: works of art may reflect and express the inner values of humanity or those of a specific religion; *historical value*: a cultural object may reflect the conditions of life at the time it was created and can illuminate the present by providing a sense of continuity with the past; *symbolic value*: artworks and other cultural objects are also repositories and conveyors of meaning which people can extract; *social value*: the work may convey a sense of connection with others and contribute to a comprehension of the nature of a society and to a sense of identity and place (Vecvagars, 2006; Mourato and Mazzanti, 2002).

99 For example, a property qualified as cultural heritage by the State in question or by UNESCO.

100 This method, long in use by environmental economists, has been adapted for estimating cultural properties.

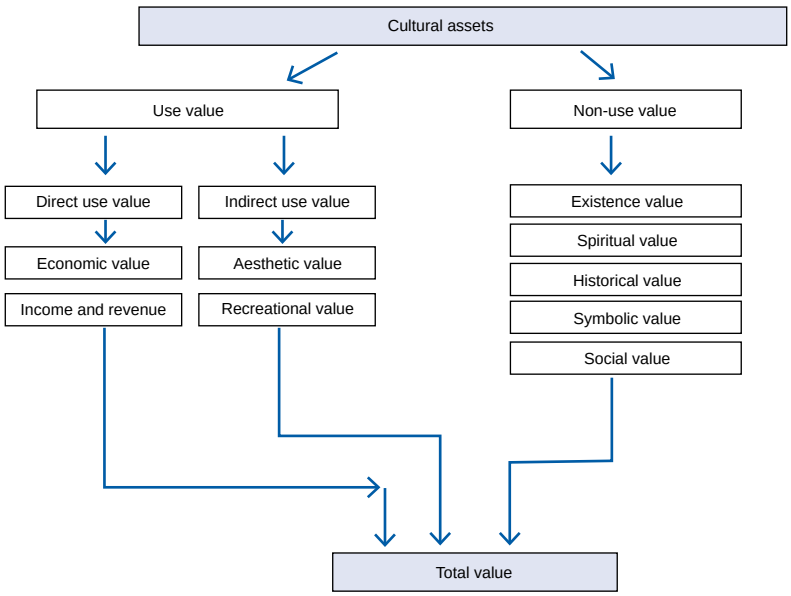
101 There will be cases where various cultural properties have been affected. As the CVM takes considerable time and resources, properties to be valued in the first round will have to be prioritized.

102 For more information, see Noonan (2002) and Navrud and Richard (2002).

103 This is the case with sites or buildings of cultural or historical value that can be used for other purposes.

administrative or commercial purposes by public or private institutions. Their value can be measured on the basis of the rent received by the owner or that paid for a building of similar characteristics.

Diagram VIII.1
Value of cultural goods



Source: K. Vecvagars, "Valuing damage and losses in cultural assets after a disaster: concept paper and research options", *Estudios y Perspectivas series* (LC/MEX/L.731), Mexico City, ECLAC subregional headquarters in Mexico, 2006.

Indirect or functional use value derives primarily from the services that the cultural asset provides: this is the case with archaeological and cultural sites, which may or may not be managed by an institution and may or may not charge an entrance fee. When a fee must be paid, the loss must be estimated in terms of the forgone revenue, taking into account the following considerations:

(i) Interruption of access to the asset, because of the disaster.

(ii) The period of time for which the asset will be closed, which may run from the occurrence of the disaster until the asset is repaired or rebuilt or until users begin to visit again.

(iii) The price of entry and the projected volume of visitors. If the latter information is not available, it can be estimated by using the historical average of visits during three years, information that may be available from the administration or that can be identified through interviews with managers.

(iv) The losses occasioned by the disaster will be the result of multiplying all these variables.

If the cultural asset has generated, and is the focal point of, other economic activities such as recreational or educational tourism with their related services (hotels, restaurants, shops) and if there is no charge for their use, the losses occasioned to this asset by the disaster may be taken as the forgone revenue from those activities, in the manner explained previously. This approach can be used, for example, with cultural assets of local or natural reputation. In such a situation, the experts from the cultural and tourism sectors must work closely together in producing their estimate so as to avoid double-accounting for losses and, recognizing that the cultural asset is a core attraction around which tourism activities revolve, they must use the estimate of those losses to identify the use value of the asset in question.[104]

[104] This involves the "travel cost method" (one of the "revealed preference methods" that rely on "surrogate markets" for observations) which is used to estimate the value of a cultural asset's recreational use (Mourato and Mazzanti, 2002; Vecvagars, 2006).

C. Estimating damage, losses and additional costs for cultural entities

The following section describes procedures for estimating the impact on cultural entities.

1. Estimating damage

As indicated above, damage relates to the total or partial destruction of physical assets. These assets include buildings and installations such as libraries, auditoriums, community or urban facilities, studios, workshops, sporting facilities and halls that generate cultural goods and services such as painting or sculpture exhibitions, concert halls, movie theatres and art galleries, as well as facilities for the production and screening of videos and films and places where amateur artists gather to pursue their work.

The damage to be evaluated includes damage to equipment, furnishings, materials and finished products in workshops and cultural enterprises, as detailed below.

The value of damage to cultural entities and enterprises must be calculated on the basis of the cost of repair, replacement, restoration or reconstruction of the physical assets partially or totally damaged. It is useful to organize the information under the following headings and to pursue the following procedure:

Buildings and installations:

(i) Collect information on the average local construction cost per square metre for various types of buildings and facilities.

(ii) For each damaged facility or a building, determined the total built area. The number of square metres that must be rebuilt can be identified using a damage scale of 1 to 4, where the upper limit could be taken to represent total destruction (100%) and consequently the need to replace a facility or building completely. The other levels could represent 25%, 50% and 75% destruction.

(iii) The average construction cost per square metre will be multiplied by the total area to be reconstructed for each type of facility or building. The sum of the values for reconstructing all the buildings affected for each administrative entity (province, department, municipality) will constitute one portion of the total damage. The other portion comprises the value of replacement or repair for equipment, furnishings and materials used in cultural activities.

Equipment, furnishings, materials and finished products:

These items may include lighting, sound, recording and computer equipment, musical instruments, raw materials and materials for decoration, scenery, photography, painting, sculpture and, in general, all those needed for professional and amateur artistic activities, and facilities for sporting and other events. The damage estimate must also consider damaged inventories of finished art works, establishing a price for each item, which will be multiplied by the number of works destroyed.[105]

It is also useful to identify the percentage of the imported component in each set of assets to be repaired or rebuilt.

For estimating damage to equipment, furnishings, materials and other types of assets used for cultural activities, the evaluator must:

(i) Determine the price for repairing or replacing each piece of equipment or furniture, instrument, set of materials or finished product.

(ii) Apply this to the number of damaged or destroyed units of each type, previously identified in each institution affected.

In the experience of the Economic Commission for Latin America and the Caribbean (ECLAC), it has been noted that libraries and bibliographic collections suffered great damage during floods.[106] In such a situation, in addition to

[105] These will be pieces that have not yet been exhibited or sold, made by artisans or artists, amateur or professional, the price of which can be determined from that for similar works sold on the market, or through information from the artists themselves.

[106] The floods that hit Tabasco in 2007, for example, damaged libraries in several municipalities and in the state capital (ECLAC, 2008a).

producing a monetary estimate of partial or total destruction of buildings, furnishings and equipment, the amount of damage to bibliographic collections must also be quantified, recognizing that they may contain the only existing copies of valuable works. To complete this task the evaluator must:

(i) Identify all the titles damaged and the price of each volume, which may be recorded by the institution or can be obtained through the trade or online. If the information for some title is not available, the price of a volume with similar characteristics can be taken as an approximation.

(ii) Multiply the price of each title by the number of corresponding volumes, to arrive at the total damage to this item.

The total cost of repairs and replacements for equipment, furnishings and assets affected, added to the cost of repairing and reconstructing buildings and facilities, will constitute the total amount of the damage, which must be determined for each administrative entity (province, department, municipality), disaggregated between public and private sector.

2. Estimating losses and additional costs

(a) Losses

The losses occasioned by a disaster relate to the interruption of cultural activities conducted by public or private entities in the affected territory. They may range from large-scale events such as concerts, fairs and cultural festivals that are organized from time to time and that are suddenly suspended, to more routine events such as film screenings, popular music reviews, theatre presentations, sporting events, amateur artist workshops and so forth.

The procedure for estimating the losses of public or private entities in the cultural area involves determining the forgone revenues through the following steps:

(i) Determine how long the entities' operations will be suspended.

(ii) Confirm the average price of admission to events and the anticipated audience size. If the latter figure is not available, it can be estimated, for example, by taking the average audience recorded by the entities for the last three years.

(iii) Multiply these parameters to calculate forgone revenues.

In the case of leisure-time workshops, if these are not offered free, a similar procedure must be followed:

(i) Determine the amount charged per person for each activity.

(ii) Determine the number of expected participants and the time during which the workshops were suspended.

(iii) Multiply these parameters to calculate forgone revenues for this item.

(b) Additional costs

Information must also be collected to determine the additional costs of the disaster, as they increase the intermediate consumption involved in supplying the service. These may relate to expenses incurred to carry out the suspended artistic and cultural programmes at another place and date, such as:

(i) Rental of other facilities.

(ii) Rental of equipment and furnishings.

(iii) Publicity campaigns.

There may be situations where private cultural institutions have had to pay salaries during downtime, and this again is information that must be obtained because of its impact on the operating surplus.

In the case of public libraries, for which there is generally no user fee, the gross value added of production is equal to intermediate consumption plus the compensation paid by these institutions to their employees,[107] and their value added is equal to such compensation. If the service is interrupted, but they continue to pay their employees,

[107] For further detail, see the examples in the chapters on education, health and housing.

there will be no change in value added. However, it must be determined if there has been or will necessarily be an increase in intermediate consumption in order to continue operating in the wake of the disaster, and for how long.

The total of entities' forgone revenues and the cessation of revenues due to the closing of workshops reflect the value of lost output. The payment of salaries while private institutions were closed, the amounts paid for rent, repairs, publicity, consumption of extra materials and so forth will mean an increase in the additional costs for this sector resulting from the disaster, and this must be calculated for each of the administrative units affected (departments, provinces, municipalities) and included in the disaster assessment report, totalling the amount for the country as a whole.

Part III
Infraestructure

IX. Transportation

A. General considerations

This chapter deals with estimating the impact of a disaster on the highways of a country or a region and on freight and passenger transport by road. Indicative costs for Colombia are used to illustrate the valuation of damage, losses and additional costs.

This handbook cannot of course address the full range of damage to the transportation sector, which includes subsectors such as water (sea, river, lake and port), air and rail transport.[108] This chapter will focus on estimating impacts on the road transport subsector, as the estimation procedure is similar to that for other transportation subsectors.[109]

Transport infrastructure is essential for economic development and social well-being. It is a key element in keeping economic and commercial activity running and it plays a predominant role in maintaining interconnection and communication between different regions and between urban and rural areas. It must also ensure mobility for persons and the transportation of goods from production centres to consumption centres, under conditions of accessibility and reasonable transit times.

B. Determination and quantification of damage

1. Road infrastructure

Damage to road infrastructure refers to the effects of the disaster on any of the elements of roads and highways that lead to total or partial suspension of service.

The value of damages will represent the cost of the works needed to restore the infrastructure to pre-disaster conditions. The estimate includes the rehabilitation works required to restore service (i.e. to make a road accessible and passable), as well as the replacement works needed to return the infrastructure to its original state. Reconstruction

[108] In the national accounts, the transport sector embraces various subdivisions, listed in box IX.1. Box IX.2 describes output and intermediate consumption of the sector, as well as the supply-demand balance in the land transport of passengers and freight.

[109] This has been one of the subsectors most affected by events of this kind (Bello and others, 2013).

must include new works that will have to be undertaken to improve or expand the affected roadway, and will be catalogued as reconstruction works.

This methodology begins with identifying the various government bodies responsible for the affected infrastructure. It then proceeds to a visual inspection and an inventory of damage.

Following are the steps to be taken in estimating the impact of a disaster in this sector.

(a) Compiling pre-disaster data

As a first step, the following institutional and statistical information on the sector must be compiled:

(i) The entities with responsibilities for the affected infrastructure, and the contact point within each entity, in order to ensure a proper flow of information.

(ii) The country's institutional framework and the situation in the affected zone or region.

(iii) The country's road infrastructure (length in kilometres) and its pre-disaster condition: in particular, the geographical areas affected and their topographical characteristics should be identified.

(iv) Road maps for the affected region, showing communication routes for the zone, in order to assess alternate routes in case of total closure.

(v) Characteristics of the roads and their functionalities.

(vi) Normal freight and passenger transport flows over the main roads.

(vii) Marginal costs of vehicle operation.

In general, the following bodies will be responsible for road administration:

(i) National highways (whether concessioned or not): central government.

(ii) Provincial/departmental roads (concessioned and non-concessioned): provincial or departmental governments.

(iii) Municipal roads: the municipalities.

These responsibilities must be adjusted to the geographical division of each country. Table IX.1 illustrates this division for countries of South America.

Table IX.1
South American countries: geographical division and infrastructure

National	Provincial/state/departmental	Municipal
Argentina	Provinces	Departments, municipalities, partidos
Bolivia (Plurinational State of)	Departments	Provinces, municipalities, cantons
Brazil	States	Territories
Chile	Regions	Provinces, communes
Colombia	Departments	Municipalities
Ecuador	Provinces	Provinces, cantons, parishes
Paraguay	Departments	
Peru	Departments	Provinces, districts
Uruguay	Departments	Municipalities
Venezuela (Bolivarian Republic of)	States	Municipalities

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Using the example of Colombia, Table IX.2 indicates responsibility for surveying the information, as well as the entity responsible for consolidating it and transmitting it to the professionals who will be estimating the disaster impact. It is important to obtain this information on the country affected by the disaster.

Table IX.2
Responsibilities for surveying and consolidating information

Road infrastructure	Information survey	Information consolidation
Municipal	Municipal governments	Departmental governments
Departmental	Departmental governments	Sector Ministry
National	Sector Ministry	Sector Ministry

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

If road administration is centralized, there will be no need for this classification, and all road infrastructure may be assumed to be national.

(b) Compiling information on road damage

The first step is to schedule a meeting with the officials responsible for the affected infrastructure and with the local authorities, in order to obtain information on the characteristics, conditions and magnitude of the disaster's impact on roads and highways.

The damage assessment provided by the national or local authorities must always be reviewed carefully, as it may be incomplete or unreliable, for example because:

(i) Some sections of the road network may be inaccessible to inspection because of the disaster.

(ii) The local or national authorities may have overestimated the value of damage, with a view to securing more funding for reconstruction.

(iii) A portion of the damage may have occurred before the disaster, as a result of faulty maintenance.

(iv) Estimates may not cover all the costs of reconstruction; they may for example omit permanent staff members already included in the budgets of the corresponding agencies.

(v) The national authorities may not take into account the damage suffered by infrastructure under local jurisdiction, or concessioned to private administrators.

With this information, a prioritized inventory should be prepared (following a visual inspection if possible) of the damage produced and of its effects in terms of road access and serviceability, as well as any possible improvements or additions on the basis of which reconstruction works might be planned or recommended. Such an inventory should be prepared for each of the government bodies responsible for the affected roadways.

Compiling this inventory will require the cooperation of the competent authorities. Two information sheets can be used, one for bridges and the second for all other roadway elements. These forms can be downloaded at the website indicated in this handbook. They will facilitate the identification and recording of the elements affected.

The following information is commonly contained in these forms:

(i) Concession: indicate whether the road on which the bridge or viaduct is located has been concessioned.

(ii) Department/province/state: the administrative division in which the affected infrastructure is located.

(iii) Municipality: if the infrastructure is on one municipality's boundary, indicate the adjacent municipality.

(iv) Name of the road: indicate the name of the affected road, as recorded in the road inventory. The first item in the name will indicate the point of origin and the second item the destination.

(v) Functionality: determine the functional classification of the affected roads —primary, secondary or tertiary— according to the following definitions:

- Primary: highways and trunk roads or expressways crossing or providing access to a provincial capital; their basic function is to integrate the principal areas of population, production and consumption in the country, and to connect it to neighbouring countries.
- Secondary: roads that link major towns to each other or to a primary road.
- Tertiary: roads that link a major town to its outlying districts, or that link those districts to each other.

(c) Information on bridges and viaducts

In compiling information on bridges and viaducts, the following considerations should be taken into account, subject to the results of a visual inspection:

(i) Name of the bridge: this will be the name that identifies the bridge or viaduct, or if it has no name, the river, channel or stream that crosses the road at the site of the affected bridge or viaduct.

(ii) Location: indicate the geographical coordinate (km) where the emergency is located, measured from the point of origin of the road.

(iii) Length of the bridge span, in metres.

(iv) Type of bridge: vehicular (V) or pedestrian (P).

(v) Type of structure: concrete (C) or metal (M).

(vi) Type of damage: use the following classification:

- Damage to foundations (C), generally caused by flooding that erodes the base, or through continuous contact with water, without proper protection.
- Damage to retaining walls or abutments (MA): total or partial destruction through failure or weakening of the foundation or superstructure, or by force of earth pressure.
- Damage to infrastructure (I): total or partial destruction caused by weakening of the bridge support structure, or because the height of a horizontal section is lower than the maximum flood crest.
- Damage to the approach ramp (TA): caused by the failure of abutments, as the bridge requires a greater water evacuation area.
- Total collapse: total loss of the structure.

To obtain the estimated replacement value, each of the types of damage must be costed, using prices applicable in the disaster zone. Table IX.3 shows indicative costs provided by the National Highways Institute of Colombia.

Table IX.3
Indicative costs relating to bridges and viaducts
(Dollars)

Type of bridge or viaduct	Unit	Value
Pre-stressed beam construction		
Recommended for spans of less than 40 m	m	13 807
Cantilevered construction	m	30 550

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of National Highways Institute (INVIAS) of the Ministry of Transport of Colombia, estimates based on unit prices for 2012.

Note: These are illustrative costs, using an exchange rate of 1,800 Colombian pesos per dollar.

(d) Information on other road elements

In compiling information on other elements of the road, subject to the data received and a field inspection, the following classification should be used, and physical magnitudes identified for each type of damage:

(i) Landslides, mudslides (D): all damage caused by instability of banks, reduced soil cohesion, or mountainside collapse.

(ii) Loss of embankments, subsidence (PB): produced by the same phenomena as above, when they occur on the lower bank; they may also be due to rotational phenomena on slopes.

(iii) Impact on drainage works (OD): blockage by silting of ditches or collapse of slopes (landslides), loss of inlets and outlets, filters, perimeter drains, and lateral or deep filters sedimentation chambers, as well as embankment losses with destruction of supports and flow control hatches.

(iv) Damage to retention or stabilization works (OCE): deterioration or loss of plain or reinforced concrete containment works or gabions, on either the upper or lower bank.

(v) Damage to ramps (T): total or partial loss through landslides, loss of upper or lower banks, liquefaction or loss of soil coherence causing subsidence or collapse.

(vi) Structural damage to tunnels (TE): floors, walls and roofs, with cracks, water leakage, total or partial closure.

(vii) Damage to electromechanical equipment in tunnels (TEE): damage affecting all equipment, from fire, power cuts, or failures in the control centres, disrupting the normal operation of the tunnel.

To determine the estimated replacement value, each type of damage must be costed using prices applicable to the disaster zone. Table IX.4 shows indicative basic costs at the national level for Colombia, supplied by the National Highways Institute.[110] The transportation expert must confirm whether national prices are appropriate for the disaster zone, and make any necessary corrections for performing the valuation.

Table IX.4
Indicative costs of mitigation works
(Dollars)

Type of work	Unit	Cost
Rubble removal and transportation over 1 km	m^3	4
Reshaping of the embankment	m^2	0.31
Laying of the road base	m^3	50
Pavement structure	m^3	561
Ditch construction	m^3	255
36-inch culvert construction	m	278
Box culvert construction	m^3	299
Gabion wall H = 2 m	m	300
Gabion wall H = 2 m	m	985
Reinforced concrete wall on piles H = 2 m	m	2.1
Reinforced concrete wall on piles H = 2 m	m	3.6
Reinforced concrete wall on slab footings H = 2 m	m	480
Reinforced concrete wall on slab footings H = 2 m	m	1.35

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of National Highways Institute (INVIAS) of the Ministry of Transport of Colombia, estimates based on unit prices for 2012.

(e) Consolidating the information

Once the information on damage has been collected, organized and analysed it can be consolidated for each body responsible for road infrastructure administration, both in the public sector (municipal, provincial/departmental and national government) and the private sector (for concessioned highways). This consolidation represents an essential tool in planning the replacement and reconstruction stages. Consolidation forms are available for download at the website for this handbook.

The overall consolidation of damages must summarize, for each department or province, the number of road segments involved, critical sites, road length, number of damaged bridges and viaducts, and their valuations.

2. Transportation company assets

Following is a summary of the main categories into which damaged or destroyed assets should be grouped for purposes of damage assessment:

[110] These are basic costs because they do not take into account expenditures by government or public utilities.

(i) Administrative buildings and facilities such as warehouses:

For estimating damage under this heading, valued at replacement cost (assuming characteristics similar to those of the original design), information will be needed on the floor area destroyed or damaged, the age of the building, and the number of square metres in the case of industrial buildings. For the first aspect, a scale can be used, ranging from 0 (no damage) to 4 (total destruction). The scale is applied to the current average value per square metre of construction. The price per square metre of construction used should not be a national average, but should be specific to the disaster zone.

(ii) Furnishings and equipment:

For valuing furnishings, a typology by size of company must be established, and current values obtained from the market. Investment in furnishings is, to a certain extent, proportional to the value of the building, but the ratio becomes smaller as the size of the establishment increases. It will also be necessary to consider specific branches.

(iii) Vehicle fleet

Estimating damage to the vehicle fleet requires the compiling of pre-disaster data. Transport firms operating in the disaster zone should be asked to report the size and composition of their vehicle fleet, together with the year of manufacture of each vehicle.

(a) Quantify the vehicles that were totally destroyed, specifying their type, model, brand and year of manufacture. Obtain information on the cost of replacing those vehicles and calculate the corresponding value of damage, specifying the percentage that is not insured.

(b) Determine the number of vehicles damaged, and estimate repair costs on the basis of information provided by the companies, again specifying the percentage that is not insured.

The sum of the costs defined above is the total amount of damage under this item.

C. Losses and additional costs

The impact of a disaster on the road infrastructure will be felt not only in that sector but across the national economy, as a result of the suspension or restriction of service.

Partial or total road closures imply greater distances and longer travel times for users, as well as higher vehicle operating costs. These factors will result in greater costs for transporting freight and passengers.

The monetary valuation of these impacts will not include the losses caused by lower freight traffic, because that economic impact is included in the estimated losses for the corresponding productive and social sectors.

Changes in flows in this sector are associated with:

(i) Higher freight transport costs due to the use of alternative, less direct routes.
(ii) Higher vehicle operating costs for freight and passenger transport, because of longer trips.
(iii) Loss of income from tolls because of road closures.

Passenger and freight vehicles can be classified as follows:

Passenger:

(i) Small vehicles (AP): 5-passenger cars and vans.
(ii) Midsized vehicles (AM): minibuses.
(iii) Large vehicles (AG): buses

Freight:

(i) Rigid 2-axle truck: straight 9-ton trucks.
(ii) Rigid 3-axle truck: 16 tons.
(iii) Tractor-trailer: 2-axle truck with semi-trailer.

1. Estimating increased freight transport costs due to use of alternate routes

In this case, the increase in freight transport costs refers to the additional costs incurred by having to use alternative, longer routes. In estimating these costs, vehicles of types C2, C3 and CS must be considered.

Using the basic information gathered both on the affected road and on the alternative route used, estimate the additional cost for all freight using the road under normal operating conditions. The additional freight transport cost estimate must take into account the following concepts:

(i) Difference in cost per ton, by type of truck: this is the difference between the cost per ton that is normally charged on the affected route and the value of transport paid for one ton using the alternative route, for each type of vehicle.

(a) Cost difference per C2 trip = cost per ton, alternate route C2 - cost per ton, affected route C2

(b) Cost difference per C3 trip = cost per ton, alternate route C3 - cost per ton, affected route C3

(c) Cost difference per CS trip = cost per ton, alternate route CS - cost per ton, affected route CS

(ii) Additional cost per trip: multiply the previously calculated portion by the capacity of each vehicle.

(a) Additional cost per C2 trip = cost difference per C2 trip * C2 capacity (9t)

(b) Additional cost per C3 trip = cost difference per C3 trip * C3 capacity (16t)

(c) Additional cost per CS trip = cost difference per CS trip * CS capacity (34t)

(iii) Additional cost per day: multiply the previous portion by average daily traffic over the affected route, for vehicles C-2, C-3 and CS, according to reported daily traffic volumes (TPD).

(a) Total additional cost C2 per day = additional cost per C2 trip * TPD for last year

(b) Total additional cost C3 per day = additional cost per C3 trip * TPD for last year

(c) Total additional cost CS per day = additional cost per CS trip * TPD for last year

(iv) The total additional cost per day is the sum of the three previous items:

Total additional cost per day = total additional cost C2 + total additional cost C3 + total additional cost CS

(v) Estimate the total additional cost of freight shipped: this is the cost incurred in transporting freight over alternative routes. It is calculated by multiplying the additional daily cost by the number of days that the affected road was closed:

Additional cost of freight shipped = total additional cost per day * number of days of closure

2. Estimating higher operating costs for freight and passenger transport over longer routes and over roads of lesser quality

This value represents the increased operating costs incurred by freight and passenger vehicles through the use of alternative routes, due to the greater distance travelled and the topography through which the road passes.

Tables IX.5 and IX.6 illustrate variable operating costs in Colombia, per kilometre travelled, for freight and passenger vehicles identified according to the topography through which the highway passes.

In estimating the additional operating costs that freight and passenger vehicles incurred by using an alternative highway, the following factors must be taken into account:

(i) Additional distance travelled: this is the difference in length between the alternate route and the affected route, differentiated by type of terrain (flat, undulating or mountainous). This information can be recorded on the form available at the website for this handbook.

(ii) Vehicle operating costs (COV): these will vary depending on the topography of the alternate route and the type of vehicle, based on the information in Tables IX.5 and IX.6. This information can be recorded on the form available at the website for this handbook.

The increased cost will be calculated by multiplying the additional distance travelled (for each type of terrain) by the operating cost of the vehicles, and it must be recorded in form No. 10 regarding higher operating costs for freight and passenger transport over longer routes.

Table IX.5
Freight vehicle operating costs
(Dollars per kilometre)

Variable operating costs	C-2	C-3	CS
Tire wear	0.08	0.13	0.23
Lubricants	0.04	0.06	0.07
Filters	0.01	0.01	0.02
Maintenance	0.14	0.14	0.19
Washing and greasing	0.01	0.01	0.02
Contingencies	0.02	0.03	0.04
Subtotal variable operating costs	**0.29**	**0.38**	**0.56**
Fuel consumption in flat terrain	0.37	0.37	0.66
Fuel consumption in undulating terrain	0.53	0.50	0.89
Fuel consumption in mountainous terrain	0.77	0.72	1.28
Total operating costs			
Total operating costs in flat terrain	0.66	0.74	1.22
Total operating costs in undulating terrain	0.82	0.87	1.45
Total operating costs in mountainous terrain	1.06	1.10	1.85
Average total operating costs	**0.85**	**0.90**	**1.51**

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of information from the Transport Department of the Ministry of Transport of Colombia, 2009.

Table IX.6
Passenger vehicle operating costs
(Dollars per kilometre)

Variable operating costs	AP	AM	AG
Tyre wear	0.0039	0.018	0.099
Lubricants	0.0061	0.016	0.048
Maintenance	0.0167	0.066	0.219
Tolls	0.0233	0.051	0.251
Wages and basic benefits	0.0506	0.073	0.083
Service station costs	0.0111	0.012	0.014
Subtotal variable operating costs	**0.112**	**0.234**	**0.715**
Fuel consumption, flat terrain	0.074	0.087	0.217
Fuel consumption, undulating terrain	0.092	0.106	0.265
Fuel consumption, mountainous terrain	0.118	0.138	0.344
Total operating cost, flat terrain	0.186	0.321	0.932
Total operating cost, undulating terrain	0.203	0.341	0.980
Total operating cost, mountainous terrain	0.130	0.221	0.637
Total average operating cost	**0.173**	**0.294**	**0.850**

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of information from the Office for Economic Regulation of the Ministry of Transport of Colombia, 2009.

3. Toll revenues forgone because of road closures

This item considers the revenues from tolls that are lost to the road administrator because of disaster-related closures. The amount is estimated by multiplying average daily traffic for the last year, for each type of vehicle that would normally use the road, by the corresponding toll rate and by the number of days of closure. A form for recording these data can be downloaded from the website of this handbook.

4. Reduction in freight volume transported

The impacts considered thus far are all relate to the increased cost of transporting freight. However, one further effect must be considered: the possibility that the volume of freight transported may decline. If an agricultural region is hit by a disaster, the volume of agricultural produce transported will shrink temporarily owing to lost or delayed production. This decline in volume should be estimated prior to estimating the higher costs of freight transportation. The decline will of course depend on losses in those sectors. Freight will likewise increase once activities recover in the affected area.

5. Total change in flows

The higher freight transport costs occasioned by the use of alternative, longer routes and the higher operating costs for freight and passenger vehicles because of longer trips represent the increase in intermediate consumption of the transport sector.

The amount of tolls that are not collected at the toll booths because of closures constitute the forgone revenue of the entity administering the road.

Each flow affects different agents. The increase in intermediate consumption relates to transport firms. The loss of toll revenue affects the company that has the concession, or the public body responsible for the highway.

Appendix 1 presents a hypothetical example of entries in the national accounts regarding the impact of a disaster on the transport and related sectors.

Box IX.1
Definition of the transport sector in the national accounts

The International Standard Industrial Classification of All Economic Activities (ISIC) Rev. 4 treats the transport sector as follows:

H. Transportation and storage. This section includes the provision of passenger or freight transport, whether scheduled or not, by rail, pipeline, road, water or air and associated activities such as terminal and parking facilities, cargo handling, storage etc. Included in this section is the renting of transport equipment with driver or operator. Also included are postal and courier activities. This section excludes maintenance and repair of motor vehicles (see class 4520) and other transportation equipment, the construction, maintenance and repair of roads, railroads, harbours, airfields, as well as the renting of transport equipment without driver or operator.

H49. Land transport and transport via pipelines. This division includes the transport of passengers and freight via road and rail, as well as freight transport via pipelines.

H491. Transport via railways. This group includes rail transportation of passengers and freight using railroad rolling stock on mainline networks, usually spread over an extensive geographical area. Freight rail transport over short-line freight railroads is included here.

H492. Other land transport. This group includes all land-based transport activities other than rail transport. However, rail transport as part of urban or suburban transport systems is included here.

H493. Transport via pipeline

H50. Water transport. This division includes the transport of passengers or freight over water, whether scheduled or not. Also included is the operation of towing or pushing boats, excursion, cruise or sightseeing boats, ferries, water taxis etc. Although the location is an indicator for the separation between sea and inland water transport, the deciding factor is the type of vessel used. All transport on sea-going vessels is classified in group 501, while transport using other vessels is classified in group 502. This division excludes restaurant and bar activities on board ships, if carried out by separate units.

H51. Air transport. This division includes the transport of passengers or freight by air or via space. This division excludes the overhaul of aircraft or aircraft engines (see class 3315) and support activities such as those associated with airport operation (see class 5223). This division also excludes activities that make use of aircraft, but not for the purpose of transportation, such as crop spraying, aerial advertising or aerial photography.

H52. Warehousing and support activities for transportation. This division includes warehousing and support activities for transportation, such as operating of transport infrastructure (e.g. airports, harbours, tunnels, bridges etc.), the activities of transport agencies and cargo handling.

H53. Postal and courier activities. This division includes postal and courier activities, such as pickup, transport and delivery of letters and parcels under various arrangements. Local delivery of messenger services are also included.

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Box IX.2
Output, intermediate consumption and final consumption in the transport sector

This box presents output and intermediate consumption by institutional sector in the transport field, as well as the supply and demand balances. Appendix 1 presents a hypothetical example using these concepts.

A. Output and intermediate consumption by institutional sector

Examination of this activity requires attention to several aspects. For example, there may well be differences in the units of measure in the freight module, which will require standardization to tons per kilometre. Similarly, the passenger segment is evaluated according to the number of passengers carried per kilometre, multiplied by the average price.

Gross output value (GrOV) freight = (t/km) * average price per ton per kilometre

GrOV passengers = (passengers/km) * average price per passenger per kilometre

These formulas are applied to any form of transport: land, rail, air, sea and inland water (there is likely to be a difference in the distance measurement unit). The method makes it possible to compare (and to add) transport of passengers and merchandise, both for urban trips and for short and long distance trips, within the national economic space.

Gross output is equal, then, to the revenues received for the provision of the services by the institutional units of the sector. These, in general, are non-financial companies, public or private, or households if they are unincorporated businesses.

1. Private transport of passengers is considered final consumption

The private transport of passengers or own-account transport is recorded as final consumption, according to the product of origin: a vehicle acquired by a household is recorded as consumption (if acquired by a firm, it is a capital good); fuel, spare parts, insurance and other expenses are recorded as final consumption of these products by households (in the case of companies, it is recorded as intermediate consumption). Consequently, if parents take their children to school, there is no transport output. Thus, any transport performed by families in their own vehicles, for example in commuting to work or taking recreational trips, does not represent transport output.

Similarly, in the case of companies, if they have a subsidiary activity that distributes the goods they generate, using their own transportation units and drivers, this will not be recorded as transport output. The expenses are treated as intermediate consumption for the subsidiary activity, the output of which is allocated to the ISIC code for the principal activity.

Useful information sources:

(i) Annual transport sector surveys (demand for service)
(ii) Companies providing the service
(iii) Administrative records on the automotive fleet by type of vehicle (installed capacity of the sector, potential supply)
(iv) Sector studies

2. Institutional sectors: private non-financial firms, government and households

The institutional sectors include non-financial companies with the principal function of providing transport services. These are market producers, as they offer the service at a price that covers or exceeds the cost of production.

In the case of public transit companies in medium-sized and large cities, they typically receive subsidies from the central government, the amount of which must be recorded in the production account.

Information sources: firms providing the service, regulatory ministries or corporate supervisory agencies.

Whenever possible, the following data should be collected:

(i) Number of passengers and distance per day, week and month, from origin to destination
(ii) Price per passenger per kilometre, from origin to destination
(iii) Number of tons carried per kilometre

a) Transport: supply and use balance

As noted previously, these are accounting identities that describe the equality between total supply and demand for each good or service available in an economy.

Supply = output + imports

From the point of view of its use, because transport is a service it cannot be accumulated or stored. Consequently, there is no entry under gross fixed capital formation or change in inventories.

Uses are recorded, then, as intermediate uses (inputs of transport by producing agents, especially freight, but also by their employees) and final household consumption, purchases that families make from transport-producing firms.

Although there will be foreign trade involved in this service (imports from other countries or exports to other countries), the present example refers to a closed economy.

The production equilibrium or balance is:

GrOV of transport services = IC plus FC,

where gross output value (GrOV) = output of transport services

IC = intermediate consumption of transport services offered by national producers

FC = final consumption of transport services by resident households

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

D. Financial needs for recovery and reconstruction

When disaster strikes, an immediate response plan must be structured to guarantee the reestablishment of communications and vehicle operation, if only to a limited extent, through measures to restore the road.

Once the situation is normalized, the process of assessing impact and damage will begin. To this end, depending on the severity of the phenomenon and any recurrence, it must be determined whether the infrastructure will have to be replaced or whether larger-scale reconstruction will be needed.

1. Financial needs for recovery

Interventions must focus on road corridors where vehicle traffic has been completely interrupted, giving priority to those that carry the greatest volumes of traffic, by undertaking works that will restore operation and serviceability. In general, this will involve the removal of rubble, the reconfiguration of embankments and placement of Bailey bridges, or the use of fords, where feasible.

Once traffic is beginning to circulate again, a decision must be taken whether to restore the highway to its original design conditions, or reconstruct it.

2. Financial needs for reconstruction

Once the road corridor has been made usable, the following aspects must be analysed in order to estimate reconstruction needs for the highway:

(i) Causes that sparked the event and possible threats to exposed elements

(ii) Pre-event status of the infrastructure

(iii) Design specifications for the highway and drainage works

(iv) History of recurrent events at the impact sites

This assessment may reveal the need to reconstruct the highway through larger-scale works in order to reduce the corridor's vulnerability.

Reconstruction of the highway involves the works needed to upgrade the technical specifications, in particular the road alignment and the hydraulic capacity of the drainage system. Generally this will include the planning of works such as bridges, viaducts and tunnels.

Replacing or reconstructing the highway will be limited, of course, by the availability of financing.

Appendix 1
Transport and roads: numerical example

A. Pre-disaster situation

A region of a small country has been hit by a disaster. One of the consequences is a landslide that has blocked and damaged Highway N-35, requiring works to restore service.

The highways ministry provides information to the disaster assessment team's transport expert. It is found that the landslide has affected 5.9 km of highway. The time needed to clear the road is estimated at 30 days. This is a highway that was built by the public sector, and the ministry is therefore responsible for its maintenance.

The event has had repercussions on the transport sector. During repairs to Highway N-35 there will be a 40 km detour, with a 30% increase in the tariff per ton per kilometre and a 20% increase in the passenger fare per kilometre.

This disaster, as indicated in chapter II involves several sectors: roads, transport and construction (including rubble removal). To simplify the example, it is assumed that a public enterprise will replace the damaged highway.

B. Impact on the government sector

1. Information survey

The government, through the highways ministry, will assume direct responsibility for restoring service on this road. The transport group carrying out the estimation, in conjunction with technical and supervisory staff of the ministry, has compiled the information shown in Table A.IX.1:

Table A.IX.1
Government: outlays for restoring service to Highway N-35

Type of works	Unit	Unit cost	Quantity	Value *(monetary units)*
Rubble removal and transport per kilometre	m^3	4	232	928
Reshaping of the embankment	m^2	0.31	141.6	43 896
Laying of the road base	m^3	50	38	1 900 000
Pavement structure	m^3	561	11.8	6 619 800
Construction of ditches	m^3	255	5.8	1 479 000
Construction of a 36-inch culvert	m	278	192	53 376
Total				11 024 072

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

This total covers the additional cost plus the value of replacing the damaged highway. From a public finance viewpoint, it represents an expenditure and the replacement constitutes an increase in gross fixed capital formation for the sector. The temporary decline in physical capital as a result of the disaster will be compensated by this investment. With this information, the gross output value for the government for this item for 2012 will be estimated. It is also assumed that the replacement is performed during 2012.

2. National accounts treatment of the effect on the public enterprise doing the reconstruction

As this enterprise does not produce for the market, but rather for the public sector, its operating surplus is zero. Its value added corresponds to compensation of its employees.

(i) Production account for the public enterprise

Table A.IX.2
Public enterprise: production account (restoration of 5.9 km of Highway N-35 roadway)
(Dollars)

Uses		Resources	
Intermediate consumption	7 386	Gross output value	11 024
Gross value added	3 638		
Total uses	11 024	Total resources	11 024

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Table A.IX.3
Government: income generation account (restoration of 5.9 km of Highway N-35 roadway)
(Dollars)

Uses		Resources	
Compensation of employees	3 638	Gross value added	3 638
Net taxes on production	0		
Consumption of fixed capital	0		
Net operating surplus	0		
Total uses	3 638	Total resources	3 638

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

The disaster results in an increase in the output of this public enterprise. This will have an impact on the public finances in an amount equal to the invoice from the public enterprises. From the government's viewpoint, these expenditure items represent gross fixed capital formation, and an additional expense associated with rubble removal.

C. Impact on the transport sector

1. Baseline

The destruction of the roadway by the landslide means that traffic on Highway N-35 is interrupted for 30 days. From discussions with the transport firms it emerges that, prior to the disaster, traffic over this road was expected to be similar to that recorded in 2011, and consequently that figure is taken as the baseline for estimated losses. This outcome is summarized in the 2011 statement of profit and loss of the transport firms (see table A.IX.4).

Table A.IX.4
2011 profit and loss statement for transport via Highway N-35

Revenues				Expenses	
	Volume	Price	Value *(thousands of dollars)*		
Passengers/km	1 500	0,5	750	Wages	650
Ton/km	1 200	2	2 400	Taxes	10
				Inputs	1 150
				Profit	1 340
Total revenues			3 150	Total expenses	3 150

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

2. Post-disaster situation

For the sake of clarity, revenues have been separated from estimated expenses of the transport companies in 2012 (see Tables A.IX.5 and A.IX.6). On the revenue side, the calculation was performed for the 11 months during which Highway N-35 was functioning normally, with a separate calculation for the month of suspension. This means that, in calculating the new annual outcome, the impact for the month of suspension must be established. Next, the estimated difference between 2012 and 2011 is detailed.

Table A.IX.5 shows that, because of the 40 km detour, there was a 75% increase in the tariff per ton per kilometre transported and a 50% increase in the fare per passenger per kilometre. Table A.IX.6 reflects the increase in costs, both labour costs and those flowing from the increase in inputs. Non-wage costs of the firms rise by 15% for the year; taxes by 5%; and wages by 10%.

Table A.IX.5
2012 estimated revenues for transport via Highway N-35
(Units and dollars)

	11 months			Month of suspension			Total for current year	Previous year	Difference
	Volume	Price	Value	Volume	Increased price	Value for the month	Value	Value	
Passengers/km	1.375	0.5	687.5	125	0.75	93.75	781.25	750	31.25
Tons/km	1.1	2	2 200	100	3.5	350.00	2 550.00	2.4	150.00
Total			2 887.5			443.75	3 331.25	3 150.00	181.25

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Table A.IX.6
2011 expenses and 2012 estimated expenses for transport via Highway N-35
(Monetary units)

	2011	2012
Wages	650	715
Taxes	10	10.5
Inputs	1 150	1 322.5
Expenses	1 810	2 048

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Table A.IX.7 presents the statement of profit and loss for 2011 and the estimated statement for 2012. As a result of the disaster, user expenditure rose by 181 monetary units, as did the revenues of the service-providing firms. The costs of those firms rose by 238 monetary units, and as a result their profits declined by 57 monetary units. Wages rose by a total of 65 monetary units, because longer distances had to be covered.

Table A.IX.7
Profit and loss statements, 2011 and 2012, for transport via Highway N-35
(Monetary units)

	2011	2012	Difference
Revenues	3 150	3 331.3	181.25
Expenses	1 810	2 048	238
Profit	1 340	1 283.3	-56.8

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

3. Treatment of the post-disaster situation in the national accounts

According to previous profit and loss statements for transport companies operating on Highway N-35, there is an increase in the gross value of output and in expenditure on inputs and remuneration. On the other hand, profits decline because of increases in spare parts, materials and wage costs. All these figures are multiplied by the 40 additional kilometres travelled and the increase in prices during the month of suspension. Tables A.IX.8 and A.IX.9 show how the differences from Table A.IX.7 are recorded.

Table A.IX.8
Transport sector: production account

Uses		Resources	
Intermediate consumption	172.5	Gross output value	181.25
Gross value added	8.75		
Total uses	181.25	Total resources	181.25

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Table A.IX.9
Transport sector: income generation account

Uses		Resources	
Compensation of employees	65	Gross value added	8.25
Net taxes on production	0		8.25
Consumption of fixed capital	0		8.25
Net operating surplus	-56.75		
Total uses	8.25	Total resources	8.25

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

In this hypothetical example, the outcome for the transport firms is a decline in gross value added because of the lower operating surplus. Costs rise more than revenues during the month in which Highway N-35 is out of service.

X. Water and sanitation

A. General considerations

Given the strategic importance of the services it provides, the water and sanitation sector is one of the first, along with the health sector, that must be rehabilitated after a natural disaster. In particular, special attention must be paid to water quality, excrement removal (sanitation) and garbage handling, as of the first stages following the emergency.[111]

The severity of the disaster's impact will depend on the degree of vulnerability of systems, which in turn is a function of four factors: location, engineering design quality, construction quality (technology, equipment and materials used) and the quality of operation and maintenance of the works.

B. Procedure for estimating damage to water and sanitation systems

Depending on the particular local characteristics, these systems may be of greater or lesser complexity with respect to their structure, scale, organization and administration. It will be important therefore to appreciate these characteristics before attempting to estimate the impact.[112]

The following sections explain the steps to be taken in estimating the impact of a disaster on the water and sanitation sector.

[111] Environmental risk surveillance will be conducted in close collaboration with the health sector specialist, and will include monitoring of water quality, proper elimination of excrement, solid wastes and rubble, vector control, and monitoring of soil, water and air pollution as well as hazardous substances.

[112] There are a number of studies and reports on this issue in the region, including those prepared by the Natural Resources and Infrastructure Division of the Economic Commission for Latin America and the Caribbean (ECLAC), which contain information that can be useful for this purpose (Ferro and Lentini, 2012; Barraguirre and Fuentes, 2010, among others).

1. Compiling information on national institutions

At the outset, it will be necessary not only to define the territory affected but also to become familiar with the general organization and functioning of sector systems at the national level.[113] These include the entities that provide drinking water and sewage services, storm drainage, and solid waste collection and processing.

Acquiring a knowledge of the organization and functioning of the systems means identifying the institutions involved in the sector, including the lead entity (which may be a ministry, e.g. of housing or public works) and the regulatory entity, if separate from the lead entity. It is very important to understand the structure of the utility firms providing these services, which may be municipal or state entities, private or mixed, as this will determine their functioning (which may differ between rural and urban areas), their bookkeeping and their accounting for losses, which will also be reflected in the national accounts.

Another important component of a proper estimation is the definition of the policy governing the water and sanitation sector, i.e. the priority accorded to various services, public and private participation, and coverage (in rural areas, for example).[114] Similarly, it is essential to appreciate the degree of decentralization of the sector, as well as policies governing investments and rates (e.g. whether there is a state subsidy).

From the foregoing it will be clear that the information on damage and losses will have to be obtained from public, municipal or private service operators, the regulatory bodies (ministries or specific entities) or the superintendency for the sector.

Once a knowledge of the general organization and functioning of the sector has been obtained, the next step is to define the characteristics of each system in the affected territory in order to establish the pre-disaster situation, the impact of the disaster, and the damage and losses suffered.

2. Compiling basic information on each system of the sector in the affected territory

(a) Drinking water system

The pre-disaster situation:

(i) Organization of the water sector: institutions providing services (divided into public and private institutions), regulatory and policy setting entities with jurisdiction over the affected territory.

(ii) Pre-disaster coverage levels of water service (urban and rural).

(iii) Disaggregation of the population served by mass-distribution and private systems (piped water systems, wells, multifamily and single-family systems).

(iv) Characteristics of the systems:

- System layout plans
- Population served before the disaster (house connections, consumption levels, other aspects)
- Rate schedules, existing subsidies and bill collection levels
- Production and invoicing of subsystems (or firms) before the disaster
- Technical coefficient of producing companies and service providers [115]

[113] The drinking water system may extend over many kilometres, from intake source to domestic connection. Thus, although the people served may not have suffered any direct impact from the event, they may be affected indirectly, for example through the loss of catchment capacity or the collapse of reservoirs.

[114] In rural as well as periurban areas, it must be determined whether the municipalities have an inventory of the number and location of private artesian and septic wells and whether they have been affected by the disaster, so that the affected families can be taken into account in recovery and reconstruction plans for the water and sanitation sector.

[115] The technical coefficient (TC) can be used to estimate value added, when the value of output is known but not the amount of inputs (TC = inputs and raw materials divided by the value of output).

The post-disaster situation:

(i) Identify the urban and rural systems affected by the disaster, their administration and functioning.

(ii) Determine the nature of damage to the affected systems, techniques and materials used in constructing system components, and physical accessibility of components of the affected systems.

(iii) Determine whether the disaster has affected water treatment facilities, which would mean additional requirements for chemical products, reagents or equipment (increase in inputs or intermediate consumption of the utility firms).

(iv) Costs of materials, construction, equipment, chemical products, reagents and other inputs needed to rehabilitate the systems.

(v) Determine the remaining capacity and level of production and billing after the disaster, indicating any increase in the price of water supplied.

(vi) Estimate the time needed for rehabilitating the affected systems.

(vii) Obtain information on the organization and activities of water and sanitation utilities for providing interim service while systems are being restored. Those measures may include temporary use of desalination plants, tanker trucks or delivery of bottled water.

(viii) Determine the measures for rehabilitating the systems.

(b) Sanitation and sanitary sewer systems

The pre-disaster situation:

(i) Organization of the sanitation sector: institutions providing services, lead entities and regulators.

(ii) Characteristics of the systems:

- Levels of coverage of sanitation and sanitary sewer services (urban and rural) before the disaster
- Population served before the disaster (home connections)
- Disaggregation of the population served by mass systems and private systems (latrines, septic tanks and pits)
- Existing rates and subsidies, as well as any changes in levels of bill collection, and any link to water service bills

(iii) Degree of sewage processing and treatment before the disaster.

The post-disaster situation:

(i) Determine the urban and rural systems affected by the disaster.

(ii) Describe the manner in which the systems are operating, including increased operating costs.

(iii) Determine the remaining capacity and level of invoicing after the disaster, indicating any increase in the price of service.

(iv) Estimate the time needed for rehabilitating the affected systems.

(c) Collection and treatment of solid wastes

The pre-disaster situation:

(i) Public and private enterprises offering solid waste collection and treatment services, and their administration.

(ii) Geographical coverage of public and private waste collection and treatment enterprises.

(iii) Rates charged for services, and paying entities.

The post-disaster situation:

(i) Determine the infrastructure and equipment affected by the disaster.

(ii) Identify home connections affected by the disaster.

(iii) Identify the accessibility of garbage disposal sites affected by the disaster.

(iv) Determine the reduction in solid waste collection and elimination capacity.

(v) Determine the increase in solid waste collection and disposal costs.

(vi) Estimate the time needed for repairing infrastructure and equipment.

(vii) Determine whether there is insurance coverage.

As the objective is to estimate damage and losses caused by a disaster in the various systems of the sector, the first step should be to determine the nature of the impact on the various components and equipment. The techniques and materials employed in their construction should be noted, as well as the possibilities for physical access to those components.

Another important piece of information relates to the organizational ability of water and sanitation institutions to provide interim service while systems are being restored, as well as the measures taken to rehabilitate the systems and the costs of materials, construction, equipment, chemical products, reagents and other necessary inputs.[116]

C. Estimating damage to drinking water and sanitary sewer systems, solid waste collection and disposal, and flood control structures

1. Determination and description of damage

Generally speaking, damage will involve the destruction or disruption of infrastructure and equipment for urban and rural services (disaggregated by components) and the destruction of stocks (chemical products, stored water, spare parts and other assets).

2. Estimation of damage

For estimation purposes, it is useful to compile a list of damage by systems (drinking water, sewage and garbage collection).

Damage should be grouped by components or subsystems for each city and each system affected. For example, in the case of an urban drinking water system, the information can be organized as follows:

(i) Catchment: intake A, intake B ....

(ii) Pumping stations: station 1, station 2....

(iii) Treatment plants: plant 1, plant 2.....

(iv) Main conduits to the storage tanks

(v) Storage tanks: tank A, tank B....

(vi) Distribution network

(vii) Other (specify in each case)

For estimating damage, a procedure along the following lines is recommended:

(i) For each damaged component, compile a summary description of its main characteristics as well as the type of damage and the approximate quantity of structures or materials affected, in the appropriate units of measurement.

(ii) For each damaged component, indicate:

- The type of structure or material
- The unit price (UP) of full replacement by component
- The unit cost of repair (R%), as a percentage of the unit price of replacement

[116] It is assumed that by the time the mission arrives work will already be under way to rehabilitate the various components of the systems, in light of the urgency of restoring service.

The estimate of the percentage (R%) of damage to some structures, materials or equipment can be obtained directly from the service provider, or through a weighted assessment that will consider whether the structures, materials or equipment can be repaired or partially rebuilt or whether, because of the scale of damage, they must be completely reconstructed or replaced. If the damage can be repaired, the cost will be estimated as a percentage of the total cost of that structure (portion of a structure, material or equipment). If the structure must be totally rebuilt or replaced, then R% = 100%.

The percentage of damage can be estimated from the assessments of the competent personnel of the service responsible for each system, or from other sources, but the final assessment will be that of the water and sanitation specialist, based on the information obtained during the mission.

The assessment will also have to consider whether any component will need to be demolished or dismantled prior to reconstruction or repair. If so, the approximate amount of material to be demolished and removed should be estimated, using (whenever possible) the same unit of measure as that applied for quantifying the damage under this heading. As this involves unanticipated work resulting from the disaster, the costs will represent an increase in additional expenditures and intermediate consumption for the sector, and will not be quantified under damage (see below, section D.2).

If the disaster has had a direct impact on warehouses or other facilities for storing spare parts, chemical products, reagents, water (tanks) and so forth, those facilities will have to be evaluated. The sector specialist must consider all available sources for determining the quantity and unit prices of the materials in question.

3. Flood control works

Dams and reservoirs play an important role in flood control. These major hydraulic structures act as physical barriers that help to regulate floodwaves and then to retain water, releasing it gradually so that the downstream flow will be less than would otherwise result (an effect known as flood lamination). Lamination capacity will depend, among other factors, on the dimensions and volume of the reservoir, on the possibilities for regulating discharges as a function of the overflow structures installed (whether these are control gates or open floodways), bottom drainage capacity and the volumes of water supplied to hydroelectric stations.

Flooding can destroy flood control works totally or partially, with particular impact on walls that have been constructed in segments along river courses for the purpose of preventing water from spilling over into surrounding agricultural lands, or from eroding the natural river bank. Such works may also be designed to protect road infrastructure, particularly in areas where flood crests may exceed the height of productive lands located along river banks. To estimate the value of damage, the following method of calculation is used:

(i) Obtain information on the average unit cost of restoring such structures.

(ii) Find data on the degree of the disaster-related impact.

(iii) Multiply the unit cost estimates by the total built area damaged by the disaster.

4. Information sources for unit costs

Generally speaking, the unit prices that must be considered in evaluating damage can be determined from studies or unit price lists normally used by the agency responsible for such systems and services. In this case, the date of the lists should be noted, and they should be updated if necessary with simple coefficients in order to correct for inflation and other factors. The unit prices may also be based on estimates from direct surveys or suitable local sources, or on "comparative unit prices" for the region, which can then be compared with those from the two previous points and used in their place if necessary.

Whatever the source of the unit price list or estimate used, the labour content and the proportion that corresponds to materials of national and imported origin, expressed in unit prices, must be considered. Water, sanitation and storm drainage works embrace a wide variety of structures, materials and equipment. The cost of some of these structures will be easy to estimate on the basis of unit price lists. This is true, for example, with water pipes and conduits, where the cost can be expressed per linear metre, either for the pipe or for the complete installation. On the other

hand, there are structures (for example, water treatment plants) that comprise various components of differing origin, technology and price. In these cases, the cost must be estimated on the basis of an overall price for the plant. As well, it is important to quantify the percentage of assets for which repairs will require imports.

D. Losses in water and sanitation systems

1. Determination of losses

(a) Water supply system

With respect to economic flows, information must be obtained for establishing alterations in the services that supply the systems.[117] The issue here is to determine the increase in intermediate consumption with respect to the pre-disaster situation and the decline in the volume of water sold. This analysis requires the following information:

(i) Pre-disaster situation

- Number of customers (residential and industrial) in the disaster zone. This information can be gathered from water companies or their associations.
- Average monthly invoice for each of these groups in the disaster zone. This information can be gathered from water companies or their associations.
- To determine the weighting of the affected zone within this sector, the two previous items of information should be collected for the entire country.
- Estimates of industrial and residential consumption of water in the disaster zone for the year in which the disaster occurs. This information can be gathered from water companies or their associations. Together with prices for the sector, it is used to prepare the baseline for gross revenues of the companies.
- Number of households that were not served. This information can be collected from the national statistical office, specifically from the household survey and censuses.
- Statistical series on sector output can be obtained for calculating the weight of this sector in the national economy. The sector production accounts expert within the statistics institute can be consulted to determine where production is generated geographically, as well as specific details for the account.
- Water pricing policy and price changes in recent years. This information can be obtained from the sector regulatory entity.

(ii) Post-disaster situation

- Reduction in sales of water.[118] The most frequent causes of this phenomenon are:[119]
  - Reduced production of drinking water (catchment, treatment, storage, distribution)
  - Reduced water delivery capacity
  - Reduced capacity for regulating or storing water
  - Decline in water consumption

[117] Appendix 2 provides an example of processing to determine the change in value added for enterprises. See also chapter II of this handbook.

[118] Attention must be paid to changes in water sales revenues suffered by the enterprises, which should be able to provide this information. Otherwise, to estimate the decline in invoicing (probable reduction in water sales to consumers in cities and towns included in the disaster zone) will require weighing the effect of the key factors that determine the lower volume of water consumption through the normal supply system. Inflation-induced price increases must also be taken into account.

[119] The causes of reduced sales are explained in greater detail in the following pages.

- Activities associated with temporary service delivery, such as water distribution by tanker trucks or other methods, including bottled water, purchase or rental of equipment and machinery, repairs, changes in water treatment processes, drawdown of stocks of inputs and materials for rehabilitation purposes, and overtime for personnel (see the corresponding procedure below).
- Increased operating costs in the catchment facilities used to replace the normal ones (totally or partially); increase in daily water production to offset abnormal losses in the delivery system; increased cost of energy and other inputs, and a combination of the foregoing points.
- Projected duration of the irregular situation.
- Insurance policies in place.

Once cost increases due to the reasons indicated above (intermediate consumption) have been determined, together with the amount of sales during the emergency, recovery and reconstruction periods, the enterprises' value added can be calculated. That value, compared with its projection for the year of the disaster, or (if that projection is not available) with the value under normal conditions (average for three years of operations, at least), will identify the losses. The sum of this indicator for all the enterprises operating in the affected territory will give the amount of losses in the sector (see appendix 2).

(b) Sewage and sanitation system

(i) Pre-disaster situation

For this system, again, it will be necessary to determine, for the disaster year, the projected levels of bill collection and their possible link to water service billing, as well as intermediate consumption or service delivery costs. If such a projection is not available, the historic amount (three year average) can be used.[120]

(ii) Post-disaster situation

As in the case of drinking water, the idea is to determine the difference in value added for the enterprises offering the service. This means identifying the increase in costs and the changes in billing for the service, as a result of the disaster. The following information will be needed for this purpose:

- Rehabilitation activities, such as inspection of the network, purchase of equipment and machinery, repairs and so forth (see the corresponding procedure below).
- Increase in treatment costs.
- Reduction in water treatment capacity.
- Post-disaster billing level, indicating any increase in the price of the service. Forgone revenues must be estimated.
- Expected duration of the irregular situation.
- Insurance in place.

(c) Collection and disposal of solid wastes

(i) Pre-disaster situation

Pre-disaster bill collection levels must be determined, together with the historic amount (three year average) of intermediate consumption or service delivery costs.

(ii) Post-disaster situation

Revenues of the service providers must be estimated for the duration of the irregular situation, as well as the increase in solid waste collection and disposal costs because of longer trips, repairs, clearing of access roads, and rental or purchase of equipment.

[120] In considering these parameters, the specialist will rely on the information indicated in section 2, "Compiling basic information on each system of the sector in the affected territory."

In the case of this service, the value of losses will consist in the reduction in revenues of the public and private enterprises concerned, and the increase in service delivery costs, for the reasons indicated in the previous paragraph.

2. Valuation of losses in water and sanitation systems

(a) Drinking water systems

Losses will generally persist for as long as it takes to rebuild or repair facilities and return them to service. These changes are reflected in lower revenues for water companies, because of the decline in billable services and water losses through damage not yet repaired, as well as the greater operating costs entailed in provisional supply arrangements. The time during which this situation prevails will vary, depending on the reconstruction schedule. Negative impacts on health must also be determined, working in close coordination with the health specialists in order to avoid duplications or omissions.

Depending on its magnitude, a disaster can affect very broad zones: cities of various sizes, towns and rural areas. The random nature of the phenomenon itself and the variability of situations will often demand a wide range of activities in order to restore service. For this reason, the estimate of changes in economic flows induced by the disaster includes those activities which, given the strategic nature of the sector, will begin during or immediately after the emergency.

(i) Possible activities involved in rehabilitating the water system

- Repairs to pipes (patching or plastic sleaving), laying of provisional mains or by-pass conduits, as well as use of valves and piping, for example, to divert leaks and avoid water losses from damaged mains.
- Drawdown of stocks of equipment, materials, chemical products and reagents.
- Boosting chlorine concentrations in water supplies already chlorinated. Installation of chlorination for untreated supplies, as well as for reservoirs or tanks. Preventive chlorination of surface or drilled wells, urban and rural.
- Temporary use of other water catchments, e.g. deep wells belonging to industrial plants or sporting facilities. These include water connections to the network, supply of power to pumping equipment, and so forth.
- Conversion of existing water storage facilities such as swimming pools or industrial reservoirs. Use of fibreglass or plastic tanks for storage and distribution of water.
- Use of tanker trucks, trailers or makeshift carriers to distribute water.
- Arrangements for temporary rationing of water in the network, when necessary and possible.
- Hydraulic measures to boost pressure in the network in order to avoid water contamination (sometimes essential, even though this may increase water losses through leakage).
- Preparation and delivery to the public of instructions on precautions to take (e.g. boiling water), rationing times, tanker truck routes, or water distribution points.
- Preparation of price lists so that people can purchase water by other means.
- More intensive use of well systems (e.g. extended operating hours), to compensate for greater losses through leakage in water storage and distribution systems.

(ii) Estimating the costs of rehabilitating the water system

Because disasters can be of such varying types and magnitude, and because regional or local situations can differ so greatly, the range of rehabilitation activities required may be very broad. To estimate the cost of these activities more closely, the problem must be simplified, grouping activities into a limited number of categories, such as the following:

- Additional labour costs. This includes the costs of professional, technical, administrative and operational personnel engaged in rehabilitation work. They can be quantified as follows:

- Prepare a simplified list of the categories of personnel engaged in this work, indicating the unit cost for each category (hourly, daily or monthly rate per person).
- For each category, estimate the number of "person-units" required for the duration of rehabilitation operations.
- Multiply these values and add the subtotals (with projected values and percentages).

• Material costs of works and repairs. This point includes an estimated budget of costs not included in the previous point, as it refers to materials, transport, fuel, energy and other inputs used in the works and repairs.[121] [122]

• Costs incurred when catchments that are not the property of the public water service are tapped for emergency supply, these costs will depend on the contractual arrangements in force.

• Use of tanker trucks for water distribution in areas that lack service from the public network. The estimate may include the cost of hiring trucks of various kinds to distribute water, on the basis of a capacity-related fee per trip, multiplied by the number of trips.

(iii) Causes of reduced water sales

Water sales can be affected by demand and supply factors. Supply factors include:

• Reduced production of drinking water: lower production or collection at the system's normal intake facilities, resulting from damage of various kinds:
  - Reduced capacity of drinking water sources (because of drought, for example)
  - Pollution of sources
  - Damage to intake structures, machinery or equipment

• Reduced water conduction capacity. This may be due to various causes:
  - Damage to water mains (pipes or other conduits) that carry water to cities or to intermediate facilities (such as treatment plants, pumping stations or storage tanks), disrupting the entire system's conduction capacity.
  - Damage to water mains, secondary conduits or distribution networks with partial impact on water conduction capacity.
  - Damage to home connections or interior networks of buildings, dwellings, industrial plants, markets and so forth that affects local or domestic water delivery.
  - Damage to pumping plants serving some or all of the system.

• Reduced water regulation or storage capacity

Any impairment to water regulation capacity diminishes the system's ability to deliver water according to variable demand schedules, particularly at times of peak demand, and results in the loss of water that isn't being stored, due to damage to the system's main regulation and storage reservoirs (with system-wide effects) or to secondary storage tanks or smaller industrial, commercial or domestic tanks.

On the demand side:

• Reduced water consumption

Water consumption in affected cities and towns may be partially or totally curtailed as a result of the damage noted in the previous points, or because people have moved to other places.

[121] As indicated in section C.2, in this case the costs of auxiliary activities must be considered, such as dismantling, and demolition and removal of rubble caused by repair works. In addition, there should be an indication of the principal tasks or activities that are deemed to be included in demolition (or dismantling) and removal of rubble, but with a single, global unit price, included under each heading. If more precise prices cannot be estimated, a percentage of the unit price of each asset can be adopted (D%), which must be different for each item, depending on the degree of difficulty entailed in the demolition or dismantling.

[122] This item can be applied in cases where certain families, particularly in rural and periurban areas, have lost their private water sources and are included in the survey of impacts performed by the municipality or other local agency.

A combination of these two factors is most likely, leading to a decline in the delivery of drinking water, lower pressure in the system, and perhaps compromised sanitary control, which could oblige people to boil their drinking water.

Obviously, a fall in water supply or demand would reduce billings and revenues for the water utilities. It is also very important to record any increases in the rates or prices charged for water service.

(b) Sanitary sewer systems

In addition to the hygiene issues associated with the lack of safe drinking water, the collapse of sewage systems will impact the quality of life severely and increase risks to public health, through a combination of various factors:

- Sewers are of no use in areas without water service, because toilets cannot be flushed.
- Breaks and blockages in the sewer network may cause sewage to spill over into the streets, raising the risk of disease or epidemics through direct contamination or the action of vectors.
- Any problems in sewage treatment plants will lead to further pollution in places where the effluent is dumped.
- The risk of flooding increases when storm sewers are damaged.

(i) Disrupted functioning of the sewage and sanitation system

In determining losses to the sanitation system, the following factors should be considered:

- Rehabilitation activities. Rehabilitation involves a wide range of activities including pipe repairs, the laying of provisional pipelines or drains and the digging of drainage ditches. They may also involve repairs to valves, gates and other installations to divert outflows from sewage or storm water pumping stations or to expel sewage that has flooded plants, chambers or ditches.

  The costs of sewer rehabilitation work will be estimated in the same manner as those for restoring drinking water systems.

- Lower revenues from sewage service billings. This impact will depend on how billing is handled in the affected cities. In cases where the sewer charge is computed as a percentage of water supply billings, losses should be estimated using the following formula:

  It = total decrease in municipal water supply billings

  a% = water bill surcharge to pay for sewage service

  S% = percentage of water supply customers who have both water and sewage service

  The decrease in sewage service billings will then be:

  Dfa = It x (a%) x (S%)

However, there may be other residents who cannot use the sewer system because it is out of service. This loss might be estimated as a percentage (Z%) additional to the one indicated above:

Dfa = (Z%) x (normal sewage billings)

When the charge represents a flat rate per sewer connection, the loss in billings can be calculated as a percentage of overall billings for the city:

Fa = total monthly sewer billings for the city

Fa/30 = average daily billing

g% = estimated percentage not charged because of the disaster

p = number of days without regular service

Then:

Dfa = (g%) x p x (Fa/30), in US$/period

Obviously, where sewage service is not billed, utility revenues will not be affected.

E. Financial needs for recovery and reconstruction

1. Financial needs for recovery

As mentioned earlier, given the strategic importance of the services it provides, the water and sanitation sector is one of the first, along with the health sector, that must be rehabilitated after a natural disaster. In particular, special attention must be paid to water quality, excrement removal (sanitation) and garbage handling, as of the first stages following the emergency.

In seeking solutions to restore water supply, consideration must be given to each potential resource, its capacity and proximity to a drainage system, as well as any possibility of chemical pollution, which must be avoided. Another important factor is to enlist the support of civil society organizations.

Recovery activities can include a temporary system for purifying water with substantial doses of chemical products, together with campaigns to inform the public about the use of ingredients, especially in rural areas. In places where the water distribution system has been compromised by the disaster, temporary arrangements must be made for distribution of bottled water or tanker truck supply. Civil society organizations can be very helpful in this regard (sports clubs, church groups, parents' organizations and so forth), in addition to support from the local or municipal authorities.

In rural and periurban areas, depending on the typology of the damage, the reconstruction stage will have to include measures for the physical protection of household wells in flood-prone zones, e.g. through raising the wellhead or installing pumping equipment.

Even under normal conditions, improper treatment of human waste can pose public-health problems. This becomes a more pressing issue in the case of disasters, when sewage removal and treatment are key to avoiding the transmission of infectious diseases and must constitute a public health priority. Thus, another urgent task during the recovery stage is to clean and repair sewage facilities. For this purpose, it is useful to identify small local firms specialized in these functions, such as generally are to be found in periurban and rural areas, as backup to the companies that normally provide these services.

Another interim solution is to install temporary chemical latrines in urban and rural areas, pending the reconstruction of water and sewage systems.

In rural and periurban areas, where latrines are the predominant method of evacuation, municipalities should compile an inventory of these units and keep it up to date, in order to help families clean up and repair their facilities destroyed by the disaster and provide them with temporary chemical latrines.

In cases where a monthly flat rate is applied, water and sanitation charges can be frozen or suspended until normal service is resumed.

2. Financial needs for reconstruction

In the reconstruction stage, it is important to remember that the repair or physical replacement of systems is no guarantee that they will withstand future disasters. Most components of water and sewage systems must be properly operated and well-maintained in order to conserve their capacity to resist damage and to facilitate immediate repairs after a disaster. Meeting these conditions will require effective organization and management, supported by well-equipped workshops, trained personnel, a supply of spare parts and a layout plan of the pipe network. The management capacity of operations and maintenance departments must be strengthened in order to ensure better surveillance of impacts on the systems as well as to facilitate the assessment of damage and reduce the time and costs of repairs.

Appendix 1

Section E of the International Standard Industrial Classification of All Economic Activities (ISIC) Rev. 4 relates to "water supply; sewerage, waste management and remediation activities". This section "includes activities related to the management (including collection, treatment and disposal) of various forms of waste, such as solid or non-solid industrial or household waste, as well as contaminated sites. The output of the waste or sewage treatment process can either be disposed of or become an input into other production processes. Activities of water supply are also grouped in this section, as they are often carried out in connection with, or by units also engaged in, the treatment of sewage".

Within Section E, Division E36 deals with the "collection, treatment and distribution of water for domestic and industrial needs". It includes "collection of water from various sources, as well as distribution by various means".

Under this division, class E3600 covers "water collection, treatment and distribution activities for domestic and industrial needs; collection of water from various sources as well as distribution by various means". The operation of irrigation canals is also included. However, the provision of irrigation services through sprinklers and similar agricultural support services is not included.

This class includes the following activities:

- Collection of water from rivers, lakes, wells etc.
- Collection of rainwater
- Purification of water for water supply purposes
- Treatment of water for industrial and other purposes
- Desalting of sea or ground water to produce water as the principal product of interest
- Distribution of water through mains, by trucks or other means
- Operation of irrigation canals

The following section of this handbook discusses production and intermediate consumption and the supply and use balances per industrial sector within this activity.

A. Private non-financial corporations

These include non-financial companies that have the principal function of collecting, treating and distributing water, through mains, by trucks or other means, to residential, commercial, industrial and other users.

They are "market producers", as they provide the service at a price that covers or exceeds the cost of production.

The information sources are the companies themselves, the entities responsible for regulating them (e.g. ministries) or corporate supervisory agencies.

The value of market output (GrOV) of these companies is obtained from their sales, using the following formula:

GrOV water (companies) = sales of water + final inventory - initial inventory

B. The supply-use balances

The balance between supply and use of water services in an economy is described by means of accounting identities, whereby:

GrOV non-financial private water companies = IC companies plus FC households

where: GrOV water = production of drinking water

IC companies, government/water = intermediate consumption, consumption of water by agents producing goods and services

FC households water = expenditure on final consumption of water by households

Appendix 2

A. Procedure for determining changes in generation of value added

The following hypothetical example shows how the sector accounts are carried over to the national accounts.

1. Initial situation (hypothetical case)

In a small country of 15,000 inhabitants, 80% of the population has drinking water service; the other 20% of the population lives in remote rural areas, and must therefore be excluded from estimates that use per capita indicators.

The water sector is wholly under private management, in the hands of the HdosO utility company. Losses from illegal connections, known as "black losses", are suspected to be equivalent to 5% of the water processed. This percentage could be determined by establishing a physical balance between the volume processed, distributed and billed. However, in terms of value, the assessment starts from the assumption that the price of those grey losses is zero, and they are therefore not included in water use. Sales include only amounts billed.

There is a non-profit institution serving households, which purchases water from HdosO and distributes it free of charge via tanker trucks to low-income households (representing an unrequited current transfer to households, and a sales transaction between non-profit institutions and private non-financial corporations).

Following are production statistics (table A.X.1) and financial statistics (table A.X.2):

Table A.X.1
Water production plants of the company HdosO

Plants	Production (thousands of m^3/year)	Fixed assets (thousands of monetary units)	Sales price	Sales (thousands of m^3)	Sales (thousands of monetary units)
Plant 1	100	30 000	0.12	95	11 400
Plant 2	100	22 000	0.12	95	11 400
Plant 3	80	15 000	0.10	76	7 600
Total	280	67 000		266	30 400

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Table A.X.2
Economic data for the company HdosO
(Monetary units)

Items	Company costs	Customer	Sales
Compensation of employees	10 032	Households	11 400
Inputs	6 992	Businesses	11 400
Taxes	1 520	Non-profit institutions serving	7 600
CFC [consumption of fixed capital]	2 000		
Total expenses	20 544	Sales	30 400

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

According to the available statistics, the production account is as follows:

Table A.X.3
Production account for the water sector
(Monetary units)

Uses		Resources	
Intermediate consumption	6 992	Gross output value	30 400
Value added	23 408		
Total uses	30 400	Total resources	30 400

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Production is calculated from the volume of sales, multiplied by the market price.

Intermediate consumption is equal to the cost of production. The production account balance is gross value added (GVA):

GVA = GrOV - IC

From this identity the technical coefficient (TC) can be derived, representing the proportion of raw materials and inputs relative to production. This ratio is assumed to be constant over the medium term and it can be used to estimate value added when the value of production is known but the amount of inputs is not:

Technical coefficient = inputs and raw materials/output value

In this example:

IC = 6992 GrOV = 30.400

TC = 6.992 / 30.400

TC = 23%

If there should be another plant where production is known to be 5,000 monetary units (MU) but there are no data on raw materials and other inputs, value added can be inferred using the TC:

GVA = GrOV x TC = 5000 x 0.23 = 1.150

GVA = 1.150 MU (calculated using a technical coefficient)

GVA represents the wealth generated during the period, i.e. the value added by the distribution of drinking water to the economy during the calendar year. It is therefore a flow, and the impact of the disaster on that flow must be defined in order to estimate the loss.

The income generation account opens with the balance from the previous account, i.e. with GVA (see table A.X.4).

The use column records payments to the factors of production: labour and capital. It also records taxes that allow the State to redistribute income (in this case, for illustrative purposes, there are assumed to be indirect taxes on water production and distribution).

Table A.X.4
Income generation in the water sector
(Monetary units)

Uses		Resources	
Compensation of employees	10 032	Gross value added	23 408
Net taxes on production	1 520		
Consumption of fixed capital	2 000		
Net operating surplus	9 856		
Total uses	23 408	Total resources	23 408

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

This example includes 2,000 monetary units (MU) of fixed capital consumption, representing the allocated share of annual depreciation.

The balance of the account is the net operating surplus, which describes remuneration to the owners of capital, i.e. it is equivalent to gross profits. The net operating surplus (NOS) is called the gross operating surplus (GOS) when it is not possible to identify the consumption of fixed capital. Thus:

GOS = NOS + CFC

Consequently, the preceding account reveals gross value added, and the income statement (profit and loss) shows compensation of employees, inputs and raw materials (intermediate consumption) and indirect taxes on production.

Consumption of fixed capital must be calculated on the basis of plant and equipment, useful life and replacement value.

The balance of the account is the net operating surplus (NOS).

These companies present profit (gross), recorded in the gross operating surplus (GOS).

2. Impact of a disaster on water production and distribution

Assume that a country has suffered a disaster with the following impacts on the water sector:

(i) Plant 1 was totally destroyed.

(ii) Plant 2 suspended production for one week and spent 1,000 monetary units (MU) to restore production.

(iii) The government has purchased temporary treatment plants for 2,500 MU and will provide water delivery service free of charge.

(iv) The company raised the price of water from plants 2 and 3 by 20%, and they have resumed their previous level of production.

(v) Inflation in the country has jumped by 10%.

The negative short-term impact entails an increase of 1,680 MU in inputs and 330 MU in wages. The increase in intermediate consumption reflects expenditure on construction (repairs) and inputs.

Intermediate consumption has its counterpart in production, due to construction and repairs of infrastructure.

(a) Impact on the non-financial private company (HdosO)

Table A.X.5
HdosO private water production plants

Plants	Production *(thousands of m^3/year)*	Fixed assets *(thousands of monetary units)*	Selling prices	New prices	Sales *(thousands of m^3)*	Sales *(thousands of monetary units)*	Sales differential *(monetary units)*
Plant 1	0	30 000	0		0	0	(11 400)
Plant 2	100	22 000	0.12	0.144	95	14 400	3 000
Plant 3	80	15 000	0.10	0.12	76	9 600	2 000
Total	180	7 000			-95	24 000	(6 400)

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

The total destruction of plant 1 reduces physical production by 95,000 m^3, and cuts sales by 11.4 billion MU. However, the price increase generates an additional 5 million MU at plants 2 and 3, which is reflected in the company's new production account.

Table A.X.6
Economic data for Hdos0 (impact)
(Monetary units)

Items	Initial	Final	Differential	Customer	Initial	Final	Differential
Compensation of employees	10 032	7 920	(2 112)	Households	11 400	1 200	(10 200)
Inputs	6 992	5 520	(1 472)	Businesses	11 400	13 680	2 280
Taxes	1 520	1 200	(320)	NPISH	7 600	9 120	2 280
CFC	2 000	1 104	(896)				0
Total expenses	20 544	15 744	(4 800)	Sales	30 400	24 000	(6 400)

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Table A.X.7
Production account for the water sector (impact)
(Monetary units)

Uses		Resources	
Intermediate consumption	6 .992	Gross output value (GrOV)	30 400
IC differential	(1 472)	GrOV differential	(6 400)
IC impact	5 520	GrOV impact	24 000
Gross value added (GVA)	23 408		
GVA differential	(4 928)		
GVA impact	18 480		
Total uses	24 000	Total resources	24 000

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Due to the closure of plant 1, the income generation table records a decline in the cost of production (employee compensation, taxes and inputs) and in the consumption of fixed capital (as the destruction of plant 1 leaves fewer assets to be depreciated).

Table A.X.8
Water sector: income generation (impact)
(Monetary units)

Uses		Resources	
Compensation of employees (CE)	10 032		
CE differential	(2 112)	Gross value added (GVA)	23 408
Net taxes on production	1 520	GVA differential	(4 928)
Taxes differential	(320)		
Consumption of fixed capital (CFC)	2 000		
CFC differential	(896)		
Net operating surplus (NOS)	9 856		
NOS differential	(1 600)		
Total uses	18 480	Total resources	18 480

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Production from plant 1 is replaced by the government, at the same costs.

The temporary plants cost 2,500 MU, which is accumulated in capital formation for this sector, against imports.

The production of plant 1 that is replaced is calculated by totalling the costs:

GrOV government water = CE + IC

GrOV government water = 2112+1472 = 3584

(b) Distribution transactions and accumulation

Distribution operations generated by the disaster are recorded in the accounts by institutional sector, as follows:

(i) Government

- The government makes transfers in-kind to households in the amount of 3,584 MU.
- It imports capital goods (treatment plants) for 2,500 MU.
- It forgoes tax revenues of 320 MU through the closure of plant 1.

(ii) NPISH

These institutions make transfers in-kind to households for 7,600 and 9,120 MU. The increase is due to higher prices for privately supplied water.

(iii) Non-financial corporations

- They record destruction of their capital reserve in the amount of 30,000 MU.
- They increase their investment by 1,000 MU to restore plant 2.
- Their gross profits decline by 1,600 MU.

(iv) Households

- They lose employment through the loss of plant 1, but get new jobs at the government's processing plants.
- A segment of households must spend more on water.
- Another segment ceases to spend for this service and receives transfers from the government.

(c) Other impacts

Construction has a positive impact, through the investment of 1,000 MU for restoration of plant 2.

Imports rise by 2,500 MU, and the trade balance with the rest of the world deteriorates accordingly.

The country's "net worth" or national wealth is affected as follows:

Table A.X.9
Change in national wealth
(Monetary units)

Destruction of plant 1	-30 000.00
Restoration of plant 2	1 000.00
Emergency plants	2 500.00
Change in net worth (wealth)	-26 500.00

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

XI. Power sector

A. General considerations

Because of its interrelationship with production, infrastructure and the social sectors, any disruption to the power sector is bound to have an impact on the rest of the economy. For the same reason, restoring power supply is a key element in post-disaster recovery and reconstruction.

In the national accounts, the power sector includes the generation of bulk electric power, transmission from the generating facilities to distribution centres, and distribution to end users. It includes: (i) operation of generation facilities that produce electric energy, including thermal, nuclear, hydroelectric, gas turbine, diesel and renewable energy installations; (ii) operation of transmission systems that convey the electricity from the generation facility to the distribution system; (iii) operation of distribution systems (consisting of power lines, posts, meters and wiring) that convey electric power received from the generation facility or the transmission system to the final consumer; (iv) sale of electricity to the user; (v) activities of electric power brokers or agents that arrange the sale of electricity via power distribution systems operated by others; and (vi) operation of electricity and transmission capacity exchanges for electric power.[123]

B. Damage

Damage in the power sector is estimated by component, grouped under three broad categories: power generation plants; transmission lines and distribution grids; and dispatch centres. The following procedure can be used to quantify damage:

1. Pre-disaster situation

A first point to take into consideration is the institutional and industrial organization of the sector, which must include:

(i) The nature of the utility companies (public or private). If they are public enterprises, whether they are regional.

(ii) Capacity and location of power generation enterprises.

[123] United Nations, 2009a.

(iii) Characteristics of the power distribution enterprises.[124]

(iv) The national regulatory entity, and the ministry to which it reports, if any.

(v) National and regional government institutions responsible for the sector.

The second objective is to obtain a clear picture of all the components of the power system in the disaster zone. This information can be gathered from the entities mentioned above.

The information on the power system must specify:

(i) Power generation plants, including hydroelectric and geothermal plants as well as conventional thermal power plants driven by steam, diesel and gas turbines, and other non-conventional generating sources such as wind turbines.

(ii) The transmission and distribution systems, which include transmission, sub-transmission and distribution lines as well as substations of all kinds that are directly related to the transport of electric energy from generation centres to final consumers.

(iii) Dispatch centres and other structures.

2. Estimating damage

Damage must be estimated for each of the power system components mentioned above, quantifying the cost of restoring the damaged or destroyed assets to their pre-disaster condition. It is also important to quantify the percentage of assets for which rehabilitation and recovery will entail imports. It will be recognized that in this sector much of the damage may well have to be resolved through imports, in the absence of domestic production. An important consideration is the age of the assets, some of which may have been fully depreciated from an accounting viewpoint.

(a) Generation facilities

In light of their special characteristics, it is appropriate to consider the civil works needed for collecting hydro and geothermal power separately from the power generating stations themselves, where the equipment for transforming primary energy into electricity is installed.

In the case of hydropower generation, the civil works must include those for managing the water resource, such as conversion and storage dams, canals, tunnels, oscillation chambers and pressurized pipelines. The estimation of damage requires a detailed list showing the structures affected and the scope of the damage. This information can be gathered from the electric companies, and verified by the national entity.[125]

Given the magnitude of these works, access roads are an important consideration. They should be treated as assets of the electricity companies, and any repair costs should not be included in damage to the transportation sector.

Damage to these facilities must be repaired in order to restore the water flow required for electricity generation; failure to do so would render the power plant non-operational, and the entire system would collapse. The costs of rehabilitation or reconstruction will depend on the degree of damage to the infrastructure. The accessibility of basic resources (land, sand and gravel) as well as the availability of labour, unskilled and specialized, may also have an impact on costs. To quantify the impact will require:

(i) An estimate of the quantity of raw materials required for the work, including the cubic metres of earth to be moved; specifications for the type of material; amounts of concrete that may be required, broken down by type and strength; the length and other characteristics of water conveyance lines, and the main mechanical components and special facilities. The costs will then be estimated on the basis of current unit values for each component. In this connection, cost estimates and quotes from contractors with recent experience locally or in regions with similar conditions will be a valuable source of information.

[124] In the case of the torrential rains that hit Colombia during 2010-2011, the damage was largely to the generating companies, not the distributors (ECLAC/IDB/DNP, 2012).

[125] As will be seen in box XI.1, the task of estimating the impact of the torrential rains in Colombia during 2010-2011 fell to the National Planning Department (DNP) (ECLAC/IDB/DNP, 2012).

(ii) An estimate of the time during which the construction equipment will be needed, as well as unit costs.

(iii) The need for both unskilled and specialized labour, as well as average wages for each category.

(iv) An assessment of the accessibility of the basic resources (land, sand and gravel) as well as the availability of unskilled and specialized labour, which will have a high impact on cost estimates.

With respect to geothermal power generation, resource extraction and management requires deep wells, conveyance pipe systems and specialized equipment for the processing and collecting of steam. Any estimate of damage to the availability and accessibility of the underground resources will require expert assistance and field research, and consequently falls outside the scope of this handbook. However, the group of power sector specialists should try to make rough estimates based on average costs, duly updated to the time of the disaster, for drilling wells in the affected zone, or in other sites with similar natural characteristics. For the remaining generation facilities, the alternative cost estimation procedures already described for hydropower plants should be followed.

The remaining components of power generation infrastructure consist of the power plants themselves, including the building and a range of mechanical, electrical and electronic equipment. The analysis should focus first on the equipment and machines that drive the generator. There will be a fundamental difference here between hydroelectric stations and plants that use heat energy through boilers, pressure tanks or steam and gas turbines.

The first are designed individually to match the characteristics of the hydroelectric site, and their replacement must obey the same considerations. However, the cost can be estimated by updating the original investment using indices that reflect the trend in international prices of similar equipment. Manufacturers' catalogues and statistics on the cost of equipment to collect power in hydroelectric plants by range of water height (metres) and flow (cubic metres per second) may also be used.

Equipment used for the mechanical processing of energy obtained from steam and from burning oil derivatives is more standardized, although it has specific characteristics depending on the size and type of facility. This includes geothermal as well as conventional power plants classified (depending on the fuel used) as steam-, diesel-, and gas-driven plants.

Their replacement costs can be estimated following the general procedures mentioned above for hydroelectric power plants, which are normally easier to estimate because the equipment is more standardized. Power plants use a range of equipment (mainly electromechanical) to convert raw energy forms –hydraulic, geothermal and those derived from oil derivatives– into electricity. This equipment is generally similar for different types of power plants, but it may vary depending on how modern the plants are and on their specialized functions. The determination of replacement costs first takes into account the investments incurred for the original purchase –especially if this was done recently– updated to account for international inflation. A second alternative is to consult cost catalogues published by the manufacturers of this equipment or costs statistics available in specialized publications.

The above comments refer to cases in which installations must be totally replaced. When damage is less severe and only repair or rehabilitation is required, the cost estimate must be preceded by a technical assessment of the scale of the damage and the real chance of repair. This work will require the participation of specialized personnel having wide experience in the repair and maintenance of this type of equipment. Laboratory tests of the affected equipment will be required to obtain more exact estimates, something that cannot be done in the relatively short time usually available to the disaster assessment team.

Lastly, the buildings that house the generating equipment must be assessed. The quantification of damage will follow the same procedures as described for other buildings, as explained below.

(b) Transmission and distribution systems

This heading includes transmission, sub-transmission and distribution lines and grids, as well as all electrical substations that may be directly related to conveying power from the generation plants to final consumers.

High-voltage lines that use large and expensive pylons should be assessed first. To facilitate visual inspections, automobiles can be used when the lines are located near passable roads, and light aircraft or helicopters in the case of cross-country lines. The number of damaged pylons, the different types of pylon, and the length of affected electrical cables will be estimated. For other lines that are carried on uniformly spaced posts, only the number of kilometres

of affected lines will be needed, with an indication of whether the damage is limited to the posts or whether it also includes considerable lengths of cable. In addition, damaged transformers and other equipment located along the distribution lines must be identified and the damage quantified.

Thereafter, a list should be made of affected electrical substations, with the most precise indication possible of all equipment that has sustained any damage, including open-air facilities and equipment located in the main substations.

Estimates of the corresponding costs should be made on the basis of the results obtained from the inspection of the facilities described above. These should take into account all information available from affected power companies or those in neighbouring areas. Because these data are frequently used, they should be readily obtainable. As in the case of power generation facilities, overall or itemized costs may also be used, such as data from contractors with applicable local experience, and equipment price statistics and catalogues.

The above comments on estimating damage in partially affected installations, in contrast to those that must be totally replaced, are also applicable to power transmission and distribution facilities. In this case, the estimate should be done separately, following the procedure described.

(c) Dispatch centres and other works

Other important facilities of utility companies are their power measurement and dispatch centres and buildings for their administrative offices. The former will house a whole range of equipment to monitor and control electricity flows between power generation plants and the main consumption areas. These facilities may range from the most elemental, using manual controls, to the most sophisticated, employing modern remote-measuring and electronic computing systems with a high degree of automated and optimized basic functions. When total reconstruction of these facilities is required, damage estimates should be based on overall costs applicable to the type of dispatch centre. In the case of partially damaged equipment and structures, an inventory of the respective parts and an estimate of the extent and magnitude of the damage will be needed; experts should be engaged when specialized equipment is involved.

Damage to administrative buildings and other facilities that might be affected by a disaster should be estimated at cost of replacement consistent with the original design. This will require information on the floor area destroyed or damaged and the value per square metre for buildings of this kind. The first aspect can be measured against a scale ranging from zero (no damage) to four (total destruction). The levels of that scale will be applied to the actual average cost of construction per square metre. It is important that the square-metre cost used should not be a national average, but specific to the disaster zone. For a more accurate estimate, unit prices should be used for the main elements that comprise such buildings, such as floor slabs, walls, ceilings, window frames and so on. Once the value of this damage has been determined, the impact on furnishings, the vehicle fleet and computer equipment can be estimated, drawing on information in the utility company's inventory records.

Box XI.1
Colombia: estimating the damage caused by the torrential rains of 2010-2011

This analysis is based on information provided by the Government of Colombia, specifically the National Planning Department (DNP) and power sector institutions. For estimating damage, information was obtained on the following items: generation (hydroelectric, gas- and diesel-fired thermoelectric), transmission and distribution networks, dispatch centres and other equipment, and home connections. For energy generation, the DNP gathered information from the Colombian Association of Electric Power Generators (ACOLGEN) and the National Association of Generating Companies (ANDEG). Information was also received from six generating companies (ISAGEN, URRA S.A, EMGESA, CHEC, Termovalle and Proeléctrica), but none was supplied by Empresas Públicas de Medellín (EPM), which has greater installed capacity.

Box XI.1 (concluded)

Table 1
Estimating damage to power generation
(Millions of pesos)

	Number	Damage	Public	Private
Hydroelectric stations				
Destroyed	1	52		
Damaged	4	6 376	2 978	3 398
Thermoelectric stations				
Destroyed	1	531 360		531 360
Damaged	2	550		550
		538 338		535 360

Source: Economic Commission for Latin America and the Caribbean (ECLAC)/Inter-American Development Bank/National Planning Department of Colombia (ECLAC/IDB/DNP), *Valoración de daños y pérdidas: ola invernal de Colombia 2010-2011*, Bogota, 2012 [online] http://www.cepal.org/publicaciones/xml/0/47330/OlainvernalColombia2010-2011.pdf.

In some cases this information is confidential and consists of companies' own estimates of the effects of the torrential rains that hit Colombia: it is therefore presented in aggregate form. In total, there was damage to four hydroelectric and three thermoelectric stations (see table 1). That damage did not disrupt service to power distributors or to users, as the system responds to power supply and demand through the energy exchange.

In the transmission and distribution network, the Ministry of Mines and Energy asked utility companies to provide information on the impact on domestic users during the 2010-2011 rainy season. It also gathered information from the Association of Power Distributors (ASOCODIS). The DNP estimated the cost of replacing service connections from the local network to the building interface (including the meter). The number of dwellings affected in each department and in each of the six socioeconomic strata was determined, using information recorded by the National Disaster Risk Management System (SIGPAD) on dwellings damaged or destroyed by department, and it was assumed that each department had the same distribution of power customers per stratum (Single Information System of the Public Utilities (SUI) of the Superintendency of Domestic Public Utilities) (see table 2). It was assumed that all dwellings destroyed and 10% of those affected by the weather suffered damage to their power connections, and that the average replacement cost was 200,000 Colombian pesos per dwelling.

Table 2
Estimate of damage to the transmission and distribution network, dispatch centres and home connections
(Millions of pesos)

Item	Unit	Number	Damage	Public	Private
Transmission and distribution network damaged	Km of network	464	2 216	2 371	4 845
	Pylons and posts	1 010	1 751	926	825
Dispatch centres and other equipment	Transformers	296	1 670	655	1 015
	Others	11	6 928	996	5 932
Home connections	Installations	69 595	13 919		13 919
Total			31 484	4 948	26 536

Source: Economic Commission for Latin America and the Caribbean (ECLAC)/Inter-American Development Bank/National Planning Department of Colombia (ECLAC/IDB/DNP), *Valoración de daños y pérdidas: ola invernal de Colombia 2010-2011*, Bogota, 2012 [online] http://www.cepal.org/publicaciones/xml/0/47330/OlainvernalColombia2010-2011.pdf.

C. Losses

As noted above, losses include, on the one hand, revenues forgone by electric power utilities during the period of disruption and, on the other hand, the additional cost of supplying power needs temporarily during rehabilitation and reconstruction of the installations affected.

1. Pre-disaster situation

Information should be obtained on:

(i) The number of residential and non-residential consumers in the disaster zone.[126] This information can be obtained from power companies or their associations.

(ii) Billing and average monthly consumption for each of these groups in the disaster zone. This information can be obtained from power companies or their associations.

(iii) To determine the weight of this sector in the affected zone, the above information should be obtained for the entire country.

(iv) Projections of residential and non-residential consumption in the disaster zone in the year of the disaster. This information can be obtained from power companies or their associations. Together with sector prices, this information could be used to prepare the baseline for gross revenues of the utilities.

(v) Number of residences that had no service. This information can be obtained from the national statistical office, specifically via the household survey.

(vi) Production statistics series for the sector, for determining its weight in the national economy. The expert responsible for the power sector production account in the national statistical office should be consulted for a geographical breakdown of power generation capacity.

(vii) Power pricing policy over recent years, differentiated by type of consumer, as well as any changes proposed for the near future. This information can be obtained from the sector regulatory entity or the power companies.

2. Estimating losses

Two types of flows must be estimated: gross revenues forgone and additional costs.

(a) Gross revenues forgone

Revenues may be lost because of damage to the power companies' assets as described in the previous section, which will reduce supply, or because of lower demand due to the destruction of homes and productive facilities. Gross revenues forgone can be determined via the following steps:

(i) Establish the baseline, i.e. the revenues that the utilities would have earned under normal circumstances.

(ii) Estimate the decline in consumption as a result of destruction or damage to homes and commercial establishments. In determining the quantity and characteristics of demand, the impact of the disaster on the company's main customers (residential and non-residential) will have to be considered. The first step will be to forecast the principal types of demand: residential demand in light of the number of unaffected dwellings; and non-residential needs in the industrial and commercial sectors, in light of the number of establishments that are in a position to keep operating, as well as the anticipated behaviour of demand for their products. For all sectors, the post-disaster purchasing power of customers will have to be estimated, because of its impact on demand. Based on the foregoing, the magnitude and the characteristics of overall power needs can be estimated.

(iii) Subtract (ii) from (i).

(b) Additional costs associated with provisional power supply

To estimate the additional cost of provisional power supply, the following must be taken into account: (i) the effective demand for electric power, obtained by calculating the gross revenues, which should be lower than pre-disaster levels and (ii) the time that it will take to rehabilitate the system or to restore damaged infrastructure to normal working condition. The length of time will depend essentially on the scope and magnitude of the disaster and the extent of the damage.

[126] Depending on the region affected, this information may be broken down among the major power consuming sectors, e.g. commerce, manufacturing, mining and oil refining. This relates specifically to the most important economic activities in the disaster zone.

The group of power sector specialists will need to quantify the costs of the alternative means for meeting estimated temporary demand, which will generally be lower than pre-disaster levels but could in fact turn out to be greater. The solutions employed to supply power requirements must ensure prompt restoration of service, for example temporary replacement of damaged generating plants by emergency plants. This will entail higher electricity production costs throughout the system.

In the case of isolated systems, "package"-type equipment may be considered, as they can be quickly mobilized and installed in the main load centres. The capital cost can be readily obtained from specialized catalogues, or estimated from recent experience in the purchase of such equipment for special needs: for example, backup plants for industrial centres or to meet the needs of isolated population groups not connected to the national power grid.

Operating costs can be estimated from the specific consumption of fuel and from transport costs to the site of the provisional installations, which should be located preferably as close as possible to the major load centres. The operating cost estimate will be supplemented by adding in labour and material costs, which can generally be obtained from the books of power companies that have made use of the same or similar equipment.

In the case of systems that, while relatively close to neighbouring systems, are not interconnected, the costs of provisional power can be readily calculated. The investigator will determine whether the nearby systems have the capacity to supply the required power. The costs of making the interconnection will then be calculated, recognizing that in some cases this may require new investments in transmission lines or substation equipment. Next, the rates at which the required power can be obtained must be determined. If there are no established arrangements for emergencies of this kind, a reasonable rate will be estimated on the basis of the additional operating costs incurred by the system selected to provide the provisional power service. There may also be cases where neighbouring systems can supply only a portion of needs. In that situation, the procedures indicated above will be followed with respect to the alternatives of stand-alone and integrated systems, in proportion to the contribution of each.

As the idea is to establish the additional costs for provisional service, the foregoing estimates and all the alternatives considered will have to be adjusted for any reduction in operating costs compared to those that the utility faces in normal times, such as the variable costs of generating units rendered inoperable by the disaster.

D. Financial needs for recovery and reconstruction

1. Financial needs for recovery

Recovery needs refer to the funds that power companies may require to keep operating until the situation returns to normal. When production costs rise significantly the State may grant a temporary subsidy, or it may increase a subsidy that was already in place before the disaster.

2. Financial needs for reconstruction

Reconstruction needs are estimated as the total of damage to assets plus the additional cost of introducing (i) technical improvements in system design; (ii) standards to ensure greater resistance to disasters (to reduce the risk to transmission and distribution systems from tropical storms, hurricanes and cyclones, there are options such as underground cables, although the cost is high and few countries have gone this route; another option is to adopt stricter building codes against earthquakes); and (iii) relocation, if necessary.

Power companies often turn to their reserves of spare parts and materials in order to restore service promptly. The replacement of these reserves must be included as a reconstruction cost, but without duplicating the cost of the assets.

Part IV
Economic sectors

XII. Agriculture sector

A. General considerations

For the purposes of this handbook, the agriculture sector comprises the subsectors of farming, livestock, fisheries and forestry. This chapter addresses each of these subsectors in turn. The agroindustry sector is examined in another chapter of the handbook.

Each of these subsectors embraces different species of cultivated plants, domestic animals, forestry plantations, and certain species of fish, molluscs and crustaceans that are part of aquaculture in inland and coastal waters.

In the case of crops, a distinction is made between short-cycle, transitory or seasonal crops (rice, cotton, maize, wheat, barley, soybeans, potatoes, broad beans, black beans, peas, quinoa, sorghum, tobacco, tomatoes, watermelons, melons; garden produce such as onions and peppers; forage crops such as alfalfa and stock-feed cabbage; long-cycle or permanent crops (e.g. bananas, plantains, yucca, coffee, sugarcane, cacao, oil palms, pineapples, oranges, grapefruit, lemons, other citrus fruits, peaches, pears, apples, grapes); and ornamental crops (plants and flowers). Livestock includes cattle, sheep, goats, swine and camelids, as well as equine species (horses, donkeys and mules), and various species of domestic poultry.

The various sections of this methodological handbook present an illustrative (but not exhaustive) list of plant and animal species that may be affected by disasters. From that list, it will be appreciated that estimating the impact of a disaster on agriculture is a big and complex task.

1. Locating the geographical or administrative region affected

An important component in estimating disaster impacts is to locate the specific region affected within the country's different geographical areas, administrative departments, or production zones. Such a differentiation makes it possible to define more closely the range of productive activities that must be included in the analysis for the agriculture sector, and also to pinpoint those parts of the national territory that have been affected by the disaster and must therefore be examined.

The Andean countries (in particular Colombia, Ecuador, Peru and the Plurinational State of Bolivia, and to a large extent, the Bolivarian Republic of Venezuela) as well as Central American countries have a highly irregular topography and are very susceptible to mountain landslides. As well, their low-lying areas are prone to flooding, while

the upland regions and Andean valleys frequently suffer from drought, frost and hail. The intensity of flooding in the Bolivian llanos and the lowlands of Colombia and Ecuador is much greater in years when El Niño or La Niña events occur. Moreover, those events can provoke climatic changes of other kinds, such as prolonged droughts, severe hail storms, early or late frosts, and other anomalies that are harmful to agriculture.

2. Seasonality of sector output

The seasonality of production is a decisive factor in estimating damage and losses within nearly all agricultural subsectors except forestry. Traditionally, farmers do their planting and anticipate their harvest with a careful eye on forecasts of the principal climatic components: temperature and precipitation. In each producing area, production calendars are established in light of the phenological phases of each crop (germination, rooting, budding of stalks and leaves, growth and sprouting of plants, flowering, fruiting, maturing and harvesting of fruits) and the regular alternation in each producing zone between dry and rainy periods in normal years.

Some transitory crops, such as rice, can be harvested two or three times from the same land during the course of a crop year. To some extent, repeat crops may present differences in terms of their seasonality, farming practices, the varieties used, and the levels of yield. For example, among permanent crops, sugarcane is harvested annually (provided the plants have received the heat they need to complete their productive cycle), in circumstances where the stumps sprout every year and can last between three and nine years (with certain types of land, climate and farming systems, up to 20 years).

With annual crops the period that elapses between sowing and harvesting must be taken into account, while with permanent crops what is important is the period from flowering until harvest. The crop production calendar is then superimposed onto this information and the date of the disaster is established. An analytical comparison between normal production indicators and those relating to the damage suffered will provide information that can be used to determine whether the damage or loss has been definitive, or temporary and recoverable. In the latter case, it is possible that the yield will be lower in the short and perhaps medium term, because of the increased impact of pests and diseases as a result of a prolonged period of high humidity and saturated soils. Another influential factor is the specific sensitivity of the different phenological stages of crops to climatic anomalies arising from one or several extreme events that may coincide in the national territory.

This last point is related to the key role that maximum and minimum temperatures play with respect to the specific heat and humidity tolerance levels of different crops, as well as the degree of ambient and soil humidity (which regulates the normal development of the different phenological phases of crops). Changes in these climatic components will have an impact on crop yields, especially when those changes occur during the plants' reproductive phase (which covers flowering, pollen formation, fertilization and fruiting). The number of hours of sunshine is also important.

Disasters may either delay or speed the normal alternation of the climatic seasons in production zones, and hence the seasonality that governs the sowing and harvesting calendars for transitory and permanent crops alike. This effect is particularly notable when heavy rainfall causes widespread and persistent flooding, or when there are prolonged droughts. When rainfall is excessive, persistent and heavy, flooding will be accompanied by high general humidity that promotes attack by fungi and other organisms harmful to crops, both short- and long-cycle.

On land devoted to permanent crops, a combination of frost and drought will affect production and productivity not only during the crop season in which these atmospheric phenomena occur but also during the following season, when the yield may be smaller and of poorer quality. Therefore, together with the decline in production, farmers will see their incomes fall. These possible delayed consequences must be taken into account in estimating the impact of disasters in the agriculture sector.

3. The pre-disaster situation in the agriculture sector

In the course of examining available background information on crop production, nation-wide and by region, attention must be paid to the agrarian structure and the relative importance of subsistence and commercial production. Other

relevant considerations are the importance of irrigation, intensive farming, mechanization and the relative prevalence of monoculture and diversified farming, together with the respective production patterns. A later section will consider what to do when information is incomplete or incorrect.

With this background, and other supplementary information, the pre-disaster situation in the agriculture sector can be determined, and a baseline developed for each of the sector components, both at the national level and for the various parts of the country affected by the event in question.

Damage will be evident from the moment of the disaster, or very shortly after. On the other hand losses, which do not only depend on the magnitude and intensity of the impact on production flows, may extend for days or months, or even years after the disaster.

Damage most frequently affects:

(i) Lands used for farming, livestock and forestry, which may suffer from erosion, sedimentation, salinization or desertification, or other negative effects that reduce or destroy the actual or potential production capacity of the soil.

(ii) Infrastructure used in farming, livestock, poultry, aquaculture and forestry activities: roads or bridges within the farm property; buildings and installations for the storage of equipment, harvested products, inputs and other production goods; irrigation or drainage systems; silos, stalls, corrals, troughs and pens for raising fish or crustaceans, among other items.

(iii) Machinery, equipment and tools used in farming, livestock, poultry, aquaculture and forestry activities.

(iv) Permanent crops that may be destroyed and must therefore be replanted, meaning that production levels may take several years to recover.

(v) Plantations of native species or exotic trees for producing logs, sawn or redimensioned lumber, or wood for use in construction, manufacturing or pulp and paper.

(vi) Other types of damage, discussed in detail below in the course of examining the subsectors that comprise the agriculture sector.

The losses most frequently caused by disasters, individually or in combination (for example, when drought and frost strike a production zone simultaneously) are:

(i) Decline in the production of transitory or permanent crops and of different species (livestock, birds and fish) because they could not be harvested or production could not take place within normal or customary time limits.

(ii) Reduction in physical productivity or lower yields than normal for the different types of transitory and permanent crops and species of livestock, birds and fish.

(iii) Lower quality of the harvest or of by-products obtained from the various components of the agriculture sector. Lesser harvest quality means lower incomes for producers.

Again as a consequence of the disaster, there will be additional costs due to the need to use greater quantities of inputs to neutralize the effects on crops, livestock and agricultural infrastructure. It may be essential to use more water for irrigation, or to pay higher prices (because of damage to road infrastructure) for the transport of production inputs, food and medications for livestock and poultry, as well as to move harvested products from production sites to consumption centres.

Some forms of damage and loss are caused in specific subsectors of agriculture, while others are general and affect all segments, as in the case of farm infrastructure. The following section discusses, first, impacts of general scope, and then specific impacts on the subsectors of farming, livestock, poultry, aquaculture and forestry.

B. Farming

1. Damage

(a) Damage to infrastructure

Infrastructure includes buildings and installations that are used to store harvested products or the inputs needed for production, such as:

i) Silos and storage sheds.

ii) Irrigation and drainage systems.

iii) Hydraulic installations and equipment.[127]

iv) Roads and bridges on farm property.

Table XII.1 illustrates an estimate of damage to agricultural infrastructure in Colombia as the result of the torrential rains (the "ola invernal") that struck the country in 2010-2011, causing major flooding. To estimate the dimensions of the area with physical assets installed on farms affected by the disaster, the following items are needed:

i) Detailed information by region, department or province on farm infrastructure. These data are compiled in a reliable manner in some countries that conduct fairly exhaustive agricultural surveys. The results of those surveys can be used to estimate the magnitude of the national area with infrastructure installed on farms affected by the disaster.

ii) Surveys that include data on average construction costs. If not available, other sources of reasonably reliable information must be sought.

iii) An estimate of the degree to which the disaster has affected infrastructure: this can be accomplished using a scale of zero (no damage) to 4 (total destruction). The levels of that scale will then be applied to the actual average value per square metre of construction.

For example, taking as a starting point an estimated current average value of 30,695 Colombian pesos, which corresponds to level 2 on the scale, if the estimated impact corresponds to level III on the scale (75% destruction), the average value per square metre of restoration will be 41,250 pesos which, applied to the total damage in square metres, gives the estimated cost of the damage suffered by farm infrastructure. In using this scale to estimate the cost of temporary restoration, the age of the structures must be taken into account, as well as the average useful life of the different types of farm infrastructure, and the materials from which they were built.

Table XII.1
Colombia: estimated damage caused by the torrential rains of 2010-2011 to farm-based infrastructure

Department	Total build area *(thousands of square metres)*	Build area affected *(thousands of square metres)*	Level of impact *(percentages)*	Value of infrastructure damaged *(millions of Colombian pesos at 2011 prices)*
Antioquia	806 790	830	0.1	34 375
Atlántico	36 600	70	0.2	2 887
Bolívar	201 570	2 170	1.1	89 512
Boyacá	346 720	90	0	3 712
Caldas	62 510	50	0.1	2 062
Cauca	312 890	90	0	3 712
Cesar	1 203 190	830	0.1	34 237
Córdoba	536 010	1 810	0.3	74 662

[127] In many countries, flood protection and control works are the responsibility of the public works ministries. This topic is addressed in chapter X.

Table XII.1 (concluded)

Department	Total build area *(thousands of square metres)*	Build area affected *(thousands of square metres)*	Level of impact *(percentages)*	Value of infrastructure damaged *(millions of Colombian pesos at 2011 prices)*
Cundinamarca	594 100	170	0	7 012
Huila	343 560	240	0.1	9.9
La Guajira	301 850	470	0.2	19 387
Magdalena	397 000	2 490	0.6	102 712
Nariño	154 890	20	0	825
Norte de Santander	112 770	110	0.1	4 537
Quindío	52 000	70	0.1	2 887
Risaralda	103100	190	0.2	7 837
Santander	745 990	1 300	0.2	53 625
Sucre	176 620	1 460	0.8	60 225
Tolima	213 540	130	0.1	5 362
Valle del Cauca	497 320	730	0.1	30 112
National	7 199 020	13 320	0.2	54 945

Source: Ministry of Agriculture and Rural Development of Colombia, "Seguimiento del impacto de la ola invernal de 2010 en el sector agropecuario", 28 January 2011; National Agricultural Survey (ENA), 2009; Agricultural Financing Fund (FINAGRO), average cost: 41,250 pesos per square metre; National Planning Department (DNP) and Colombian International Corporation (CCI).

The data on damage to irrigation canals are provided by the responsible national institution, which will generally conduct a quick survey of damage to concrete-lined canals as well as systems with earth-lined canals. Water intakes or secondary and tertiary distribution canals may also have been damaged by the disaster, as well as gates and other lesser hydraulic works used to conduct and distribute irrigation water. Such infrastructure may be destroyed, obstructed or partially blocked by mud and sediments carried by the rivers that feed the irrigation systems. As well, there may have been damage to deep wells and their equipment, and to other works that supply water for irrigation.

Drainage channels may show similar damage to that described in the case of irrigation systems and canals. Among other negative impacts, the disruption of drainage will prolong the time during which fields are inundated, causing them to deteriorate through sedimentation or salinization.

To estimate damage to irrigation and drainage infrastructure, the following calculation procedure is used:

(i) Obtain the average estimated cost of repairing or rehabilitating the canals, per linear kilometre.

(ii) Seek information on the number of kilometres affected by the disaster. The unit costs of restoration may be obtained from national or regional irrigation and drainage institutions, or from irrigation system user associations.

(iii) Multiply the average estimated cost of repairs or rehabilitation by the number of kilometres affected by the disaster in order to obtain the value of damage to irrigation and drainage infrastructure.

The exploitation of aquifers depends on such factors as size, geographical location, topography, climate, soil type and hydrology in the various producing zones. These factors determine whether tubular wells can be built and used to extract groundwater for irrigation purposes. Whether many or few tubular wells are installed depends on the groundwater potential.

Pumps can also be fitted for irrigation in canals, rivers and streams. National irrigation institutions have data on the unit costs of implementing and equipping pumping stations, and these can be used to estimate damage in terms of the number of pumps affected by the disaster.

Roads and bridges constructed on agricultural properties may be affected by the disaster, and will have to be restored or rehabilitated. The value of damage is estimated as follows:

(i) Obtain data on the cost of repair per linear kilometre (available from agriculture ministries, producers' associations or public works ministries).

(ii) Multiply that unit cost by the estimated number of kilometres affected to obtain the total estimated cost. (For example, using information from producers' associations, it is estimated that 500 linear kilometres of farm access roads must be rehabilitated, at an estimated cost of 36,000 Colombian pesos per kilometre. Consequently, the total cost of rehabilitation for this infrastructure will be 18 million pesos).

(b) Damage to lands

Damage to lands used to grow crops means that they have deteriorated to the point where they can no longer be exploited, or that their productive potential has been reduced markedly. Such damage can result from:

(i) Water and wind erosion

(ii) Desertification

(iii) Sedimentation on flatlands along river banks

(iv) Gradual salinization[128]

(v) Floodwaters that undermine riverbanks

(vi) Landslides on sloping lands

On this point, it is important to note that, in general, with the exception of overflowing watercourses, these factors result from environmental degradation that accelerates or aggravates the effects of the disaster.

Some of the damage inflicted on croplands may be irreversible, while some will be temporary. The recovery of this productive capital will depend on the economic cost and the period of time needed to amortize the investments for restoring production capacity.

To estimate the cost of recovery:

(i) Delimit the affected area and define its geographical location (for example, 300 ha in zone A with mud or sand deposits that are very difficult to remove (irreversible damage); another 200 ha in the same area covered with various types of plant waste (recoverable lands).

(ii) Determine the main productive use of these lands: transitory or permanent crops, or a combination of both.

(iii) Compile data on recent average market prices for land and for the affected products.

(iv) Estimate potential production during the years it will take to restore the production base, using current average productivity per hectare (for example, net income from one hectare of bananas in flooded zone A may be estimated at 5 million pesos; to restore its production capacity will take three years, and potential income lost can therefore be estimated at 15 million pesos).

(v) In the absence of reliable information, the cost of recovery per hectare can be estimated indirectly. For example, 500 ha on which 3 million pesos will have to be invested for recovery over three years, implying an estimated cost of 1.5 billion pesos. Forestry services or private forestry companies can provide data on the costs per hectare of removing deposits of plant wastes and stones.

Damage to machinery and equipment used for producing crops —in particular tractors, harvesters, harrows, other specialized machinery, fumigation equipment, tools and other artifacts used in systems, processes and fieldwork— is estimated as follows:

(i) Assign an average value per physical unit affected.[129]

(ii) Multiply that value by the number of units totally destroyed.

(iii) If the damage has been partial, estimate the value of repairs by applying the prevailing market price for a given level of impact within a scale (procedure similar to that indicated for infrastructure).

[128] Salinization can also happen abruptly from the encroachment of water due to tsunamis or tidal waves in coastal areas, produced by tropical storms, hurricanes or cyclones.

[129] Whenever possible, the estimation of disaster impacts should take into account a prompt or gradual adaptation of the agriculture sector to climate change, especially if damage and losses are due to unsuitable siting of crops from an agricultural and ecological viewpoint. In this way the costs incurred will not be attributed solely to the disaster, and the economic and environmental implications of replanting in the same place will be thoroughly examined.

Some disasters can cause damage to harvested products, farm input inventories, and other goods for use in productive processes that are kept on the farms affected by the disaster. In this case, distinguish between total and partial destruction in order to assign to each damaged product an average commercial value which, multiplied by the number of units affected, will give the total estimated replacement value.

When atmospheric events are intense and sustained (for example, winds from a category 5 hurricane), permanent crops may be destroyed (breakage or snapping of branches, stripping of leaves, collapse of the system, violent uprooting of plants, or other severe damage), and such crops will therefore have to be replaced. The costs of replanting per hectare will be estimated as follows:

(i) Determine the number and location of the hectares that must be replanted, bearing in mind their degree of vulnerability, the apparent impact of climate change and the possibility of relocating the affected farmers to other lands.

(ii) Obtain data on the cost of planting per hectare.

(iii) Seek information on the annual amount of additional investments and the costs of fieldwork until the new plants come into production and output and yields can return to normal.

(iv) Multiply the number of hectares that must be replanted by the unit cost of replanting per hectare, until pre-disaster production levels are reached, in order to obtain the total cost of replanting.

Generally speaking, it will take around three years for the newly replanted crops to achieve previous average yields, although this will depend on the specific features of each permanent crop. Damage estimates will include the costs incurred by producers until economic losses are cancelled. Replanting costs and the expenses involved in crop management per hectare can be obtained from agriculture ministries or farmers' associations.

2. Losses

(a) Transitory crops

Estimating losses to transitory crops involves a determined effort to collect data and figures from various sources within agriculture ministries that compile, process, validate, review and release quantitative and qualitative information from various primary sources. As indicated above, it is important to determine whether data on crop damage during the disaster period have been enumerated, recorded and processed, taking into account the sowing and harvesting calendars specific to each product.

Generally speaking, crop planting times will depend on the seasonal rainfall pattern, the characteristics and humidity of the soil, and market prices. In turn, harvest times will depend on the length of the growing cycle for each crop (in the case of transitory crops, the average will be between four and six months, except in upland areas where it may be longer). Rainfall patterns and their monthly distribution will have an impact on the quantity and quality of the harvest. Farmers take their production decisions on the basis of their own knowledge of the local rainfall regime, supplemented with information gleaned from weather forecasts and frequent checking of soil humidity, something that is essential to ensure proper germination of the seeds.

To estimate the impact of a disaster on each crop, the decrease in the gross output value (GrOV) must be calculated. Such a reduction may result from a smaller harvested area or from lower yields on lands that were not directly affected (not flooded) by the disaster but have been compromised by a greater incidence of phytosanitary problems caused by excessive ambient or soil humidity, changes in daily temperature extremes, or fewer hours of sunshine. Both kinds of impacts are illustrated in Box XII.1.

The gross output value lost due to a smaller harvested area is calculated in the following manner:

(i) Determine the planted area (in hectares) recorded or estimated at the beginning of the crop year during which the disaster occurred.

(ii) Determine the area affected by the disaster.

(iii) Apply to the affected area the corresponding unit yields. If the projected yield for the disaster year is not available, the average for the last three years can be taken, thus compensating for annual harvest variability, in order to estimate the volume of production lost because of the disaster.

(iv) Obtain producer prices at the farm gate for each product.

(v) Multiply the volume of production lost by the average producer price to obtain the gross output value lost on the unharvested area. See table 1 of box XII.1 for an example of application of this procedure, as well as the other tables.

Gross output value lost through lower yields is calculated as follows:

(i) Obtain estimates of the lower harvest yields.

(ii) Compare these with average physical productivity data for each crop.

(iii) Multiply the difference between average yields and the estimated lower yields by the harvestable surface area on lands not directly affected (not flooded), in order to obtain the lower harvestable volume.

(iv) Multiply that lower volume by the corresponding producer price (see table 1 of box XII.1) to obtain the estimated reduction in the gross output value on lands not directly affected by the disaster (see table 2 of box XII.1).

The total estimated gross output value of transitory crop losses caused by the disaster is derived by adding together the gross output value lost through inability to harvest the affected area and the gross output value of production harvested but with lower yields on lands not flooded but affected by excessive ambient and soil humidity, as well as other causes resulting from the meteorological event (see table 3 of box XII.1).

Box XII.1
Transitory crops

This example presents data highlighting what happened in the second half of 2010 and the first half of 2011, when Colombia experienced a La Niña event causing prolonged heavy rainfall that triggered floods. This differentiation made it possible to detail and document the changes in production and physical productivity for each crop during the two phases of the phenomenon.

For each crop affected, an estimate was made of the volumes that could not be harvested during the periods examined, because of the withering or destruction of crops planted on flooded lands. Using average producer prices per metric ton, gross output value lost for each transitory crop was estimated for the periods from July to December 2010 and from January to June 2011 (see table 1). In the case of Colombia, it was determined that yields of rice and soybeans had increased during the first half of 2011, under the impact of the heavy rains, while physical productivity of cotton, beans, potatoes and tobacco declined.

Table 1
Colombia: transitory crop losses through on cultivated area

Crop	Planted area, 2010-2011 *(hectares)*	Area affected in 2010B *(hectares)*	Area affected in 2011A *(hectares)*	Yields in 2010B *(metric tons per hectare)*	Yields in 2011A *(metric tons per hectare)*	Volume of production lost in 2010B *(metric tons)*	Volume of production lost in 2011A *(metric tons)*	Producer price *(pesos per metric ton)*	GrOV lost in 2010B + 2011A *(millions of Colombian pesos at 2011 prices)*
Cotton	45 558	5 171	1 563	1.03	0.75	5 326	1 172	6 160 286	40 032
Rice [a]	465 000	12 759	11 759	5.20	5.80	66 347	63 800	890 642	115 914
Barley	9 053	179	252	2.60	1.70	466	429	907 835	813
Beans	94 891	1 170	1 143	1.60	1.40	1 872	1 601	2 471 527	8 582
Maize	421 182	11 270	13 634	2.60	2.60	29 302	35 448	616 951	39 948
Potatoes	128 701	972	1 782	19.80	16.50	19 241	29 410	450 224	21 904
Sorghum	21 620	735	303	3.00	3.00	2 204	910	569 685	1 774
Soybeans	28 668	2 584	897	2.40	2.80	6 202	2 512	1 037 373	9 040
Tobacco	9 829	106	313	1.90	1.70	201	533	3 320 377	2 438
Wheat	14 250	49	145	1.70	1.70	83	247	1 046 436	345
Garden produce	122 056	2.506	3 158	16.35	16.07	40 973	50 743	746 105	68 429
Subtotal	1 360 808	37 500	34 191						309 217

Source: Ministry of Agriculture and Rural Development of Colombia, agroforestry statistics, 30 June 2011; "Seguimiento del impacto de la ola invernal de 2010 en el sector agropecuario", 5 June 2011; Evaluaciones agropecuarias municipales preliminares, 2010; National Planning Department (DNP), 28 January 2010 and Colombian International Corporation (CCI).

[a] For the most part, these are traditional crops.

Note: The figures in this table were revised by technical staff of the Ministry of Agriculture and Rural Development of Colombia in consultation with the respective producers' associations. The first evaluation period runs from October 2010 to January 2011, the second from February to June 2011. Average producer prices were used for each period.

Box XII.1 (concluded)

Table 2
Colombia: transitory crop losses through lower yields

Crop	Harvestable un-flooded area *(hectares)*	Estimated reduction in yields d *(percentages)*	Expected lower yield *(kilograms per hectare)*	Lower harvestable volume due to the disaster 2010B + 2011A *(metric tons)*	Reduced GrOV *(millions of Colombian pesos at 2011 prices)*	Total GrOV lost due to the disaster *(millions of Colombian pesos at 2011 prices)*
Cotton	38 824	2.0	1.0	800	4 927	44 958
Rice	441 241	1.0	5.2	22 945	20 435	136 350
Barley	8 621	-	2.6	2	2	815
Beans	92 578	2.0	1.6	2 962	7 322	15 904
Maize	396 627	1.0	2.6	10 303	6 637	46 304
Potatoes	125 947	2.0	19.4	49 875	22 455	44 359
Sorghum	20 582	0.1	3.0	62	35	1 809
Soybeans	25 187	0.1	2.4	60	63	9 102
Tobacco	941	2.0	1.9	358	1 187	3 625
Wheat	14 056	5.0	1.6	1 195	125	1 595
Garden produce	116 392	1.0	16.2	1 903	14 198	82 628
Subtotal	1 289 116				78 231	387 449

Source: Ministry of Agriculture and Rural Development of Colombia, agroforestry statistics, 30 June 2011; "Seguimiento del impacto de la ola invernal de 2010 en el sector agropecuario", 5 June 2011; Evaluaciones agropecuarias municipales preliminares, 2010; National Planning Department (DNP), 28 January 2010 and Colombian International Corporation (CCI).

Table 3
Colombia: transitory crop losses
(Millions of Colombian pesos at 2011 prices)

Crop	GrOV lost through inability to harvest an affected area	GrOV lost through lower yields on un-flooded lands	Total GrOV lost
Rice	115 915	21 562	137 476
Garden produce	68 429	14 198	82 627
Potatoes	21 904	22 455	44 359
Maize	39 948	6 357	46 304
Cotton	40 032	4 927	44 958
Beans	8 582	7 322	15 904
Soybeans	9 040	63	9 103
Tobacco	2 438	1 187	3 625
Sorghum	1 774	35	1 809
Barley	813	2	815
Wheat	345	125	470
Total	309 220	78 232	387 450

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of data provided by the Ministry of Agriculture and Rural Development of Colombia.

(b) Permanent crops

As indicated with respect to transitory crops, the first step is to identify the permanent crops that have been affected by the disaster. The next is to estimate the impact of the disaster on each crop by calculating the reduction in the gross output value (GrOV) due to the smaller area harvested as well as to lower yields on lands that were not directly flooded but have been compromised by a greater incidence of phytosanitary problems caused or exacerbated by excessive ambient or soil humidity, changes in daily temperature extremes, or fewer hours of sunshine. Both kinds of effects are illustrated in box XII.2.

The gross output value lost per area not harvested is calculated as follows:

(i) Determine the area planted in each crop (in hectares) at the beginning of the crop year in which the disaster occurred.

(ii) Define the area that is harvested annually and that has been affected by the disaster.

(iii) Determine the proportion of the affected area that could not be harvested.[130]

(iv) Multiply the yields for the harvested area in order to obtain the volume of production lost (in metric tons).

(v) Obtain average producer prices per metric ton.

(vi) Multiply the volume of production lost by average producer prices to obtain the gross output value lost because of the disaster (see table 1 of box XII.2).

In examining the impact of the disaster on permanent crops, it is best to determine whether they were planted alone or in association with certain transitory crops, recognizing that in the latter case yield variability may be greater for certain crops (such as plantains, bananas, mangoes, oranges and other citrus fruits).

In the case of permanent crops, harvesting begins when the plants are two or three years old, which implies that greater investments will be needed to establish the plants, and the labour costs of tending the crop will be greater. Nor can permanent crops be quickly replaced by other long-cycle or transitory crops. Moreover, as a climate change adaptation policy decision, it may not be necessary to replace damaged or lost crops.

Other disaster-related losses with permanent crops are due to the decline in yields through such factors as excess humidity, phytosanitary problems and greater cloud cover, which will reduce the number of hours of sunshine. Lower yields may also be due to a combination of adverse impacts from simultaneous atmospheric phenomena such as drought and hail, where the impact will be felt more strongly during the following harvest season, when the fruits harvested will be smaller and of poorer quality, translating into reduced yields and lower incomes for producers.

The gross output value lost through lower yields, as illustrated in box XII.2, is calculated as follows:

(i) Obtain estimates for the lower harvest yields.

(ii) Compare these estimates with average physical productivity data for each crop, and calculate the difference.

(iii) Multiply the difference by the harvestable surface area on lands not directly affected, in order to obtain the lower harvestable volume.

(iv) Multiply that lower volume by the corresponding producer price (see table 1 of box XII.2) to obtain the estimated reduction in the gross output value on lands not directly affected by the disaster (see table 2 of box XII.2).

The total estimated gross output value of permanent crop losses caused by the disaster is derived by adding gross output value lost through inability to harvest the affected area to the gross output value of output harvested but with lower yields on lands not flooded but affected indirectly, in particular by excessive ambient and soil humidity resulting from the meteorological event (see table 3 of box XII.2).

[130] In the estimate of the impact of the torrential rains in Colombia, this ratio is 0.2.

Box XII.2
Permanent crops

Continuing with the example of Colombia, for the nine permanent crops in question the harvested area affected by the torrential rains was determined, for the second half of 2010 and the first half of 2011.

Table 1
Colombia: permanent crop losses on unharvested land

Crops	Planted area 2010-2011 *(hectares)*	Harvested area affected [a] 2010-2011 *(hectares)*	Normal average yield *(kilograms per hectare)*	Production volume lost *(metric tons)*	Producer price *(thousands of pesos per metric ton)*	GrOV lost *(millions of Colombian pesos)*
Fruit trees	247 661	6 078	13 371	16 254	1 024	16 643
Sugarcane	214 947	3 628	112 483	81 618	284	23 047
Panela cane	203 919	6 647	6 733	8 951	877	7 849
Plantain	348 510	9 692	7 557	14 667	523	7 676
Palm	342 547	5 345	17 050	18 226	261	4 761
Coffee	664 479	23 791	685	3 259	7 297	23 782
Bananas	37 536	1 244	13 051	3 247	640	2 077
Cacao	119 102	3 263	512	344	4 276	1 428
Yucca	207 095	1 867	11 232	4 193	3 916	1 641
Total	2 385 796	61 555				89 004

Source: Ministry of Agriculture and Rural Development of Colombia, agroforestry statistics, 16 December 2010; "Seguimiento del impacto de la ola invernal de 2010 en el sector agropecuario", 28 January 2011; Evaluaciones agropecuarias municipales, 2009; National Planning Department (DNP), 28 January 2010.

[a] This column is derived by multiplying by 0.2 the harvested area affected by the average yield.

Note: In the average yields of oil palms, physical productivity is expressed in fruit; the average producer price is expressed in pesos per ton of fruit. In the case of cacao, coffee and sugarcane, the harvested area affected is based on information from the Ministry of Agriculture and Rural Development.

Table 2
Colombia: permanent crop losses through lower yields

Crop	Harvestable un-flooded area *(hectares)*	Anticipated lower yield *(kilograms per hectare)*	Difference between normal and diminished yield *(kilograms)*	Lower harvest volume due to the disaster *(metric tons)*	Reduction in GrOV *(millions of Colombian pesos at 2011 prices)*
Coffee	710 857	671	14	9 952	72 611
Sugarcane	167 553	111 358	1,125	188 497	53 594
Cacao	94 500	502	10	945	4 042
Fruit trees	235 000	13 237	134	31 490	32 246
Plantain	333 947	7 491	76	25 380	13 283
Panela cane	184 552	6 666	67	12 365	10 842
Yucca	220 840	11 007	225	49 689	19 445
Bananas	43 867	12 855	196	8 598	5 500
Palm	244 412	16 965	85	20 775	5 427
Total	2 235 529				216 995

Source: Ministry of Agriculture and Rural Development of Colombia, agroforestry statistics, 16 December 2010; "Seguimiento del impacto de la ola invernal de 2010 en el sector agropecuario", 28 January 2011; Evaluaciones agropecuarias municipales, 2009; National Planning Department (DNP), 28 January 2010.

Box XII.2 (concluded)

Table 3
Permanent crop losses
(Millions of Colombian pesos at 2011 prices)

Crop	GrOV lost		Total GrOV lost
	Through inability to harvest	Through reduced production	
Fruit trees	16 648	32 246	48 889
Sugarcane	23 147	53 594	76 740
Panela cane	7 849	10 842	18 691
Plantain	7 676	13 283	20 960
Coffee	23 782	72 616	96 398
Palms	4 761	5 427	10 188
Bananas	2 077	5 500	7 577
Cacao	1 428	4 042	5 470
Yucca	1 641	19 445	21 086
Total	89 004	216 995	305 999

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of data provided by the Ministry of Agriculture and Rural Development of Colombia.

(c) Allocating losses by region

Box XII.3 illustrates the distribution by department of losses due to the disaster taken as an example.

Box XII.3
Colombia: permanent crop, transitory crop and total losses

It is very important to determine those departments of the country that have recorded the greatest losses, in both transitory and permanent crops. This information can be obtained from the Ministry of Agriculture which, in turn, will receive data and figures from the producers' associations.

Department *(millions of Colombian pesos at 2011 prices)*	Permanent	Transitory	Total	Share *(percentages)*
Antioquia	29 788	14 232	44 019	6.5
Atlántico	532	499	1 031	0.1
Bolívar	14 074	25 682	39 756	5.7
Boyacá	3 063	29 264	32 327	4.7
Caldas	9 222	595	9 816	1.4
Casanare	2 597	20 419	23 016	3.3
Cauca	13 298	2 361	15 659	2.3
Cesar	4 114	12 059	16 173	2.3
Córdoba	2 301	62 698	64 998	9.4

Box XII.3 (concluded)

Department *(millions of Colombian pesos at 2011 prices)*	Permanent	Transitory	Total	Share *(percentages)*
Cundinamarca	6 297	35 472	41 770	6.0
Huila	20 936	3 172	24 108	3.5
La Guajira	1 412	4 251	5 663	0.8
Magdalena	11 991	3 914	15 905	2.3
Meta	10 438	19 876	30 313	4.4
Nariño	1 781	19 601	21 381	3.1
Norte de Santander	12 063	16 315	28 378	4.1
Quindío	19 500	451	19 950	2.9
Risaralda	10 603	178	10 781	1.6
Santander	28 129	25 286	53 415	7.7
Sucre	5 626	53 795	59 241	8.6
Tolima	10 097	13 963	24 060	3.5
Valle	88 140	23 368	111 508	16.1
Subtotal	305 999	387 449	693 448	100.0

Source: Ministry of Agriculture and Rural Development of Colombia and Colombian International Corporation (CCI).

C. Livestock

1. Damage

(a) Damage to total stocks and by species

As a backdrop for estimating the impact of the disaster on livestock, information must be gathered on:

(i) The dimensions and characteristics of the cattle herd and the productive orientations of the various species of cattle raised in the country.

(ii) In the case of cattle, the percentages of the herd intended for beef production, beef and milk (dual-purpose) and specialized dairy production.

(iii) If reliable and detailed information is available, compile data on the principal breeds used in the different production systems and their distribution within the national territory by region, department or province.

(iv) Gather data on the herd makeup by sex and age, as well as the degree of correspondence between that structure and the productive use of the different breeds (generally, in hot zones, most females will be reserved for breeding purposes, both in beef and dual-purpose systems, while in cooler zones cows will be used essentially for milk production). The age differentiation is relevant for estimating damage to herds, as well as production losses due to lower unit yields. Sexual differentiation makes it possible in the short term (assuming that reliable data are available) to estimate damage in terms of breeding females lost (number of wombs) and the consequent reduction in expected annual births. If such quantitative estimates cannot be made, there should at least be a qualitative annotation that the effects will persist for several years, during which herd growth will be less. It is important here to take into account the period of time for which damage to the herd is being estimated,

and whether that estimate is of national or regional scope. In the latter case, it is more likely that the livestock enterprises affected will provide detailed quantitative information required to estimate the impact of the disaster on breeding females and the time it will take for the disaster's impact on herd growth to disappear.

(v) Gather detailed information on the total area covered with livestock pasture and superimpose on this the available data on the area affected by the disaster. In this way, it is possible to estimate the number of animals affected by heavy and prolonged flooding, and to define the zones, regions or departments in which a portion of the herd is recorded or estimated as killed.

(vi) Cattle fattening and rearing pens, milking stalls, sheds, stables, corrals of wood and other materials, pigsties and other buildings and installations.

It is important here to bear the following in mind:

(i) Generally speaking, livestock breeders' associations will provide the agriculture ministries with figures on the numbers of animals killed by the disaster, and these data will be reviewed and commented on by the official veterinary services.

(ii) The same sources can provide information on the estimated average unit price of the animals killed. In determining this value there may be discrepancies of varying importance between the Ministry and the livestock breeders. The estimated value per head is of critical importance for estimating the monetary value of herd losses and consequently the scope of economic damage suffered by livestock breeders, and the likelihood of subsequent claims for government assistance (see table 1 of box XII.4).

Box XII.4

Table 1
Colombia: cattle herd losses caused by the torrential rains of 2010-2011

		Affected	Percentage
Cattle raising area of the country (hectares)	38 225 681	1 165 413	3.0
Estimated cattle herd in 2011 (animals)	28 040 926	2 068 385	7.4
		Animals killed	**Value of damage to herds *(millions of Colombian pesos at 2011 prices)***
October and December 2010		115 075	77 676
January and May 2011		45 890	30 976
Value of damage to herds in 2010-2011		160 965	108 652

Source: Economic Commission for Latin America and the Caribbean (ECLAC); Inter-American Development Bank (IDB) and Ministry of Agriculture and Rural Development of Colombia.

Continuing with the example of Colombia, it is important to determine the departments of the country that have recorded the greatest damage to cattle herds. The Ministry of Agriculture and Rural Development has information compiled by its own staff, and figures and detailed data provided by the cattle breeders' associations on the impact of the disaster on the herd. This information can be used to determine the scope of the impact at the departmental level, as indicated in table 2.

Table 2
Colombia: estimated damage to cattle herds by department caused by La Niña, October 2010 to June 2011

Department	Number of animals killed	Damage to cattle herds [a] *(millions of Colombian pesos at 2011 prices)*	Estimated number of animals displaced
Antioquia	396	267	39 665
Arauca	3	2	193
Atlántico	16 352	11 038	112 478
Bogotá, D.C.	0	0	0
Bolívar	83 069	55 397	560 119
Boyacá	228	154	35 886

Box XII.4 (concluded)

Department	Number of animals killed	Damage to cattle herds [a] *(millions of Colombian pesos at 2011 prices)*	Estimated number of animals displaced
Caldas	140	95	6
Caquetá	15	10	4 700
Casanare	0	0	0
Cauca	12	8	12 834
Cesar	13 442	9 073	307 950
Córdoba	4 003	2 702	190 731
Cundinamarca	324	219	20 660
Guaviare	0	0	0
Huila	58	39	150
La Guajira	332	224	8 661
Magdalena	11 704	7.9	357 770
Meta	0	0	1 700
Nariño	0	0	330
Norte de Santander	1	675	5 600
Putumayo	0	0	0
Quindío	23	16	5 360
Risaralda	310	209	16 200
Santander	1 939	1 309	88 212
Sucre	28 045	18.93	242 445
Tolima	510	344	33 991
Valle del Cauca	59	40	16 750
Vichada	0	0	0
Total	160 965	108 652	2 068 385

Source: Economic Commission for Latin America and the Caribbean (ECLAC); Inter-American Development Bank (IDB) and Ministry of Agriculture and Rural Development of Colombia.
[a] Average estimated price per animal killed: 675,000 Colombian pesos.

In the case of a drought, the procedure for estimating the value of animals killed is the same as that described above for flooding, namely:

(i) Obtain figures on the number of animals killed: cattle, sheep, swine, camelids, equines (horses, mules and donkeys) and, if possible, poultry.
(ii) Using reasonably reliable information, estimate the average producer price of each species of livestock affected.
(iii) Multiply the number of animals killed by the average producer price for each species to calculate the monetary value of livestock losses.

Total damage to livestock herds of the Plurinational State of Bolivia (cattle, sheep, equines and camelids) caused by flooding in hot, humid low-lying areas and by drought in other regions of the country as a result of the La Niña event of late 2009 and early 2010 is shown in table 3, by species.

Table 3
Plurinational State of Bolivia: summary of damage to livestock at the national level due to La Niña, 2009-2010
(Bolivianos at 2010 prices)

Damage to cattle herds in Beni	13 912 500
Damage to cattle herds in Chaco	9 903 050
Damage to cattle herds in the Altiplano	767 550
Damage to sheep flocks in the Altiplano	110 700
Damage to camelid stocks in the Altiplano	709 800
Total value of damage in bolivianos at 2010 prices	25 403 600

Source: Economic Commission for Latin America and the Caribbean (ECLAC)/World Bank, on the basis of information from the training workshop of the Vice Ministry of Agriculture and Rural Development (VDRA), Ministry of Rural Development and Lands (MDRT) of the Plurinational State of Bolivia.

2. Losses

(a) In the production of beef and other meat

The production of beef and sheep meat is reduced by flooding or droughts, events that affect the nutritional status of animals.[131]

These losses are estimated as follows:

(i) Subtract the number of animals killed from the total herd affected.

(ii) To the balance of the live herd affected apply the normal slaughter rate (expressed as a percentage, starting with 10%) to estimate the number of animals affected that were destined for slaughter.

(iii) Obtain information on average productivity in kilograms per carcass (e.g. 195 kg) under normal conditions.

(iv) The animals affected by the disaster and sent to the slaughterhouse will obviously have live weight that (according to informed sources in agriculture ministries or livestock associations) may be lower by 15% to 30%, depending on the scope, intensity and duration of the disaster. For example, applying a 22% loss to a 195 kg carcass, the reduction in meat production per animal would be around 42 kg by live weight).

(v) This lower average productivity per carcass is multiplied by the total number of animals affected and slaughtered, in order to obtain the estimated total loss in meat production, expressed in kilograms or tons of live weight.

(vi) Obtain information on the average estimated price per kilogram or ton of live weight and multiply this by the volume by which meat production has declined in order to obtain the estimated value of losses in millions of monetary units.

As in the case of damage to cattle herds and other species, it is important to identify the departments of the country that have recorded the greatest losses in meat production in order to determine the scope of the disaster's impact at the departmental level, as indicated in table XII.2.

Table XII.2
Colombia: meat production losses due to La Niña, 2010 and 2011

Department	Losses *(millions of Colombian pesos at 2011 prices)*
Antioquia	2 331
Atlántico	201
Bolívar	1 054
Boyacá	908
Caldas	360
Casanare	2 820
Cauca	771
Cesar	1 283
Córdoba	1 350
Cundinamarca	1 155
La Guajira	1 262
Huila	832

[131] In the case of sheep and camelids, in addition to meat losses there will be immediate or potential losses of wool production because of the animals killed by the disaster. Animal wool is normally harvested once a year, generally in the summer. Consequently, if the disaster strikes in that season or at shearing time, estimates of meat production losses will have to be supplemented with information on potential wool losses, especially for sheep's wool in zones specialized in annual wool production. Firms in the wool business can provide quantitative information for estimating the delayed effects of the disaster on sheep and camelid stocks.

Table XII.2 (concluded)

Department	Losses *(millions of Colombian pesos at 2011 prices)*
Magdalena	1 145
Meta	3 750
Nariño	455
Norte de Santander	647
Quindío	63
Risaralda	71
Santander	1 334
Sucre	617
Tolima	1 073
Valle del Cauca	500
National total	23 982

Source: Department for Social Prosperity of the Ministry of Agriculture and Rural Development of Colombia, on the basis of information from the Colombian Livestock Federation (FEDEGAN).

(b) In milk production

Generally speaking, the dairy herd is distributed across all regions, departments or provinces of all countries, and all milk production systems typically coexist. In the specialized system, European breeds are used (Holstein, Guernsey, Ayrshire, Jersey and others), while the dual-purpose system is based on breeds that produce both beef and milk (Brown Swiss, Norman, zebu and others).

Losses in milk production caused by the disaster are estimated as follows:

(i) Obtain official figures on the proportion of the cattle herd devoted to milk production (or if official figures are not available, estimate the percentage of the national cattle herd).

(ii) Establish or estimate the structure of milk production by type of breed (relative share of dual-purpose cattle and specialized cattle within the national dairy herd).

(iii) Obtain figures on the actual or estimated quantity of milk cows.

(iv) Collect actual or estimated figures on the daily volume of milk production (in millions of litres) from dual-purpose breeds and from specialized milking breeds.

(v) Obtain official or estimated data on the destination of milk production to establish the relative weight of industrial demand, intermediaries and warehouses, on-farm consumption, artisanal processing (e.g. cheesemaking) and other subsidiary uses.

(vi) Obtain figures and data from agriculture ministries or dairy associations on the trend of producer prices per litre of milk during the months in which floods or droughts were heaviest; changes in those prices could reflect a contraction of supply or more active intervention by intermediaries and local cheesemakers, who might temporarily absorb a greater share of demand because of transport problems caused by flooding.

In general, the livestock authorities and milk producers estimate the percentage decline in milk deliveries during the months when the disaster's impact is most evident and intense. That information can be used to estimate the thousands of litres of milk that go uncollected each day.

As indicated above, because milk production is widely spread across the national territory, it is especially important to determine the relative share of each province, department or region in daily losses under this heading (ECLAC/IDB/DNP, 2012).

D. Poultry

1. Damage

Poultry farming is a significant component of the livestock economy in many countries of Latin America and the Caribbean. In order of importance, it ranks just behind beef and dairy production, and it is concentrated in a relatively few regions of each country that account for a large percentage of chicken meat and egg production, as well as breeding hens.

In general, poultry breeders' associations or federations will inform the agriculture ministries of flood damage to poultry farms, especially when they have been inundated, for example, by overflowing rivers, breached dams or flood retainer walls, or sudden land subsidence. Floods may destroy poultry pens and other installations, wholly or partially, and can cause damage to lesser equipment or infrastructure. Taken as a whole, such damage can disrupt that process of fattening poultry or delay the housing of the flock. In both cases, the output of chicken meat and eggs will be reduced. On farms located close to watercourses, the access road may be flooded and bridges may be obstructed or damaged structurally, rendering them temporarily unusable.

To deal with the consequences of disasters, poultry farmers adopt preventive or corrective measures such as repairing rural transport routes and on-farm roads, constructing gabions and other minor infrastructure, keeping drains and ditches clean, restoring damaged poultry installations, repairing nesting cages, and acquiring or leasing specialized machinery such as pumps.

The damage caused by the disaster is estimated in the following manner:

(i) Obtain information on the dimensions and nature of the damage to poultry installations caused by the disaster.

(ii) Compile estimates of average unit costs of repair and replacement of the assets affected.

(iii) Multiply the unit costs by the number of items destroyed in order to obtain an estimate of the total damage.

During the flooding that hit the Bolivian department of Santa Cruz following the heavy rains generated by El Niño between 2006 and 2007, for example, the affected poultry businesses used the following procedure to estimate damage from flooding:

(i) They found that 2% of the surface area of production installations had been damaged, equivalent to 115,000 m^2.

(ii) The cost of restoration was estimated at 2 dollars per square metre.

(iii) After multiplying the number of square metres by the unit cost of repair, the flood damage for the department as a whole was estimated at US$ 230,000.

2. Lost production of chicken meat and eggs

According to poultry breeders' federations and associations, the principal causes of loss from disasters may include:

(i) Disruption in the delivery of feed supplies to poultry farms, resulting in lower yields (because birds being raised for meat may have to go a long time without food or water, and the coloration of their meat and entrails may be altered).

(ii) Poultry operations must cope with ongoing problems and alterations to their production and marketing activities.

(iii) Increased poultry mortality due to frequent transshipment because of damage to principal, secondary and even tertiary transport routes.

(iv) Fluctuations in the power supply to poultry operations, with a negative impact on chicken meat and egg production.

The value of losses in poultry operations is calculated as follows:

(i) Determine the number of birds affected, distinguishing between those being raised for meat, commercial laying hens, heavy breeding hens and others.

(ii) Estimate the increased mortality rate of chickens, commercial laying hens and heavy breeding hens.[132]

(iii) Apply those increases (usually expressed as percentages) to the total affected population of chickens, commercial laying hens and heavy breeding hens.

(iv) Obtain estimated average producer prices for each type of bird (chickens, commercial laying hens and heavy breeding hens).

(v) Multiply the number of birds killed (chickens, commercial laying hens and heavy breeding hens) by the estimated average prices to obtain the gross value of losses for each type of bird due to the disaster (see table 1 of box XII.5).

To calculate or estimate the value of other types of loss in poultry operations due to the disaster (for example through lower productivity because of higher transport costs for feed or for taking products to market, or because of higher or lower chicken and egg prices on markets that are temporarily underserved or saturated), the same procedure as indicated in the previous paragraph should be followed (see box XII.5).

3. Additional costs

Flood-related disruptions to the transport of inputs to farms as well as the transfer of poultry farm products to market can saddle poultry operators with freight surcharges (which will vary depending on distance and on temporary road conditions). Carriers will charge higher rates because they must use secondary or tertiary roads to transport inputs or products. The emergency may also result in lower meat quality, market supply shortfalls, and higher prices for chicken meat and eggs, all of which will usually be passed on to consumers.

Box XII.5
Poultry

Poultry farming is characterized by having the highest feed-to-meat conversion ratio, within a confined physical space (pens or cages) over a very short time period. For physiological reasons, birds prosper in a fresh and well ventilated environment; due to their anatomy and their plumage, they cannot adjust their body temperature when they are subjected to extreme heat or cold. Consequently, poultry breeders must climatize their breeding and their meat and egg production facilities in order to improve environmental conditions and avoid lower yields, expressed in terms of live weight and feed conversion, or bird survival.

When prices rise for the basic poultry feed ingredients (maize, sorghum, soybeans, wheat and fats), this will have an impact on the structure of production costs for poultry meat and eggs, and poultry farmers will be obliged to be more efficient in terms of genetic improvement of birds, handling and feeding practices, and sanitary conditions for breeding and fattening.

Table 1
Plurinational State of Bolivia: poultry losses in Santa Cruz caused by El Niño, 2006-2007

Items	Percentage affected	Units	Dollars per unit	Total in dollars
Loss of birds				
Meat-producing chickens (1 116 840 units affected)				
Higher mortality	5	55 842	1.51	84 321
Chickens drowned		111 684	1.51	168 643
Commercial laying operations (25% of 433 142 units affected)				
Higher mortality	2	8 663	5,00	43.314
Birds drowned	3	12 994	1.51	19 621
Light breeding hens (15% of 7 187 units affected)				
Higher mortality	3	216	5.00	1 078
Birds drowned	2	144	1.51	217
Heavy breeding hens (25% of 267 939 units affected)				
Higher mortality	5	13 397	5.00	68 985
Birds drowned	2	5 359	1.51	8 092
Subtotal				394 271
Total losses				2 130 771

Source: Economic Commission for Latin America and the Caribbean (ECLAC) and Inter-American Development Bank (IDB)

[132] Mortality among light and heavy breeding hens has the further consequence of disrupting egg laying for the time needed to replace the laying flock and return to full egg production. This impact should also be quantified. The quantitative information required for estimating these losses can be obtained from the poultry operations affected by the disaster, particularly in the case of flooding.

Box XII.5 (concluded)

Table 2
Plurinational State of Bolivia: poultry operation losses in Santa Cruz caused by El Niño, 2006-2007

Items	Percentage affected	Units	Dollars per unit	Total in dollars
Productivity losses				
Slower weight gain in meat-producing chickens, through stress and feeding delays		245 705	0.68	167 079
Eggs	5	1 515 996	0.0375	56 850
Light laying hens	2	10 062	4	4 025
Heavy laying hens	3	562 672	0.3	168 802
Subtotal				396 756
Losses through higher transport costs		Units per day	Dollars per square metre	
Birds shipped domestically	20	15 000	1.200	18 000
Eggs shipped domestically	20	500 000	906	13 590
Losses in transport of inputs		Quantity		
For producing chickens	12	4 467 360		884 537
For producing eggs	12	48 000 000		201 600
Losses through lower prices on saturated markets	Lower price	Unit per kilogram		Dollars per kilogram
Meat-producing chickens	0.1875	4 467 360		837 630
Eggs	0.00125	48 000 000		60 000
Subtotal				897 630
Total				2 412 112

Source: Economic Commission for Latin America and the Caribbean (ECLAC) and Inter-American Development Bank (IDB).

E. Fisheries

1. Aquaculture

Fish farming in marine, brackish or fresh water is based on managing the natural resource in such a way as to achieve higher and faster production of fish, crustaceans and molluscs than would be possible under natural conditions. Pisciculture is based on breeding fish, crustaceans and molluscs in ponds and then concentrating them in naturally productive areas through the use of cages or tanks and structures in which immobile animals (oysters) can thrive, as well as introducing fish, crustaceans and molluscs into natural habitats (reefs) or keeping them in breeding areas (clams).

(a) Damage

The waters in which fish, shrimps and other aquatic species are bred and grown must be maintained under specific physical and chemical conditions (with respect to temperature, salinity and level of oxygen) which, when altered by a disaster, can cause high mortality among the species in question.

Damage to aquaculture is estimated in the following manner:

(i) Obtain estimates on the water surface area affected.

(ii) For that surface area, calculate the area devoted to the farming of fish, crustaceans and molluscs. Estimate as well the area devoted to different species within each of these groups.

(iii) Obtain figures on average unit costs of constructing tanks, cages and other installations for the cultivation of fish and crustaceans, which will usually be available from aquaculture firms that keep detailed accounts of their production costs and are an important source of information on cost estimates for restoring properties destroyed. These data can be obtained from government institutions, in particular agriculture ministries.

Box XII.6 illustrates application of this procedure.

Box XII.6
Colombia: damage to the aquaculture industry caused by La Niña, 2010-2011

(Millions of Colombian pesos)

Aquaculture production, in particular that located along the coasts, near or in swamps and lagoons, is highly vulnerable to flooding in rivers and estuaries, which can cause severe destruction. Floods and hurricanes cause high mortality rates for fish, molluscs and crustaceans, as well as significant damage to installations, in particular floating cages and fish rearing tanks, which may be obstructed or filled by thick layers of mud or slime; breeding and fishing equipment can also be damaged.

	Departments						Total
	Atlántico	Bolívar	Córdoba	Sucre	Meta	Valle	
Costs of restoration	2 020	58 535	5 117	34 500	137	90	100 399
Shrimp	600	55 505		34 500			90 605
Fish	1 420	3 030	5 117		200	27	9 794

Source: Ministry of Agriculture and Rural Development of Colombia on the basis of information from the Colombian Institute for Rural Development (INCODER).

(b) Losses

Various species of fish are grown for commercial purposes (tilapia, bocachico, cachama or pacu, catfish, parca or bluefish, and others). For aquaculture purposes, shrimp are the most popular crustaceans. During floods, where waters are running with great force and velocity, mortality rates among farmed fish and shrimp are very high. During the La Niña event of 2010-2011 in Colombia, for example, many firms reported total loss of their production, while others indicated that they had suffered a high percentage of loss, and only a few reported low losses.

Table XII.3 illustrates the importance of disaster impacts in departments where shrimp and certain fish species were cultivated. Losses for aquaculture firms are calculated as follows:

(i) Determine, for each department or province, the water surface area (in hectares) devoted to the cultivation of fish, crustaceans and molluscs.

(ii) Calculate the total surface area (in hectares) of water devoted to the production of fish, crustaceans and molluscs.

(iii) Estimate the number of fry killed (in millions).

(iv) Estimate the number of tons of shellfish (for example shrimps) and fish killed.

(v) Obtain information on average producer prices for species of fish, crustaceans and molluscs.

(vi) Multiply the average individual prices by the volume of fish, crustaceans and molluscs killed to obtain the gross value of aquaculture losses caused by the disaster in each department.

Table XII.3
Colombia: losses in aquaculture production caused by La Niña, 2010-2011

		Department						Total
		Atlántico	Bolívar	Córdoba	Sucre	Meta	Valle	
Water surface area (hectares)		59	1 211	171	690	5	3	2 139
Shrimp (hectares)		12	1 110		690			1 812
Fish (hectares)		47	101	171				319
Fry killed (millions)		2.3	2.6	1.6		2.0		8,5
Shrimp killed (tons)		15	1 133		390			1 538
Fish killed (tons)		148	462	453			4	1 067
Gross output value (millions of pesos)		1 391	18 223	3 125	5 070			28 036
Shrimp (millions of pesos)		123	14 729		5 070			19 922
Fish (millions of pesos)		1 268	3 494	3 125		200	27	8 114
Price per kilogram	Shrimp	8 200	13 000		13 000			12 953
	Fish	8 568	7 563	6 898				7 420

Source: Colombian Institute for Rural Development (INCODER) and Directorate of Fisheries of the Ministry of Agriculture and Rural Development of Colombia.

F. Capture fisheries

In capture fisheries, different methods are used to catch fish or crustaceans, such as nets (vertical nets, trawl nets or trammel nets) or traps, or with hook and line. Capture fishing is pursued in marine, brackish and fresh waters, and may be organized as a large-scale industrial or small artisanal operation. Marine fisheries include both inshore and deep sea activities and operations; inland fishing is conducted in rivers, lakes, reservoirs and estuaries.

Capture fisheries may lead to overfishing, which will have an adverse ecological impact not only because it degrades fish stocks and alters their size and structure but also because it affects other species that are part of the various food chains. Certain fishing equipment and practices may be geared to catching fish of the desired species, but at the same time they may injure other species and even destroy their habitat. Bottom trawling can disrupt many marine communities. Ship anchors and unregulated diving can also cause significant damage to coral reefs.

It is important to present separate results for microenterprises, which typically practice artisanal fishing, and for large-scale fishing companies. Compilation of pre-disaster information should include determining how many firms belong to each type. This task is much more difficult in the case of microenterprises.

1. Damage

The assets of the sector include: (i) the infrastructure of fishing enterprises; (ii) furnishings; (iii) equipment, including storage and refrigeration facilities, as well as the equipment used in fishing itself, such as boats and nets; and (iv) fish stocks.

Infrastructure damaged or destroyed must be valued at pre-disaster replacement cost. This estimate must be made per square metre of construction. Furnishings and equipment will be valued at prevailing market prices, while fish stocks must be valued at producer prices.

Table XII.4 presents the estimate of damage caused in this sector by hurricane Felix and the torrential rains that struck the Autonomous Region of the North Atlantic in Nicaragua in 2008. That storm destroyed 60% of artisanal fishing equipment and reduced the productivity of artisanal fisheries. The lobster fishery was severely affected, in both its industrial and artisanal branches. Events of this kind can cause important damage to fishing equipment, as illustrated in table XII.4. In this case, the storm destroyed traps, boats, diving equipment, outboard and inboard motors, compressors and other equipment.

Table XII.4
Nicaragua: damage to capture fisheries

Type of equipment	Number of units lost	Cost (córdobas per unit)	Total cost (thousands of córdobas)
Dinghies	120	84 150.0	10 098.0
Deep-sea fishing vessels	10	233 750.0	2 337.5
Sailboats	127	48 620.0	6 174.7
Cayucos (canoes)	1 248	7 480.0	9 335.0
Creels	44 830	561.0	25 149.6
Boilers	381	9 350.0	3 562.4
Compressors	11	374 000.0	4 114.0
Diving equipment	3 720	3 740.0	13 912.8
Fishing gear	57	7 480.0	426.4
Trammel nets	555	4 675.0	2 594.6
Seine nets	29	28 050.0	813.5
Atarraya nets	120	691.9	83.0
Handlines	3 500	168.3	589.1
Outboard motors	119	93 500.0	11 126.5
Inboard motors	9	224 400.0	2 019.6
Total	54 836		92 336.7

Source: Economic Commission for Latin America and the Caribbean (ECLAC), Impacto del huracán Félix en la Región Autónoma del Atlántico Norte y de las lluvias torrenciales en el noroeste de Nicaragua (LC/MEX/L.860/Rev.1), Mexico City, ECLAC subregional headquarters in Mexico, September 2008.

2. Losses and additional costs

Hurricanes can also cause production losses by reducing catch sizes and lowering the yield of farmed fish, crustaceans and molluscs, which are valued at producer prices for each species. Table XII.5 shows the estimation of losses by type of fleet, reflecting the reduced catches due to hurricane Felix and the torrential rains that affected the Autonomous Region of the North Atlantic in Nicaragua in 2008.

As well, the additional costs must be estimated whenever possible: these may include the costs of inputs and fuel expenses, due to the longer runs required to capture fish that have migrated to other areas.

Table XII.5
Nicaragua: fishery production losses due to Huricane Felix

Species	Type of fleet	Estimated reduction in production *(pounds)*	Price *(córdobas per pound)*	Estimated losses *(thousands of córdobas)*
Shrimp	Artisanal	44	62.3	2 746.3
Lobster	Artisanal	173	244.0	42 161.9
Fish	Artisanal	271	23.5	6 365.9
Subtotal	Artisanal			51 274.1
Lobster	Industrial	143	244.0	34 919.5
Fish	Industrial	36	23.5	837.8
Subtotal	Industrial			35 757.3
Total				87 031.4

Source: Economic Commission for Latin America and the Caribbean (ECLAC), Impacto del huracán Félix en la Región Autónoma del Atlántico Norte y de las lluvias torrenciales en el noroeste de Nicaragua (LC/MEX/L.860/Rev.1), Mexico City, ECLAC subregional headquarters in Mexico, September 2008.

G. Forest fires

Various types of disaster can cause significant damage to forests and woodlands. Prime among these are forest wildfires, followed by heavy and prolonged flooding, which affects mainly young saplings in the first year after transplanting, as their root system is not sufficiently developed to tolerate the excess humidity of flooded soils. Hurricane-force winds affect both plantations and natural forests (uprooting trees, breaking and defoliating branches, and stripping fruits). Prolonged and severe droughts also impact forests, and heavy wave action can damage mangrove swamps.

1. Damage

A forest fire is an uncontrolled conflagration that, if it spreads, will consume and destroy nearly all plant matter (cultivated and wild plants) in its path, and will also affect livestock, enclosures and dwellings, as well as causing injury to people and the environment. Such fires spread very quickly on lands covered with woody vegetation, shrubs or grass, whether alive or dry.

Some forest fires are of natural origin, while others – the great majority – are caused by humans. The first kind are fairly rare, and are sparked by volcanic eruptions or lightning storms. The second may be caused by accident, carelessness, ignorance, or may be intentionally set. In countries with extensive natural forest lands or with plantations for producing paper pulp or lumber (primarily for construction, as in the case of Chile), forest fires are caused by the burning of agricultural or forest wastes, or of garbage, improperly extinguished cigarettes, unattended campfires, and arsonists.

Forest fires cause damage of the following kinds, among others:

(i) They destroy old or more recent stands of trees.

(ii) They alter the species makeup of native forests.

(iii) They cause the migration or death of various species of animals, birds, insects and microorganisms.

(iv) They upset the ecological balance by disrupting biological chains, and changing both the number and diversity of species.

(v) They break up contiguous forest areas, and destroy or at least weaken such ecosystems.

(vi) They pollute the environment and destroy the beauty of the landscape.

(vii) They destroy natural habitats and cause the loss of cultural heritage.

(viii) They change the ratio between precipitation and runoff in watersheds which, in turn, can lead to greater flooding.

In estimating damage to forests, a distinction must be made between lands covered with native forest and those that are planted with trees that will be harvested for their lumber. In the latter case, forest fire damage is estimated using the same method as for permanent crops. As described earlier, this involves the following steps:

(i) Define the geographical location of the plantations affected by the forest fire.

(ii) Determine the species of trees that have been affected.

(iii) Estimate the surface area planted in each species (in hectares) and collect information on the age of the plantations.

(iv) Compile background information on the productive cycle of each forest species affected, and its specific characteristics (from time of planting until the trees reach harvestable size) and the potential uses of their wood.[133]

(v) Multiply the yield figures by the forested area affected (in hectares) to obtain the volume of wood production destroyed by the forest fire.

(vi) Obtain data on the average producer prices per unit of measure, and multiply these by the volume of production burned in order to estimate the gross output value destroyed.

[133] The dimensions of a tree are measured in terms of the circumference of the trunk (in centimetres) at a specific height, and by the length of the trunk (in linear metres).

Forestry companies are a valuable source of information both on the existing plantations affected and on the lumber business and the primary forestry industry for exotic (non-native) species. Average prices per unit of measure are also relatively easy to obtain.

In Chile, for example, it is known that radiata pine plantations produce around 500 m^3 of lumber per hectare per year: productivity is thus high, reducing the unit cost of production. On the best Chilean plantations of eucalyptus (primarily the species Eucalyptus globulus), mature trees (those around 20 years old) reach heights of 60 m and diameters of approximately 50 cm. Eucalyptus plantations are geared to the production of wood pulp and firewood, as well as structural lumber for housing construction and furniture manufacture.

When fire destroys vegetation covering extensive areas of natural forest, specific methods must be used to estimate the damage. These procedures are described in the chapter of this handbook on the environment, dealing with the socioeconomic and environmental valuation of these forests, with respect both to the functions assigned them and the services they provide or generate.

H. Total damage and losses in the agriculture sector

A series of tables is used to summarize and total all the damage and losses caused by the disaster to each component of the agriculture sector, so as to determine the overall magnitude of the impact. Tables XII.6 and XII.7 illustrates the preparation of the summary tables, differentiating between:

(i) Regional, administrative or departmental jurisdictions affected by the disaster, as identified in the course of the report, and

(ii) The impact on each component of the agriculture sector, valued separately in terms of damage and losses.

The summary tables present the results of the analysis for estimating damage and losses in economic terms and they provide details that can be used to set priorities for programmes and projects of reconstruction, restoration and mitigation.

Table XII.6

Colombia: summary of damage, by department, to livestock, poultry, agriculture and farm infrastructure

(Millions of Colombian pesos at 2011 prices)

Department	Livestock	Poultry	Aquaculture	Infrastructure	Total	Departmental share *(percentages)*
Antioquia	267	20		34 375	34 662	4.6
Arauca	2				2	0.0
Atlántico	11 038		2 020	2 887	15 945	2.1
Bogotá, D.C.		20			20	0.0
Bolívar	55 397		58 535	89 512	203 444	26.8
Boyacá	154	188		3 712	4 054	0.5
Caldas	95			2 062	2 157	0.3
Cauca	8	11		3 712	3 731	0.5
Caquetá	10				10	0.0
Cesar	9 073	23		34 237	43 333	5.7
Córdoba	2 702		5 117	74 662	82 481	10.9
Cundinamarca	219	841		7 012	8 072	1.1
La Guajira	224			19 387	19 611	2.6
Huila	39	26		9 900	9 965	1.3
Magdalena	7 900			102 712	110 612	14.6

Table XII.6 (concluded)

Department	Livestock	Poultry	Aquaculture	Infrastructure	Total	Departmental share *(percentages)*
Meta		2	137		139	0.0
Nariño				825	825	0.1
Norte de Santander	675			4 537	5 212	0.7
Quindío	16			2 887	2 903	0.4
Risaralda	209			7 837	8 046	1.1
Santander	1 309	125		53 625	55 059	7.2
Sucre	18 930		34 500	60 225	113 655	15.0
Tolima	344			5 362	5,706	0.8
Valle de Cauca	41	6	90	30 112	30 249	4.0
Total	108 652	1 262	100 399	549 580	759 893	100.0

Source: Economic Commission for Latin America and the Caribbean (ECLAC), Impacto del huracán Félix en la Región Autónoma del Atlántico Norte y de las lluvias torrenciales en el noroeste de Nicaragua (LC/MEX/L.860/Rev.1), Mexico City, ECLAC subregional headquarters in Mexico, September 2008.

Table XII.7
Colombia: summary of losses, by department, to crops, livestock, poultry, fish and crustaceans
(Millions of Colombian pesos at 2011 prices)

Department	Crops	Livestock	Fish	Poultry	Total	Departmental share *(percentages)*
Antioquia	44 019	2 804		146	46 969	6.2
Atlántico	1 031	3 535	1 391		5 957	0.8
Bolívar	39 756	1 054	18 223		59 033	7.7
Boyacá	32 327	4 951		115	37 393	4.9
Caldas	9 816	360			10 176	1.3
Casanare	23 016	771		32	23 819	3.1
Cauca	15 659	2 820		16	18 495	2.4
Cesar	16 173	1 730			17 903	2.3
Córdoba	64 998	1 550	3 125		69 673	9.1
Cundinamarca	41 770	3 348		1 315	46 433	6.1
Huila	24 108	832		44	24 984	3.3
La Guajira	5 663	2 817			8 480	1.1
Magdalena	15 905	1 145			17 050	2.2
Meta	30 313	3 750	200	23	34 286	4.5
Nariño	21 381	683			22 064	2.9
Norte de Santander	28 378	842			29 220	3.8
Quindío	19 950	63			20 013	2.6
Risaralda	10 781	71			10 852	1.4
Santander	53 415	1 848		2 581	57 844	7.6
Sucre	59 421	617	5 070		65 108	8.5
Tolima	24 060	1 073			25 133	3.3
Valle del Cauca	111 508	500	27	174	112 209	14.7
Total	693 448	37 164	28 036	4 446	763 094	100.0
Sectoral share (percentages)	90.9	4.9	3.7	0.6	100.0	

Source: Economic Commission for Latin America and the Caribbean (ECLAC), Impacto del huracán Félix en la Región Autónoma del Atlántico Norte y de las lluvias torrenciales en el noroeste de Nicaragua (LC/MEX/L.860/Rev.1), Mexico City, ECLAC subregional headquarters in Mexico, September 2008.

As a final step, a summary table must be prepared containing all the damage and losses by subsector and department. Its contents will show the total outcome of estimates of the impact caused by the disaster(s). Such a table has the advantage of revealing the relative weight of the two types of negative impact examined and, at the same time, defining the products and the jurisdictions that have been most affected by the disaster. Damage (reduction in assets) and losses (alteration of flows) are conceptually distinct. Consequently, adding the two together gives an idea of the magnitude of the negative economic impact of a disaster on the agriculture sector.

I. Financial needs for recovery and reconstruction

Upon completion of the quantitative estimate of disaster-caused damage to assets and losses to production in each subsector and in each region, department or province, that evaluation must be used to estimate the financial resources that will be needed to restore or reconstruct each of the productive lines affected.

To recover or restore the production capacity of the agricultural sector it will usually be necessary to design and implement a series of short- and medium-term activities designed to relaunch or reassemble the productive lines disrupted, destroyed or wiped out by the disaster. These activities may include the provision of additional working capital, timely supply of seeds and critical inputs for production, rehabilitation of buildings, installations and other damaged infrastructure, and design and prompt implementation of emergency lines of credit.[134]

Generally speaking, with short- and long-cycle crops, reviving production after a disaster means ensuring that producers, individually and as members of firms, will have access to sufficient agricultural inputs, seeds and other reproductive materials to allow them to relaunch or reactivate the production that was affected by the extreme event. Among the inputs in greatest demand will be chemical organic fertilizers, pesticides, insecticides, herbicides, machinery, equipment and farm tools, as well as other working implements that have been damaged or rendered unusable.

Specific lines of action, whether temporary or longer term, must be designed so as to differentiate between the needs for financial, operational and management assistance to small and medium-sized producers. Depending on the situation, these actions may include free delivery of production inputs and selected seeds, the timely provision of technical assistance, and the establishment of subsidized credit programmes with terms consistent with the specific agricultural structure of the zones affected by the disaster.

At the present time, there is relatively easy access in all countries to detailed official publications on crop production costs, which can be used to estimate the expenses incurred by farmers for establishing and managing the production process up to the phenological stage at which each crop was impacted by the disaster. On the basis of such quantitative data, it will be possible to estimate, in absolute or relative terms, the portion of the total production cost for each affected crop, an amount that will serve as the basis for determining the components as well as the dimensions and characteristics of the programmes that will have to be designed to provide inputs, seeds and working tools to producers so that they can re-plant their crops. Depending on the situation, such programmes may include the delivery of material support, the granting of temporary tax relief, or the introduction of lines of credit geared explicitly to reactivating the production processes affected by the disaster.

Some of the damage to the agricultural production base may be irreversible, while other impacts will be temporary. The recovery of this productive capital will depend on the economic cost involved and on the length of time needed to amortize the investments for restoring production capacity.

The cost of recovery must be estimated as follows:

(i) Delimit the affected area and define its geographical location (for example 300 ha in zone A with mud or sand deposits that are very difficult to remove (irreversible damage); another 200 ha in the same area covered with various types of plant waste (recoverable lands).

[134] Territorial or agro-ecological planning is part of a long-term policy for adapting the agricultural sector to climate change, which is not considered in this handbook. The same applies to the linkages between risk management and the vulnerability to natural disasters of specific places or lands. These are very important issues that go well beyond the purposes and needs of estimating the impact of those events, with the greatest detail possible, as the basis for designing sustainable agricultural and environmental policies.

(ii) Determine the main productive use of these lands: transitory or permanent crops, or a combination of both.

(iii) Compile data on recent average market prices for land and for the affected products.

(iv) Estimate potential production during the years it will take to restore the production base, using current average productivity per hectare (for example, net income from one hectare of bananas in flooded zone A may be estimated at 5 million pesos; to restore its production capacity will take three years, and potential income lost can therefore be estimated at 15 million pesos).

(v) In the absence of reliable information, the cost of recovery per hectare can be estimated indirectly. For example, 500 ha on which 3 million pesos will have to be invested for recovery over three years, implying an estimated cost of 1.5 billion pesos. Forestry services or private forestry companies can provide data on the costs per hectare of removing deposits of plant wastes and stones.

A separate and very important question has to do with the fallout from the disaster, expressed in terms of greater risk of food insecurity and exacerbation of food and nutritional problems for small farmers, who are involved in agriculture production either as producers or as farm workers, and for whom this activity is their principal source of income and food supply. The most important crops for small farmers are generally basic grains (maize, beans, rice, barley, oats, wheat), yucca, plantain, banana, garden produce, citrus fruits, temperate climate fruits, pineapples, coffee and other goods for local consumption.

Previous pages have shown that disaster-induced production cuts will mean food shortages, which must be offset by sufficient and timely imports of the missing items, either in the form of purchases abroad or donations or other international food aid. In the case of additional purchases from abroad, the financial resources needed to pay for them must be estimated. To this end, the quantities that must be imported will have to be determined, and then multiplied by the international market prices for those goods. It may well be that the value of imports will be higher than the estimated value of production losses caused by the disaster.

International food aid programmes such as the World Food Programme (WFP) of the Food and Agriculture Organization of the United Nations (FAO) will donate food for the people most affected by natural disasters. The available information on the volumes covered by those programmes must be incorporated into the data on the status of the food balance and the total domestic availability of food. Donations must also be taken into account when designing food-related programmes intended to provide employment for farm workers who have lost their jobs because of the disaster.

The financial needs for recovery of the agricultural sector will be estimated as follows:

(i) Locate, with sufficient detail, the areas for immediate intervention within the departments and municipalities affected.

(ii) Describe in detail the damage or losses caused by the disaster in each of the subsectors in which assets and infrastructure must be rebuilt and production restored as promptly as possible.

(iii) Establish concrete objectives for each line of activity involved in recovery and reconstruction, the timing and sequence of the planned work, the estimated requirements for skilled and unskilled labour, as well as inputs and other goods and services that must be used to reactivate or rehabilitate production activities affected by the disaster.

(iv) Estimate the financial resources that will be needed to carry out the planned activities, expressed in terms of provisional budgets in which the required amounts and estimated time limits will be established.

XIII. Manufacturing

A. General considerations

Manufacturing is a diverse sector of the economy, encompassing all of the subcategories given below:[135]

(i) Manufacture of food products
(ii) Manufacture of beverages
(iii) Manufacture of tobacco products
(iv) Manufacture of textiles
(v) Manufacture of garments
(vi) Manufacture of leather and related products
(vii) Manufacture of wood
(viii) Manufacture of pulp, paper and paper products
(ix) Printing and reproduction of recorded media
(x) Petroleum refining
(xi) Manufacture of chemicals and chemical products
(xii) Manufacture of basic pharmaceutical products and pharmaceutical preparations
(xiii) Manufacture of rubber and plastics products
(xiv) Manufacture of other non-metallic mineral products
(xv) Manufacture of basic metals
(xvi) Manufacture of computer, electronic and optical products
(xvii) Manufacture of electrical equipment
(xviii) Manufacture of machinery and equipment, including transport equipment
(xix) Manufacture of furniture and musical instruments
(xx) Other manufactures

[135] The classification given here is based on the International Standard Industrial Classification of All Economic Activities (ISIC) (see United Nations, 2009a).

A country's national accounts do not usually include all of these subdivisions, because not all are relevant in every country's economy.

Between 2000 and 2011, manufacturing represented an average of 5% of GDP in Latin America and the Caribbean (3.3% in the Caribbean and 5% in Latin America). Between 2005 and 2010, 12% of jobs in Latin America and the Caribbean were in manufacturing. The figure was 9% in the Caribbean and 12.7% in Latin America.[136]

The manufacturing sector is heterogeneous, too, in terms of establishment size by number of workers employed. National statistical offices in the various Latin American countries do not classify firms by employment strata in the same way.[137] It is best to use the specific classification employed in the country itself to estimate the impacts of a disaster on the manufacturing sector. Another point is that manufacturing surveys do not reflect microenterprises (those with five workers or fewer). It is important to try to capture the impact on this sector since many microenterprises are not insured and have more limited access to bank credit than larger firms.

Another key issue to bear in mind is the local or regional nature of disaster effects. For that reason, the establishment —not the firm— is the statistic used, because the firm's headquarters could well be geographically distant from the site of production. Losses are usually reflected at the site of the firm's legal address, not at establishments themselves. Since the estimate should try to reflect impacts on the regional economy —such as on employment and output— the focus should be on establishments.

B. Damages

The estimate of damage in the manufacturing sector must establish the effect on its assets, which are grouped into the following categories: (a) buildings and facilities; (b) machinery and equipment (including transport equipment); (c) furnishings, and (d) inventories of goods being processed, finished goods, raw materials and spare parts. Two basic pieces of information are needed to estimate damages: the level of destruction of each type of asset and the price of replacement. These should be determined for each of the four categories.

The government offices responsible for the sector should participate in the estimation team; if this is not possible, estimations should be prepared in close consultation with these agencies, as well as with trade groups and producers' associations. All official estimates should be verified on the ground.

When calculating damage, the specialist should distinguish between establishments of differing sizes, according to the classification used in the country, as noted earlier. Damage in the private sector and in State enterprises should also be calculated separately. The extent to which assets are insured against damage should be considered for both sectors.

The following procedure is suggested for estimating damage in the manufacturing sector:

[136] The data for Latin America refer to the following countries: Argentina (2005-2010), Bolivarian Republic of Venezuela (2005-2008, 2010), Brazil (2005, 2006, 2008, 2009), Chile (2006, 2009), Colombia (2006-2010), Costa Rica (2005-2010), Dominican Republic (2008-2010), Ecuador (2005-2010), El Salvador (2005-2010), Guatemala (2002-2004), Honduras (2005-2010), Mexico (2005, 2006, 2008, 2009), Nicaragua (2001, 2005), Panama (2005, 2006, 2009, 2010), Paraguay (2005-2009), Peru (2005-2010), Plurinational State of Bolivia (2005-2008), Uruguay (2006, 2010). The data for the Caribbean refer to the following countries: Belize (1993, 1994, 1997-1999), Guyana (1992, 1993), Haiti (2001), Jamaica (1999, 2001, 2002), Suriname (1999). Data provided by the Socio-Economic Database for Latin America and the Caribbean (SEDLAC).

[137] For example, the National Institute of Statistics (INE) of Chile groups firms in seven categories: 10-19 workers (firms with nine workers or fewer are also classified in this group); 20-49 workers; 50-99 workers; 100-199 workers; 200-499 workers; 500-999 workers; and 1000 or more workers. The National Institute of Statistics (INE) of the Plurinational State of Bolivia uses three categories: 5-14 workers; 15-49 workers; and 50 or more workers. The National Institute of Statistics (INE) of the Bolivarian Republic of Venezuela uses four categories to classify firms in its annual surveys of the manufacturing sector: 5-20 workers; 21-50 workers; 51-100 workers; and 101 or more workers. As of 2007, the manufacturing survey was replaced by a survey of large manufacturing firms, defined as the 140 firms with the most sales. These examples illustrate the diversity of criteria used to classify firms in the region.

1. Compilation of pre-disaster information

Immediately after a disaster occurs, the national authorities responsible for the post-disaster emergency stage usually act very quickly to provide information on the area affected (alternatively, this can be done by the estimation team at the start of their assessment). It is important to have a clear picture of the number of establishments there were in the area, and of their various characteristics, before the natural disaster occurred. Much of this information is available online or can be obtained electronically from the relevant agencies.

The main sources of information include the following:

(i) The most recent industrial census or survey.

(ii) Patents and trademark offices.

(iii) Industry promotion offices or municipal records.

(iv) Local and sectoral chambers of commerce and trade unions.

(v) Associations of insurance companies.

2. Estimating damage

Once the basic information set out above has been collated, the damage must be quantified by type of asset. Normally, the first pieces of information come from preliminary reports on the event, issued by official and non-governmental organizations, which may include a preliminary count of the number of establishments and the different levels of damage. This is only preliminary information, however, and should be treated as such, since these reports' main objective is not to quantify the damage suffered by the manufacturing sector.

As a second step, on the basis of meetings with the relevant public and private-sector officials and field visits, an approximate count should be made of the number of establishments affected, their branch of activity and their size (large, medium-sized and small firms, depending on the number of staff employed). Next, the damage suffered in each of the categories of assets should be ascertained. The damage is converted into monetary units by valuing the relevant assets in terms of replacement costs (considering assets of similar characteristics to the original design).

A survey may be carried out during a field visit. A census approach is suitable for large firms: since they are fewer in number, they can all be covered. For medium-sized firms, a representative sample may be taken. The results of this sample-based survey should be interpreted with caution and verified against other sources, inasmuch as the sampling may not match that of the national statistical office's manufacturing survey and because establishments may have incentives to overestimate the damage. A systematized survey interview is a difficult methodology to apply in the case of microenterprises because of their diversity and large number.

There follows a review of the main categories of assets damaged or destroyed for evaluation purposes:

(a) Buildings and facilities

Damage under this heading is to be valued at replacement cost, on the basis of the original design. For this, information is needed on the floor area damaged or destroyed and the value per square metre of construction for industrial-type buildings. For the former, a scale from zero (where there is no damage) to four (for total destruction) may be used. The scale is applied to the average current value per square metre of construction. It is important to make sure that the price used per square metre of construction is not a national average, but an average for the area where the disaster occurred.[138]

(b) Machinery and equipment

Under this heading, machinery and equipment replacement prices are determined in respect of total or partial damage. This category includes a firm's entire vehicle fleet.

[138] The age of the building is another piece of information that should be gathered by the group of specialists. It should be passed on to the macroeconomic experts, who will use it in estimating the impact on the capital stock. If the building had fully depreciated, its replacement will increase the capital stock and thus have a positive impact on potential output.

Larger firms usually have a proportionally higher stock of these assets, both because their staff work under better conditions and because they more frequently need equipment such as forklifts and a fleet of vehicles for transporting raw materials, intermediate products or finished goods. Intermediate and small enterprises, on the other hand, usually outsource these activities. For valuing damage under these headings, depending on the scale of the damage, it may be most simple and advisable to obtain their up-to-date market values. Investments in machinery and equipment are, to a certain extent, proportional to the value of buildings and facilities, although the validity of this relationship depends directly on the size of establishments. The specific branch of activity must also be taken into account because —for example— the vehicle fleet accounts for a much higher proportion of a firm's total assets in the soft drinks and cement industries.

The value of these items as they appear in manufacturing surveys refers to the value registered in firms' accounting records, which do not include accumulated depreciation as a function of the number of years of useful life since acquisition. They also show acquisition prices, except in countries with high inflation, where a periodic restatement of physical assets is advisable. Such limitations are especially significant in the case of machinery and equipment, where rapid technical progress affects replacement value.

As in the case of buildings and facilities, damage to machinery and equipment in large industrial enterprises must be estimated in conjunction with their executives and in consultation with the national authorities. These figures must then be examined and adjusted, on the basis of the replacement value of the equipment destroyed and, in the case of imports, the unit value of recent purchases.

When assessing the damage suffered by medium-sized and, especially, small establishments, the varied nature of the affected industries and the inconsistencies typical of data obtained through direct surveys may require analysts to rely more on census parameters, which will need to be assessed and updated.

(c) Furnishings

For assessing damage to furnishings, the specialist must establish a typology by size of firm and obtain updated market values for those furnishings in the market. The larger an establishment is, the smaller the ratio of investment in furnishings to building value will be; distinctions must also be made between specific industries.

(d) Inventories

This heading includes finished goods produced by the company in question, goods being processed, raw materials, and other goods such as spare parts that are not directly related to production. This is one of the headings that suffers the most damage during a disaster because space limitations often mean that warehousing facilities are less protected than buildings housing machinery and equipment.

Some of the stock is likely to have been imported. In this case, relevant information on large enterprises can be obtained from official sources and from the firms' own records. In the case of medium-sized and small enterprises, estimates for those that have suffered greater damage should be based on the ratio of stock to total fixed assets, which is normally slightly higher for medium-sized companies.

The sum of the four headings above gives the total damage.[139]As noted earlier, it is important to ascertain the proportion of firms suffering damage that were insured. Both the magnitude of total damage and the magnitude of the damage to uninsured stock should be recorded. The latter figure is the most relevant from the point of view of public policy.

It is also important to estimate the imported component of the damaged goods, which will fall mostly under the headings of machinery and equipment and raw materials inventories. This will enable calculation of the foreign exchange needed to replace the assets in question. If this information is not available at the establishment level, indirect sources may be consulted, such as the breakdown of national and imported costs of investment projects on record with development or commercial banks, and macroeconomic statistics showing the imported components of gross investment.

[139] The estimate of damage for the sector should not be confused with the effect on its capital stock. They are different because part of what is destroyed may be fully depreciated and thus no longer forms part of the capital stock.

C. Losses and additional costs

A disaster may be expected to disrupt the flows in the manufacturing sector, and additional costs, as well as losses, will need to be estimated. Damage sustained by industrial establishments located in a disaster area will obviously have a negative impact on production flows because of both the temporary suspension of activities —for as long as the rehabilitation lasts and until pre-disaster production levels are recovered— and relative shortages of inputs caused by the temporary interruption of communications and sales channels.

The following procedure is suggested for estimating losses in this sector:

1. Compilation of pre-disaster information

This will be used to build a baseline for the estimates. Data are needed on the recent performance of the sector and its outlook if the disaster had not occurred.

This information includes:

(i) Statistical series on the sector's production from national statistical offices, central banks or industry planning departments. It is important to secure quarterly and/or annual data. If they are available, monthly production indexes offer a more precise overview of the sector's recent performance. As shown in table XIII.1, indicators of this sort are available for 13 Latin American countries; these estimates usually aim to capture quarterly and annual activity levels, and generally correlate closely with them.

(ii) Employment statistics series for the manufacturing sector, showing the numbers employed. It is also useful to determine the structure of employment in the sector, i.e. by type of worker. This information may be available in industrial surveys.

(iii) Preliminary reports prepared on the event itself by government or private sector institutions.

(iv) Other surveys conducted by national statistical offices, ministries of industry or trade or central banks.

(v) Information from bulletins published by chambers of commerce.

(vi) Economic and statistical information published by or available in producers' or industry associations, such as the association for industries such as textiles, clothing, food, electrical appliances, construction materials, and so forth.

(vii) Information prepared by other groupings, such as associations of micro and small enterprises and industries, development banks, manufacturing workers' unions or social security institutions.

Table XIII.1
Latin America (13 countries): monthly index of manufacturing production
(Percentages)

Country	Indicator
Argentina	Monthly industrial estimator (EMI)
Bolivia (Plurinational State of)	Global index of economic activity, manufacturing
Brazil	Productin indicator - general
Chile	Industrial production index
Colombia	Real manufacturin production activity (survey with and without cofee threshing)
Costa Rica	Monthly index of economic activity (IMAE), by industries, manufacturing
Ecuador	Industrial volume index (IVI), index of registered activity levels (INA-R), manufacturing
El Salvador	Index of economic activity (IVAE), manufacturing
Honduras	Monthly index of economic activity (IMAE), manufacturing
Mexico	Index of physical volume of industrial activity
Nicaragua	Industrial production index
Uruguay	Monthly GDP, manufacturin
Venezuela (Bolivarian Republic of)	Index of industrial physical volume

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of information from national statistical offices in the respective countries.

2. Estimating losses and additional costs

As mentioned in chapter II, sector flows are altered as a result of two factors: (a) changes in the potential gross output owing to the interruption to the production process, i.e. the potential gross income that industrial establishments will lose because of the disaster, and (b) the additional costs of restoring production. These costs involve actual disbursements and boost activity in other sectors, such as transport. It is advisable to distinguish between these two factors, as described below:

(a) Interrupted or delayed production

Production flows may be interrupted because of the destruction of assets and transport infrastructure, or both, or by the interruption of power and water supplies or other services. In the first case, the forgone production —the income loss— resulting from the destruction of assets must be quantified. Goods already produced and ready for market at the time of the disaster formed part of the firm's inventories at that point in time, and so must be included in the accounting of the damage, even if they were not part of the firm's desired inventory.

Local trade associations often gather information to estimate losses due to the suspension of production, whose results may serve to identify the worst affected establishments. The specialist is advised to interview the managers of some of these establishments. As in the case of direct damage, these interviews can be systematized in the form of a survey that includes questions about normal monthly production. This is a somewhat informal survey and will not necessarily meet the standards of sampling techniques that ensure the data obtained will be representative. The results may be biased and should be compared with official estimates produced by bodies such as the ministry of industry and the tax office.

The interruption of production flows is associated with the scale of damage in the manufacturing sector. The greater the damage, the longer it will take to replace assets and, therefore, the longer the production flow of establishments in the area affected will be interrupted. An estimate of how long production will be suspended is important for quantifying losses. For example, if the disaster struck at the start of the second quarter and it is estimated that an establishment's production will be totally suspended for six months, the disaster's impact on the factory will be equal to half the year's expected production. Losses are not measured against the factory's full capacity, but against expected production. As mentioned in chapter II, the producer price is the one that matters for valuation in the manufacturing sector.

In this example, it is important to remember that the impact is felt by the establishment and the local economy, not the sector as a whole or the economy at the national level, because increased production flows in similar establishments in other parts of the country can compensate for the interruption of the production of a good in one area.[140] In this regard, it is useful to have data on idle capacity in the main manufacturing segments since this, together with the capacity of the area where most production is carried out, can yield a clear picture of the potential to make up for lost production using other national sources. In the case of an industrial complex where the firms are the only producers of a particular good in the country, the impact will be fully passed on to the manufacturing sector and therefore to the economy at large.

At this point, with the information on the sector and on the magnitude and area affected by the disaster, it is advisable to begin working with the officials responsible for preparing the accounts for the industries affected in the national statistical office. The aim is to understand how the information collected and estimated may be translated into an impact on the manufacturing sector and, in turn, what effect this could have on other sectors. This could be accomplished using the input-output matrix.[141]

In sum, the gross value that an establishment will not produce is obtained as follows:

(i) Estimate the number of months that production will be suspended.

[140] This is part of what Albala-Bertrand (1993) describes as society's response to the disaster.

[141] For example, the survey of firms affected could compile data on their production chains. This information should include the origin of inputs and the destination of the intermediate or final products processed by the damaged firms. However, since this is an informal survey, it is not a good substitute for the input-output matrix.

(ii) Estimate the flow that would have been produced monthly had the disaster not occurred. Two pieces of information will be required: pre-disaster estimates and details of any seasonal fluctuations in production in the sector. This flow is valued at producer prices.

(iii) The gross value is obtained by multiplying the number of months by the monthly gross value of lost production.

Production may also be delayed, not because of the destruction of company assets, but because of damage to transport routes within the disaster area and to target markets, for example. In this case, production flows can be resumed almost immediately, because the damage is not to the establishments themselves. Unforeseen accumulation of inventories should not be counted as a loss, because it represents only a variation in stock. The gross value of delayed production is obtained using a procedure similar to that described in the previous point.

(b) Additional costs

In connection with the previous point, the destruction of a transport route can lead to higher transport costs, because establishments will have to select and use alternative (longer and perhaps poorer) transportation routes. This information must be shared with the transport specialist to avoid duplication, and should be treated as a reduction in the sector's value added; the operating surplus will fall because of higher unit costs of production (providing that the higher cost is not passed on to consumers). Higher costs in the manufacturing sector can also increase the gross value produced by other sectors.

These additional costs vary by industry and will be higher for those in which transport accounts for a large proportion of costs, such as in the sugar and cement industries. The additional costs incurred by firms should be quantified by kind of economic activity, as should those incurred by the public sector to alleviate the impact on manufacturing.

D. Impact on employment and the external accounts

Disasters affect manufacturing employment at the local level owing to:

- The destruction of establishments, which interrupts production.
- Damage (destruction or obstruction) to transport routes, which hinders the movement of products and inputs.

In these circumstances, local demand for labour will shrink in manufacturing, and workers' wages in the sector will fall. The spatial dimension is important here, since, as mentioned earlier, lost production can be substituted by production from another area of the country, which could have a positive impact on employment and wages in other regions. The disaster could displace both production and employment to parts of the country not affected by the disaster.[142] The destruction of establishments has longer-term effects on employment than production issues caused by damage to factors external to factories, such as transport links. The information collected on the possible temporary, local reduction in employment in the sector should be passed on to the macroeconomic team responsible for estimating the local impact of the disaster on employment and the national impact. As explained in chapter XVI, for this it is important to bear in mind the reassignment of production within the sector and consequently the potential increase in employment in other parts of the country.

With respect to the impact on manufacturing exports, information may be obtained from private export associations and industrial producers' associations, which often compile such information on export firms. It is also advisable to contact the foreign trade office and the export development bank, or private banks that have export finance portfolios. In some countries, special attention should be afforded to firms that produce goods for re-export, i.e. maquila firms. Certain characteristics of these firms must be taken into account for estimating the impact of natural phenomena: (a) they are usually insured against damage; (b) they are labour-intensive; and (c) their assets may be prone to rapid depreciation. The survey should compile more extensive information on these firms and government authorities should be consulted on the best way of dealing with them.

[142] This does not mean that those employed in the disaster area will be employed elsewhere in the country. The point is rather that the substitution of production could increase employment in this sector in unaffected areas.

Damage in the manufacturing sector will have an impact on the fiscal accounts both through lower tax receipts and through the higher spending the public sector may have to incur to alleviate the disaster's impacts on this sector.

E. Financial needs for recovery and reconstruction

1. Financial needs for recovery

Production is likely to restart first in establishments least damaged by the disaster. Note that in the normal course of activity in the sector, payments are not received against product delivery; rather there is a grace period for payment to be made. The same applies to inputs.

When production is interrupted, the flow of income to establishments is interrupted as well, which compromises them financially owing to the mismatch that arises between accounts payable, contractual obligations to workers and accounts receivable. If this happens, firms will need to refinance their liabilities. This is a negotiation between firms and the banking sector. The government can, however, be apprised of or even take part in this negotiation, to ensure that temporary facilities are extended to firms in difficulties.

Resuming production could also require financing for working capital under softer conditions than those usually available in the disaster zone. The government could use a variety of mechanisms for this, such as: (a) guaranteeing such loans to lower risk and thereby bring down the interest rate; (b) using a second-tier bank as a guarantor to have the private banking sector administer the loans and thereby contribute to the sector's recovery; or (c) extending lines of credit directly through public banks.

For seriously damaged establishments, the assessment should consider uninsured damage and the time the insurance will take to pay. Again, this is a matter between two private sector agents. However, here, too, the government may be apprised of the discussions, oversee contract fulfilment and, where insured sums differ from replacement costs, participate in financing the difference by helping to lengthen loan periods and securing local interest rate discounts. If necessary, the government could also offer temporary tax relief to all damaged firms.

Microenterprises with low capital endowments in the manufacturing sector may be forced to fully recapitalize if their capital stock was lost in the disaster. They should be treated in two different ways, depending on whether they had microfinancing before the disaster. If they did, the government could act as a guarantor to fund recapitalization. In these circumstances, the microfinancing agency will likely be familiar with the capital destroyed, which may well have been loan security. In the second situation, the government could use a second-tier bank to channel resources through microlenders and thus take advantage of their experience with microenterprise clients.

2. Financial needs for reconstruction

Reconstruction, unlike replacement, should aim to improve on the quality of pre-existing assets by making them more resistant to future disasters. In manufacturing establishments, reconstruction needs to encompass improvements to buildings and facilities, and machinery and equipment:

(a) Buildings and facilities

Reconstruction can entail changes in legal standards, for example, regarding building codes, design and land use, depending on the type of threat most likely in the area. It is necessary to define, together with the authorities, what components of vulnerability reduction it will be financially feasible to introduce during reconstruction process, to comply with possible changes in regulations, and to introduce in new buildings, which will increase their costs.

(b) Machinery and equipment

A natural disaster can be seen as an opportunity to achieve a major technological upgrade by substituting damaged machinery for cutting-edge technology.[143] This is a decision firms themselves must make.

The government's contribution to this process involves three types of action:

(i) Change the legal framework on land use and building codes, and create oversight measures to ensure that they are observed.

(ii) Oversee and, if necessary, contribute to the financing of works external to establishments or industrial parks, such as levees, reservoirs, retaining channels and dykes.

(iii) Facilitate mechanisms for lowering the financial cost of reconstruction for vulnerability reduction in the private manufacturing sector.

[143] Using a sample of 49 countries, Crespo Cuaresma, Hlouskova and Obersteiner (2008) found that only countries with certain levels of development improved their capital stock after a natural disaster. That is, these countries manage to "rebuild better".

XIV. Commerce

A. General considerations

The main categories of commercial activity are wholesale trade,[144] retail trade,[145] sale and servicing of vehicles and electrical household appliances, and hotel and restaurant services. These categories include various subcategories,[146] such as:

(i) Wholesale on a fee or contract basis
(ii) Wholesale of agricultural raw materials, live animals, food, beverages and tobacco
(iii) Wholesale of household goods
(iv) Wholesale of non-agricultural intermediate products, waste and scrap
(v) Wholesale of machinery, equipment and materials
(vi) Other wholesale
(vii) Non-specialized retail trade in stores
(viii) Retail sale of food, beverages and tobacco in specialized stores
(ix) Other retail trade of new goods in specialized stores
(x) Retail sale of second-hand goods in stores
(xi) Retail trade not in stores
(xii) Repair of personal and household goods
(xiii) Sale of motor vehicles
(xiv) Maintenance and repair of motor vehicles
(xv) Sale of motor vehicle parts and accessories
(xvi) Sale, maintenance and repair of motorcycles and related parts and accessories

[144] Wholesale trade is the resale (sale without transformation) of new and used goods to retailers or to industrial, commercial, institutional or professional users (see United Nations (2009a)).
[145] Retail trade is the resale (sale without transformation) of new and used goods to the general public for personal or household consumption or utilization. Some retailers act as agents for a principal and sell either on consignment or on a commission basis (see United Nations (2009a)).
[146] This classification is based on the International Standard Industrial Classification of All Economic Activities (ISIC) (see United Nations (2009a)).

(xvii) Retail sale of automotive fuel

(xviii) Hotels, camping sites and other provision of short-stay accommodation

(xix) Restaurants, bars and canteens

Some of the subdivisions of the categories "hotels, camping sites and other provision of short-stay accommodation" and "restaurants, bars and canteens" are influenced by tourism. In a country where tourism is a major industry, it would be advisable to estimate the impact of a disaster on this sector separately (see chapter XV).

As was done in the chapter on the manufacturing sector, a comprehensive list of the commercial sector's subdivisions is provided here, although not all of them are usually included in a country's national accounts because some of them will be of little importance in a given economy.

From 2000 to 2011, "wholesale and retail trade, repair of goods, and hotels and restaurants" accounted for 16% of GDP in Latin America and the Caribbean (18% in the Caribbean and 14% in Latin America). From 2005 to 2010, this sector accounted for 23% of all jobs in the region (20% for the Caribbean and 23.9% for Latin America).[147]

The sector's heterogeneity is reflected not only in the wide range of activities that it includes, but also in the size of the companies involved. Given the fact that, as stressed in this handbook, the effects of natural disasters tend to be localized,[148] the commercial establishment is the statistical unit to be used, rather than the company, since companies tend to have offices in many different geographical locations. Normally, losses are going to be recorded in the location where a firm has its legal domicile, rather than where its various outlets or branch offices are located. Yet, because estimates of the impact of a natural disaster are intended to reflect the effects on the regional economy in terms of employment and production, the focus should be on local branches or offices. This is clearly the case for large commercial chain stores.

B. Damage

Damage in this sector is estimated on the basis of the cost of replacing what has been totally or partially destroyed. The assumption is that the replacement assets will have the same capacity and will be of the same quality as those that were in place before the disaster occurred. As is also the case in the manufacturing sector, assets are grouped into the following categories: (a) buildings and facilities; (b) machinery and equipment (including transport equipment); (c) furnishings; and (d) inventories.

Two basic pieces of information are needed in order to estimate damage: the extent to which each type of asset has been destroyed or damaged, and the replacement costs of the assets in question. It is advisable to determine these costs separately for each of these four different categories of assets.

The government offices responsible for the sector should participate in the assessment team; if this is not possible, estimates should be prepared in close consultation with these agencies, as well as with trade groups and merchants' associations. The assessments made by each of these types of institutions should be checked with other sources and verified on the ground.

When assessing the damage, it is best to divide up the different establishments by size based on the country's own classification of activities, as mentioned earlier. One of the steps that should be taken before appraising the damage is to differentiate between companies that were insured and those that were not, since the authorities will want to have accurate information on the extent of the damage that is not covered by insurance. It is also important

[147] The data for Latin America refer to the following countries: Argentina (2005-2010), Bolivarian Republic of Venezuela (2005-2008, 2010), Brazil (2005, 2006, 2008, 2009), Chile (2006, 2009), Colombia (2006-2010), Costa Rica (2005-2010), Dominican Republic (2008-2010), Ecuador (2005-2010), El Salvador (2005-2010), Guatemala (2002-2004), Honduras (2005-2010), Mexico (2005, 2006, 2008, 2009), Nicaragua (2001, 2005), Panama (2005, 2006, 2009, 2010), Paraguay (2005-2009), Peru (2005-2010), Plurinational State of Bolivia (2005-2008) and Uruguay (2006, 2010). The data for the Caribbean refer to the following countries: Belize (1993, 1994, 1997-1999), Guyana (1992, 1993), Haiti (2001), Jamaica (1999, 2001, 2002) and Suriname (1999). Data provided by the Socio-Economic Database for Latin America and the Caribbean (SEDLAC).

[148] See chapter II.

to determine how long insurance companies will take to settle the claims. If State-owned enterprises are active in this sector, then it is suggested that separate estimates be prepared for public and private enterprises.

The recommended procedure for preparing damage estimates in this sector is as follows:

1. Compilation of pre-disaster information

The following basic information on commercial establishments needs to be obtained in order to provide a quantitative basis for the estimates:

(i) The number and size of commercial establishments, by subsector, in the disaster area.

(ii) The physical facilities, including a description of typical furnishings and equipment, and the merchandise in stock. It is preferable to compile this information by subsector.

One of the main sources of this type of information is the municipality or municipalities in the disaster zone, since commercial establishments have to obtain operating permits from them.

Additional information can also be obtained from the ministry of trade or from national, regional and industry-specific chambers of commerce. These organizations usually have detailed information on their members' scale of operations and sales. Based on the above information, a typology of what are usually privately-owned stores in the disaster area can be constructed.

It is best to begin compiling this information before the assessment team's arrival in the disaster area. This information can then be supplemented with the more specific data that can be gathered while working on the ground.

2. Damage estimates

A disaster assessment team with knowledge of the geographical area in question and armed with the information initially provided by a variety of local sources should then tour the area to determine how many commercial establishments and other associated facilities have been damaged and to assess the extent of the damage.

There is evidence that large commercial enterprises account for a sizeable percentage of total sales at the national level. It is therefore suggested that the team start with the estimates for these companies. It is also reasonable to assume that these firms will be insured, and the association of insurers will therefore be another useful source of information. Similar assumptions can be made in the case of medium-sized firms. Microenterprises, which tend to be numerous in developing countries, will be dealt with separately.

Companies of this type should be consulted in order to determine how many of them will be submitting insurance claims for their damaged assets, and this question should be asked in respect of each of the types of assets mentioned above. This will make it possible to construct a preliminary typology of the damage sustained by the sector. Another important piece of information is how long insurance companies will take to settle claims. This has a bearing on the recovery process and on the fiscal effort that will have to be made, since, even for firms with insurance coverage, delays in payment on claims can slow their return to a business-as-usual operational stance.

Associations of different types of commercial firms and regional chambers of commerce are another useful source of information for the preparation of damage estimates, since they may have data that can be used to gauge the extent of the damage sustained by the assets of member firms.

Information can also be gathered by interviewing business owners or representatives, and this information can be systematized using a survey form. In order to be able to gauge the degree to which the survey results will be representative, it is necessary to have an accurate population count, which is why it is so important to have information on the pre-disaster situation, including the number of commercial establishments in each segment in the disaster area, disaggregated by the size of those establishments.

Field visits by the assessment team and the responses to the survey questionnaire should provide enough information to determine the type of damage sustained, on average, by each kind of establishment, to assign an

average value to that damage and to establish what is required in order to rebuild. Using all the various sources of information that are available, an estimate of the total damage sustained by each type of asset can then be prepared:[149]

(a) Building and facilities

In order to estimate damage in this category, valued at the cost of replacing the assets with others of a similar design, information must be obtained on the floor area of the destroyed or damaged facilities, how old the buildings or other assets were, and the value per square metre of the commercial buildings or structures.

(b) Machinery and equipment (including transport equipment, refrigerated display cases and cold storage equipment)

Information is needed on the replacement prices for each type of unit in order to evaluate total or partial damage under this heading. Companies' entire vehicle fleets fall into this category as well.

(c) Furnishings

Display cases and storage make up most of the items in this category for this sector. In order to place a value on the damage sustained under this heading, and depending on how serious the damage is, it may be fairly simple to obtain up-to-date market prices for these furnishings and to calculate what percentage of the value of buildings and facilities they represent.

(d) Inventories

This category includes all merchandise that was intended for sale but was still warehoused at the time that the disaster hit. The market prices for these products should be obtained in order to arrive at an appraisal.

The sum of the figures for these four categories equals the total damage caused by the disaster in the commercial sector. It will also be important to determine what percentage of the replacement assets will have to be imported.

C. Losses and additional costs

The damage sustained by commercial establishments located in the disaster area will obviously have a negative impact on sales, both because of the temporary suspension of business activity while the stores or other facilities are rebuilt and because the supply of merchandise will be reduced for a time owing to the temporary interruption of communications or other basic services and the disruption of marketing channels.

The following procedure for estimating losses in this sector is recommended:

1. Compilation of pre-disaster information

The ultimate objective in gathering this information is to construct a baseline for the estimate preparation process. To this end, it is necessary to ascertain the nature of recent trends in the sector and to find out what the outlook for it would have been if the disaster had not occurred. It is therefore important to determine how much of the national and regional economies are accounted for by this sector.

Basic information is needed on commercial sales indices (CSIs). This indicator can be used to construct a more realistic baseline scenario for the sector because CSIs are calculated each month with a lag of approximately 45-60 days. CSIs are usually national indices, and it will therefore be necessary to meet with the staff of the national statistical office or central bank who are responsible for calculating them in order to learn whether they use regional

[149] For further details on the methodological procedure to be used, see chapter XIII.

weightings or not and what types of statistics they base those indices on. Table XIV.1 shows the sales indices for different countries that may be used for these calculations.

Information also needs to be compiled on the monthly sales of the different sizes and types of businesses that are active in the location that was hit by the disaster. Since most Latin American and Caribbean countries levy a value added tax (VAT), this information can be obtained from the offices responsible for tax collections.

The possible sources for this type of information are as follows:

(i) The tax office.

(ii) Regional and product-specific chambers of commerce, which may have sales information on their members.

(iii) Statistical series on sales that are on file with national statistical offices, central banks or sectoral planning offices.

(iv) Sectoral GDP series that are part of the country's national accounts, broken down by branch of economic activity, which are kept by the national statistical office or the central bank. Since this information may have been compiled long before the disaster occurred, projections for the current year should be calculated on the basis of recent growth rates for the sector.

(v) Employment series for the sector.

Table XIV.1
Latin America (12 countries): sales indices

Country	Index
Argentina	Real retail sales index
Bolivia (Plurinational State of)	Global index of economic activity
Brazil	Index of volume of retail sales
Chile	Index of retail sales (IVCM)
Colombia	Retail sales index
Costa Rica	Monthly index of economic activity (IMAE)
Ecuador	Index of registered activity levels (INA-R)
El Salvador	Index of economic activity (IVAE)
Mexico	Net wholesale trade index in real terms, by urban area
Nicaragua	Monthly index of economic activity
Uruguay	Wholesale trade index
Venezuela (Bolivarian Republic of)	Index of volume of wholesale and retail sales

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of information from the national statistical offices and central banks of the respective countries.

This information is used in four ways:

(i) To gain a clear picture of how much of the national economy this sector represents.

(ii) To determine how this sector was trending before the natural disaster.

(iii) To understand how important this sector has been as an employer.

(iv) To provide all the available reference material for an assessment of what the outlook for the sector would have been if the disaster had not occurred. It is important to see how well the information that has been compiled dovetails with the trends seen in the sector during the year. This is especially important when a disaster hits from the second quarter onward.

2. Estimating losses and additional costs

(a) Losses

In order to estimate losses, information has to be gathered on gross monthly sales for each commercial establishment. These figures can be obtained from the national tax office. If only national, rather than monthly, data are available, any seasonality factor present in the series has to be taken into account when extrapolating the data. It is important to remember that, as mentioned earlier, large-scale enterprises usually account for a significant percentage of total sales, and it is to be expected that information on those firms will be easier to collect.

The amount of time that it will take for business activity to return to normal is also a very important factor. Lost income is recorded for the period of time that is required to rebuild facilities, repair or replace furnishings and equipment that have been destroyed and reinstate a full supply and flow of merchandise. Losses may be sustained in connection with:

- Damage to assets in the sector (destruction of buildings, furnishings and inventories)
- The shutdown of basic services and/or communications
- The temporary interruption of the flow of merchandise owing to the breakdown or blockage of transport routes or to the shutdown of production
- Temporary labour shortages
- Possible downturns or upturns in the demand for goods owing to a widespread reduction in the population's income or to an increased need for construction materials, respectively

With these two pieces of information (an estimate of the monthly sales that would have been made had it not been for the disaster and the number of months in which service is going to be interrupted), it is possible to calculate the gross value of the sales of each company that did not take place or that were delayed. A full analysis therefore has to be made of how and when the above-mentioned problems will be resolved, taking into account the difficulties that these businesses will face in obtaining the financing they need. Note that this is one of the lowest-value-added sectors.

Another factor (one that has to do with the fact that natural disasters have very local particularities) to be taken into consideration is the fact that regional changes in expenditure may occur. For example, sales of merchandise may increase in a region where commerce is not a major activity because the government or private businesses begin to buy products there in order to donate them to the people in the disaster zone. Because of this type of dynamic, national commercial sales indices may not reflect the impact of a natural disaster.

A final consideration is the fact that the losses sustained in various production sectors, such as crop-raising, livestock, fisheries and manufacturing, were calculated on the basis of producer prices. When these values are converted to consumer prices, they yield a figure for the gross value of the commercial sales of what will no longer be produced by those other sectors. This factor should be taken into account by both the team that is estimating the damage sustained by this sector and the macroeconomic group.

(b) Additional costs

As is also true in the manufacturing sector, intermediate consumption may rise as a consequence of:

- The rental of other premises while establishments that have been destroyed or damaged are being rebuilt or repaired.
- The acquisition of other sources of electricity and water on a temporary basis (e.g. the rental or purchase of portable electrical generators).
- The use, for a limited time, of alternative (and possibly more expensive or more remote) sources for the purchase of merchandise to be sold on the market.

This increase in intermediate consumption will boost demand in other sectors and therefore have a positive impact on them. Note that payment for overtime or any increase in wages should not be recorded as an increase in intermediate consumption but instead as a positive effect on the value added of the commercial sector (see section C of chapter II).

D. Microenterprises

As mentioned earlier, microenterprises (which are defined as enterprises with fewer than five workers)[150] are underrepresented in official statistics. The independent workers in this group warrant attention, since, because they are not organized, it is difficult for them to make their voices heard or to make others aware of their interests. Microenterprises typically have very little capital, but as a sector they are a major employer. Table XIV.2 shows the percentages of workers in selected Latin American countries who are employed in microenterprises.[151] In view of the above-mentioned characteristics, and given the fact that these workers have the least benefits in terms of contracts, health insurance and pensions, it is important not to overlook them when estimating the impact of a disaster.

Table XIV. 2
Latin America (16 countries): employment in microenterprises [a]
(Percentages of total employment)

Argentina	38.4
Bolivia (Plurinational State of)	67.8
Brazil	47.3
Chile	33.1
Colombia	60.9
Costa Rica	38.8
Dominican Republic	54.2
Ecuador	60.1
El Salvador	58
Honduras	63.5
Mexico	44.5
Panama	41.7
Paraguay	63.5
Peru	61
Uruguay	36.5
Venezuela (Bolivarian Republic of)	46

Source: Universidad Nacional de La Plata/World Bank, Socio-Economic Database for Latin America and the Caribbean (SEDLAC).
[a] The figures shown for all the countries are from 2011 except in the cases of Argentina and Panama, where they correspond to 2012, and El Salvador, where the data are from 2010.

Within the microenterprise sector, it is important not to overlook male and female non-professional or informal own-account workers who are employed in family businesses and rely upon that form of work for their livelihoods. Since these workers' houses are often their base of operations, the impact on them of losing the goods and materials they need to run their business can be extremely serious. This is the economic sector that has the greatest difficulty in

[150] This definition of microenterprises corresponds to the definition based on employment in the informal sector.
[151] This information on employment in microenterprises is also available for certain other countries, but it has not been included in table XIV.2 because it is less recent. This applies to the following Latin American countries: Guatemala, 69% (2004) and Nicaragua, 64.7%, (2005), and the following Caribbean countries: Belize, 51.1% (1999); Jamaica, 71.4%; and Suriname, 21.5% (1999).

making a recovery, since its members have so little access to financing and since disasters often destroy the community social capital that is such an important source of support for these workers.[152]

The procedures outlined above are based on the assumption that this kind of information is available. This poses a challenge in the case of microenterprises, since it is expensive to put together a representative sample that can then be surveyed.

Information on the pre-disaster status of these types of enterprises can be obtained from the country's household survey or its income and employment survey. This information, when combined with the geographical data on the municipalities that were the hardest-hit by the disaster, will serve as a basis for estimating the income levels of people who were working in microenterprises.

Another source of information that will be useful, at least for estimating the number of microenterprises that were in the disaster area, are microlenders and public and private programmes and projects, which have been sharply increasing in number in the region in recent years (Minzer, 2010 and 2011; Pineda and Carvallo, 2010). Data that these agencies could be requested to provide includes information on their microenterprise loan portfolio, the percentages of that portfolio that were placed in the various sectors, and the number of microenterprises in the disaster area that had bank loans and the number who are reporting that they have sustained damage from the disaster. This information may make it possible to estimate the disaster's impact on the microenterprise sector. For example, when the impact of Tropical Storm Noel was being estimated (ECLAC, 2008d), it was found that, of the microenterprises operating out of poor households and working with microlenders, 80% were in commerce, 10% in the services sector and 10% in manufacturing. Box XIV.1 provides a detailed picture of the procedure used in this report to arrive at a gender-sensitive estimate. Experience indicates that there is a close relationship between microenterprises and this type of approach, and it would therefore be a good idea for the assessment team to work closely with the group focusing on gender-related issues in developing this portion of the impact evaluation.

Box XIV.1

Tropical Storm Noel (2007). Dominican Republic: impact on microenterprises operating out of dwellings

Procedure

i) The calculations, which were based on statistics reported by the National Housing Institute (INVI), indicated that 90% of the dwellings that were totally or partially destroyed were those of people living below the poverty line.

ii) The sources for the necessary data were the latest edition of the *Human Development Report* put out by the United Nations Development Programme (UNDP), *the Social Panorama of Latin America* published by the Economic Commission for Latin America and the Caribbean (ECLAC) and information from the household surveys conducted by the National Statistical Office. The size of the economically active female population working in the informal sector on an own-account basis was established, and this figure was then applied to the total number of damaged dwellings of members of the poor population in order to determine the number of female microentrepreneurs in each of the provinces that had been hit by the storm, with the assumption being that at least one adult woman lived in each of the damaged housing units.

iii) The number of microenterprises operating out of dwellings, by province, was set at 76% of that figure (with that percentage being provided by microfinance banks). It was also calculated that 10% of the dwellings were being used as storehouses or as a base of operations for microentrepreneurs working as street vendors, and this figure was added to the number of dwellings associated with microenterprises. The number of microenterprises for each sector was estimated at 80% of that figure for commerce, 10% for production and 10% for services, in line with the trend seen in loans from microcredit institutions. (Source: Savings and Loan Bank of the Dominican Association for the Development of Women (ADOPEM)).

iv) The damage was assessed on the basis of the value of the capital stock at the disposal of microenterprises, by sector, as reported by microlenders.

v) Losses were estimated by calculating revenues lost over a three-month period, which is the estimated length of time that it would take for women microentrepreneurs to re-start their operations, based on information provided by key sources in the areas hit by the storm and by microlenders.

[152] For further information on this sector, see the chapter on the gender approach in this handbook.

Recuadro XIV.1 (concluded)

Dominican Republic: microenterprises based in low-income dwellings impacted by Tropical Storm Noel, 2007

Province	Damaged dwellings	Women (total)	Female microentrepreneurs	Dwelling-based businesses	Microenterprise base	Total dwelling-based microenterprises
Santo Domingo	2196.0	2 196	112	85	11	96
Distrito Nacional	968.4	968	49	38	5	42
San Cristóbal	6030.0	6 030	308	234	31	264
Peravia	702.9	703	36	27	4	31
Barahona	3915.0	3 915	200	152	20	172
San Juan	322.7	323	16	13	2	14
Monseñor Nouel	1395.0	1 395	71	54	7	61
La Vega	567.0	567	29	22	3	25
Duarte	2677.5	2 678	137	104	14	117
San José de Ocoa	1395.0	1 395	71	54	7	61
Total	20169.5	20 170	1 029	782	102	884

Dominican Republic: damage sustained by microenterprises based in low-income dwellings impacted by Tropical Storm Noel, 2007

Province	Microenterprise sector			Damaged assets, by sector *(thousands of Dominican pesos)*			Total
	Commerce	Manufacturing	Services	Commerce	Manufacturing	Services	
Santo Domingo	77.5	9.6	9.6	908.7	160.8	96.5	1 166.0
Distrito Nacional	33.9	4.2	4.2	397.5	442.2	42.2	881.9
San Cristóbal	211.5	26.4	26.4	2 479.8	442.2	265.3	3 187.4
Peravia	24.6	3	3	288.4	50.3	30.2	368.8
Barahona	137.3	17.1	17.1	1 609.8	286.4	171.9	2 068.1
San Juan	11.3	1.4	1.4	132.5	23.5	14.1	170.0
Monseñor Nouel	48.9	6.1	6.1	573.4	102.2	61.3	736.8
La Vega	19.8	2.4	2.4	232.2	40.2	24.1	296.5
Duarte	93.9	11.7	11.7	1 101.0	196.0	117.6	1 414.5
San José de Ocoa	48.9	6.1	6.1	573.4	102.2	61.3	736.8
Total	707.6	88	88	8 296.6	1 845.9	884.4	11 026.9

Source: Economic Commission for Latin America and the Caribbean (ECLAC), *Evolución del impacto de la Tormenta Noel en República Dominicana* (LC/MEX/L.853), Mexico City, ECLAC subregional headquarters in Mexico, 2008.

[a] The Dominican Association for the Development of Women (ADOPEM) is a non-governmental organization that works to promote and build entrepreneurial capacity and the social and human capital of its clients and their families by providing training, advisory services, research and project implementation services in various areas. Microenterprise projects are funded by the ADOPEM bank (see [online] www.bancoadopem.com.do).

E. Financial needs for recovery and reconstruction

1. Financial needs for recovery

One of the main inputs required by commercial establishments in order to restart their business activities is the working capital they need to pay their bills so that they can acquire more merchandise to sell.

Another major factor is for supply routes to be re-established, so early action to restore links with the rest of the world is of vital importance.

In addition, since commercial activities are one of the last links in the production chain and, in the case of retailers, are in direct contact with final consumers, those consumers must have the ability to buy their merchandise if these businesses are to start up again. Ensuring that consumers have the means to purchase the goods that these businesses sell is therefore a prime factor in the sector's recovery.

2. Financial needs for reconstruction

When dwellings or other assets are to be rebuilt, rather than replaced, they should be rebuilt in a way that will represent an appreciable improvement over the pre-disaster situation in terms of their ability to withstand future disasters.

(a) Buildings and facilities

Most of the assets in the commercial sector that will have to be rebuilt are stores and storehouses. Reconstruction may involve changes in building codes, regulations on permissible designs and zoning laws, depending on the types of disasters to which the area in question is prone. During reconstruction, it is important to work with the authorities to determine what financially feasible improvements can be made to reduce the degree of vulnerability to future disasters. Such improvements must, of course, be in keeping with any regulatory changes that are being made and would increase the cost of the new buildings.

(b) Machinery and equipment

The commercial sector is not machinery-intensive, but it does use equipment to move merchandise, such as forklifts, and special storage equipment, such as freezers. Governments can be of assistance in this respect by introducing mechanisms for lowering the financial cost of replacing the equipment needed to restore normal operations.

XV. Tourism

A. General considerations

1. Introduction

With tourism becoming increasingly important in a number of Latin American and —especially— Caribbean economies, in some cases the sector may warrant separate examination in order to estimate the economic impact of disasters, to which these economies are particularly vulnerable.

Tourism encompasses all the activities in which people engage during travel to and stays in places other than their usual environment, for a period of less than one year. The reason for travel may be leisure, business or any other purpose unrelated to the exercise of a paid activity. The tourism sector does not exist as such in the national accounts. However, in view of its growing importance, efforts by the World Tourism Organization (UNWTO), the Organization for Economic Cooperation and Development (OECD) and the United Nations Statistics Division to measure the sector since the 1990s have led to the development of a tourism satellite account.[153]

In relation to tourism, the first decision that has to be made for estimating impact is to define which activities will be included in the sector. This handbook considers two possibilities:

(i) To define tourism as including hotels, travel agencies, tourism operators and guides and recreational services.

(ii) To define tourism as it is defined in the satellite account, i.e. as an activity that encompasses various industries such as hotels, food and beverage services, the various forms of passenger transport, travel agencies, tourism operators and guides, and cultural, recreational and other entertainment services.

The difference between the two definitions is that the satellite account includes a larger number of activities. The considerations set forth below are based on the first definition, which excludes such items as passenger transport and food and beverage services.[154] The second definition should be used when a disaster occurs in a region where

[153] A satellite account is an extension to the national accounts for a specific sector, using the same conceptual and methodological framework. It broadens the analytical capacity of the national accounting system in a flexible way without distorting the core systems by generating other kinds of indicators.

[154] For these items, please consult the transportation and commerce chapters of this handbook.

tourism in the main activity, when obviously the area's typical products and related products[155] have to do with inflows of visitors.

In the past few years, tourism has become important in terms of income generation, investment and employment in several of the region's countries and has become a driver of some Latin American and Caribbean economies, with particular features in different countries. Costa Rica, for example, has developed green tourism, while Peru is pursuing a combination of green and ethnographic tourism and the Caribbean countries attract tourists through cruises and activities revolving around the enjoyment of scenic beauty.

Generally speaking, international inbound tourism has significantly increased its contribution to the economy throughout Latin America and the Caribbean in recent years. The growth and opportunities it generates create a series of production linkages with other local or imported goods and services, including transport, communications and information technology, financial and business services, commerce, construction and the production sectors in general. Tourism can also give rise to substantial imports of goods and services. In short, the impact of a disaster on the sector has many ramifications for other sectors.

Table XV.1 shows inbound tourism as a proportion of GDP in the Latin American and Caribbean countries. The percentage is higher for the Caribbean, but given that the figures are national, they could mask the importance of tourism for certain regions in particular countries. Tourism can be an economic driver in specific places without necessarily being a significant part of the national production structure. Since disasters are essentially local phenomena, it is essential to survey economy activity in a tourist area hit by a disaster in order to determine the scope of the impact, in terms of not only direct damage but also the losses and impact in related sectors. Generally speaking, in the event of a disaster, both inbound and outbound tourism drops heavily, as does the use of tourism-related services.

Table XV.1
Latin America and the Caribbean: inbound tourism consumption
(Percentages of GDP)

Country	2000	2005	2006	2007	2008	2009
Saint Lucia	39.7	44.5	31.6	31.5	31.5	31.3
Bahamas	31.0	30.6	28.4	29.3	28.6	....
Antigua and Barbuda	43.7	35.7	32.3	29.2	27.8	27.7
Saint Kitts and Nevis	17.8	27.6	27.0	24.3	19.3	15.3
Belize	13.3	19.2	21.4	22.6	20.5	18.9
Dominica	17.8	19.1	22.7	21.6	19.1	18.0
Saint Vincent and the Grenadines	24.3	23.3	22.7	19.8	16.5	15.4
Grenada	21.5	12.9	16.6	17.8	16.0	15.8
Jamaica	17.6	16.0	17.5	16.6	15.9	....
Dominican Republic	12.1	10.5	11.0	9.9	9.2	....
Panama	5.4	7.2	8.3	9.3	....	....
Costa Rica	9.3	9.1	8.3	8.5	8.5	....
El Salvador	3.3	4.9	5.9	5.7	5.3	....
Guyana	11.2	4.3	4.1	4.7	5.1	....
Nicaragua	3.3	4.2	4.4	4.6	4.4	5.6

[155] "Typical products" are those which would not exist or whose consumption would be much lower in the absence of tourism. "Related products" are those consumed by visitors which do not figure on the list of typical products.

Table XV.1 (concluded)

Country	2000	2005	2006	2007	2008	2009
Honduras	3.7	4.8	4.7	4.4	4.4	....
Uruguay	4.1	4.0	3.6	3.9	3.8	4.5
Guatemala	2.6	2.9	3.0	3.1	2.7	2.2
Trinidad and Tobago	4.5	3.7	2.7	2.9	....	....
Bolivia (Plurinational State of)	1.2	3.6	2.9	2.5	1.8	....
Argentina	1.1	1.8	1.8	1.9	1.6	1.5
Peru	1.6	1.8	1.9	1.9	1.9	1.9
Mexico	1.6	1.5	1.4	1.4	1.3	1.4
Ecuador	2.8	1.3	1.2	1.4	1.4	....
Chile	1.6	1.4	1.3	1.4	1.5	1.4
Colombia	1.4	1.1	1.2	1.1	1.0	1.2
Paraguay	1.2	1.3	1.2	1.0	0.8	....
Venezuela (Bolivarian Republic of)	0.4	0.5	0.5	0.4	0.3	0.3
Brazil	0.3	0.5	0.4	0.4	0.4	0.4
Barbados	28.7	30.1	32.7	....	....	....
Haiti	3.5	1.9	2.5	....	....	....
Suriname	4.7	....	....	....	....	....
Cuba	....	....	....	....	....	....

Source: Economic Commission for Latin America and the Caribbean (ECLAC), "América Latina y el Caribe: indicadores macroeconómicos del turismo", *Cuadernos Estadísticos de la CEPAL*, No. 39 (LC/G.2485-P), Santiago, Chile, 2011. United Nations publication, Sales No. S.11.II.G.1 [online] http://www.eclac.cl/deype/cuaderno39/esp/index.htm.

2. Tourism and vulnerability

In many countries in the region, tourism depends on the preservation of natural resources and sociocultural heritage. Yet many destinations still lack land ordinance plans to ensure that growth occurs in harmony with the environment. It is well known that in some areas or regions —such as the Caribbean or Central America— the tourism developments most frequented by international vacationers are highly exposed to natural phenomena with significant destructive potential. The best tourism destinations in the region are frequented by tropical storms and hurricanes in the case of the Caribbean, and high river waters, floods and earthquakes on the Pacific coast of Central America. The greater risks in these areas are associated with the lack of suitable zoning for environmental management and governance of natural resources, and lax building standards for hotel construction and nearby human settlements; for example tourism facilities have sprung up in many destinations without proper planning for concerns of local population vulnerability.

Although vulnerability varies from one country to another, the fragile nature of the land and marine ecosystems in the region is obvious. The impact of a disaster on tourist areas or areas where tourist activities are carried out is worse in the absence of strict compliance with land use regulations.

Other long-lasting natural phenomena, such as droughts and prolonged eruptions of volcanic ash, can indirectly affect tourism through the supply chain —farming and agribusiness, or even access to water for human consumption and electricity— or by reducing the services foreign tourists expect.

B. Damage

Damage to the tourism sector is estimated on the basis of the cost of replacing the assets that were totally or partially destroyed, on the premise that the replacements will have the same capacity and quality as the original. The following procedure is suggested for this estimation.

1. Pre-disaster information

In order to compile information on the situation in the sector before the disaster, specialists will need to ascertain the number and capacity of hotels, number of travel agencies and tourism operators and firms providing recreational services, and number of tourist attractions in the area hit by the disaster. Some of this information is available on the Internet or may be obtained by e-mail from the relevant agencies. In this case, it is possible to start processing the information even before formally initiating an estimation of disaster impacts and effects.

The following are some of the sources which may be consulted:

(i) The ministry of tourism and regional tourism offices, and chambers or associations or tourism and hotel companies.

(ii) Tax offices, patent registries and municipal records. Information may be obtained on the type of firms and the activities of tourism SMEs and informal tourism-related enterprises.

(iii) The national tax office.

(iv) The institution responsible for the country's national accounts,[156] especially if it produces a tourism satellite account. If so, it would be useful to secure a list of the firms surveyed or sampled for the preparation of the account, in order to focus on them for the damage estimation.

(v) Insurance firms.

Certain international sources could also be of assistance in some cases. These include the Caribbean Hotel and Tourism Association (CHTA), the Central American Tourism Integration Secretariat (SITCA), the Caribbean Tourism Association (CTA), the World Tourism Organization (UNWTO), and international reinsurers.

2. Compilation of information on the situation arising from the disaster

This information is collected from official data provided by the ministries of the country affected and from conversations and/or interviews with economic agents in the tourism sector and with agents working in related sectors. The press provides another source of information, and may serve to provide selective data on the damage. Together, these data give the team analysing the sector an overview of the situation before the field visit.

3. Estimating damage

The estimate of damage in the tourism sector must establish the effect on assets, which are grouped into the following categories: (a) facilities; (b) furnishings, and (c) equipment (including transport equipment). Two basic pieces of information are needed to estimate damages: the extent of destruction of each type of asset and the price of replacement. These should be determined for each of the three categories.

It is important to prepare these estimates in close consultation with the government offices responsible for the sector, as well as with trade groups and producers' associations. The specialist should also verify all available official estimates during field visits.

When calculating damage, the specialist should distinguish between tourism and hotel companies whose assets are backed by insurance, and those whose assets are not. This is important from the point of view of public

[156] Usually the national statistical office or the central bank.

policy. It is reasonable to assume that medium-sized and large hotels and tourism firms will have insurance. Similarly, it is safe to assume that uninsured assets will belong mostly to small firms, which are likely to need greater support from the State in the event of a disaster.

It is also important to quantify the percentage of assets whose recovery will require imports. These assets can be classified later by other parameters such as size, geographical location or the socioeconomic level of the client who requires it.

The first pieces of information come from initial reports on the event issued by official and private sector organizations, which may already contain a preliminary count of the number of establishments with different levels of damage.

This information should be corroborated at meetings with relevant public and private officials and through field visits. All these data together should permit an approximate count of the number of establishments affected and their size (grouped by the number of workers they employ).[157] Next, the damage suffered in each of the categories of assets should be ascertained. The damage is converted into monetary units by valuing the relevant assets in terms of their pre-disaster replacement cost. As mentioned in the introduction, under the definition of the tourism sector used in this chapter, the different types of assets must be differentiated for each of the kinds of business in this sector: travel agencies, tourism operators, providers of recreational services and hotels. Damage should be estimated for each of these.

It must be decided whether to include the estimation of damage to assets such as historical monuments (which are a tourist attraction) under the category of culture (see chapter VIII). In the case of beaches, only damage to assets built for their enjoyment should be included. For this reason, it is important to have direct, ongoing communication with the mission's cultural and environmental specialists to avoid double accounting.

Field visits may involve interviews with the main agents affected in the tourism sector and other sectors in the tourism chain. Such visits should be conducted together with other sectoral experts, especially those in commerce, manufacturing, culture and macroeconomics, so as to integrate the information, avoid double accounting and calculate the overall impact of the disaster on the tourism sector. There follows a summary of the main categories in which assets are to be grouped.

(a) Tourism facilities

Damage under this heading is to be valued at pre-disaster replacement cost. For this, information is needed on the destroyed or damaged floor area, age of the building and the value per square metre of construction in buildings used for tourism purposes. It is important to make sure that the price used per square metre of construction is not a national average, but a (pre-disaster) average for the area where the disaster occurred, and to distinguish between insured and uninsured facilities.

It is also important to classify damaged facilities by size. Smaller tourist concerns are likely to have fewer facilities insured and therefore smaller chances of immediate recovery.

(b) Furnishings

Larger tourist enterprises usually have a proportionally larger endowment of these goods. Medium-sized and small firms have fewer assets and often outsource these services. For assessing damage to furnishings, and depending on the extent of the damage, the simplest and most advisable course is to obtain up-to-date market values.

If the disaster had a relatively small impact on furnishings, however, indirect estimates will suffice. For example, the value invested in hotel furnishings is to some extent proportional to the value of the buildings.

[157] Hotels can be classified by maximum capacity. i.e. number of rooms.

(c) Equipment

Under this heading, information is needed on replacement prices for each piece of equipment in order to value total or partial damage. This category includes the establishment's entire vehicle and waterborne fleet. Estimates will also have to be made for cleaning and maintenance equipment, kitchen equipment, and equipment for common areas, among others. This category includes, as well, electricity plants in hotels and other tourism complexes.

The values of these items refer to the value registered in firms' accounting records, which do not include accumulated depreciation as a function of the number of years of useful life since acquisition. They also show acquisition prices, except in countries with high inflation, where a periodic restatement of physical assets is advisable.

As in the case of buildings and facilities, damage to equipment in large tourism enterprises must be estimated together with their executives, in consultation with the national authorities. These figures must then be examined and adjusted, on the basis of the replacement value of the equipment destroyed.

(d) Other assets

Other assets include roads within tourism developments. Damage to this sort of fixed asset should be recorded under tourism because it belongs to a hotel complex. The valuation should be performed following the guidelines established in the chapter on the transport sector. Water systems in hotel and tourism complexes should also be included under this heading.

C. Losses and additional costs

Damage sustained by tourism establishments located in a disaster area will obviously have a negative impact on the provision of service flows. The following procedure is suggested for estimating losses in this sector:

1. Compilation of pre-disaster information

This information is needed to build a baseline for the estimate, for which data must be obtained on the sector's recent performance and its pre-disaster outlook. This is used to build up a picture of what the sector would have looked like if the disaster had not occurred, to compare with the actual, post-disaster situation. It is important to compile all the monthly data available. Taking an average for previous years without considering the sector's recent performance could produce a biased baseline and therefore an inaccurate estimate of the event's impact.

This information may be obtained from various sources, including:

- National statistical offices, central banks or tourism planning departments.
- Population censuses and annual surveys of economic activity and employment.
- Reports on the number of visitors arriving at airports and other transport terminals.
- Preliminary reports on the event itself issued by government or private sector institutions.
- Statistical information from bulletins published by tourism associations. Also, information available from the hotel association, especially indicators on room occupancy, and from the tourism department.

ECLAC (2011) compiled a list of information on the tourism sector (social and economic data, among others) which can be obtained for the different countries in Latin America and the Caribbean. Below is a list of countries and the type of tourism sector information available for each.

Table XV.2
Latin America and the Caribbean: information available on the tourism sector
(Percentages of GDP)

Country	Annual	Quarterly
Antigua and Barbuda	X	X
Bahamas	X	X
Barbados	X	
Belize	X	X
Bolivia (Plurinational State of)	X	X
Brazil	X	X
Chile	X	X
Colombia	X	X
Costa Rica	X	X
Cuba		
Dominica	X	
Ecuador	X	X
El Salvador	X	X
Grenada	X	
Guatemala	X	X
Guyana	X	
Haiti	X	
Honduras	X	X
Jamaica	X	
Mexico	X	X
Nicaragua	X	X
Panama	X	X
Paraguay	X	X
Peru	X	X
Dominican Republic	X	
Saint Kitts and Nevis	X	
Saint Lucia	X	
Saint Vincent and the Grenadines	X	
Suriname	X	X
Trinidad and Tobago	X	
Uruguay	X	X
Venezuela (Bolivarian Republic of)	X	X

Source: Economic Commission for Latin America and the Caribbean (ECLAC), "América Latina y el Caribe: indicadores macroeconómicos del turismo", Cuadernos Estadísticos de la CEPAL, No. 39 (LC/G.2485-P), Santiago, Chile, 2011. United Nations publication, Sales No. S.11.II.G.1 [online] p://www.eclac.cl/deype/cuaderno39/docs/agrupaciionesypaises.pdf.

2. Estimating losses and additional costs

(a) Losses

Estimation of losses refers to changes in the gross output value associated with the interruption of tourist services and/or the postponement of operation. As in other sectors, the interruption of flows of tourist services has to do with the magnitude of damage. The greater the damage, the longer it will take to replace the assets and, therefore, the longer the flow of service provision in the area affected will be interrupted.

In this example, it is important to recall that the impact is on the establishment and the local economy, not on the sector or the economy at the national level. This is because tourist activity which is suspended in a particular area of a disaster-hit country can be compensated, at the national level, by increased activity in another, unaffected area. In this regard, it is useful to have data on idle capacity in the main tourism-related segments and the activities that have ceased in the disaster area. This will give accurate information for measuring local or regional losses.

Loss of income may be associated with:

- Damage to hotel facilities, in terms of destruction of buildings, furniture and warehouses.
- Damage to the assets of hotel operators.
- Lack of basic services and/or communications. Tourist demand often falls in areas that have been hit by a disaster, because of damage in related sectors, such as road infrastructure and access routes, airports, water and sanitation systems, electricity and communications, and so forth. This can lengthen or worsen unoccupancy in tourism establishments.

Two pieces of information are needed to estimate loss of income:

(i) An estimate of how long it will take for service provision to return to pre-disaster levels. It is important to consider the seasonal nature of tourism, because if the interruption occurs in high season the lost revenue will be greater than if it occurred in low season. In addition, although it will represent a small proportion of the costs, it is advisable to estimate possible cancellations of foreign reservations months after the event. This can occur owing to lack of information on the state of facilities, the services in the sector and related activities.

(ii) The monthly value of the services not provided. This estimate should be performed for the various items: accommodation, entertainment, food industry and commerce associated with tourism. Tourism associations and offices often compile information for estimating the amounts that would be lost in the event of the suspension of tourist services, and these can be used to determine which establishments have been worst affected. Interviews should be conducted with senior staff of these organizations, and with those of hotel associations and tourist agencies and operators, then systematized to draw conclusions about activities that have ceased in the sector.

The gross value of lost income is then obtained by multiplying the two items above. This refers to forgone revenues, i.e. the sum that, because of the disaster, will not now be earned.

As noted above, revenue losses also occur when the disaster forces the postponement of tourist services not because of destruction of company assets but because of, for example, damage to an airport, a port or roadways. In this case, tourism activity can be resumed almost as soon as connections are restored, since the establishments themselves were not affected. This is assuming that obstacles to the arrival of tourists have been removed.

In order to estimate the gross value of what will no longer be produced, then, it is necessary to quantify the time the activities have been postponed and multiply that by the average monthly income of the tourism sector in the area. It is important to include related activities and the value chains in which different economic agents are providing services to the tourism sector.

In performing these estimates, it is important to include and differentiate the losses in small firms with little capital to finance their recovery, SMEs and firms without insurance.

(b) Additional costs

Flows can also be altered by additional costs to the sector, associated, for example, with:

- An advertising and information campaign to attract national and international tourists back to the area.
- A rise in insurance premiums in response to the possibility of another disaster occurring. This can erode revenues and reduce the return on activities in tourism establishments.

Some of these additional costs will increase intermediate consumption and therefore reduce the sector's value added. They may also lead to an increase in gross value in other sectors. This positive impact on activity in other sectors should be captured in the assessment.

D. Financial needs for recovery and reconstruction

1. Financial needs for recovery

Tourism's close link with other sectors of the economy makes it essential to take immediate action to restore all types of transport activities and to recover road and airport infrastructure and communications in general. Production activities and other vital services, like water and sanitation, are also essential to the sector.

In the case of beach tourism, as well as repairing facilities, it is essential to begin work as soon as possible on clean-up and the removal of debris preventing the use of sea and river fronts.

Given the nature of this sector, based on inflows of local and foreign visitors, it is particularly important to advertise the recovery and rebuilding of the facilities. The government and private enterprise often share the costs of this if tourism is an important economic activity for the region or country.

Small and medium-sized tourism firms will also need support, since most of them lack insurance. This may take the form of special credit lines for recapitalization, based on temporary schemes of low-rate lending, secured by the government to lower risk.

Generally speaking, the government should not only share the cost of advertising campaigns with private business, but should also help to generate lines of credit for recovery and recapitalization, channelled through the banking system as described for manufacturing and commerce.

2. Financial needs for reconstruction

The reconstruction of large hotels and related services is usually financed by insurance payments. In this case, the government should monitor that new buildings meet disaster risk reduction standards in terms of both location and infrastructure. For small hotels and microenterprises, however, as well as overseeing compliance with standards, the State may provide support through concessional lending to support reconstruction of damaged facilities and related equipment.

Part V
Overall and cross-cutting effects

XVI. Macroeconomic impact

A. General considerations

The information gathered by sector-specific task forces should be consolidated and used as a basis for estimating the impact of the disaster on various macroeconomic aggregates, such as GDP, employment, public finances and external accounts, both over the short term (usually the year in which the disaster occurs) and over the medium term (the time required to recover and rebuild). It is best if this task (the consolidation of information on damage, losses and additional costs) is carried out by a team headed by a specialist in macroeconomics and a specialist in national accounts.

One of the tasks that the team should carry out beforehand is to compile historical series on the various macroeconomic aggregates so that its members can gain an understanding of the economy's main characteristics, i.e. the major production sectors and their locations, the main exports, trends in external trade balances, fiscal accounts, external and domestic public debt, past trends in inflation, general economic trends and the current phase of the business cycle. This information should be gathered before beginning the work involved in estimating the effects and impacts of the disaster, as suggested in chapter II. It is recommended that the persons involved in this effort should include staff members of the national statistical office, the central bank, the budget office, the ministry of finance and other departments responsible for producing these statistical series. Once all of these data have been compiled, it is advisable to give a presentation or to disseminate this information by other means to the members of the team who are going to be working on the impact estimates so that they will have an overall picture of the economy of the country in question and of how important the sector that they are going to be studying is in terms of the economy as a whole and the disaster zone.

It is also important for the group assigned to assess the macroeconomic effects of the disaster to check the consistency of the various estimates by comparing the expected trends in the relevant variables with the results arrived at based on the sectoral, regional or partial compilations of information that are provided. An assessment of the economy's expected performance and the expected behaviour of its main aggregates are inputs that will be needed in order to proceed with the macroeconomic analysis.

This chapter is structured as follows: section B discusses how the information on the damage caused by the disaster should be consolidated; section C provides an overview of how the losses and additional costs should be aggregated; and section D shows how these inputs should be used in estimating the impact on macroeconomic aggregates.

B. Consolidation of the damage and timetable for reconstruction

The data on the damage sustained in each sector should be aggregated in order to obtain a figure for the total damage caused by the natural disaster. If the replacement of damaged assets or the reconstruction plans will involve applications for loans from international agencies, then these sums could be expressed in a hard currency.

A decision will have to be reached as to the monetary units and currencies in which the information on damage, losses and additional costs will be presented. Throughout this handbook, it is suggested that the local currency and current prices for the year in question be used. This should be made clear at the beginning of the report and should be added as a subheading in each table. As noted below, specific types of information (e.g. data on external accounts) may be given in a different currency. The same exchange rate should be used for all the conversions made in the report, and an explanation of the approach used for this purpose should be provided.

It is suggested that this information be presented in a number of different ways, such as:

(i) Disaggregated by department or province. As mentioned elsewhere in this handbook, the impacts of disasters are primarily local in nature, and this is why geographical disaggregation of the data is so important. Providing a sectoral profile of the damage that is broken down by department or province will provide a clearer picture of the damage sustained by each sector in each federal or regional administrative district.

(ii) Percentage and amount of the damage sustained by the public sector and by the private sector. This quantification will show how much of each sector's assets have been affected by the disaster. In the case of the private sector, separate compilations should be provided on the damage sustained by corporate assets and by household assets, to help visualize the impact of the disaster.

(iii) Percentage of the damaged assets that were covered by insurance. This information, when combined with the disaggregation for the public and private sectors, will provide policymakers with an idea of the priority financial burden involved and figures for uninsured household assets and uninsured public-sector assets.

(iv) Imports required for recovery and reconstruction in each sector. This information will provide an approximate idea of the impact that the disaster will have on external accounts over a number of years as assets are gradually replaced. It is important to express the cost of recovery and reconstruction for each year in hard-currency terms.

Replacing assets, especially if this involves reconstruction, may take several years, which will obviously have an impact on macroeconomic variables during different periods of time (e.g. GDP via the investment that this will entail). Because this will also have an impact on economic activity, especially in a labour-intensive sector such as construction, jobs will be affected as well. The impact on external accounts will be determined by the import component of the replacement or rebuilding of assets in each of the years following the disaster. This coefficient will vary over time. One of the factors that will influence the trend in these variables will be the speed of the replacement and reconstruction process, which will depend on the economy's ability to execute these works and on the private and public sectors' capacity for financing them. The timetable for the replacement or reconstruction of assets will largely depend on the financial constraints under which the public sector is operating. Different scenarios for the pace of reconstruction are a valuable input for computation of the different possible trends that these variables may follow in the future.

These damage estimates will provide an idea of the disaster's impact on the economy's capital assets. The damage to be deducted from total assets is the damage or destruction of assets that have not been fully depreciated. The useful life of any given asset is determined by the amount of time that has passed since it was built. This is why so much emphasis has been placed throughout this handbook on the importance of determining the year of construction of each asset that has been damaged or destroyed.[158]

The quantification of the damage can also be used to estimate the impact on potential GDP. To this end, residential capital has to be separated from non-residential capital, since the former is not used for production.[159]

[158] For further information on the useful life of various assets, see Aravena, Jofré and Villareal (2009).

[159] As noted in chapter II, ECLAC has estimated potential GDP for many different countries in Latin America and the Caribbean. See Aravena (2010).

Box XVI.1, which is based on Aravena (2010), explains the methodology to be used for estimating this variable. Box XVI.2 discusses the approach used to estimate the impact on potential GDP in 2010 of the heavy rains and flooding that occurred in Colombia.

Box XVI.1
Estimating potential GDP

An economy's potential growth rate, which is understood as being the rate that it would achieve if its production resources were in full use, is one of the most important concepts in economic analysis and particularly in economic policy decision-making. Potential GDP is not an observable variable, however, and it therefore has to be estimated.

A summary explanation will be provided here of the approach used to estimate potential growth in Latin America based on the production function methodology, which offers the advantage of being based on a solid theoretical model, unlike other purely statistical methodologies. This approach involves estimating total factor productivity (TFP) and making an assessment of the potential use of factors of production (labour and capital).

TFP is calculated by computing the difference between GDP growth rates and the corresponding rates for labour and capital stock, with the latter being adjusted on the basis of an index of installed capacity use.

The capital stock of the different types of production assets available in the economy is estimated using the following formula:

$$K_{t,j}^{p} = \sum_{\tau=0}^{T_j} I_{j,t-\tau} R_{j,\tau} E_{j,\tau}$$

where $I_{j,t-\tau}$ is the investment of age τ expressed at constant prices, $R_{j,\tau}$ is a function of retirement from use, which determines the proportion of the investment made τ time ago that is still in effect, while $E_{j,\tau}$ represents the age-efficiency profile; this profile indicates show much productive efficiency is lost as assets age.

In order to attain the greatest possible coverage in terms of geography and time frames, just two types of production assets are considered: machinery and equipment, and construction,[a] which have average useful lives of 20 and 50 years, respectively.[b]

In order to ascertain the scale of the flow of capital services, information is gathered on the effect of variations in installed capacity use throughout the full range of the business cycle. Variations in the use of installed capacity are estimated on the basis of energy consumption series.

Potential employment is measured by deducting the trend unemployment rate, as estimated using the Hodrick-Prescott filter, from the economically active population as published by the International Labour Organization (ILO).

Source: Economic Commission for Latin America and the Caribbean (ECLAC).
[a] Based on official figures on gross fixed capital formation for each country.
[b] Sensitivity analyses have been conducted for a variety of average life cycles and rates of efficiency loss; at the extreme ends of the spectrum, the rate of variation for capital is less than 10%.

C. Consolidation of lost production and additional costs

The flows that are altered as a result of the disaster are classified as losses (mainly what would have been produced that was not and deferred production) and additional costs (as explained in chapter II). Losses and additional costs are expressed in gross terms. In order to measure their impact on the sector concerned, they need to be converted into aggregate values using the coefficients for the country's input-output matrix. This has to be done on a sector-by-sector basis because the technical coefficients are different for each sector.

When reference is made to losses and additional costs, it is best to determine whether the reference is to gross value or value added. The use of one or the other will depend on the context. For example, if additional costs are to be expressed in terms of economic activity, then value added should be used, since GDP is the sum of regional aggregates. If, on the other hand, the focus is on a disaster's impact on public finances, then the figures should be expressed in gross terms, since, in this case, the point is to see what total public expenditure has been or will be. For the reasons stated in chapter II, it is important to separate the gross output value that was not produced or whose production was deferred from additional costs. The gross output value that was not produced, by sector, should be added in order to calculate the total gross output value. The same thing should be done with the deferred gross output value and with additional costs.

As in the case of damage, this information should be disaggregated in various ways in order to show how the production losses have been distributed spatially and between the public and private sectors. In presenting the data on the gross output value that was not produced or that was deferred, the following categories are suggested:

(i) By department or province. This disaggregation is important because, as mentioned earlier, it will show up the local nature of the disaster's impact.

(ii) Percentage and amount corresponding to the public sector and to the private sector. If possible, small-scale producers should be shown separately from the rest. Also, again if possible, these data should be disaggregated by department or province.

(iii) The market for which the gross output value that was not produced or that was deferred would have been destined (i.e. the domestic or external market). The latter datum will show the scale of the impact of the natural disaster on exports.

In the case of additional costs, it is suggested that, in addition to presenting the data by department/province and by public/private sector, the data on the impacts on public-sector finances should be disaggregated by the level of government concerned. This is explained in detail in section D.2.

D. Macroeconomic impact

The information on damage, losses and additional costs is used to estimate the impact that the disaster has had on economic activity, employment, household income, public finances and external aggregates. This effect is basically the difference between what would have happened in each of these areas if the disaster had not occurred and the projections of what is going to occur in its aftermath. It is important to note that both of these scenarios are hypothetical.

The general approach[160] to estimating this differential for GDP, employment, the fiscal balance, the inflation rate and the external balance is as follows:

(i) Compilation of historical statistical series on each of these variables with a view to gaining an understanding of the characteristics of the economy before the disaster occurred. It is important to take into account what phase of the business cycle the economy was in when the disaster occurred, since all of the above-mentioned variables will be strongly influenced by that factor. Disregarding this factor can lead to an underestimation (if the economy was in the upswing of the business cycle) or overestimation (if the economy was in the downswing of the business cycle) of the impacts.

(ii) Compilation of detailed information on what the expected trends in these macroeconomic variables for the rest of the year were before the disaster hit —in other words, the most recent projections for each variable developed by government agencies (ministry of finance, ministry of economic affairs and the central bank). It is best if these projections specify all the relevant information (including the trends observed in the economy as a whole during the year). For example, if a natural disaster were to occur in July, the projections should include all the data covering the period up to that point in time. If the projection is from the end of the preceding year or the beginning of the current year, its use may lead to a bias in the estimation of the impact on these macroeconomic variables.

The projections for the different variables should be consistent with one another, and this should be considered by the task force and discussed with the appropriate authorities. If these projections are not up to date at the time of the disaster, they should be cross-checked using the macroeconomic data for the year. If these data are not available, the macroeconomic task force should work with its national counterparts to compile updated data.

(iii) On the basis of these estimates of losses and additional costs, and looking at what portion of the damaged assets may be replaced or restored within the year, the next step is to build hypothetical post-disaster scenarios for these macroeconomic variables.

[160] The specific factors of importance in each case will be discussed in the corresponding subsections of this chapter.

1. Economic activity

The estimation of a disaster's impact on economic activity is based on supply-side estimates of GDP and, as such, is derived from the information on each of the affected sectors that is compiled by specialists in that sector. The procedure to be used for estimating the impact on economic activity is as follows:

(i) Compilation of pre-disaster information. This includes both past and more recent information, which should encompass all the relevant economic data for the current year up to the time when the disaster hit.

This includes:

- GDP series, which can be derived from the national accounts by branch of economic activity.
- All the available information on monthly variables relating to economic activity.[161]
- Input-output matrices.

If the country publishes GDP statistics for each department, then all of this information should be compiled for use in gauging how influential the economic activities of the departments hit by the disaster are in the overall economy and in determining what their pre-disaster production profiles were.[162]

(ii) Projected pre-disaster trend in GDP for the rest of the year. This is the baseline information for the estimates and covers the sector's recent performance as well as an extrapolation of how it would have performed if the disaster had not occurred. Official economic projections can be obtained from the ministry of finance, the central bank or the ministry of economic affairs. It is important to mention the source of the official projections in the report.[163] If no such projections are available or if they do not include pre-disaster data, then they will have to be prepared by the members of the team who are specialists in macroeconomics and national accounts.

These projections should be prepared at the sectoral level, since this is the appropriate level of disaggregation for impact assessments. In other words, a baseline should be prepared for each sector.

(iii) Post-disaster GDP projections. These projections should be prepared for, at the least, one- and two-year horizons using the following procedure:

- Changes in flows should be divided into those that have a negative effect on economic activity and those that have a positive effect. The former include lost and deferred output. The latter include additional costs and the percentage of the damaged assets that are going to be replaced in the current year. The baseline scenario may be one in which there will be no reconstruction, which will show up the effects of the disaster, since no action will be taken to return the economy to its pre-disaster state.[164]
- Note that the national component of the losses sustained by various production sectors, such as crop-farming, stock-raising, fisheries and manufacturing, is computed using producer prices.[165] These should be converted to consumer prices, since those are the prices used in calculating GDP. In fact, this correction, less specific taxes and the sector's input costs (which can be derived from the technical coefficients of the input-output matrix), constitutes a loss that is attributed to the commercial sector, as explained in chapter XIV. Care should be taken in this regard in order to avoid double accounting.
- The data should be disaggregated by subsectors corresponding to the disaggregation of the input-output matrix so that the coefficients will be correct.
- Using the coefficients of this matrix, each one of the components of the disruption of flows (additional costs, losses and the portion of the damage that may be repaired during the current year) should be converted into value added.

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[161] For a list of possible variables to be used, see Cantú, Acevedo and Bello (2010).

[162] The national staff responsible for compiling these statistics at the departmental level should be consulted or asked to join the macroeconomic team so that they can help the team gain a deeper understanding of the data.

[163] In the event that the information from various sources (e.g. the central bank and the ministry of finance) differs, government counterparts should be consulted in order to decide which source should be used.

[164] If this type of situation is not likely to occur, as in the case of countries that have sufficient resources to carry out a large part of the recovery and reconstruction works on their own, then this item should not be included (as in the case of Colombia discussed in box XVI.2).

[165] This is not necessary when dealing with retail commerce, since consumer prices are already being used.

- For the damage that may be repaired during the current year and assets in the process of being rebuilt, it is advisable to construct two scenarios for possible paths to be taken by the economy following the disaster.
- The impact on economic activity in each sector, in each of these scenarios, will be estimated by deducting the net effects of the disruption of flows from the hypothetical course of economic activity in the absence of the disaster.

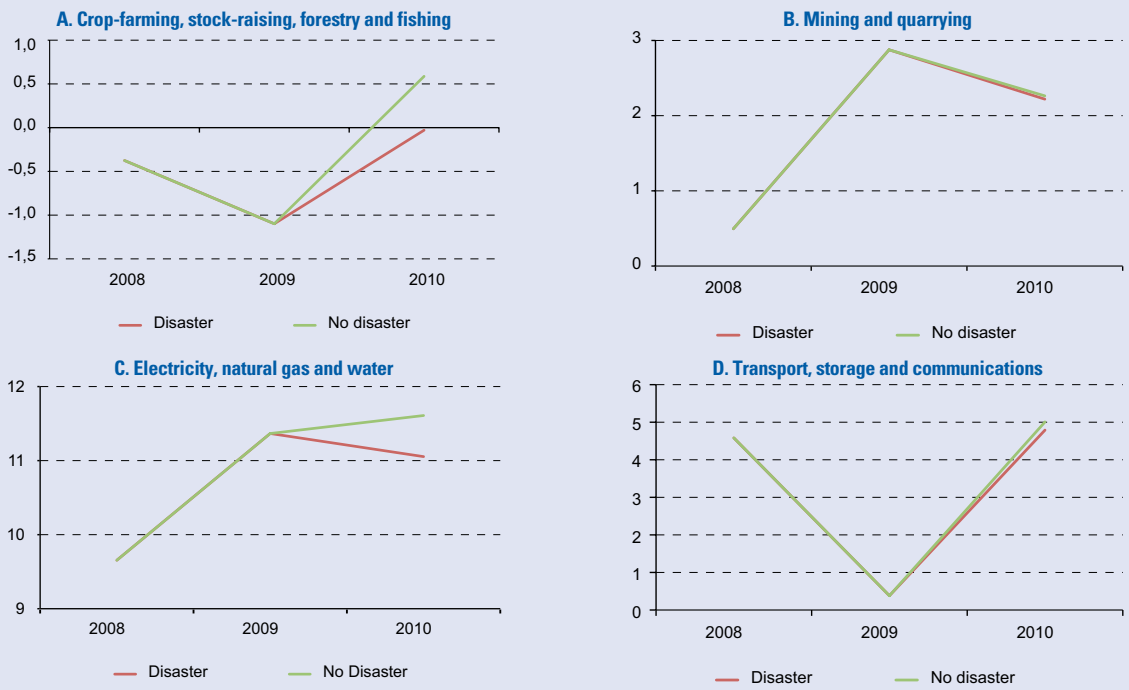
If GDP data by department are available, then it is best to estimate the impact of the disaster at that regional level. Box XVI.2 provides an example of the procedure used to arrive at an estimate of this type for the winter storms that hit Colombia during 2010-2011.

Box XVI.2
Impact of the 2010-2011 winter storms in Colombia on economic activity

The impact on economic activity of the rains and flooding that occurred in Colombia in 2010 is estimated at 0.12 percentage points of GDP growth. If these storms had not occurred, GDP growth is projected to have been 4.43%; as it was, the rate was 4.31%. The hardest-hit sector was crop-farming, stock-raising, hunting and fishing, followed by mining and quarrying.

Ultimately, the rains and flooding destroyed 0.56% of the existing production capital (valued at 6.7 trillion Colombian pesos), or 5.7% of gross fixed capital formation for 2010, with most of this being accounted for by damage to communication routes, public services and utilities, and agricultural infrastructure. Damage to capital assets, including residential capital, amounted to 9.6% of gross capital formation for 2010. Given the amount of GDP accounted for by capital assets, this corresponds to a decline in the country's production capacity, or potential GDP, of around 0.4 percentage points. Given the scope of the reconstruction programme, this decrease can be reversed, thanks to the scale of investment and productivity boosts afforded by the fact that the replacement equipment will be more efficient.

Figure 1
GDP growth, by selected branches of activity, 2005-2010
(Percentages)



Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of official figures.

Box XVI.2 (concluded)

Impact on regional GDP

Estimates of the impact on GDP in Colombia were prepared. Given the fact that the flooding was so localized, however, an effort was made to arrive at approximations of the effect on GDP in certain departments based on the following assumptions:

(i) The departmental structure in terms of branches of economic activity has been unchanged since 2007, the last year for which these data were available from the National Administrative Department of Statistics (DANE).

(ii) Information was available on crop-farming, stock-raising, forestry, hunting and fishing; transport, storage and communications; and mining and quarrying.

Coal mining is a major activity in the two hardest-hit departments: La Guajira registered a drop of nearly 6.6 percentage points in its GDP growth rate, while Cesar witnessed a 4.0 percentage-point decrease. They were followed by other departments in which agriculture was hurt: Sucre had a 1.1 percentage point decline in growth; Quindío, Meta, Norte de Santander and Magdalena all recorded drops of 0.4 percentage points. Other departments, such as Valle, Santander and Atlántico, sustained heavy losses in absolute terms in crop-farming, stock-raising, forestry, hunting and fishing, but because they are bigger, the decrease in their GDP was small in relative terms. This demonstrates that gaining an overall picture of the effects of the disaster involves capturing sharply differing impacts from one region to the next, which will, in turn, require the compilation of up-to-date regionally and locally disaggregated statistics.

GDP in 2011

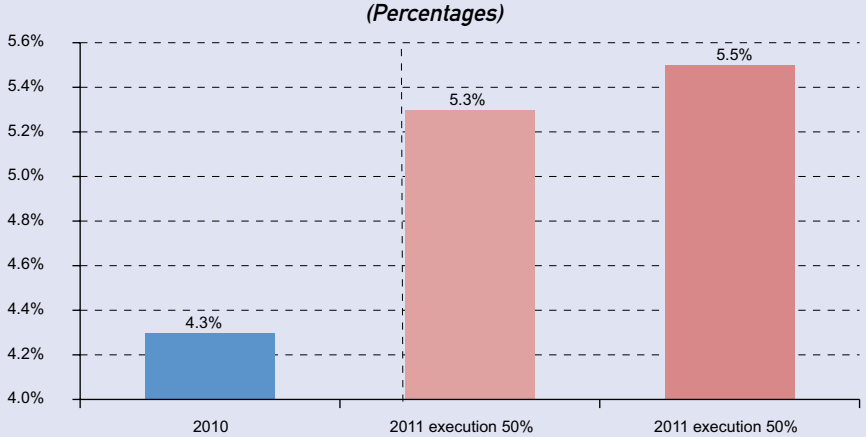
GDP growth in 2011 outstripped GDP growth in 2010. The year-on-year variation in GDP growth for the second quarter of 2011 amounted to 5.2%, 0.5 percentage points higher than that registered in the second quarter of 2010. The three activities that recorded the fastest year-on-year growth rates in the second quarter of 2011 were mining and quarrying (10.3%), commerce, repairs, restaurants and hotels (7.2%), and transport, storage and communications (7.1%). In mining and quarrying, this trend was chiefly accounted for by rising value added for crude oil and natural gas and for minerals such as uranium and thorium. In the commercial sector, retail sales and, in particular, the upturn in sales of durable goods, were drivers of growth. The four slowest-growing sectors were construction (-0.5%), electricity, natural gas and water (1.5%), manufacturing (2.1%) and crop-farming, stock-raising, hunting, forestry and fishing (2.2%).

Economic activity in the first quarter of 2011 was still affected by the rains that had begun in October 2010. The decline in expected income for 2011 was much smaller than it had been in 2010. The results recorded up to the second quarter indicate that these effects were far outweighed by the economy's performance and by spending associated with the emergency and recovery efforts. Growth projections for the Colombian economy were revised upward in the first half of 2011, and ECLAC estimated that growth of the Colombian economy for 2011 would be 5.3% (see ECLAC (2011b)).

In 2011 the government spent an estimated 6.55 trillion pesos on emergency assistance and on investment in mitigation and adaptation. The expenditure of all these resources posed a major challenge for Colombia's public sector, given how far advanced the year was and other macroeconomic considerations, such as the fact that the government had been adopting a more prudent fiscal stance in view of the level of uncertainty existing in the external economy. Since these expenditures mainly concerned non-tradables, they can be expected to have contributed to an appreciation of the real exchange rate. This could have the opposite effect on inflation, as, although increased demand could add to inflationary pressures, the appreciation of the exchange rate would be expected to curb price increases.

Given these conditions, it was projected that the Colombia economy would close out 2011 with a growth rate of between 5.3% and 5.5%. The upper value in this range could be reached if all the above-mentioned resources were actually spent. As shown in figure 2, the lower value would be registered if around 50% of the budgeted expenditures were executed. Given the data constraints existing at the time that this exercise was undertaken, the estimates for 2011 were regarded as being of indicative value only. If the timetables for the reconstruction projects, disaggregated by department, had been available, the estimate could have been more accurate.

Figure 2
GDP growth rate, 2010-2011
(Percentages)



Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of official figures.

Source: Economic Commission for Latin America and the Caribbean (ECLAC)/Inter-American Development Bank/National Planning Department of Colombia (ECLAC/IDB/DNP), *Valoración de daños y pérdidas: ola invernal de Colombia 2010-2011*, Bogota, 2012 [online] http://www.cepal.org/publicaciones/xml/0/47330/OlainvernalColombia2010-2011.pdf.

2. Public finances

Data on the additional fiscal costs associated with a disaster are an important input for the public sector, given its role in the emergency, recovery and reconstruction efforts. The total cost is the sum of increased expenditure and a potential decrease in tax receipts. Because these two items are so disparate –since the former is made up of actual outlays, whereas the second has to do with the failure to collect some portion of projected tax revenues– it is best to calculate the two figures separately. The increase in expenditure encompasses:

(i) A considerable time horizon, since the increase will include both short-term items, such as the provision of shelter and food, the establishment of temporary schools and hospitals, the clearing of a transport route and so forth, and long-term works, such as those involved in replacing damaged assets or rebuilding infrastructure, which will require expenditures over a multi-year time frame.

Box XVI.3 shows the annual amounts to be spent on emergency and reconstruction works in Colombia in 2011-2014 and the corresponding funding sources. The reader will see that, in this case, the increase in expenditure was financed by a number of different sources: sale of public-sector assets (Colombian Petroleum Company (ECOPETROL)), wealth taxes and a tax on financial transactions, and public-sector borrowings that are to be repaid over a three-year time horizon.

(ii) A broad institutional structure, since the situation involves all the various (i.e. national, departmental and municipal) levels of government. The main objective in this connection is to estimate the impact on central government finances, since usually a natural disaster leads to the declaration of a state of emergency, which means that the central government will take the necessary actions because the disaster is of a scale that exceeds the capabilities of subnational governmental structures. If possible, given the localized nature of such events, an attempt could be made to quantify the fiscal cost for government structures at the regional level.

The potential downturn in tax revenues is associated with declines in income tax receipts, since the pace of economic activity can be assumed to slow down, and decreases in the revenues from taxes such as value added tax (VAT) owing to losses in the various production sectors. In all of these sectors, except commerce, the gross value of lost output is measured in producer prices. Converting these figures into consumer prices entails including the costs to the commercial sector, its profit margin, and VAT and other taxes. Note that the increase in these types of taxes that may be generated by any of the additional costs, as noted above, should be deducted.

The following procedure for estimating the fiscal impact of a disaster is recommended:

(i) Obtain information on past and recent trends, with emphasis on the pre-disaster trends in fiscal accounts. For the historical data, it is best to have accounts showing outlays and income, disaggregated according to various categories, for at least the last eight years. The object is to understand the structural characteristics of the country's fiscal accounts, i.e. trends in the main sources of tax receipts, expenditures by operational categories, the historical budget execution percentage, etc.

For recent trends, the information should be provided on a cash basis, that is, what was collected and what was spent prior to the disaster. All of this information can be obtained from two sources: the finance ministry and the national budget office. The budget offices of regional governments should also be consulted.

(ii) Ascertain what the fiscal balance was expected to be for the rest of the year if it had not been for the disaster. This information is usually provided in the national budget. Because this provides the assessment baseline, it is important to correct the figures for the historical budget execution percentage and for other events, such as any additional credits that may have been approved prior to the disaster.

(iii) Determine the nature of any possible post-disaster fiscal balance scenarios. These scenarios will be determined, as in other cases, by the extent of the damage that is to be restored in the same year that the disaster occurred, the timetable for reconstruction in subsequent years and the sources of financing for the work to be done.

Box XVI.3
Impact of the 2010-2011 winter storm on public finances in Colombia

In order to provide some leeway for the achievement of short-term and medium-term goals (See Ministry of Finance and Public Credit of Colombia, 2010) and to ease the pressure on macroeconomic equilibria, the Government of Colombia decided to spread out the fiscal cost of expenditures and investments undertaken in response to the 2010-2011 rains and flooding. This box presents the costs incurred in 2010 separated from those that will be recorded during 2011-2014.[a]

(1) Fiscal cost in 2010

The fiscal cost of the 2010 winter storms amounted to 0.2% of GDP, which was equivalent to 1 trillion pesos. The central government's deficit closed out at 3.9% of GDP, which was 0.2 percentage points less than the deficit recorded in 2009 and 0.4 percentage points below the initial deficit projections for that year. The fiscal deficit for the consolidated public sector, including the cost of the disaster works, was 3% of GDP.

In 2010, the extrabudgetary funds allocated for dealing with the emergency were administered by the National Disaster Fund. Since these arrangements were made towards the end of 2010, a substantial proportion of the funds (approximately 85% of the total) were to be spent in 2011.

(2) Fiscal cost in 2011

The general budget for 2011 was modified (Decree No. 145 of 21 January, declared unenforceable by the Constitutional Court) to allow for an additional 5.7 trillion pesos in funds, to be financed with current revenue (15%), capital resources (76%) and special funds (9%). The responsibility for administering those funds was assigned to the National Disaster Fund (3.5 trillion pesos), the Adaptation Fund, which was founded under Decree No. 4819 of 2010 (1.5 trillion pesos), and to various other existing funds such as the National Royalties Fund and the National Social Housing Fund (FONVIVIENDA) (0.7 trillion pesos) (see next table).

The additional resources were to come from an increase in the property tax base, from a 25% surcharge to be levied on those already paying the financial transactions tax (Decree No. 4825 of 2010), from the transfer of stock in ECOPETROL (Decree No. 4820 of 2010, found to be unenforceable by the Constitutional Court on 4 April 2011 (Decision No. C-242)), from the National Royalties Fund, from unused resources of the Coffee Sector Reconstruction Fund (FOREC) and from the issuance of short-term domestic debt.

Executing the budget allocations for emergency response actions and reconstruction works in 2011 and the unused funds from 2010 posed a major challenge. Nearly 40% of all the expenditures under these headings were to be carried out in 2011. The scenarios used to estimate the GDP growth rate for 2011 differ in terms of the percentage of budget execution, which can be expected to have a smaller multiplier effect because most of this expenditure was being financed with tax revenues. The possible inflationary impacts of these expenditures, which are channelled into non-tradable goods, should be monitored. Financing the National Disaster Fund in 2011 entailed an additional 1.7 trillion pesos of indebtedness that should be covered in 2013-2014 by increased tax receipts.

Colombia: sources of financing for emergency action and adaptation measures, 2011-2014
(Trillions of pesos)

Year	2011	2012	2013	2014	Total
Total	5.7	2.3	2.6	3.8	14.4
National Disaster Fund	3.5	1.8	--	--	5.3
Property tax	0.8	0.8		0.7	2.3
Financial transactions tax		1.0	1.0		2.0
FOREC	0.9				0.9
Debt	1.7		(1.0)	(0.7)	
Adaptation Fund	1.5	0.5	2.6	3.8	8.4
ECOPETROL	1.5	0.5	1.8	3.7	7.5
Property tax			0.8	0.1	0.9
Direct responsibility	0.7	--	--	--	0.7
National Royalties Fund	0.4				0.4
FONVIVIENDA	0.2				0.2
Special funds	0.1				0.1

Source: Ministry of Finance and Public Credit of Colombia.

(3) Fiscal cost 2012-2014

During this period, the emphasis will be on adaptation, with 79% of the expenditure related to the impact of the winter storms falling under that heading. The receipts from the sale of ECOPETROL stock are to finance 69% of the expenditure for this period and 87% of the Adaptation Fund. This operation will entail below-the-line financing.

Source: Economic Commission for Latin America and the Caribbean (ECLAC)/Inter-American Development Bank/National Planning Department of Colombia (ECLAC/IDB/DNP), *Valoración de daños y pérdidas: ola invernal de Colombia 2010-2011,* Bogota, 2012 [online] http://www.cepal.org/publicaciones/xml/0/47330/OlainvernalColombia2010-2011.pdf.

[a] Information from the National Public Budget Department and the Macroeconomic Policy Department of the Ministry of Finance and Public Credit and the Public Investment and Finance Division of the National Planning Department. Includes additional public expenditure undertaken in response to the winter storms; does not include public investment in risk reduction actions that had been budgeted for in 2011 before the disaster hit.

3. Inflation

Prices are another economic variable that could be affected by a disaster. Information on price levels is published on a monthly basis, chiefly by national statistical offices. It is unlikely that the disaster will have any major impact on the overall rate of inflation, even for a few months, since this rate is calculated on the basis of a weighted index of the shopping basket of a typical consumer, which includes a wide variety of products, and the supplies of such a wide range of items are unlikely to be affected all at once.

Generally speaking, the rate of price increases in a country is calculated on the basis of the consumer price index (CPI) for metropolitan areas or, if the index is constructed, the national CPI. This is another reason why the index may not reflect the impact of the disaster. As has been emphasized earlier, most natural disasters are localized.

A closer look at the price indices for certain categories and subcategories of goods and services could provide a clearer picture of the effects on this variable.[166] This information would be a useful input for determining the effect of the disaster on the prices of products that are most likely to have been impacted. For example, if there have been floods, information provided by the agricultural expert could be used to determine which crops will yield smaller harvests. This supply shock may be reflected in price increases if the area is a major producer of certain goods for the nation as a whole and if any excess demand cannot be met with imports.

Another type of information that can be useful in tracking price changes is provided by the price indices for major cities which are prepared in many countries. The price index for the city closest to the disaster area could be monitored; however, this information will still be for that urban area. Information of this type on rural areas is usually not available.

Lastly, it is important to determine whether the published CPI has been adjusted for seasonality. If it has not, then projections for this variable will have to take seasonal variations into account, since these are known to be an important element in price series.

The following procedure for estimating a disaster's impact on this variable is recommended:

(i) Compilation of pre-disaster information, which should include not only the trend in the overall CPI, which is used to calculate the inflation rate, but also the different categories or classifications and the CPIs for the relevant cities.

(ii) The projected inflation rate for the rest of the year before the disaster struck. This projection can usually be obtained from the central bank.

(iii) Post-disaster inflation projections.

In summary, a disaster is unlikely to have a significant impact on inflation. This analysis can be usefully targeted on the trend in prices of a given category of the CPI, however. In addition to any quantitative information, sectoral analyses can be undertaken to determine the impact of supply constraints (owing to smaller harvests, losses of manufactured goods, the interruption of marketing channels or damage to transport routes, among other things) on the prices of given goods and services that will have to be supplied by alternative means.

[166] In Colombia, for example, the National Administrative Department of Statistics (DANE) used the following categories: food, housing, clothing, health, education, leisure, transport, communications and other. Price indices for these subcategories and even for individual products are generally available on request.

Box XVI.4
Impact of Colombia's 2010-2011 winter storms on inflation

Prices rose by 3.2% in 2010, which was just slightly above the mid-point of the target range (2%-4%) set by the Bank of the Republic. This represented an increase of 1.2 percentage points over the 2009 level, which was depressed by the trend in commodity prices on international markets as a result of the global financial crisis.

The categories in which the highest inflation rates were recorded were health (4.3%), food (4.1%), education (4.0%) and housing (3.7%). Health, education and housing prices rose the most during the first three quarters, when the cumulative rates of increase amounted to 94.2%, 99.0% and 81.5%, respectively, of the total inflation rate for the year. In the food category, which has a weighting of 28.2% in the CPI, 36.4% of the annual inflation rate was registered in the last quarter.[a] Since the disaster is likely to have affected food prices as a result of poorer harvests or difficulties in transporting foodstuffs from production zones to urban centres, where consumption is concentrated, the analysis will be focused on this category.

Annual inflation as measured by the CPI and the CPI category for food rose steadily from October on (see figure 1). In view of this steady increase, the Bank of the Republic decided to send a signal to the market by raising its intervention rate by 25 basis points on 25 February 2011 (from the 3% level that it had been since April 2010 to 3.25%), thereby possibly launching a relatively contractionary phase in the monetary policy cycle.

Within the category of food products, the subcategory for which the sharpest price increases were recorded in the last quarter of 2010 was perishables, in which prices climbed by a cumulative rate of 11% in 2010; the largest increase within that subcategory was for vegetables, for which the inflation rate was 15.3%. The basic rates of expenditure in 2010 that rose the most were those for onions (75%), other fresh vegetables (55.6%), peas (30.2%), other root vegetables (23.4%), and sugar cane (21.8%). Perishables are weighted at 3.9% in the CPI and at 13% in the food category for the CPI.

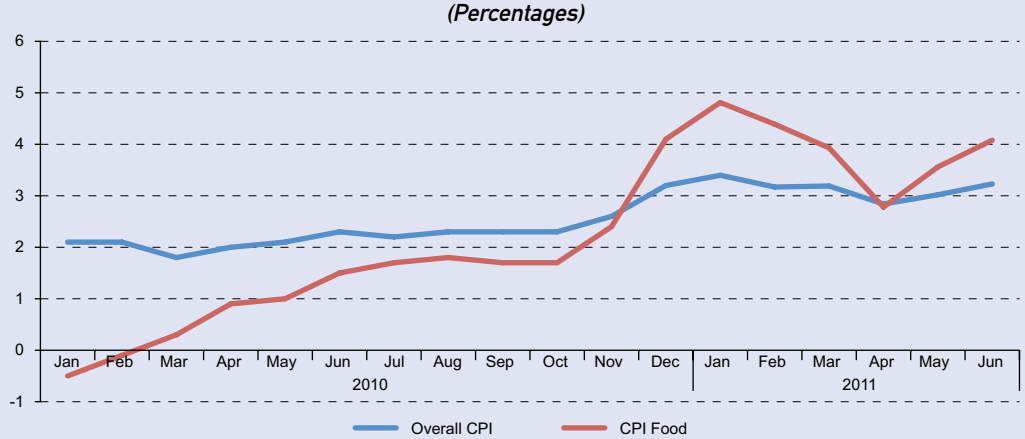
While the inflation rate for the final quarter was heavily influenced by the rise in food prices, the upswing was not entirely attributable to the winter storms. Two other variables that were at work were the fact that agricultural prices always tend to rise during the winter and the fact that the prices of these products were rising on international markets during this period.[b] In fact, food prices had been climbing since the second half of 2010 and had risen even more sharply in January 2011 —so much so that they outstripped the levels recorded during the 2008 crisis.[c] The food price index compiled by the Food and Agriculture Organization of the United Nations (FAO) indicates that this price category rose by 14.8% in 2010, with a 4.8% rise in the fourth quarter. This indicator actually reached an all-time high in January 2011.

The available information indicates that the impact of the winter storms on the annual inflation rate amounted to approximately 0.1 of a percentage point.[d] This means that, if these storms had not occurred, the inflation rate would have closed out at 3.1%, which is near the midway point in the target range established by the Bank of the Republic.

The effects of the winter storms were felt between November 2010 and January 2011. In February, March, April and May, a significant slowdown in the rate of increase in prices for perishable goods, relative to the inflation rate of the preceding three months, was recorded.[e] This demonstrates that, as was to be expected, the storms' effect on prices was short-lived. It was expected that the year-end inflation rate for 2011 would fall somewhere within the target range (2%-4%) established by the Bank of the Republic.

The CPI reflected the increase in producer prices, with the producer price index (PPI) for 2010 paralleling the trend seen in consumer prices (the annual inflation rate for the PPI was 4.4%, with an upswing in the fourth quarter). One of the factors in this trend was the increase in the PPI for produced and consumed goods, which basically registers domestically produced goods and was up by 5.2% as of December, whereas the index for imported goods showed a rise of just 0.7% owing to the trend in the real exchange rate. The branch of economic activity with the sharpest price rise was crop-farming and stock-raising (11.4%), while prices for the manufacturing and mining sectors climbed by 4.9% and 2.8%, respectively. In January 2011, both the annual inflation rate for the total PPI and the inflation rate for producer prices in the crop-farming and stock-raising sector were down from their end-2010 levels. This trend was not evident in the CPI.

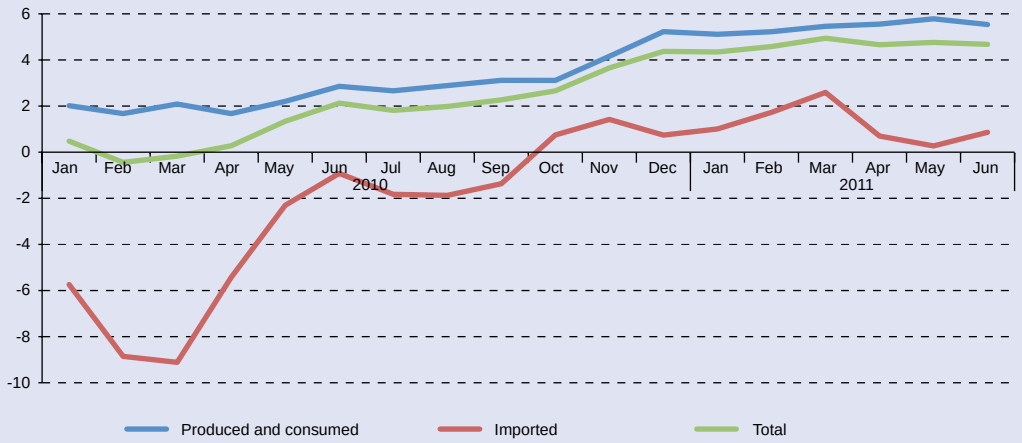
Figure 1
Colombia: inflation, 2010-2011
(Percentages)



Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of figures from the National Administrative Department of Statistics (DANE).

Box XVI.4 (concluded)

Figure 2
Colombia: Inflation. Producer price indices, 2010-2011
(Percentages)



Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of figures from the National Administrative Department of Statistics (DANE).

Source: Economic Commission for Latin America and the Caribbean (ECLAC)/Inter-American Development Bank/National Planning Department of Colombia (ECLAC/IDB/DNP), *Valoración de daños y pérdidas: ola invernal de Colombia 2010-2011*, Bogota, 2012 [online] http://www.cepal.org/publicaciones/xml/0/47330/OlainvernalColombia2010-2011.pdf.

[a] The rise in the CPI excluding food items was 2.8% for 2010, that is, 0.4 percentage points less than the rise in the overall CPI rate.
[b] The Bank of the Republic inflation report of December 2010 also says that the fact that less cropland was planted in 2010 because prices had been so low in 2009 could have been another contributing factor.
[c] See ECLAC/FAO/IICA (2011).
[d] This could have to do with the fact that the storm-ravaged regions are not major suppliers for the urban centres that have the greatest influence on the CPI. See Bank of the Republic of Colombia (2011a).
[e] See Bank of the Republic of Colombia (2011a).

4. Employment and income

One of the variables that is closely related to economic activity and household income is employment. In order to gather the basic information that will be needed, it is recommended that data on the following variables over an eight-year period, as a minimum, be compiled:

(i) Employment: the structure of employment by gender, age,[167] education,[168] rural/urban area, region of the country, formal/informal sector and production sector (at the single-digit International Standard Industrial Classification of All Economic Activities (ISIC) level).

(ii) Unemployment rate: by gender, urban/rural area and region of the country.

(iii) Average wages: by gender and by formal/informal sector.

(iv) Labour-force participation rate: by gender and by region of the country.

National household or employment surveys are the main source of data on these variables.[169] This may mean that the latest available information could be from at least six months before the disaster. Information on employment and wages may also be obtained from regional producers' associations and, if they exist, regional development promotion organizations. This information can be cross-checked with the survey data. Special emphasis should be placed on gathering information on the labour income of own-account workers and workers in the hardest-hit sectors.

In the event of a disaster, employment will be hurt by the destruction of production capacity, social infrastructure or both, but it will be boosted by the additional labour requirements associated with the emergency itself and with

[167] The following age groups are suggested: 15-24 years, 25-64 years and 65 years and over.
[168] The following categories are suggested: primary, secondary and university.
[169] Household survey data on these variables can be obtained from the Household Survey Data Bank (BADEHOG) of ECLAC and from the Socio-Economic Database for Latin America and the Caribbean (SEDLAC) of the Centre for Distributive, Labour and Social Studies (CEDLAS) of the Universidad de la Plata and the World Bank.

the recovery and reconstruction stages. Estimating the net outcome of these two kinds of effects will provide an indicator of the overall impact on employment. This estimate will not provide information on how widely the effects on different groups may vary, however. For example, workers from other parts of the country may come to help with the reconstruction work if the local workers employed in the affected activities do not have the right skills and cannot be retrained within a reasonable period of time. This is why it is important to prepare sectoral as well as overall estimates for the disaster area if at all possible; these estimates should be disaggregated by employment (formal or informal), age groups (young, not young) and especially by sex. If these disaggregations are not possible, then a more general analysis of the possible differential effects on these groups should be provided.

The following procedure is suggested:

(i) Obtain historical series on national employment and on employment in the disaster area. For the disaster area, the employment levels for the different groups mentioned above should be gauged. Information on these employment variables should be processed for a multi-year period and be cross-referenced with data on income in order to have a clear picture of the relationship between the two types of variables at both the national and disaster-area levels. It would be helpful to contact the officials in charge of preparing these kinds of surveys or to bring them into the assessment team so that the team can get a good grasp of the regional limitations and characteristics of the surveys.

(ii) Revise the trend in employment projected prior to the disaster for the rest of the year. This information can usually be obtained from the ministry of economic affairs or the ministry of finance. This trend and the projected trend in GDP should be consistent. If possible, these national figures should be converted into regionally disaggregated data.

(iii) Analyse post-disaster employment trend scenarios. The nature of these scenarios will depend on how much of the damaged assets are going to be replaced in the same year as the disaster occurred, which will be determined by the availability of financing and the construction sector's capacity. The scenarios can be developed using sectoral data. If the data are not available or unreliable, another approach would be to calculate the elasticity of employment in each branch of economic activity to GDP and to then apply that ratio to the scenarios for each economic activity. As mentioned earlier, these overall scenarios will not take local factors, gender or age groups into account, and it is therefore recommended, based on sectoral evidence, that analyses and/or projections of the impacts on this variable at the regional level be developed.

It is very important for these impacts to be taken into account by the team preparing the estimates. The method to be used will depend on what kind of information is available. Once the impact on employment has been estimated, it is suggested that estimates be prepared on the impact on personal income. In order to do this, the figures on employment for each scenario must be combined with the data on the average wages of workers in the hardest-hit sectors and on the labour income of informal workers. It is important to differentiate the average wages of urban workers from those of rural workers and average wages in the formal sector from those of the informal sector, since they usually differ.

The impact on household income will influence other social-sector variables, such as poverty. It is to be expected that, temporarily, more people in the disaster zone will fall below the poverty line in the wake of a disaster. It should be noted that income-based poverty measurements have been challenged and become a controversial subject in recent years, and efforts have been made to replace them with multidimensional poverty indices.[170] These calculations should not be interpreted as measuring the impact in terms of poverty but rather as an indicator of the need for monetary transfers to households affected by the disaster, along with some additional considerations. For example, families who are living in shelters are receiving a number of basic services, such as lodging, food, water and lighting. If poverty is measured solely on the basis of income and these in-kind transfers are not converted into monetary values, then clearly the measurements will be underestimating these families' capacity to consume.

For countries that have information on GDP calculated on the basis of factor income, another approach can be taken. For each scenario, the proportion of the estimated GDP of each branch of economic activity corresponding to factor payments for labour can be calculated. This will provide an approximate idea of the amount of forgone wages. Usually, when the base year is changed, GDP is calculated from a supply-side, demand-side and factor-payments standpoint. Figures for GDP based on factor payments are usually published later than the others. The latest available

[170] See Alkire and Santos (2011) and UNDP (2010).

information can be used to estimate the amount of lost labour earnings under the assumption that the proportions of the various factor payments remain unchanged. In addition, since the impacts of disasters are primarily localized, it can be assumed that the regional structure of those impacts corresponds to the national structure. It is important for the experts in charge of compiling these statistics to be involved in this work.

5. Impact on external accounts

The alteration of flows and the replacement of damaged assets may have an impact on the country's external accounts. Examples of some of the ways in which this may occur are:

(i) A portion of lost or delayed output could have been destined for foreign markets.

(ii) Temporary shortages of some products may be covered by imports.

(iii) The replacement of damaged assets may boost imports of goods or of imported components of replacement goods. This could include the importation of foodstuffs and other inputs such as seeds and pesticides.

(iv) A decrease in tourism revenues.

(v) An increase in unrequited transfers from the rest of the world (grants and donations) in the form of disaster relief and increased remittance receipts in the private sector spurred by disaster-related decreases in private incomes.

(vi) Reinsurance payments. These payments should be carefully monitored in view of the possibility of delays.

In estimating the amounts of transactions such as those mentioned above, the team will need to work with experts in each of the sectors concerned. The following procedure for estimating the balance-of-payments effect is recommended:

(i) Compilation of pre-disaster information. This includes historical series and more recent data. It is best if the historical series provide detailed information on certain balance-of-payments accounts so that the country's export structure and its sectoral import profile can be determined. This information should cover at least two business cycles. If a natural disaster occurred during that period, then the external sector's reaction to the event should be analysed. The more recent data should cover the relevant variables throughout the year up to the time of the disaster so that they can be incorporated into the projection for the year and, at the least, for the following year.

(ii) Pre-disaster balance-of-payments projections for the rest of the year. This information serves as the baseline for the other estimates.

(iii) Post-disaster balance-of-payments projections. These scenarios should dovetail with the GDP scenarios. Higher imports should be associated with greater economic activity, and greater economic activity should be associated with more reconstruction activity.

XVII. Mainstreaming a gender perspective

A. Introduction

Disasters result from the materialization of a latent threat, combined with the vulnerability of a particular community. They affect men and women in a differentiated manner —to women's disadvantage— largely because of underlying gender relations in society that shape the inequity and vulnerability in which women live their lives.[171] One of the main consequences of crises triggered by disasters is women's loss of capital and the erosion of their participation in economic activity, which in turn further entrenches their disadvantage (Blaikie and others, 1996; Rubin and Rossing, 2012; Bradshaw and Arenas, 2004; Bradshaw, 2013; UNISDR, 2002).

Here, we identify, analyse and attribute value to the differences in disaster impacts on men and women, with a view to offsetting hidden negative factors, such as women's lack of economic independence and autonomy, the excess burden of unpaid reproductive work[172] they perform, and their greater time poverty,[173] asset poverty and income poverty.

By attributing a value to the assets and income men and women lose in these circumstances, we also provide a framework for considering their different needs when it comes to government action and public policies for recovery and reconstruction, and this contributes to equity and helps make investment more efficient.[174]

One very important principle in applying the gender perspective to estimating the economic impact of a disaster is that it must cut across all sectors: social (housing, education and health); production (manufacturing, agriculture, commerce, tourism); infrastructure (transport and communications, energy, water and sanitation); and the environment. The first step, then, is to compile gender-disaggregated data and information in general to ascertain the different effects and needs among men and women.

[171] Women in low socioeconomic strata are more vulnerable to disasters than men, even in terms of life expectancy, insofar as more young women than young men lose their lives, on average, in a disaster (Neumayer and Plümper, 2007).

[172] Reproductive work refers to all domestic tasks performed to maintain families and contribute to their survival and well-being. An essential part of this is the care of children, older adults and the sick, which is carried out basically within the private household domain. Productive work is associated with the public sphere and takes place on the basis of income-generating mercantile arrangements.

[173] Women's total work time (work both included and not included in the System of National Accounts) is greater than men's in both rural and urban areas, owing to women's excess burden of unpaid work in the form of direct caregiving and household tasks (Aguirre, García Sainz and Carrasco, 2005; Budlender, 2008). This leaves women with fewer opportunities to improve their skills and obtain better wages, participate in the labour market, play a prominent role in public affairs and enjoy quality leisure time—and this situation becomes more acute after a disaster.

[174] One of the immediate outcomes of this exercise is to shine a light on women's —still disregarded— contribution to households and to society, which is another justification for the emphasis on women's activities and the disaster's impact on them.

Persisting stereotypes mask women's economic, social, political and cultural status, and the relevant information is often not disaggregated by sex. The team analysing the gender impact of a disaster must therefore work very closely with the experts responsible for each sector, tap data from key information sources and conduct statistical processing to prepare indicators that will serve their purposes.

This chapter sets forth a methodology for estimating the effects of a disaster on men and women, for teaching purposes, since specific impacts come to light in disaster situations. The forms that disaster impacts take for the two sexes can be classified in two groups: socioeconomic and anthropological. Both need to be identified taking into account the victims' milieus and the gender relations in their society and households. This will be very useful for planning policies and action for the rehabilitation and reconstruction stages.

A useful first step is to form a diagnosis of the situation prior to the disaster (a baseline) as regards the demographic, socioeconomic and political situation of men and women. This can be obtained from sex-disaggregated national statistics on poverty, education, health, employment and demographic traits, which should also give a picture of the ethnic composition of the population, especially in the areas affected. Important data include the proportion of households headed by women in the total population and in the young population (under 25 years of age), as well as adolescent motherhood rates. It is also useful to be aware of the type of the housing most common in the affected area (geographical departments, provinces or municipalities), including differentiation of owners and occupiers by sex. The sex disaggregation of heads of owner-occupied or rented households affected by the disaster is important information, which can be obtained from population and housing censuses, surveys of households and living conditions, and surveys conducted by local disaster-management agencies.[175]

It is also important to have an awareness of how much ground —legally, politically and culturally— the gender perspective has gained in the country or area. This may be gleaned by reviewing research and documents on the subject, consulting policies being implemented by the various levels of government and identifying local and national social organizations and the gender issues they address. A directory of agents and stakeholders involved in gender issues is a very useful tool for obtaining the necessary information and data to identify the main problems and assign them a quantitative and qualitative value.

The rest of this chapter is organized as follows: section B sets forth the methodology for mainstreaming the gender perspective in estimation of the effects and impacts of a disaster and section C quantifies the effects of a disaster in those activities making up the livelihood of much of the poor population. Section D discusses the socio-anthropological effects of a disaster on the victims and, lastly, section E considers the recovery process from a gender perspective.

B. Socioeconomic effects of disasters

The socioeconomic effects of disasters encompass the differentiated impacts suffered by men and women in the various social, production, infrastructure and environmental sectors, as well as in areas not visible in the national accounts, such as informal activities.

One of the greatest socioeconomic effects is damage and losses in the livelihoods of men and women in low-income sectors in both rural and urban areas, and the increase in the unpaid reproductive work shouldered by women (in emergency, rehabilitation and reconstruction work).

These impacts are quantified on the basis of estimations of damage and losses in each of the entities affected, disaggregated by administrative divisions and expressed in national currency or dollars.

[175] See, for example, Espina (2010).

1. Estimating losses and damage in the various economic sectors

In collecting information and analysing the data for the various economic sectors, experts must consider how the disaster has affected men and women in different ways. Accordingly, they must include the gender perspective in estimating damage and losses, and in qualitative observations on the effects of the disaster. Gender-disaggregated information is therefore needed from the first stage of the analysis. It is especially important to bear this recommendation in mind when analysing damage to road infrastructure, energy, transport and communications, large and mid-sized commerce, and tourism, because these are not discussed in detail in this chapter.

A number of issues that disaster estimation experience has shown to be important are set forth below. They relate to housing, health, education, agriculture and the environment.

(a) Housing

Analysis by the group estimating the damage for this sector[176] should include information on any legislation, public policies, programmes or projects in place to promote equitable access by men and women to home ownership, particularly any which favour female heads of household or breadwinners. There are important issues to be aware of regarding the situation of female heads of household who (owing to emigration by men or other reasons) are not the legal owners of the destroyed property, since this may jeopardize their enrolment in post-disaster housing support schemes.

(i) Damage in the housing sector

Assessment of damage in the housing sector must consider the following:

- Total or partial destruction of housing stock by region (urban and rural) and by administrative entity. Under a gender-based approach to this sector, the information must be disaggregated by the sex of the owner or tenant.
- Total or partial destruction of household goods. This includes those goods and utensils which women use in performing reproductive work (which they mostly shoulder).

Destruction of household goods makes women's living conditions more difficult and increases the time they are forced to spend on reproductive work, especially in poorer segments of the population. The data to be reported by the housing experts should include a classification by socioeconomic level of destroyed or damaged dwellings by administrative entity affected by the disaster (administrative departments, provinces, municipalities, and so forth).

Once that classification has been made, the experts must establish the various sets of domestic goods that are to be assigned a replacement value, which should also reflect the level of household income.

The damage to housing by administrative entity is then valued on the basis of the number of urban and rural houses destroyed or damaged, by socioeconomic level, and the value of the domestic goods or equipment corresponding to each level. These values are added together to give the total countrywide (see box XVII.1)

Box XVII.1
State of Tabasco 2007 (Mexico): damage to the housing sector as a result of flooding in 2007

According to estimates by the Tabasco state housing authority, 73% of urban dwellings damaged in the floods of 2007 belonged to low-income sectors, 26% to middle-income sectors, and 1% to high-income sectors. All the flooded dwellings in rural areas belonged to low-income sectors. The value of domestic equipment was also calculated for each socioeconomic level: 15,000 Mexican pesos in low-income sectors (urban and rural); 25,360 Mexican pesos in middle-income sectors; and 129,763 Mexican pesos in high-income sectors. These values were multiplied by the number of dwellings in each of the sectors, for the various municipalities affected (urban and rural).

[176] The estimation of damage and losses in the housing sector is analysed in chapter VII.

Box XVII.1 (concluded)

Table 1
State of Tabasco 2007 (Mexico): urban dwellings flooded and damage to household equipment, by socioeconomic level, 2007
(Number of houses and thousands of Mexican pesos)

Municipality	Number of urban dwellings flooded				Value of equipment destroyed *(thousands of Mexican pesos)*			Total value of damage to domestic goods in urban dwellings *(thousands of Mexican pesos)*
	Total	Low-income group	Middle-income group	High-income group	Low-income group	Middle-income group	High-income group	
Balancán	682	498	177	7	7 470.4	4 498.3	885.3	12 854.0
Cárdenas	1 269	926	330	13	13 895.2	8 367.1	1 646.7	23.909.0
Centia	2 647	1 933	688	26	28 988.7	17 455.7	3 435.3	49 879.7
Centro	64 226	46 885	16 699	642	703 277.4	423 482.2	83 341.9	1 210 101.5
Comalcalco	724	529	188	7	7 930.6	4 775.4	939.8	13 645.8
Cunduacán	4 721	3 447	1 228	47	51 697.8	31 130.1	6 126.5	88 954.4
Emiliano Zapata	1 873	1 367	487	19	20 511.1	12 350.9	2 430.7	35 292.7
Huimanguillo	801	585	208	8	8 771.2	5 281.6	1 039.4	15 092.2
Jalpa	1 099	802	286	11	12 029.0	7 243.3	1 425.5	20 697.8
Jalpa de Méndez	4 865	3 552	1 265	49	53 276.5	32 080.7	6 313.5	91 670.7
Jonuta	2 092	1 527	544	21	22 908.8	13 794.7	2 714.8	39 418.3
Macuspana	2 080	1 518	541	21	22 772.3	13 712.5	2 698.6	39 183.4
Nacajuca	10 453	7 631	2 718	105	114 465.1	68 925.8	13 564.7	196 955.6
Paraíso	1 449	1 058	377	14	15 865.6	9 553.6	1 880.2	27 299.4
Tacotalpa	709	518	184	7	7 767.6	4 677.3	920.5	13.365.4
Teapa	188	137	49	2	2 062.5	1 241.9	244.4	3.548.8
Tenosique	389	284	101	4	4 264.6	2 568.0	505.4	7.338.0
Total	100 270	73 197	26 070	1 003	1 097 954.4	661 139.1	130 113.2	1 889 206.7

Source: Economic Commission for Latin America and the Caribbean (ECLAC), *Tabasco: características e impacto socioeconómico de las inundaciones provocadas a finales de octubre y a comienzos de noviembre de 2007 por el frente frío número 4* (LC/MEX/L.864), Mexico City, ECLAC subregional headquarters in Mexico, 2008.

The values for damage to urban and rural household goods were then added together to obtain the value for damage per administrative entity, and these figures were subsequently totalled to reach the value for damage in the state of Tabasco.

Table 2
State of Tabasco 2007 (Mexico): total damage to urban and rural household goods as a result of flooding, 2007
(Number of houses and thousands of Mexican pesos)

Municipality	Number of rural dwellings flooded	Value of damage to rural household goods *(thousands of Mexican pesos)*	Value of damage to urban household *(thousands of Mexican pesos)*	Total value of damage to urban household goods *(thousands of Mexican pesos)*
Balancán	1 103	16 541.6	12 854.0	29 395.6
Cárdenas	1 855	27 825.5	23 908.9	51 734.4
Centia	3 723	55 839.4	49 879.7	105 719.2
Centro	29 194	437 906.3	1 210 101.5	1 648 007.8
Comalcalco	1 059	15 881.2	13 645.8	29 527.0
Cunduacán	6 902	103 526.1	88 954.4	192 480.5
Emiliano Zapata	3 028	45 417.6	35 292.7	80 710.2
Huimanguillo	1 171	17 564.6	15 092.3	32 656.9
Jalpa	2 518	37 761.9	20 697.9	58 459.7
Jalapa de Mendéz	2 212	33 173.4	91 670.8	124 844.3
Jonuta	2 942	44 128.0	39 418.3	83 546.4
Macuspana	2 924	43 865.1	39 183.4	83 048.5
Nacajuca	4 752	71 273.4	196 955.6	268 229.1
Paraíso	2 118	31 771.3	27 299.3	59 070.6
Tacotalpa	1 626	24 384.4	13 365.5	37 749.9
Teapa	432	6 474.7	3 548.9	10 023.5
Tenosique	630	9 443.1	7 337.9	16 781.0
Total	68 185.2	1 022 777.4	1 889 207.1	2 911 984.5

Source: Economic Commission for Latin America and the Caribbean (ECLAC), *Tabasco: características e impacto socioeconómico de las inundaciones provocadas a finales de octubre y a comienzos de noviembre de 2007 por el frente frío número 4* (LC/MEX/L.864), Mexico City, ECLAC subregional headquarters in Mexico, 2008.

ii) Alterations to economic flows in the housing sector

These alterations include:

- The additional cost of post-disaster clean-up and removal of debris in dwellings affected, disaggregated by sex of household head (owner or tenant).
- Lost income from suspension of housing rental, disaggregated by sex of the owner.

(b) The health sector

Under a gender-based approach to the estimation of damage in the health sector, gender-disaggregated information is needed on access to health services during the emergency. It must be established that sufferers of chronic illnesses should receive medical attention without gender discrimination of any kind. The report should include morbidity rates and record the reproductive and mental health services provided to the affected population, in general, and those in shelters, in particular. The data on the population and the medical care provided is to be disaggregated by gender, and emphasis afforded to data regarding the presence of and care of adolescents; pregnant, puerperal and breastfeeding women; single-parent families and lone children.

It is also necessary to ascertain that the distribution of food and basic personal hygiene materials has been equitable, and remains so, between men and women, and between male and female single heads of household. Equitable access by women and girls to information, communications and training on health-related issues must also be respected.[177]

Where a disaster results in population being displaced and the social fabric of communities and families' daily lives being destroyed, women and girls can find themselves in danger of gender violence, particularly sexual violence. The health authorities and those responsible for managing the situation in the disaster-hit area must be aware of this and take steps to put protection measures in place.[178]

(c) The education sector

An important point to observe is whether the disaster has interrupted education, and if children and adolescents of both sexes are able to continue with their studies after the disaster. Interrupted education leads to women spending more hours on reproductive work and creates obstacles to their entry to paid employment.

The socioeconomic analysis conducted before estimating the disaster's effects should include the processing of statistics on children's education, and should look in particular at dropout rates by sex resulting from earlier crises in the area affected (caused by an earlier disaster or recurring disasters).[179] The findings of this research are useful for making recommendations on policies aimed at foreseeing and avoiding school dropout. Dropout can occur because of food crises which have forced adults to emigrate, or when families slip further into poverty and cannot (especially if they are single-parent families) afford even the minimum cost of keeping their children in school. In this case, children stop going to educational establishments because they lack clothes, money for transport and school supplies, or even food. Sometimes school dropout can be the result of children having to go out to work, or girls staying home to help with reproductive work.

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177 Generally speaking, it is women who undertake care of others, and the cleaning and adaptation of shelters in the areas affected. This must be borne in mind when organizing informative talks and meetings on health problems and issues. Times and conditions should be arranged to ensure that women can attend, so that they are not excluded from this important information (IASC, 2008).

178 It is essential to be aware of the guidelines, standards and directives on these issues prepared by the various agencies of the United Nations, in order to take the steps necessary to safeguard the rights of women, girls and boys and to ensure their protection and care. In this respect, recommendations and guidelines have been set forth by the Inter-Agency Standing Committee (IASC, 2005; IASC, 2008).

179 The possibility of securing this information will depend on the period when the impact assessment is being carried out, and on the administrative capacity of ministries of education. In general, this information is not known until the close of the school year or the start of the next one, although information on the recent disaster may already be being processed. In this case it is necessary to secure access to that information.

(d) The agriculture sector

The estimate of the impact (damage and losses) on crops, livestock and fisheries is the responsibility of the agriculture sector expert and should be based on data disaggregated by the sex of the main producers. As well as the backyard economy sustained by women, the area affected may have small enterprises supported by public institutions and NGOs, which will not be visible in the data processed for the agricultural sector. This can occur with small-scale aquaculture,[180] hydroponic crops and small greenhouse-grown flowers, herbs and vegetables, which are not covered in the chapter on agriculture. Information on damage and losses in these small enterprises can be supplied by the relevant institutions (ministries of agriculture, planning and social development, institutes of women's affairs and anti-poverty NGOs, among others).

The entities which support these activities keep records on beneficiaries, which should yield sex-disaggregated data on the enterprises affected.

The value of damage can be calculated from information on the sum invested and the losses, which are to be estimated on the basis of unit market price (by the kilogram, dozen, etc.) multiplied by the volume of lost production and the time until production can resume or return to normal levels.

(e) The environment

A disaster's impacts on the environment usually involve the destruction of livelihoods for the population (especially for women) whose economic activities rely on natural resources (Sudmeier-Rieux and others, 2006). This has been seen in particular in coastal areas and areas bordering rivers and large bodies of water. For example, the "pikineras" of Nicaragua's Autonomous North Atlantic Region support their families by selling lobster parts locally (ECLAC, 2008c; CEIMM, 2007), and women on the Yucatán coast fish for small crustaceans to sell as bait to fishermen.[181]

One of the livelihoods common in communities living in forested areas is the sale of natural or processed forestry products, such as seeds, medicinal plants, ferns, wild orchids, mushrooms, fibres and honey. Powerful meteorological events such as hurricanes, typhoons and tropical storms can reduce or obliterate these sources of income in areas where natural defences, such as mangroves, dunes or natural river courses, have been lost.[182] For example, 1,300 women lost their place of work and fishing gear in Nicaragua as a result of Hurricane Felix. Many women in rural communities in Tabasco, who until the floods of 2007 used wild cane to make craft products, lost their livelihoods when the river overflowed and the cane rotted—and these areas did not recover until a year later. This represented the loss of US$ 700 per person during the three-month sales season, affecting thousands of women in these areas (ECLAC, 2008a).

The following information must be obtained to quantify these losses: the number of people of both sexes whose activities rely on natural resources in the area affected; the types of products they sell and the quantity in a given period of time (a day, a week or a month); the prices of these products; and the time for which they will be unable to work.[183] These data are then used to estimate the sum of the losses. This information can be obtained from visits to the affected area, and through interviews with representatives of grass-roots organizations, groups of victims, NGOs and public agencies.

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[180] In Mexico, a number of aquaculture projects have been supported by municipal governments through the Women's Affairs Department. Mexico also has a women's programme in the agricultural sector (PROMUSAG), run by the Ministry of Urban, Territorial and Agricultural Development (SEDATU).

[181] Interview with groups of fisherwomen in San Felipe (Yucatán, Mexico), who, as well as fishing for crustaceans every night, are developing mangrove replanting schemes.

[182] This occurs when the environmental services provided by ecosystems are not taken into account, or not sufficiently appreciated, at the planning stage of investments. The Millennium Ecosystem Assessment found that one of the most degraded and endangered services was that of regulating the impact of natural events (IDB, 2006).

[183] For example, water pollution caused by Hurricane Ida, which hit El Salvador in 2009, forced 1,500 small-scale fishing families to stop work for three months. The losses recorded in that period amounted to some US$ 1.3 million, on the basis of an average income of US$ 10 per fisherperson per day (ECLAC, 2010b).

Prolonged droughts[184] in rural communities have multiple effects on families' lives, including hunger, undernutrition and —especially in the case of men— migration.[185] Droughts tend to oblige women and children to spend more time on reproductive work, especially the imperative of fetching water from areas further from the home. Water is needed not only for families' nourishment and personal hygiene, but also for livestock, which can fall sick and die from dehydration. The cost of obtaining water rises, as well, because families often have to pay for water from tankers. As well as the time spent fetching water, families have to spend time looking for wild produce to supplement a diet narrowed by crop failure or reduced harvests.

As well as the value of losses of agricultural products (whether in backyard economies or in the agriculture sector), the effects of an event of this sort increase the reproductive work performed by women and the costs of water, if the heads of household are obliged to pay for it, all of which must be included in the estimation.

The increase in reproductive work may be estimated by attributing an hourly value to personal service provision, multiplied by overtime with respect to the normal burden of reproductive work —thereby making the increase more evident— for all women aged 15 to 69 affected in the disaster area. This value should be presented by political/administrative division for the areas affected, separately from other calculations.

The mission's expert on water and sanitation should be consulted to obtain data on the price of water supply, the quantity of water families have to buy per day and how long this situation lasts. The indicator per family (or household) is then multiplied by the number of female-headed families or households. A breakdown of households by the sex of household head can be obtained from statistical offices for the country's different administrative units. This same procedure, with a gender perspective, is to be followed to estimate losses in the water and sanitation sector caused by other types of disasters.

C. The impact of disasters on women's and men's livelihoods

As well as estimating the impact of a disaster on the various economic sectors included in the national accounts, it is essential to quantify the effects on the means of support[186] of large swathes of the low-income and poor populations. Studies on disaster effects, various estimates by ECLAC and other agencies, and numerous empirical observations suggest that the poorest and most vulnerable segments of the population are usually the worst affected,[187] not only because of the destruction of livelihoods but also because the crisis situation lasts longer in population groups that lack the savings or assets to facilitate access to financial resources to compensate for the economic effect of a disaster[188] (Espina, 2010; Bradshaw and Arenas, 2004; DAW/UNISDR, 2001; Blaikie and others 1996; Juneja, 2008).

Generally speaking, many of the economic activities carried out in these population segments fall within the informal economy and thus may not be included in the damage and loss estimate for the production sectors.

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184 This section refers specifically to droughts because they are slow-building events which do not cause immediate damage to physical assets the way hurricanes and earthquakes do, for example. Their impacts (especially on women) can therefore go unnoticed if the damage and loss estimate is performed when they have yet to reach a critical stage, when backyard and farm animals fall sick and die.

185 See ACH (2010) for a dramatic example of the effects of drought on populations.

186 The term "means of support" has been used as opposed to "livelihoods", because it is a much broader concept covering all assets or types of household capital (human, natural, physical, financial, social and political) and the activities by which household members process or use them to obtain live-giving outcomes (nourishment, health and so on). These processes are part of a conceptual framework that also encompasses vulnerability factors and the institutional setting. Disaster impact assessment involves other United Nations agencies and these concepts are usually applied by experts from FAO and ILO to identify livelihood and employment situations. This assessment is carried out alongside or after the estimation of damage and loss to economic activities performed by ECLAC. On livelihoods, see FAO/ILO (2009).

187 Although a natural event does not discriminate by socioeconomic level, its impact varies by household exposure to threat and the degree of physical, social, economic and political vulnerability of men and women living in the affected area. The depth and duration of the crisis are also reflected in psychological effects. For example, a study on the effects of the 2010 earthquake in Chile found that the population in the lower income quintiles was more prone to post-traumatic symptoms for longer than the wealthier quintiles (Contreras and Puentes, 2012).

188 What is more, disaster victims may already have debts on loans obtained in the informal sector, which carry higher rates of interest, as seen in the case of women affected by the earthquakes of January and February 2001 in El Salvador (Arenas, 2001).

The first step, then, is to identify the most important production activities carried out by men and women in the affected area, and those activities which have been worst affected by the disaster. This will require information disaggregated by sex and by area of residence (urban and rural).

Data on the affected area from national statistical information (surveys and censuses) can then be processed to generate indices applicable to the data on women and men affected by the disaster.[189] It is useful to process these data before estimating the disaster's impact. In particular, if the number of dwellings totally or partially destroyed is already known, the population associated with those dwellings can be classified by sex on the basis of households per dwelling, number of household members, and percentage of men and women in the different age groups, among other data. Then, for example, the number of home-based microenterprises affected can be estimated. The Human Development Report which the United Nations Development Programme (UNDP) prepares for each country is another valuable input. It is also essential to gather information (from interviews, for example) from social organizations, NGOs, neighbourhood associations, churches and other institutions.

Interviews with local political authorities (mayors, for example) and administrative authorities from the various public offices representing ministries of economic affairs, industry and agriculture are another fruitful source of information. Government officials whose work brings them into direct contact with the population can provide very useful information, because they are aware of technical parameters, price data for inputs and products, and qualitative information for identifying items that are not visible in the statistics on men's and women's economic activities. This is relevant to the backyard economy,[190] which is not counted in the national statistics and accounts. As agricultural experts working on disaster estimation in the field have confirmed, and recent studies on the rural sector have emphasized, the backyard economy constitutes a production asset base for many women (Deere and Contreras, 2011).

Given that official documents do not carry quantitative information on informal activities, data from public or private microlending institutions are very important. This information, combined with the field sources mentioned earlier, can support an approximate estimate of the incidence of informal economic activities. Data on the informal activities identified and on the financial impact they have sustained form an essential input for public and private projects and programmes aimed at rapid recovery of livelihoods among the population affected. As in the case of the production sectors, the estimation will be based on the valuation of damage and losses. Since this is valued in monetary terms, an important step is to ascertain the cost of replacing assets destroyed and the market price of finished products. It is also necessary to establish how long activities and flows will be suspended.

Damage refers to the total or partial destruction of assets, consisting of: (i) equipment, machinery and tools used in small workshops or in microenterprises, whether home-based or not (at replacement price), and (ii) production inventories and inputs stored in the dwelling or at adjoining sites (at current prices).

Losses refer to: (i) reduced production in the backyard economy (livestock at replacement prices and —at current prices— eggs, milk or related products, and the harvest from fruit trees and small plots sown for home consumption or partly for sale), and the increased time devoted to wild harvesting to supplement the family diet; (ii) lost income from home-based commercial, production or services enterprises (based on the time that will elapse before these can be re-established); and (iii) interest on unpaid debt or financing arrears, when goods have been acquired on credit that is still outstanding.

1. Damage and losses in non-agricultural activities

In the analysis of a disaster's impact on the low-income population, the damage and losses affecting men's and women's economic activities are directly linked to the total or partial destruction of their dwellings (and must draw on information from that sector). In low-income sectors, the dwelling is not only a place to live, but also a locus of self-employment tightly bound up with the source of income. For example, an analysis carried out in 2007 by ADOPEM (Savings and

[189] In some countries (El Salvador, for example), this information can include sex-disaggregated data on the number of household members engaged in commerce or the production of foods and services (information from CELADE).

[190] Includes the rearing of poultry and small livestock for domestic consumption or small semi-mercantile enterprises; the production of wool, yarn, eggs, milk and milk products; and the care and management of fruit trees and small plots sown with vegetable produce, among others, adjacent to the dwelling and for self-consumption, or semi-mercantile purposes.

Loan Bank) in the Dominican Republic, a microlending institution, found that 76% of female-run microenterprises were dwelling-based. And although 10% of women carried out itinerant economic activities, again in 10% of cases the home nevertheless served as the base of operations and as storage for production inputs (ADOPEM, 2007). In the case of men, 46% ran their business from their homes.

This information is then used, together with the indices obtained from national socioeconomic studies (such as the Human Development Report prepared by UNDP and household surveys), to estimate the damage and losses to enterprises, disaggregated by gender. An example of the procedure followed for estimating disaster-inflicted damage and losses is set forth below (see box XVII.2).

Box XVII.2
Dominican Republic: Damage and losses in women´s non-agricultural activities as a result of Tropical Storm Noel of 2007

The calculation was based on information on the number of dwellings totally or partially destroyed, as reported by the National Housing Institute (INVI). Ninety per cent of that total was considered to correspond to families living in poverty.

Several documents were consulted: the most recent available edition of the *Human Development Report* produced by the United Nations Development Programme (UNDP), *Social Panorama of Latin America* of the Economic Commission for Latin America and the Caribbean (ECLAC), and household survey information from the National Statistical Office (ONE) of the Dominican Republic. The total percentage of the economically active female population engaged in own-account work in the informal sector was found to be 5.1%. This figure was applied to the universe of damaged dwellings corresponding to the population under the poverty line, to establish the universe of female microenterpreneurs in each province affected, assuming that at least one adult woman lived in each affected dwelling.

The figure obtained was multiplied by 76%, since the data indicated that 76% of microenterprises run by women operated out of their own dwellings. Another 10% was calculated on the basis of data that showed that proportion of dwellings being used as storage or centres of operations for itinerant businesses (ADOPEM, 2007). This result was added to the estimated number of dwelling-based microenterprises.

Table 1
Dominican Republic: microenterprises in dwellings totally or partially destroyed by Tropical Storm Noel, 2007
(Number of dwellings and microenterprises)

Province	Total poor dwellings destroyed	Women (total)	Female microenterpreneurs	Microenterprises run from dwelling	Dwelling used as base for microenterprise	Total microenterprises in dwellings
Santo Domingo	2 196	2 196	112	85	11	96
Distrito Nacional	968	968	49	38	5	42
San Cristóbal	6 030	6 030	308	234	31	264
Peravia	703	703	36	27	4	31
Barahona	3 915	3 915	200	152	20	172
San Juan	323	323	16	13	2	14
Monseñor Nouel	1 395	1 395	71	54	7	61
La Vega	567	567	29	22	3	25
Duarte	2 678	2 678	137	104	14	117
San José de Ocoa	1 395	1 395	71	54	7	61
Total	20 169.5	20 170	1 029	782	102	884

Source: Economic Commission for Latin America and the Caribbean (ECLAC), *Evolución del impacto de la Tormenta Noel en República Dominicana* (LC/MEX/L.853), (LC/MEX/L.864), Mexico City, ECLAC subregional headquarters in Mexico, 2008.

To estimate the number of microenterprises in each sector, the result of the above operation was multiplied by the percentages corresponding, respectively, to commerce (80%), production (10%) —consisting in most cases of food preparation— and services (10%), since this was the sector distribution observed in microlending (information provided by the manager of ADOPEM of the Dominican Republic).

Damage was then estimated on the basis of the amount of capital stock available to female microenterpreneurs in each sector, as reported by the microlender. This gave the following values: 11,725 Dominican pesos for commerce, 16,750 Dominican pesos for production, and 10,050 Dominican pesos for services, which were then multiplied by the number of microenterprises estimated for each segment. The resulting figures gave the amounts of total damage by province which, when totalled, give the overall damage countrywide.

Box XVII.2 (concluded)

Table 2
Dominican Republic: damage to dwelling-based microenterprises caused by Tropical Storm Noel, 2007
(Thousands of Dominican pesos)

Province	Microenterprise segment			Damage to assets by segment (thousands of Dominican pesos)			Total damage (thousands of Dominican pesos)
	Commerce	Production	Services	Commerce	Production	Services	
Santo Domingo	77.5	9.6	9.6	908.7	160.8	96.5	1 166.0
Distrito Nacional	33.9	4.2	4.2	397.5	442.2	42.2	881.9
San Cristóbal	211.5	26.4	26.4	2 479.8	442.2	265.3	3 187.4
Peravia	24.6	3.0	3.0	288.4	50.3	30.2	368.8
Barahona	137.3	17.1	17.1	1 609.8	286.4	171.9	2 068.1
San Juan	11.3	1.4	1.4	132.5	23.5	14.1	170.0
Monseñor Nouel	48.9	6.1	6.1	573.4	102.2	61.3	736.8
La Vega	19.8	2.4	2.4	232.2	40.2	24.1	296.5
Duarte	93.9	11.7	11.7	1 101.0	196.0	117.6	1 414.5
San José de Ocoa	48.9	6.1	6.1	573.4	102.2	61.3	736.8
Total	707.6	88.0	88.0	8 296.6	1 845.9	884.4	11 026.9

Source: Economic Commission for Latin America and the Caribbean (ECLAC), *Evolución del impacto de la Tormenta Noel en República Dominicana* (LC/MEX/L.853), (LC/MEX/L.864), Mexico City, ECLAC subregional headquarters in Mexico, 2008.

Lost income was calculated over three months, the period that key sources in the area affected and representatives of microlending entities suggested that women would need to resume their economic activities. This gave a monthly amount of 8,500 Dominican pesos for commerce, production and services.

Table 3
Dominican Republic: losses of dwelling-based microenterprises caused by Tropical Storm Noel, 2007
(Thousands of Dominican pesos)

Province	Microenterprise segment			Losses by segment (thousands of Dominican pesos)			Total losses (thousands of Dominican pesos)
	Commerce	Production	Services	Commerce	Production	Services	
Santo Domingo	78	10	10	1 976	245	245	2 466
Distrito Nacional	34	4	4	864	107	107	1 079
San Cristóbal	212	26	26	5 393	673	673	6 740
Peravia	25	3	3	627	77	77	780
Barahona	137	17	17	3 501	436	436	4 373
San Juan	11	1	1	288	36	36	360
Monseñor Nouel	49	6	6	1 247	156	156	1 558
La Vega	20	2	2	505	61	61	627
Duarte	94	12	12	2 394	298	298	2 991
San José de Ocoa	49	6	6	1 247	156	156	1 558
Total	708	88	88	18 044	2 244	2 244	22 532

Source: Economic Commission for Latin America and the Caribbean (ECLAC), *Evolución del impacto de la Tormenta Noel en República Dominicana* (LC/MEX/L.853), (LC/MEX/L.864), Mexico City, ECLAC subregional headquarters in Mexico, 2008.

2. Damage and losses in craft industries

One of the most common economic activities among the self-employed and a frequent source of income for rural women is the home-based making of crafts for sale.

To estimate damage and losses in this area, it is necessary to ascertain the approximate number of women engaged in this activity in the affected area; the quantity of machines, equipment, inputs and finished production destroyed; the value of replacing machines, equipment and inputs; and the market price of the finished goods. This information may be obtained from civil society organizations (crafts or agricultural associations, NGOs and microlenders, among others) in the area affected during field visits, and by telephone interviews with key sources.

Since these activities are carried out within the home, the damage may be linked with the number of homes destroyed (information gathered by the group performing the estimates on the housing sector). If there is no reliable information on the number of craftswomen affected,[191] indicators from population censuses (for example, the number of women in the 15-70 age group) may be used along with information from household surveys. In the case of the Plurinational State of Bolivia, for example, household surveys yield the percentage of women working unwaged in manufacturing in each of the country's administrative regions.

In several Latin American countries, the craft sector is important in estimating a disaster's impact on indigenous men and women, since high percentages of the population are engaged in this activity. Weaving and fabrics, for example, contribute to the maintenance of this group's identity and culture, and these goods are also a source of income in tourism markets. Light needs to be shed on the situation of indigenous men and women because this group, generally speaking, suffers discrimination and high levels of poverty and exclusion, and is still not identified as a specific category in the data compiled during an emergency, which makes it difficult to include their specific needs in post-disaster rehabilitation and recovery programmes.

Where specific data are lacking in disaster-hit areas with a higher percentage of indigenous population,[192] the evaluation team may use demographic indicators on ethnic composition of households from population censuses, and field information on the articles sold, on average, by women and their market prices, the equipment and inputs they use, and their replacement price. For example, the estimates of the effects of Hurricane Stan in Guatemala ascertained the number of dwellings destroyed in the region and found that over 70% of the population in the worst affected areas consisted of indigenous groups whose main economic activity was the production of dresses known as huipiles,[193] made by women in their own homes (ECLAC, 2005b). Census data revealed that the average household had at least two women aged over 15 years and data from key sources in the affected area were used to establish the average number of finished products, inputs and looms per dwelling. The prices of these items were found through visits to traders in the area.[194] These indicators were then applied to the number of destroyed dwellings to estimate the value of the cultural goods lost, which also served to calculate the resources needed for recovery and to prepare projects for that purpose.

3. Damage and losses in agricultural activities carried out by women

The backyard economy, especially in rural and peri-urban areas,[195] is one of the main items to take into account when estimating losses in women's activities, because it is not captured in the national accounts, which do, conversely, include production (crops and livestock) on plots and small farms.

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191 Generally speaking, rural areas are worse affected by climate events and travel to the area where craftswomen live can often become very difficult. However, efforts should be made to organize a meeting with their representatives, with support from NGOs or women's organizations, or to obtain information from these organizations.

192 Disaster management agencies do not often compile information on victims by ethnic identity. This can lead to a failure to respect victims' cultural identity in emergency and reconstruction work in areas of cultural diversity (see the section on human rights policy in this chapter).

193 These are made with fabric woven on craft looms, which are in themselves objects of great cultural and artistic value in Guatemala, Peru, the Plurinational State of Bolivia, Ecuador, Mexico and other countries.

194 United Nations volunteers working in the affected area can provide important information and are very valuable in identifying specific situations.

195 There is no standard definition for "rural" across all the countries, and backyard economies are also found in urban and peri-urban areas, as observed in Nicaragua, for example.

Losses in the backyard economy must be identified because they are an important part of families' food security and because they can generate income for buying agricultural inputs. The destruction or suspension of these activities, combined with the impact of a disaster on commercial agriculture, can inflict one blow after another on rural families (hunger, sale of assets, exodus and emigration, for example). For women and children, in particular, the destruction of the backyard economy increases the time they have to spend on wild harvesting (herbs and wild fruits, honey and mushrooms, among others) to supplement the family diet, as occurs during the droughts the El Niño phenomenon causes in the Bolivian Chaco (*Ministry of* Rural *Development and Land*, 2010; ACH, 2010).

The following procedure is suggested for estimating losses in the backyard economy:

(i) Ascertain the number of rural dwellings totally and partially destroyed[196] and, if there are no reliable data on the number of households or dwellings engaged in this activity, establish indices to identify this number —or the percentage of the rural female (agricultural) population involved— on the basis of data from population and housing censuses and household surveys.[197]

(ii) Estimate the average number of domestic animals or crops per rural dwelling, differentiating by type of animal and crop present at the time the disaster occurred. Usually, each plot has a small number of animals and crops, while the range of species is very broad. The combination of livestock and crops may vary in different parts of the country, which may have mountainous, prairie and coastal areas. The most important plant and animal species in the backyard economy can be identified from local information gathered in the field by the ministry of agriculture, experts from FAO in each country and women famers' organizations. Current market prices for produce also need to be verified (taking into account that this produce is mainly for household consumption, with only a small part perhaps being sold directly in local markets).

(iii) Apply prices to the estimated quantities of animals and crops separately, then determine the monetary value of losses per rural dwelling destroyed.

(iv) Multiply the monetary value of losses per rural dwelling destroyed by the total number of dwellings destroyed, by administrative area. Then add together the monetary value of losses for all the administrative areas affected to obtain the total for losses countrywide. Qualitative aspects also need to be considered in estimating the price of products (for example, the purpose of the enterprise); this information can be provided by female producers or local experts (see box XVII.3).

If no specific information is available, evaluation teams may draw upon data from national statistics (household surveys, population and housing censuses, and surveys of living conditions, among others).[198] These data and information compiled in the field from key sources can then be used to prepare indices to apply to the rural dwellings destroyed.

[196] Disasters triggered by climate events (hurricanes, floods, overflows, and so on) can obliterate the backyard economy altogether.

[197] Mexico's Ministry of Agriculture keeps detailed records on the various sorts of agricultural activities carried out by municipality, which can be crossed with information on the rural population or rural households. In rural areas of El Salvador, population and agricultural censuses include sex-disaggregated data on the engagement of rural households in animal-rearing or crop farming.

[198] For example, information available in the Plurinational State of Bolivia includes data on the percentage of rural women engaged in unpaid agriculture and on the proportion of rural homemakers.

Box XVII.3
State of Tabasco (Mexico): backyard economy losses caused by flooding in 2007

In the estimation of damage and losses caused by flooding in Tabasco (Mexico) in November 2007, it was found that poultry was raised mainly for sale at Christmas, when its prices are highest; accordingly, this price was taken as the basis for calculations (ECLAC, 2008a). The estimate used information from the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) on the number of chickens and turkeys produced yearly by each municipality in the state of Tabasco. This figure was used to calculate the production over six weeks (the average production period for chickens and turkeys) for each municipality. To this amount was applied the percentage of rural dwellings flooded to obtain a weighted average of the numbers of birds lost in each of the municipalities affected. The number obtained for each species was multiplied by the price reported for the bird, to obtain the total sum of losses.

The quantification of losses and damage recorded in women's economic activities helps to pinpoint the contribution they make to their households and to national economies. In the case of the floods in Tabasco, the quantification showed that women contributed close to 13% of the value of the state's poultry production at the time of the disaster. Research on small farms also shows that there is at least one adult female responsible for food production in each household (Campillo, 1994; Kleyson, 1996).

Table 1
State of Tabasco (Mexico): backyard poultry losses caused by flooding, 2007
(Mexican pesos)

Municipality	Total dwellings per municipality (INEGI)	Rural dwellings flooded *(number of dwellings)*	Women	Rural dwellings flooded *(percentages)*	Chickens lost per dwelling *(weighted averages)*	Backyard chicken losses *(Mexican pesos)*	Turkeys lost per dwelling *(weighted averages)*	Backyard turkey losses *(Mexican pesos)*	Total losses *(thousands of Mexico pesos)*
Balancán	14 648	1 103	1 103	7.5	525.2	78 774.6	548.8	164 640.2	243.4
Cárdenas	55 087	1 855	1 855	3.4	480.3	72 037.7	92.7	27 813.8	99.9
Centla	23 200	3 723	3 723	16.0	1 001.4	150 216.6	425.1	127 538.3	277.8
Centro	152 493	29 194	29 194	19.1	3 300.0	495 001.5	922.2	276 672.3	771.7
Comalcalco	41 474	1 059	1 059	2.6	342.5	51 370.6	46.3	13 898.2	65.3
Cunduacán	27 225	6 902	6 902	25.4	2 427.0	364 054.6	336.9	101 082.2	465.1
Emiliano Zapata	7 734	3 028	3 028	39.1	620.2	93 033.2	656.8	197 029.9	290.1
Huimanguillo	39 606	1 171	1 171	3.0	410.5	61 569.7	90.4	27 107.4	88.7
Jalpa	8 921	2 518	2 518	28.2	833.8	125 073.0	665.9	199 771.1	324.8
Jalpa de Méndez	17 252	2 212	2 212	12.8	838.5	125 780.4	229.4	68 810.8	194.6
Jonuta	6 751	2 942	2 942	43.6	1 758.2	263 733.5	1 009.4	302 831.9	566.6
Macuspana	34 447	2 924	2 924	8.5	870.1	130 516.4	417.3	125 182.8	255.7
Nacajuca	22 752	4 752	4 752	20.9	1 756.6	263 487.3	269.6	80 872.3	344.4
Paraíso	18 708	2 118	2 118	11.3	652.8	97 924.3	104.2	31 258.7	129.2
Tacotalpa	10 307	1 626	1 626	15.8	501.8	75 265.5	399.4	119 810.1	195.1
Teapa	12 323	432	432	3.5	73.8	11 070.6	80.9	24 261.9	35.3
Tenosique	14 986	630	630	4.2	165.2	24 777.8	275.7	82 711.3	107.5
Total	507 914	68 185	68 185	13.4	16 557.9	2 483 687.4	6 571.0	1 971 293.1	4 455.0

Source: Economic Commission for Latin America and the Caribbean (ECLAC), *Tabasco: características e impacto socioeconómico de las inundaciones provocadas a finales de octubre y a comienzos de noviembre de 2007 por el frente frío número 4* (LC/MEX/L.864), Mexico City, ECLAC subregional headquarters in Mexico, 2008.

4. Increase in women's reproductive work

The inequity in gender relations is perhaps best illustrated by the heavily entrenched stereotype that women are responsible for the care of children, the sick and the elderly, as well as domestic work in general. To this is added, in rural areas, the collection of firewood, wild harvesting and the fetching of water.[199] The time women spend on these tasks in normal circumstances —on average, almost three times as much as men[200]— increases greatly after a disaster: as well as the extra time spent on reproductive work because of the loss of the dwelling and domestic goods, women are expected to queue to receive assistance being distributed by aid agencies; take care of the injured, the sick, the elderly and children (education establishments are closed); fetch water from further afield and make it drinkable; and contribute to community emergency work. This work is not lessened where families are forced to go to shelters. This particular impact heavily restrains women's mobility and carries a high opportunity cost in lost income, by preventing women from seeking work outside the disaster area or recovering their income-generating economic activities.

To calculate that cost, the increase in the number of hours women (those aged 15-59 and 60 and over) spend on reproductive work is estimated, as well as the length of time the situation will last. This will depend on the seriousness of the disaster and the country's capacity to offset its effects and enable victims to regain normal lives. Information should be gathered from shelters and from the women housed there, from disaster management entities, and from civil society organizations and other relevant sources.

The hourly price of domestic labour should not be used for this calculation, because reproductive work is already undervalued.[201] Previous estimations of disaster effects have used the hourly wage corresponding to community, social and health services, or personal services —for example in the Plurinational State of Bolivia (see box XVII.4).

Box XVII.4

In the case of the flooding in the Plurinational State of Bolivia in 2010, the increase in the time spent by women on reproductive work was estimated by calculating an additional five hours per day for 45 days, for women aged 15 to 59, and an additional two hours per day, also for 45 days, for women aged 60 or over. The hourly wage for community and personal services was set at 7 or 8 bolivianos, by region.

Table 1
Plurinational State of Bolivia: increase in the value of reproductive work performed by women as a result of flooding, 2010
(Bolivianos)

Department	Total women affected	Women aged 15-59	Increase in total time on reproductive work	Value *(bolivianos)*	Women aged 60 and over	Increase in total time on reproductive work	Value *(bolivianos)*	Total value of reproductive work *(bolivianos)*
Beni	11 968	6 463	1 454 175	10 179 225	634	57 060	399 420	10 578 645
Chuquisaca	6 107	3 298	742 050	5 194 350	489	44 010	308 070	5 502 420
Cochabamba	32 704	18 772	4 223 700	16 894 800	2 584	232 560	930 240	17 825 040
La Paz	29 542	17 341	3 901 725	31 213 800	2 600	234 000	234 008	31 447 808
Santa Cruz	11 811	7 288	1 639 800	11 478 600	638	57 420	401 940	11 880 540
Oruro	3 489	2 016	453 600	3 628 800	331	29 790	238 320	3 867 120
Total	95 621	55 178	12 415 050	78 589 575	7 276	654 840	2 511 998	81 101 573

Source: Economic Commission for Latin America and the Caribbean (ECLAC), *Evaluación del impacto acumulado y adicional ocasionado por La Niña, Bolivia* (LC/MEX/L.863/Rev.1), Mexico City, ECLAC subregional headquarters in Mexico, 2008.

[199] Climate-change-related phenomena are expected to add to the difficulties of work performed by rural women and children (UNFPA, 2009; UNDP, 2007; Guzmán, 2010).

[200] In Ecuador, Guatemala and Mexico, rural women contribute approximately 80% of the total time spent on (unpaid) care work in households, including direct care and household tasks. In Ecuador and Mexico, women spend 44 hours and 30 hours per week more on these tasks, respectively, than men (Ortega, 2012).

[201] Reproductive work (care provision and household tasks) is not valued either economically or socially; it is unpaid and not recorded in the national accounts.

D. Socio-anthropological effects of disasters

The socio-anthropological effects of a disaster refer to the following: the change in levels of risk tolerance from before the disaster, inequitable access to information, unequal preparation (to women's disadvantage) for a disaster, and the level of violence towards women in the affected area; the various mechanisms men and women use to deal with emergencies and the recovery stage; the existence, or not, of a gender policy for disaster management, for example, in the distribution of aid and the management of shelters; the application, or not, of a human rights policy, in general, and a gender perspective, in particular, in disaster management; and the rate of female-headed households, pregnancy and adolescent mothers in the population affected.

The main sources of information for determining these effects are national and local civil society protection and disaster-management entities: the Red Cross, and NGOs that support the population and operate research, programmes or projects on gender issues. Other valuable sources are ministries of planning and health, social welfare institutes and agencies that administer or oversee shelters for the affected population; these may be government or social organizations, churches or international agencies such as the International Organization for Migration (IOM), among others. The information obtained from interviews with victims in shelters or places of residence may broaden qualitative information on the situation of the victims, although it should be treated with caution, owing to the small size of the sample.

1. Evaluation of the impact during the emergency and in shelters

At this stage of the analysis, it is important to establish whether there is a central body coordinating and overseeing the management of shelters and whether it applies a gender policy, including respect for human rights in emergency situations or disasters.

(a) Gender policy

There follows a non-comprehensive account of the main points to consider in establishing whether a gender policy is being applied.

(i) Compilation and organization of information on victims disaggregated by sex, age group and ethnicity. Also, a record of data on single-parent families and on pregnant, puerperal or breastfeeding women.

(ii) Equitable access by women and men to decision-making on emergency work in communities and shelters.

(iii) The distribution of space in shelters to ensure separate sanitary services for men and women; minimum safety standards for boys, girls and women (good electric lighting and doors that lock); and adequate provision of health services in shelters to avoid sexual health impacts.

(iv) Measures to prevent abuse and violence against women and girls.

(v) Provision of reproductive health services for women and adolescents, especially in the case of pregnant, puerperal or breastfeeding women.

(vi) Organization and equitable distribution between men and women of cleaning and tidying work, and the preparation of food and distribution of aid.

(vii) Priority provision of food aid to women in the family, especially those who are heads of household.

(viii) Organization of care for the sick, the elderly and children to prevent these tasks from being assigned to women alone.

(ix) Provision of care and psychological support to men and women of all ages.

(x) Provision of humanitarian assistance in keeping with the needs of each sex (there should be sanitary towels, shaving equipment, babies' bottles and diapers, among other things).

(xi) Monetary compensation for women for community reproductive work performed during the emergency stage.

(xii) Inclusion of women in paid work during the emergency stage.

(xiii) Inclusion in humanitarian assistance of the domestic utensils used mainly by women.

(b) Human rights policy[202]

All the relevant public agencies (ministries of defence and security, risk- and disaster-management bodies and humanitarian assistance agencies, among others) should apply a human rights policy and measures should be in place to prevent the restriction or violation of the civil, economic, social, political and cultural rights of male and female victims, on the premise that the human rights approach takes precedence over a purely assistance-based approach. This is associated with the principle that all individuals are bearers of rights, and discrimination of any kind is unacceptable. The field evaluation should afford attention to the following rights, which may be violated during the crisis caused by a disaster:

(i) The right to personal safety, identity (including cultural identity) and privacy. Respecting this right means dealing as quickly as possible with the loss of identity documents; avoiding disparaging the cultural identity of men and women on the basis of ethnic differences; and taking the necessary measures to prevent violence of any kind against women, girls and boys.

(ii) The rights of children, girls and boys alike. Respect for these rights means avoiding breaking up families or separating orphans from their communities or extended families, and preventing other sorts of abuse.

(iii) The right to food. Respecting this means preventing national or foreign food aid from being warehoused owing to red tape while the population goes hungry.

(iv) The right to education. Respecting this right means avoiding interrupting education while damaged or destroyed educational establishments are repaired or replaced.

(v) The right to non-discrimination against women. Respecting this right means preventing women's exclusion from information and decisions about the organization of community life and the household during the emergency and the reconstruction. It also means avoiding their exclusion from the administration of food resources, house ownership and land during the reconstruction stage.

(vi) The right to a livelihood and to work. Respecting this means preventing victims, both men and women, from being excluded from emergency and reconstruction work and using local resources during these stages (the skills of persons of both sexes, and local materials and means of production, among others) in order to provide livelihoods and employment to the population affected.

(vii) The right to health. Respecting this means preventing health service provision from being suspended while permanent facilities are rebuilt.

(viii) The right to participation in public affairs and freedom of expression and information. Respecting this means preventing the exclusion of the population affected from decisions on emergency work and projects and the rebuilding of their communities.

E. Financial needs for recovery and reconstruction

1. Financial needs for recovery

An essential condition for formulating recovery plans (rehabilitation and reconstruction) is the participation of men, women, boys and girls both in local land planning projects and in production schemes. A disaster can be turned into an opportunity to improve living standards through rebuilding to improve previous facilities, and in this task local knowledge is very important, as is attention to the needs and aspirations of the different age groups and genders.

One of the first measures to consider is the re-establishment of means of support of the low-income population. Identifying and estimating damage and losses suffered in the different activities in which men and women were engaged before the crisis is valuable information for developing production schemes that can be mounted quickly,

[202] It has been established that gender equality is a human right, and human rights are the first priority in situations of disaster and conflict, as enshrined in the spirit and the letter of the existing legislation on protection. It is important to highlight this link. With respect to the international legislation, see IASC (2008; 2005).

including the replacement of the equipment, tools and inputs men and women have lost in the disaster and need to carry out their economic activities. This includes restoring the resources needed for making crafts, which in turn speaks to the recovery of cultural goods that are valuable for other economic sectors, such as tourism and commerce.

In rural areas, seeds, agricultural inputs, livestock and water are essential for families to prevent food insecurity in the medium and long term, and for women, in particular, to recover backyard production and, with it, some economic autonomy.

Remuneration for the reproductive work women perform in shelters is not only fair; it also has a powerful effect on the recovery of their households.

Recovery programmes should be prepared and operated by employing the victims themselves, men and women, to carry out tasks such as removal of debris, clean-up and reopening of access to affected areas, and the rehabilitation of churches and schools used as shelters: this is a means to help reactivate the local economy. What is more, these programmes have the potential to give victims of both sexes training in building-related skills which will enhance their employment opportunities and participation in the labour market and in reconstruction programmes after the disaster. This is in addition to courses and workshops for retraining or the broadening of employment opportunities for both sexes.

Underlying gender relations must be taken into account and other support projects planned, however, to help women into productive employment and give them the opportunity to participate in training and in meetings where community affairs are decided. At this stage, then, it is necessary to create the conditions to reduce the burden of reproductive work for women and remove barriers to their mobility. This includes replacing domestic equipment and taking urgent steps to rebuild other sectors, such as education. For example, the rapid reopening of educational establishments for boys and girls; monetary or in-kind support for obtaining the supplies, including clothes, that children need to attend school; and the organization of a transport system to facilitate school attendance. These steps are also aimed at preventing school dropout, especially among girls, who are often expected to undertake reproductive work in times of crisis while their parents seek work.

Health care must be focused on pregnant and breastfeeding mothers and children under 1 year of age, especially those born during the emergency stage, after the disaster and in shelters. Care must also be taken to ensure hygiene in shelters and promote measures to protect the reproductive and sexual health of the population in shelters. Ongoing care is needed for men and women with chronic diseases of all ages, which is also related to adequate nutrition. Mental health treatment for male and female disaster victims of all ages is also a measure that contributes to recovery.

2. Financial needs for reconstruction

In rebuilding dwellings and in the spatial planning of new projects, it must be recalled that they are not only living spaces but also a means of support for low-income men and women. An important first step is to identify women who support households whose dwelling has been destroyed and establish whether they can gain access to it. The removal of physical, legal and economic obstacles barring low-income women from access to proper housing needs to be considered, as this is also needed for the pursuit of their income-generating activities.[203]

One of the most necessary steps for returning family life to normal, especially for women heads of household, is the repair, building or rebuilding of education establishments at all levels, because this aids their entry into the labour market.

[203] In areas where there is no drinking water network, this must be made a priority, as should universal provision of housing for the lower-income population (especially in rural and peri-urban areas). This is a crucial measure for supporting women's economic autonomy, because lack of piped drinking water in the household limits women's participation in the labour market, compared with women in households connected to a drinking water supply (Ortega, 2012). The members of poor households that lack piped drinking water can spend, on average, 14% of their productive time fetching water (ECLAC, 2010a).

As noted earlier, in coastal areas and areas adjacent to large bodies of water, men and women pursue various income-generating activities based on natural resources. In these areas, reconstruction has to do with projects to regenerate the environmental services of ecosystems, for example, planting mangroves and local plant species, which can become a source of employment and income for the population, especially for women. A good way of supporting these measures is to form associations of women workers, to promote access to credit and training.

At the reconstruction stage, support in the form of credit and training is also beneficial for the engagement of men and women in microenterprises in the various areas of commerce, small-scale production and services, as well as groups of craftspeople.

XVIII. The environment

A. Introduction

The geomorphological and ecological impacts of different types of disasters have specific environmental implications, as has been noted in the preceding chapters of this handbook. Natural events that trigger disasters are clear manifestations of the forces of nature, and the earth's ecosystems have evolved in the way that they have because of their influence and impacts. For example, the germination of some crops, the regrowth of some types of pastures, shrubs and even trees, and the everyday existence of some ecosystems or natural habitats depend on periodic fires or annual flooding.

The natural healing of the environment within a specific time frame is a function of its capacity to absorb the impacts of extreme events, especially long-lasting ones. The natural process involved in an environment's recovery is the result of the combined action of natural progression and ecological evolution, water purification, the assimilation and transformation of chemical substances, the filtering of pollutants, biogeochemical cycles and photochemical reactions in the atmosphere.

B. Ecosystems and the goods and services that they provide

Ecosystems are environmental systems that are located in specific areas. They are made up of different communities of live organisms that interact with the physical elements (air, the soil, water, light, temperature) surrounding them. Ecosystems are differentiated on the basis of their biotic communities, the characteristics of their habitats and specific sorts of natural processes.

1. The main types of ecosystems

The main types of ecosystems are agricultural ecosystems, forests, coastal ecosystems, grasslands, savannahs, and chaparral and matorral, or shrubland, ecosystems. Each one of these types of environments encompasses different ecosystemic subcategories.

(a) Forest ecosystems and natural biomes

According to estimates calculated by the Food and Agriculture Organization of the United Nations (FAO) (2007), forest ecosystems cover around 30% of the earth's land surface, constituting the planet's largest land-based stock of biomass and serving as home to 70% of all continental plant species (Groombridge, 1992). The planet's many tropical forests are particularly rich in biodiversity.

Because of the large amount of land that they cover and because most forests have reached a mature successional stage, forest ecosystems perform extremely important environmental functions at the local, regional and worldwide levels. In less developed countries, forest ecosystems continue to serve as a habitat and source of livelihood for millions of people (FAO, 1999).

The positive effects of the interaction of forests and water resources can be seen in three main areas: the soil, the quantity and quality of water, and microclimates.[204]

A biome is defined as a large geographical region characterized by certain forms of life that have evolved and adapted to a relatively uniform set of conditions. Examples include tropical rainforests, savannahs and deserts (TEEB, 2010).[205] Table XVIII.1 shows the relative extent of different types of biomes in Latin America and the Caribbean, according to a 2001 study.[206]

Table XVIII.1
Latin America and the Caribbean: types of biomes
(Percentages)

Types of biomes	Porcentage
Tropical and subtropical moist broadleaf forest	44.1
Tropical and subtropical grassland, savannah and shrubland	16.4
Desert and xeric shrubland	11.3
Tropical and subtropical dry broadleaf forest	8.8
Temperate grassland, savannah and shrubland	7.9
Montane grassland and shrubland	3.9
Tropical and subtropical coniferous forest	2.8
Temperate broadleaf and mixed forest	1.9
Grassland and savannah subject to flooding	1.5
Mediterranean forest, woodland and scrub	0.7
Mangrove swamps	0.6

Source: Economic Commission for Latin America and the Caribbean/United Nations Environment Programme (ECLAC/UNEP), *The Sustainability of Development in Latin America and the Caribbean: Challenges and Opportunities* (LC/G.2145(CONF. 90/3)), Santiago, Chile, 2001.

[204] Forests help, for example, to reduce runoff and soil erosion, prevent landslides and flooding and purify drinking water. There is also evidence that forests regulate wind, evaporation, rain patterns, sedimentation and local changes in the climate.

[205] *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations* (TEEB) study is being sponsored by the United Nations Environment Programme and funded by the European Commission and by several international organizations and government institutions in developed countries, including the Federal Ministry of the Environment, Conservation and Nuclear Safety of Germany, the Department for Environment, Food and Rural Affairs and the Department for International Development of the United Kingdom, the Ministry of Foreign Affairs of Norway, the Ministry of the Environment of Sweden, the Ministry of Housing, Land Management and the Environment of the Netherlands and the Ministry of the Environment of Japan. Further information about this study can be found on the TEEB website [online] at www.teebweb.org.

[206] Agricultural ecosystems have been analysed in depth in the chapter on agriculture, and it therefore suffices here to note that, as these ecosystems formed, their biotic and abiotic components were subjected to a succession of major changes that have influenced farming practices, the evolution of cultivated vegetation and domestic animals, and the dynamics and make-up of rural agricultural communities and population groups.

Forest biomes account for 58% of the land surface that has plant cover, followed by savannahs or plains (around 18%), where the plant cover is composed of grasses and shrubs.[207]

(b) Coastal ecosystems

Coastal ecosystems include estuaries, wetlands, marshes, marine swamps and coral reefs. Coastal biomes are highly productive habitats that play a very important role in protecting shorelines against wave action, high tides, major floods and sedimentation. When the environmental effects of economic development in coastal areas are combined with the impacts of natural disasters, the flows and paths of major rivers can be altered. When this happens, changes also occur in the accumulation of silt and other sediments in fishing grounds, around coral reefs and in areas where fish, crustaceans and other shellfish are bred and farmed. The dredging and draining of wetlands and marshes, land reclamation, and the destruction of mangrove swamps and other fragile land areas all have a severe impact on coastal ecosystems.

2. Environmental goods and services supplied by ecosystems

(a) Environmental dimensions

The environment has a physical dimension, a biotic dimension and a perceptual dimension, and each one of these can be affected in specific ways by the impact of a natural disaster. Each environmental dimension also encompasses different types of natural assets: (i) the physical dimension includes soil, water and air; (ii) the biotic dimension encompasses plants and animals (including fish and shellfish); and (iii) the perceptual dimension is composed of the non-material goods that nature provides, which take the form of aesthetic, spiritual and psychological inspiration, recreation and leisure time spent in natural surroundings, ecotourism, and scientific and cultural knowledge.

(b) Environmental goods and services

All of these ecosystemic dimensions are sources of goods. Some of these goods have price tags and can be traded on the market, while others cannot. The main goods that these ecosystems provide are: lumber, firewood, coal, food crops, fibres, edible plants and fruits, forage, wild seeds, non-timber products, wild game, rattan and other reeds, ornamental and medicinal plants, fish, algae, natural biocides and wood for use in craftwork.

The environmental services that they provide include the following:

(i) Supply of the conditions required in order to grow food crops, raw materials for use in construction, as fuel and as inputs for the pharmaceutical industry, fresh water (surface streams and groundwater) and medicinal plants.

(ii) Regulation of air quality and of the local microclimate, prevention of erosion, maintenance of soil fertility, flood control, disease containment, reduction of air pollution and precipitation. They also help to regulate carbon dioxide in the atmosphere (plants and trees sequester carbon), purify waste water, aid in the decomposition of animal and plant waste, create the necessary conditions for the pollination of crops (such as cacao and coffee) that depend on natural pollination agents, biological control of harmful pests and transmissible diseases, and the moderation or attenuation of natural hazards (floods, storms and landslides).

(iii) Support for almost all other services, particularly the conservation of habitats and shelters for a wide range of plant and animal species, biodiversity and gene banks.

(iv) Supply of non-material benefits to be derived from nature, such as aesthetic information, spiritual and psychological experiences, recreation and tourism, aesthetic appreciation and inspiration for endeavours in cultural fields, the arts and design, and knowledge relating to education and the sciences.

[207] For detailed information on the characteristics, locations, distribution and environmental significance of each of the 12 biomes listed in table XVIII.1, see ECLAC/UNEP (2001).

C. Assessment of the environmental effects and impacts of a disaster

1. Information requirements

Shortcomings in terms of the quality or timeliness of information on the stock of natural resources existing in a given area —or, even worse, the absence of such information altogether— make it very difficult to assess the damage that has been sustained in economic terms. Generally speaking, the results obtained in these types of situations have to be analysed carefully after the fact in order to detect errors or unsubstantiated conclusions.

The information that is to be gathered in order to assess the impacts of a natural disaster needs to be carefully examined in order to determine its source, the purpose for which it was compiled, its geographical coverage, the classifications used for its analysis and the methodologies used to estimate physical and economic indicators. It should be borne in mind that, when information is scarce, estimates may be used over and over again until they end up being accepted as hard data. By the same token, appraisals that are regarded as being valid for a given location should not be extrapolated for application in other locations or other contexts without first making the necessary corrections.

In order to appraise environmental damage and losses as efficiently as possible, the assessment team should try to gain access to:

(i) Publications on biomes and habitats in the disaster area, including compendiums dealing with the flora and fauna in that zone.

(ii) Surveys of the natural capital or biological stock existing in the affected zone or the usable output of the relevant ecosystems.

(iii) Publications containing baseline studies or assessments of the status and trends of local and regional biological resources.

(iv) Prior studies on the ecosystems that have been affected by the disaster, including any economic appraisals of environmental goods and services produced by those ecosystems which are of local or national importance.

It is particularly important to sift through the information compiled on the environmental effects of the disaster in order to specify exactly what kinds of consequences have been seen in exactly what locations within the different geographical areas and administrative districts of the country in question.

An exchange of information and analyses with the persons responsible for estimating the economic, social and infrastructural impacts of the disaster will make it possible to focus the appraisal of environmental damage on the areas affected by the disaster. For example, if a hurricane has ravaged coastal ecosystems (mangrove swamps, seagrass meadows, coral reefs, beaches) or if forest ecosystems have been hurt by cyclones, fires or a prolonged drought, the appraisals of the impact on the various sectors will complement each other and will provide important inputs for the overall environmental assessment.

2. Determination of the baseline

In order to determine the pre-disaster environmental status of the area, it will be necessary to compile reliable information on the pre-existing conditions in each of the main environmental components within the officially designated disaster area. In addition, an effort must be made to seek out information that can be used to determine what relationship may exist between the scale of the damage caused by the disaster and the extent of environmental degradation that may have been present before the event occurred (e.g. garbage dumps that were obstructing natural drainage canals). A comparison of the impacts of a given natural disaster in an area that was already displaying a high degree of environmental degradation with another in which the environment was healthier will make it possible to discern the role played by the environment itself in mitigating or intensifying the damage caused by natural disasters.

The chapter on agriculture underscored the fact that national government agencies that analyse and interpret satellite images are a valuable source of detailed information on land cover and can provide other analytical inputs that will be of use in establishing a pre-disaster baseline that can then be used as a point of reference when assessing the damage. The government department responsible for environmental matters, with the support of

information from the agencies that compile satellite images and aerial photographs, can monitor the impacts of the natural disaster and arrive at more precise determinations of the scale and severity of the impacts on each environmental component.

In the case of long-lasting disasters (e.g. droughts), the baseline will have to be defined on the basis of the most accurate estimate possible of how the situation would have unfolded if it had not been for the disaster. If it becomes necessary to estimate the impact of a forest fire during a drought, the amount of land that is usually engulfed by forest fires in any given year needs to be calculated. The difference between that figure and the amount of land burned by the forest fire in question can usually be taken to represent the effect of the drought.

3. Appraisal techniques for measuring the impacts of disasters

(a) Environmental damage and losses

In this context, "damage" is understood to refer to the destruction, reduction or alteration of the quantity and/or quality of environmental stocks or of assets that have been developed for the purpose of tapping into natural capital. "Losses" are defined as impacts on the quality or quantity of environmental services that result in a reduction or modification of the production or productivity levels or flows of these services or in an increase in the prices that they command.

The various types of damage and losses sustained by each ecosystem have to be identified. When accurate statistics and indicators on physical and biological environmental variables are available, they can be measured against the parameters established by national environmental agencies in order to develop appropriate and consistent appraisals of the economic value of the damage and losses caused by the disaster.

Relatively few of the environmental changes triggered by a natural disaster can be assessed on the basis of market prices or expressed in hectares, number of livestock deaths, production or productivity losses measured in terms of tons per unit of farmland, or the number of hectares of coral reefs that have been destroyed.

(b) Qualitative analysis

In general, a qualitative analysis based on some sort of scale that will make it possible to differentiate between categories and degrees of damage will need to be undertaken before any of the various direct and indirect economic estimation techniques can be applied.

The use of a qualitative scale offers two advantages: first, it provides a way to describe the force, intensity and duration of a disaster; and, second, it makes it possible to assign quantitative values to the wind velocity or force of a hurricane,[208] the force or intensity of an earthquake, the area covered by a forest fire, the amount of land flooded by torrential rains or overflowing rivers, the amount of erosion caused by prolonged heavy rains on steep terrain, the consequences of strong winds that sweep over areas with light-textured soils, ocean swells or large waves that destroy coral reefs, etc. The recommended qualitative scale includes the following categories:

(i) Nil, barely perceptible or very slight impact. The environment can recover from this type of impact quickly. If it is necessary to take action to facilitate or expedite that recovery, the cost of the programmes that will be called for will be almost negligible.

(ii) Minor or minimal impact. This kind of impact will be easily quantifiable and will not destabilize the ecosystem. The environment will recover within a short period of time and, as the environmental changes that have been caused will not be significant, the recovery costs will also be low.

(iii) Moderate impact. The environment will be able to recover from this kind of impact in the short term. The environmental disturbances may be significant, but if they are confined to a fairly small area, their consequences will be moderate and their mitigation will therefore not be very costly.

[208] The Saffir-Simpson scale measures the intensity of the winds generated by tropical storms (hurricanes and cyclones). The Fujita scale is used to measure the wind intensities of tornados, but those events occur very rarely in the region.

(iv) Severe impact. Obvious environmental disruptions will be found over a fairly large area. It may be possible for the environment to recover from these disturbances in the short or medium term if appropriate mitigation measures are used to counteract the problems caused by the disaster.

(v) Very severe impact. The large-scale consequences of this kind of impact are very serious and spread out over a large area, which may encompass more than one region within the country concerned. There is a possibility that a partial recovery can be made over the medium or long term, but it will be very costly and the chances that the affected resource will be usable in the future are small.

(vi) Total impact: The ecosystem will not be able to recover from the damage caused and the chances of future use of the area are nil. In this kind of situation, natural resources will take a long time (25 years or more) to recover.

(c) Overlapping effects of environmental damage and losses

Environmental damage and losses are not always readily identifiable and may be difficult to assess because it can be hard to separate the specifically environmental effects from damage and losses in the other sectors covered in this handbook.

Examples of environmental disturbances that may be caused by a natural disaster include:

(i) Qualitative changes in seawater and/or algal blooms.

(ii) Alteration of the shoreline owing to erosion, sedimentation or the accumulation of debris, and loss of beaches (or sand) or other coastal areas that are frequently used for recreation and as vacation sites or areas in which marine sports are practised.

(iii) Elevated salinity, which may alter the breeding behaviour of some species of fish, crustaceans and other shellfish that are less able to tolerate excessive salinity.

(iv) Destruction of coral reefs or their fragmentation, discoloration or asphyxiation by increases in algae and changes in seagrass meadows.

(v) Changes in land and aquatic (freshwater and oceanic) habitats of wildlife and marine birds.

(vi) Destruction of environmental infrastructure in protected areas or national parks (e.g. roadways, bridges, sign posts and facilities used for environmental education programmes or research).

(vii) Alteration of landfills and/or refuse collection and disposal systems.

When production and commercial activities conducted in agricultural, forest or coastal ecosystems are affected by a natural disaster, estimates of the economic effects should be included in the corresponding social, economic or infrastructural category. In order to avoid double accounting, appraisals should be conducted in coordination with the groups in charge of the estimates for those sectors,[209] and estimates of environmental damage and losses should be included only if the impacts have not already been attributed to other sectors.[210]

When environmental authorities take on the job of designing and implementing programmes or projects to restore natural assets that have been damaged by a disaster (e.g. assets in protected areas or national parks), the economic estimates of the corresponding effects should be included in the environmental assessment. Losses of environmental services for which there are no established markets should be estimated on the basis of changes in flows; examples include the carbon sequestration or water-cycle regulation services provided by forests.

4. Appraising impacts on goods that have market prices

Uncontrolled forest fires, category 3 or higher hurricanes, tropical storms, volcanic eruptions and droughts are the types of disasters that cause losses and other permanent or temporary damage over large areas in the various types

[209] The teams assessing the effects of a disaster in each of the other sectors will be working on the basis of man-made stocks. The environmental team, on the other hand, will be estimating damage and losses sustained by natural ecosystems.

[210] Examples might include water shortages, problems with water quality attributable to pollution or damage to water distribution systems (water and sanitation sector), and problems with overland, maritime, river or air transport caused by landslides or the silting up of ports or rivers (transport and infrastructure sectors).

of native forests. One means of estimating the damage sustained by forest stocks is to use the commercial price of timber and non-timber forest products that have a market price. In the case of natural forests located in protected areas that cannot be used for commercial purposes, the damage and losses caused by a natural disaster can be estimated by using appraisal techniques that make it possible to arrive at approximate values for the environmental services that those forests provide.

(a) Destruction of timber

The procedure to be used for a direct appraisal of the value of timber destroyed by a natural disaster is as follows:

(i) Determine the surface area affected by the disaster. As an example, in Nicaragua an estimated 700,000 hectares of forest were directly in the path of Hurricane Felix.

(ii) Establish what percentage of the forested land hit by the storm has been classified as potentially harvestable for commercial use.[211] To use the same example as above: 75% of the total surface area (75% of 700,000 hectares, i.e. 525,000 hectares) had been classified as commercially usable. The other 25% (175,000 hectares) had been classified as a protected area.

(iii) Determine what types of forests are in the affected area. To continue with the same example, the forest damaged by the storm was composed of broadleaf trees (65%, or 455,000 hectares), conifers (22%, or 154,000 hectares) and mixed forest and other types of forest plant cover (fallow land and scrubland) (13%, or about 91,000 hectares).

(iv) Hurricanes generally affect the ecosystems located in their paths to differing extents as their force and intensity vary. The forest ecosystem damaged by Hurricane Felix was classified as sustaining heavy damage (52%), moderate damage (36%) and slight damage (12%). In the zones that sustained heavy or moderate damage, the storm had been a category 3 hurricane; the areas that were only damaged slightly were those where the storm had dropped to a category 1 hurricane (see table XVIII.2).

(v) Since a hurricane's powerful winds down trees, strip the leaves off those that remain standing, and carry away nuts, seeds and other non-timber products, the amount of plant cover that has been damaged will have to be estimated in order to convert this into a figure for severely impacted canopy cover. In order to determine the scale of the damage to the forest resources, supplementary information will have to be compiled (see table XVIII.2).

(vi) Continuing with the same example, of the total 156,800 hectares in which the trees were affected, 55% of the trees were blown over and defoliated, which equals 86,240 hectares where the impact was severe and trees were totally destroyed; 30% of the trees in the forested areas sustained moderate damage were blown over and defoliated, which equals 47,040 hectares of land in which the trees were totally destroyed by the storm; finally, in areas that sustained slight damage, 15% of the trees were blown over and defoliated (15% of 156,800 hectares = 23,520 hectares of trees that were totally destroyed).

(vii) The next step is to estimate the amount of timber that has been lost. In the example, for the 156,800 hectares on which the trees were totally destroyed (some of these trees may still be harvestable), it is calculated that the average timber yield is 18 cubic metres per hectare. Multiplying 156,800 hectares by this average yield gives a figure of 2,822,400 cubic metres of timber lost as a result of the hurricane.

(viii) The estimated yield (18 cubic metres of timber per hectare) is then multiplied by the estimated market price (e.g. US$ 20 per cubic metre of timber) for the trees that are still standing, with the result being US$ 360 per hectare. When this figure is multiplied by the 156,800 hectares where the trees were destroyed, the result —US$ 56,448,000— is the estimated value of the timber that was lost as a consequence of the hurricane. Table XVIII.2 provides a summary of the results of this methodology for estimating the value of the timber that was destroyed by the hurricane.

[211] Forests and other woodlands where there are no legal, economic or technical obstacles to logging operations.

Table XVIII.2
Estimation of timber destroyed in a forest ravaged by Hurricane Felix
(Percentages, hectares and dollars)

Estimated area of forested land	Percentages	Hectares
Area of commercially harvestable forest	75	525 000
Area of protected forest (not harvestable)	25	175 000
Total	100	700 000
Type of harvestable forest impacted by storm		
Area of hardwoods [a]	65	455 000
Area of conifers [b]	22	154 000
Area of mixed forest and other woodlands	13	91 000
Total	100	700 000
Level of impact on area of commercially harvestable forest (525 000 hectares)		
Area of commercially harvestable forest affected by the hurricane	85	448 000
Scale of impact on native forest		
Severe	52	232 960
Moderate	36	161 280
Slight	12	53 760
Total	100	448 000
Area of forest exhibiting differing impacts		
Trees very severely impacted (area)	55	86 240
Trees moderately impacted (area)	30	47 040
Trees slightly impacted (area)	15	23 520
Total	100	156 800
Estimated value of timber destroyed (2008 dollars)		
Estimated timber yield in the impacted 156 800 hectares (m^3) (18 m^3 per hectare of trees affected)		2 822 400
Average price of cubic metre of timber (2008 dollars)		20
Estimated value of timber destroyed (2008 dollars)		5 644 800

Source: Economic Commission for Latin America and the Caribbean (ECLAC), *Impacto del Huracán Félix en la Región Autónoma del Atlántico Norte y de las lluvias torrenciales en el noroeste de Nicaragua* (LC/MEX/L.860/Rev.1), Mexico City, ECLAC subregional headquarters in Mexico, September 2008.
[a] Trees that are classified as angiosperms are leafy hardwoods with well-defined, large crowns. Their leaves are broad and laminate, and they may be evergreen or deciduous.
[b] Conifers are softwoods which are classified as gymnosperms.

The classification of the severity of the impact, in terms of both the area involved and the volume of trees that have been destroyed, will be determined primarily by the path of the storm, the type of forest that has been damaged (tropical forests situated in warm, humid climates are mixed, with spots or parts of the forest where hardwood or coniferous species predominate, either in isolation or in conjunction with other species) and the topography. The sustained winds of 100 km/hr or more of hurricanes that are category 3 or above on the Saffir-Simpson scale are strong enough to blow over mature, well-rooted trees in old-growth (primary) forests. These winds also lay waste to younger trees in secondary forests.

Taking another example for the purpose of examining the procedure for appraising forest damage, in one case where a mangrove swamp had been hit by a hurricane, the environmental authorities decided to place priority on the rehabilitation of one strip of the area because it provided a buffer against the movement of water and wave action generated by tropical storms.

The impacted area has been estimated at 2,300 hectares, and 500 hectares of that area has been chosen for replanting because it is the most vulnerable part of the area and is unlikely to recover on its own. The cost of replanting has been estimated at US$ 4,800 per hectare; by multiplying those 500 hectares by the US$ 4,800 estimate, the partial damage to that portion of the mangrove swamp can be estimated at US$ 2,400,000. (This approximate figure

does not include the cost of restoring other environmental goods and services in the mangrove swamp that were affected by the damage.)

To use another example: A 7,200-hectare shaded coffee plantation was hit by a hurricane. Only 40% (2,880 hectares) can be restored over a five-year period. An environmental appraisal determined that 14 cubic metres per hectare of firewood[212] could be produced annually that would command a price of US$ 4 per cubic metre (US$ 56/ha/year). Accordingly, the estimated total value of the loss of firewood can be calculated by multiplying US$ 56 by 2,880 hectares, for an estimated loss of US$ 161,280.

(b) Estimating damage to non-timber forest products

Non-timber products include honey and other major bee products, nuts, a wide range of fruits, mushrooms, essential oils, flowers, ornamental plants, types of wood used to make handicrafts, vines that can be used to make baskets, brooms and ropes, hunting grounds, fishing grounds, and poisons and other derivatives of wildlife and flora. Non-timber products are a source of livelihood for many rural families whose members live in or near native forests, but those products may not have established or well-known market prices.

Some public and private institutions try to place economic values on certain non-timber native forest products (such as the local production of honey and some of its derivatives, or local harvests of nuts, palm hearts, fruit and ornamental plants) that may have market prices. Some of these products are highly sought-after by some consumers and may fetch much higher prices than timber. In fact, some non-timber goods and services from certain types of natural forests may generate as much or more income as is derived from the sale of timber, firewood and charcoal, as in the case of the chestnuts produced in Brazil and the Plurinational State of Bolivia, rubber, and other non-timber products that have established market prices. The procedure for appraising these kinds of losses is the same as described above: the volume of annual harvests is multiplied by the corresponding unit prices.

5. The appraisal of environmental damage to soil, water and air

The physical environmental damage and losses resulting from disasters are primarily manifested in their impacts on land and water resources, although air quality may also be affected to a lesser degree. Different types of plant cover will have a strong influence on the amount of soil that may be lost due to water or wind erosion resulting from a disaster.

(a) Land and soil

Erosion is the main cause of soil degradation, and its extent is determined by soil type, local climatic conditions, land use (plant cover), the terrain and resource management policy. Other significant causes of soil loss include landslides and rockfalls caused by natural disasters, especially in steep terrain (steep-gradient slopes and ravines), but these factors do not usually have such a crucial impact as conventional causes of erosion do.

Erosion by water courses is a function of the gradient of the terrain, the plant cover and the root network, the amount of rainfall during a given period, and the percentage of total rainfall that becomes runoff. For example, in land where there is a 25% slope and where runoff amounts to 10% of total rainfall, erosion may be severe. In cropland, the soil loss may range between 20 and 50 tons per hectare per year. In forests with slopes and runoff percentages of around 4% of total rainfall, soil loss may range from 5 to 15 tons per hectare per year (Mutis and Sandoval, 2001).

According to the Food and Agriculture Organization of the United Nations FAO, impacts on soil of less than 0.5 tons per hectare per year can be regarded as normal. Erosion is considered to be mild when the loss amounts to between 0.5 and 5 tons per hectare per year and to be moderate when it totals between 5 and 15 tons per hectare per year. This situation is reflected not only in a lower level of fertility, but also in a reduced water storage capacity. Table XVIII.3 shows the FAO estimates for the various impacts on the soil and the extent of soil lost, by hectare and by year.

[212] The types of trees planted to provide shade for coffee plants are not suitable for use as timber and are generally used for firewood.

Table XVIII.3
Laminate soil erosion
(Tons per hectare per year)

Soil loss	Tons per hectare per year
1. Normal	Less than 0.5
2. Slight	Between 0.5 and 5.0
3 .Moderate	Between 5 and 15
4. Severe	Between 15 and 50
5. Very severe	Between 50 and 200
6. Catastrophic	Greater than 200

Source: Food and Agriculture Organization of the United Nations (FAO), *A Provisional Methodology for Soil Degradation Assessment, Rome*, 1980.

Soil degradation may increase sharply because of the very heavy rains that a natural disaster can trigger. In assessing the cost of such phenomena, it may be helpful to know that desert and arid areas normally lose between 0.5 and 12 tons per hectare per year of soil due to water erosion. In semi-arid and dry ecosystems, soil loss due to erosion can be significantly greater, and in semi-arid, sub-humid areas, the loss can amount to 200 per hectare per year or more, which is considered to be a catastrophic level (FAO, 1980).

The extent of the soil damage sustained by agricultural ecosystems will be influenced by the types of production systems that are in use and may range from moderate to severe, whereas such damage generally ranges from slight to moderate in forest ecosystems. In land covered by a layer of mulch,[213] the impact varies from normal to slight. In areas where the land is bare, however, the impact is generally quite strong and may be severe or very severe.

In grassland ecosystems, the root systems of the grasses form a strong, dense netting that curbs soil and water losses. In improved pastureland or in pastures with leguminous plants, the web of roots improves the stability of soil aggregates, and the more stable they are, the smaller the soil fertility losses caused by a natural disaster will be; this is especially important when a disaster is coupled with heavy rains and increased runoff (Gijsman and Thomas, 1995).

The procedure to use in assessing the economic effects of soil damage caused by natural disasters is as follows:

(i) Compile information on the geographical location of the impacted areas, their size, the types of soils that are present and their degree of fragility. It is also important to ascertain if the land in the area has tree cover or is brushland or grassland or is under cultivation. Landslides and rockfalls are usually confined to a fairly small area, and their effects therefore tend to be limited in extent.

(ii) It is crucial to determine the types of land use involved in the impacted area in order to assess the damage in economic terms. From an edaphological standpoint, cropland soil loss is measured in terms of the reduction in nutrients and organic matter contained in each hectare. Most countries have detailed soil studies and reports on the content of primary nutrients (nitrogen, phosphorus and potassium) (NPK) and organic matter. These data can be used to estimate the amount of nutrients that have been lost as the result of a disaster. These estimates can then be supplemented by specialists who can go out to observe the symptoms of nutrient deficiencies exhibited by cultivated or wild plants.

(iii) Gather information on the prices of the simple or compound fertilizers (phosphate-, nitrogen- and potassium-based fertilizers with different mixes designed for use in different types of soil). Information of this type can be found in the price schedules published for fertilizer markets or can be obtained by consulting fertilizer vendors.

(iv) Multiply the kilos of nutrients lost per hectare by the price of the fertilizers concerned in order to arrive at an estimate of the monetary value of the damage caused by the disaster. This procedure makes sense when

[213] There are many different types of mulch or partially decomposed compost. These substances cover bare soil and thus help to prevent surface runoff, regulate soil temperature, conserve humidity and prevent the growth of weeds by blocking sunlight. They also gradually supply nutrients for the soil as they decompose.

dealing with crops or products that have market prices. If this is not the case, the team will be dealing with environmental services, which will have to be assessed on the basis of shadow prices.

(v) In order to replace the organic matter that was lost as quickly as possible, manure from different types of domesticated animals or other decomposing organic matter will be added to the soil. In this case, the amounts of organic fertilizer or compost used will have to be multiplied by their respective market prices, and the result added to the value of the fertilizers that have been used.

This procedure for appraising soil losses should be carried out with support from specialists in edafology. Even with their assistance, this can be a time-consuming task if up-to-date, verifiable information is lacking. These difficulties may make it necessary to estimate the value of the soil damage caused by a natural disaster on the basis of the market price of cropland that is of comparable quality and productivity or on the basis of the value of the reduction in production or in productivity of farmlands that have become less fertile as a result of a disaster. When the damage can be repaired, then the value of the damaged land can be estimated on the basis of the cost of restoring the soil fertility that was degraded (losses of nutrients and organic matter). Information can also be obtained from soil conservation programmes and projects.

When the land damaged by a disaster is being used for residential purposes, for human settlements or for beaches used by vacationers, the valuation of the impact should be included in the estimates for those sectors.

(b) Water

It is no easy task to assign a direct value to the quantitative and qualitative damage done to water resources (natural assets). This can be attempted by estimating the investment that will be required to build the works that will be needed to restore the damaged assets.

This estimate should not include the construction work required for the catchment, transport or utilization of water for human consumption or industrial use, for the generation of electricity or for the supply of water for agricultural irrigation channels and systems, since all of this should be tallied up in the accounts for the corresponding sectors. In cases where irrigation facilities are flooded, the estimate of the damage and losses should be incorporated into the analysis done for the agricultural sector. By the same token, when a disaster (e.g. a prolonged and unexpected drought) leads to shortages of water for multiple uses, these impacts should be assessed as part of the estimates for the agriculture, industry, commerce, energy, tourism, and housing and human settlements sectors.[214]

(c) Air

Air can be polluted by certain types of natural disasters, such as volcanic eruptions and forest fires, as well as by human activity in urban and rural areas. Thus far, no economic value has been assigned to the clean air consumed by living organisms, including human beings. Therefore, any indefinite or temporary change in air quality can be estimated only on the basis of the cost of the steps taken to clean this resource.

The deterioration of air quality as a result of temporary atmospheric pollution can be measured and appraised on the basis of the additional costs involved in implementing health programmes (increased current expenditure) and the expenditures made to protect the population during the period of time that is needed to monitor and reduce air pollution. These additional costs should be registered in the estimates for the health sector.[215]

For example, a volcanic eruption pollutes the air in a nearby city and reduces visibility, which hampers inter-urban transport. The additional costs occasioned by the eruption should be registered as increased costs in providing medical attention to the population, the cost of purchases of face masks and the added cost of transporting cargo and people over longer or more costly routes during the months that pass before the environmental disturbances abate. The tourism sector may also see a reduction in tourist arrivals. These effects should be appraised as part of the impact assessment for the health, transport and communications, and tourism sectors, as well as the agricultural sector if the eruption leads to the deposition of ashes and other pyroclastic flows on cropland or grasslands.

[214] See, for example, ECLAC (2002a).
[215] These expenditures are clearly going to boost economic activity in the commercial sector.

6. Environmental services: appraisal techniques and examples

When a monetary value cannot be established directly because there are no market prices for the goods or services in question or because not enough quantitative information is available, the value of the environmental effects of a natural disaster will have to be estimated by indirect means. Techniques are available for identifying and measuring the physical and economic cause-effect relationships that can be used as a basis for determining what other prices can be used (shadow prices) in calculating the estimates. It may also be possible to estimate the value of environmental goods and services for which no market prices are available by consulting users in order to determine the values that they assign to those goods and services.

(a) Use values and non-use values

From an economic standpoint, natural resources are assets (natural capital) from which goods and services are derived that can be used to increase people's well-being. The aggregation of the different individual values of the components of natural capital is referred to as the total economic value, or TEV. This aggregate include use values and non-use values; in addition, use values are divided into direct-use and indirect-use values.[216]

Direct-use values include all the goods and services produced by an ecosystem that can be consumed or used as inputs for production processes. Some of these goods and services have market prices and are traded in established markets (e.g. timber, firewood and coal).

Indirect-use values include a number of types of environmental services or ecological functions performed by forest ecosystems which will be discussed in the following section.

Some environmental services are tangible, while others are not, and this is another factor that makes it difficult to estimate their actual value. Option values are used when there is uncertainty as to the present use and the future supply of a given resource. There are two types of option values: option values as such (when an environmental service whose future use is uncertain continues to have a latent value until such time as people decide to use it or not to use it); and quasi-option values (when a given value cannot be assigned to a specified environmental service until such time as information is made available that will make it possible to determine if certain benefits will be derived from it in the future. As an example, the maintenance of a forest ecosystem will offer the possibility of attaining future benefits from the environmental services provided by that forest ecosystem, whereas the destruction of that ecosystem would preclude that possibility.

The concepts of bequest value or heritage value refer to the present enjoyment of services that an ecosystem provides in a way that ensures that they will be available to future generations. Existence values are an intangible, psychological benefit which stems from the simple recognition that a resource exists; the chances of that resource being used, either in the present or in the future, do not enter into the equation. Examples would include the survival of a given species of wildlife that is in danger of extinction or the continued existence of especially beautiful forests or natural conservation areas.

(b) Indirect estimation methodologies

There are a number of different indirect estimation methods; the choice of which method to use will depend on whether the basic information required for one method or another is available.[217] Since surrogate prices are used in order to establish the value of many environmental services, there is a risk that the estimated values may be very inaccurate. The use of shadow prices to estimate the economic value of environmental services for which there are no market prices is an established and widely accepted practice, but it is important to remember that the goods and services that a value is being attached to may be unique or may be located in ecosystems that are very different from the ones in which the service being used as a substitute value is to be found.

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[216] Use values are derived from the consumptive use of natural resources (e.g., the burning of firewood) or their non-consumptive use (tourism activities). Use values that are defined as functional values can be understood as being indirect benefits that people enjoy as a consequence of the primary ecological function of a given resource. One example would be the indirect use value of wetlands associated with the fact that they filter groundwater that is then used on land that is at a lower elevation than the wetlands in question.

[217] For a more detailed description of these methods, see Dosi (2000).

When the restoration cost method is used (the amount that would have to be invested in order to restore the natural capital damaged by a disaster), an attempt must be made to estimate the impacts of the disaster over the length of time that it will take to restore the asset.[218]

The hedonic price method entails identifying and separating out the specific value of each component of the total value of an environmental service. This method is quite complex and difficult to apply.

The travel costs method uses the travel costs plus the cost involved in staying in a given area within certain ecosystems as indicators of the value of the environmental services that the location in question provides to tourists (such as landscape, natural beauty, recreation and artistic or spiritual inspiration).

Contingent valuation methods measure willingness to pay (WTP) for an environmental service or willingness to accept (WTA) compensation for the elimination of an environmental service. These methods may be used to estimate intangible values (option values, existence values or bequest values).

The use of contingent valuation methods is increasing nearly as fast as people's preferences are changing, particularly those of people who enjoy higher socioeconomic living standards and who see forests as places for recreation and tourism rather than solely as a source of physical goods and services.

The change-in-productivity method is based on the idea that, if an environmental attribute forms part of an economic activity's production function, then the effects of environmental changes can be measured by the impact that they have on production levels.

(c) Examples

(i) Forest and woodland ecosystems

Two examples are provided below of approaches to the valuation of environmental services provided by forest and woodland ecosystems. In the first example, estimated percentages are calculated based on the results of a valuation of environmental services supplied by forests in Mexico. These estimates are derived from calculations presented in a study by Constanza and others (1997), supplemented by other per unit estimates of areas of timber stock prepared by INEGI (National Institute of Statistics, Geography and Informatics, now known as the National Institute of Statistics and Geography) in 1995 and by the Centre of Private Sector Studies for Sustainable Development (CESPEDES) in 1999 (see table XVIII.4).

Table XVIII.4
Mexico: environmental services provided by forests, 1997
(Percentages)

Type of service	Tropical forests	Temperate forests
Supply services	29.3	26.1
Non-timber products	17.3	24.8
Medicinal resources	12.0	1.3
Regulation services	**65.1**	**61.0**
Climate regulation	11.2	29.1
Control of impacts from disasters	0.3	---
Regulation of the water cycle	0.7	---
Prevention of erosion	12.2	---
Soil formation	0.5	3.0
Soil nutrients cycle	35.9	---
Removal and absorption of waste	4.3	28.9
Support services (habitat)	**---**	**---**
Intangible services	**5.6**	**12.9**
Tourism and recreation	5.5	12.0
Scientific, cultural and psychological services	0.1	0.9
Total value (dollars per hectare per year)	2 007	302

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of Robert Constanza and others, "The value of the world's ecosystem services and natural capital", University of Maryland [online] http://www.esd.ornl.gov/benefits_conference/nature_paper.pdf, 1997; National Institute of Statistics, Geography and Informatics (INEGI) and Centre of Private Sector Studies for Sustainable Development (CESPEDES).

[218] This method cannot be used if restoration is not economically feasible or if the asset in question cannot be repaired.

Table XVIII.5 shows the results of the valuation of environmental services provided by forest ecosystems in three Central American countries that were hit by Hurricane Felix in September 2007.

Table XVIII.5
Costa Rica, Honduras and Nicaragua: reference values for environmental services provided by forest ecosystems
(Dollars at 2007 prices per hectare per year)

	Costa Rica Primary forest	Costa Rica Secondary forest	Honduras	Nicaragua
Carbon sequestration	38.00	29.26	35.00	35.00
Protection of water resources	5.00	2.50	9.00	9.00
Protection of biodiversity	10.00	7.50	9.00	9.00
Protection of ecosystems	5.00	2.50	36.0	3.00
Total	58.00	41.76	56.60	56.00

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of C. Carranza and others, "Valoración de los servicios ambientales de los bosques de Costa Rica", San José, Ministry of the Environment and Energy (MINAE), 1996; Robert Constanza and others, "The value of the world's ecosystem services and natural capital", University of Maryland [online], http://www.esd.ornl.gov/benefits_conference/nature_paper.pdf, 1997; ECLAC, "Proyecto de creación de la oficina de implementación conjunta de Honduras", Canadian International Development Agency (CIDA); and ECLAC, I*mpacto del Huracán Félix en la Región Autónoma del Atlántico Norte y de las lluvias torrenciales en el noroeste de Nicaragua* (LC/MEX/L.860/Rev.1), Mexico City, ECLAC subregional headquarters in Mexico, September 2008.

The second example concerns a hypothetical valuation of the environmental services provided by a wooded area in which 3,200 hectares of primary forest and 6,100 hectares of secondary forest were damaged so severely by a natural disaster that these areas either cannot be restored at all or could be restored only over the very long term. In addition, the disaster impacted 7,200 hectares of a shade-grown coffee plantation, 4,320 hectares of which was destroyed, while the remaining 2,880 hectares can be restored over a five-year period. The government has put in place a system for the issuance of payments for environmental services provided by these forests; the owners receive these payments in exchange for conserving these woodlands for a 20-year period. The system covers the supply of one good (firewood) and three environmental services: flood control; prevention of soil erosion and maintenance of soil fertility; and conservation of biodiversity.[219]

The annual loss of the environmental services provided by the primary forest has been estimated at US$ 58/ hectare; a discount rate of 7% has been applied to this value in order to arrive at the present value of the income generated by conservation of the forest for 20 years (the government used this 7% rate for the evaluation of investment projects; obviously, the appropriate rate would be different in another country under different circumstances). This yields a figure for lost income of US$ 672/ hectare, which, when multiplied by 3,200, comes to an estimated loss of US$ 2,150,400.

In the case of the secondary forests, the same procedure yields an annual loss of US$ 41/ hectare, which, when converted into the present value of future income flows, comes to US$ 475/ hectare. This figure, multiplied by 6,100 hectares, gives a loss of US$ 2,897,500.

When the same procedure is applied to the case of the shade-grown coffee plantation, the first value turns out to be US$ 21/ hectare.[220] The present value of the future flow of income per hectare would therefore be US$ 244, which, when multiplied by 4,320 hectares, comes to US$ 1,054,080. Therefore, the total loss of environmental services from the primary and secondary forests damaged by the disaster totals US$ 6,101,980, as shown in table XVIII.6, which is based on the estimates presented here.

[219] The environmental service of carbon capture and sequestration was not taken into consideration because the parts of the trees removed during annual pruning were used as firewood.

[220] The value of the wood –a good for which a market price exists– has been estimated at US$ 56/ hectare, which, when multiplied by the 4,320 hectares that were damaged, yields a figure of US$ 241,920.

Table XVIII.6
Estimation of forest environmental services destroyed by a disaster
(Dollars)

Ecosystem	Lost value per year (dollars per hectare)	Present value of future income loss per year a (dollars per hectare)	Present value of lost income over 20 years [a]
Primary forest			
3,200 hectares destroyed	58	672	2 150 400
Secondary forest			
6,100 hectares destroyed	41	475	2 897 500
Shade-grown coffee plantation			
4,320 hectares destroyed	21	244	1 054 080
Total forest environmental services lost			6 101 980

Source: Economic Commission for Latin America and the Caribbean (ECLAC).
[a] Calculated using a 7% discount rate.

(ii) Coastal ecosystems

The biodiversity present in tropical coastal zones includes mangrove swamps, seagrass meadows and coral reefs, all of which are home to large amounts of invertebrates, fish and plants, and some of these ecosystems rival the biotic complexity of tropical forests. Their evolution has been associated with frequent natural events of varying intensities, such as tropical storms, which bring extremely strong winds and high, crashing waves. The effects of natural disasters of this type extend deep into the ocean and may include the suspension of sediments, soil salinization, the fracturing of hard-bodied organisms, and the sweeping up of fragments or entire organisms by the powerful ocean currents and eddies.

Sites where tidal movements are fairly weak (shallow water) that are in the path of a hurricane or large storm are severely affected in terms of the distribution and number of organisms that they house. For example, a storm that generates 5-metre waves causes currents of water to move at speeds of between 3 and 4 metres per second at a depth of 10 metres, and this is accompanied by a layer of sediments in suspension that varies in depth. The size of the area that is swept over by the large waves produced by a hurricane will depend on the predominant orientation of the waves.

(iii) Mangrove swamp ecosystems

These ecosystems are located in tropical and subtropical coastal zones in tidal areas (exposed to both high tide and low tide) or in sheltered areas (gulfs, coves, inlets, marshes, estuaries, river mouths) where the seabed is soft (sand, lime, clay) and where freshwater runoff flows into them periodically. These are amphibious habitats (i.e. habitats having some characteristics of aquatic habitats and some of land habitats) in which certain species of mangrove trees predominate in conjunction with a wide range of woody and herbaceous species. Mangroves tolerate extreme salinity and low concentrations of oxygen in the water and the soil; they have evolved to survive and flourish in a very particular type of environment by changing and adapting in ways that have endowed them with very special physiological and anatomical traits.

Mangroves play a key role in protecting coastal areas from wind erosion and wave erosion. They are highly productive and host a large number of aquatic, amphibian and terrestrial organisms. They also are home to many species of fish, molluscs and crustaceans during the juvenile stage of their life cycle.[221] As such, they play a vital role in coastal and offshore fisheries as well. In addition, they provide a temporary habitat to many species of migratory birds coming from the northern and southern hemispheres and are a valuable source of valuable water-resistant hardwoods (long-fibre woods) for local communities. They also produce tannins that can be used in curing and dyeing.

[221] Mangrove swamps are a habitat for many juvenile pelagic and coastal fish, molluscs, crustaceans, echinoderms and annelids that, in the adult stage of their life cycles live in phanerogram grasslands, wetlands and coastal lagoons, coral reefs or other habitats, including inland freshwater bodies. Approximately 70% of the organisms harvested from the oceans spend some part of their lives in a mangrove swamp or coastal lagoon.

Mangrove swamps can be appraised on the basis of the goods they produce that have a market price. The environmental services that they supply can be measured on the basis of the amount of investment that would be necessary to restore their ecological functionality after a natural disaster and to ensure that they provide the environmental services and goods that they have supplied in the past (a number of studies have used the above-mentioned methodologies to conduct valuations of mangrove swamps).

The destructive power exerted by hurricanes in mangrove swamps depends on the force and velocity of the wind, the duration of the storm and the amount of rainfall (which declines after the eye of the hurricane has passed). The immediate visual impact of a storm has to do with the amount of trees that have had their leaves stripped off (when defoliation is severe, a total of between 4 and 5 tons/hectare may cover the ground). The most severe damage is sustained by older trees and the flowers, fruits and seeds whose destruction retards the regeneration of species of trees and alters the composition of the forest.

For example, in 2008, Hurricane Felix damaged 24,200 hectares of mangroves along the coasts of Nicaragua and destroyed vast stretches of trees whose wood is highly valued by local communities (ECLAC, 2008c).

The periodic destruction or damage of mangrove swamps is reflected in reduced structural complexity and in the less important role played by climax vegetation in these biomes.

(iv) Coral reef ecosystems

Coral reefs are solid structures that develop in tropical waters where wave action and ocean currents provide a constant flow of nutrients for both the coral and the algae that live in symbiosis with the coral. These structures are highly prized habitats for a wide range of aquatic species. Because of their strategic position between the coastline and the open sea, coral reefs serve as solid barriers that protect mangrove swamps and seagrass meadows from the waves. By the same token, mangrove swamps and marine grasses protect the reefs from the damage that would be caused by sedimentation and are excellent spawning and nursery areas for many aquatic species that live in coral reef ecosystems.[222]

The main environmental services provided by coral reefs are: opportunities for tourism and recreation, habitats for fish and protection of fish species, maintenance of biodiversity and sources for the extraction of sand to restore beaches and dunes. In addition, coral absorbs the carbon dioxide in the water and thereby helps to regulate the climate. The pharmaceutical industry has also become interested in gaining access to certain raw materials that can be obtained from coral reefs. Following a natural disaster (particularly in the case of hurricanes and tropical storms), if there are signs that coral reefs may have been affected, a submarine inspection will need to be conducted by professional divers. Their findings can be supplemented by interviewing fishermen and other people whose specialized knowledge can help the assessment team to ascertain the size of the affected area, the severity of the damage and the scale of losses.

Economic appraisals of coral reefs in Australia, Aruba and Jamaica have assigned monetary values to damaged reefs of between US$ 7,500 and US$ 500,000 per hectare, depending on the reef's location and the role it plays in the coastal ecosystem concerned.

The damage done to coral reefs by hurricane winds can mar their great beauty, and this translates into economic losses. Near the Caribbean island of Anguilla, for example, coral formations and the beaches are often swept over by waves that have been whipped up by hurricanes or tropical storms, and this has badly hurt the occupancy rates and operation of tourism destinations on the island. Efforts are under way to design means of restoring the reefs by means of coral transplants (ECLAC, 1995).

In a hypothetical case that serves to illustrate an approach to the environmental assessment of an area in the vicinity of a coral reef, it was posited that the present per-hectare value of the reef ranged from US$ 90,000 to US$ 320,000. It was then determined that an area measuring 7,000 linear metres in length and 75 metres in width

[222] The Great Barrier Reef, off the coast of Queensland, Australia, occupies some 2,000 km^2 and is one of the largest natural structures on earth. It is followed by the Meso-American Reef, which occupies over 700 km^2 and is located in the Caribbean Sea off the coasts of Mexico, Belize, Guatemala, Nicaragua and Honduras; this reef is home to a vast variety of living organisms (some 60 different types of coral and over 500 species of fish). In 1998 the World Wildlife Fund (WWF) classified this reef as a coastal ecosystem of worldwide importance and recommended that no effort be spared in order to ensure its conservation.

had been irreversibly damaged or could be restored only in the very long term. The coral surface was appraised at US$ 205,000 per hectare (the simple average of its estimated present value). Since its total area was calculated to be 52.5 hectares, its total value came to US$ 10,762,500.

(v) Seagrass ecosystems

These ecosystems are quite extensive in the coastal areas of all the continents except Antarctica. The plant cover of these underwater zones looks like large prairies.[223] These particular plants have flowers, long, narrow leaves and are almost always green. Because they rely on photosynthesis for their survival, they grow in areas within the photic zone (no deeper than 50 metres, approximately). Most seagrass meadows are found in sheltered, shallow coastal areas. The plants are rooted in sand, mud or even rocky substrata, and their complete life cycle (including pollination) is spent underwater.

Seagrass meadows are highly diversified and highly productive ecosystems. They may be home to hundreds of associated species belonging to a wide range of phyla,[224] including juvenile and adult fish, free or epiphyte (macroscopic or microscopic) algae, molluscs, nematodes and others. The leaves of these marine grasses are nutrient-poor, but they nonetheless serve as food for many herbivores (tapirs) and fowl (ducks and swans). Seagrass meadows provide a series of ecological goods and services; they enrich fishing grounds, reduce coastal erosion caused by wave action, produce oxygen and are used as fertilizers and in the manufacture of furniture and weavings.

Natural disasters or disturbances such as hurricanes and tropical storms have an impact on seagrass meadows despite their high degree of phenotypic plasticity, which allows them to adapt rapidly to environmental changes. The surface area of seagrass meadows can be reduced by sedimentation, mechanical destruction of the habitat or overfishing. An excessive input of nutrients (eutrophication) is toxic for them and stimulates the growth of epiphytes and algae.

Hurricanes and tropical storms uproot the plant formations making up seagrass meadows. Hurricane Keith, which swept over land in the vicinity of the Belize and Miskito keys, destroyed hundreds of hectares of marine grasses, which were then seen floating on the ocean's surface.

The damage caused by a natural disaster to seagrass (which has no market price) can be assessed on the basis of the cost of replanting programmes. It is also possible to estimate the value of the environmental services provided by seagrass meadows by assessing the contribution they make to the natural recovery of sand on beaches that have been damaged by wave action or the role they play as a habitat to a number of different species of fish.

(vi) Impacts on wildlife

An assessment conducted in north-eastern Nicaragua in the wake of Hurricane Felix and the torrential rains that it brought along with it (ECLAC, 2008c) concluded that 25 species of mammals (including jaguars, pumas, tigrillos and tapirs) had been impacted, along with some 215 species of birds, some of which are iconic and in danger of extinction, such as the Harpy Eagle, the Bat Falcon, Quetzals and Scarlet Macaws. Some 12 species of snakes and a large number of insect species were also impacted.

Impacts on wildlife are one of the major types of environmental damage done by natural disasters, not only because of the intrinsic value of wildlife and the opportunities for tourism that they provide, but also because they are a very important source of protein for indigenous communities. Many of the animals that have not been killed by a disaster may then be hunted down because people are short of food. Subsistence fishing is also negatively affected by the toxic sediments borne by swollen rivers.

It is usually not possible to appraise the impact on wildlife or the resulting loss of biodiversity directly. An indirect assessment can be made by estimating the cost of programmes for repopulating the affected species. In some cases, the damage caused to certain species of wildlife can be estimated if a price range can be assigned to them. The value of (sports or traditional) hunting permits can also be used as a point of reference. It should be borne in mind that, even if a commercial value can be assigned to an individual animal of a given species, it may not necessarily be valid to apply that price to the whole of the affected population of that species.

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[223] Many seagrass meadows superficially resemble the terrestrial grasses of the Poaceae family.

[224] Phyla are a principal taxonomic subdivision of the animal kingdom that is defined on the basis of animals' general body plan, which is why animals as diverse as clams, snails and octopi are all in the same phylum (the Phylum Mollusca).

(vii) Habitats and natural biomes

The relationship between climate and vegetation has been recognized for many years now, and some researchers have therefore tried to construct a global ecological classification system and to place the different habitats and natural biomes within a geographical framework. They believe that the physical environmental factors (soils, nutriments, climate patterns, light, seasonality and humidity) that are characteristic of a given region can be used to determine the biological identifiers of different ecosystems. Based on this school of environmental determinism, Leslie Holdridge developed a system of what have become known as Holdridge life zones (HLZ), which can be easily recognized and differentiated from each other as natural units based on their original natural vegetation or by the changes it exhibits.

In recent years, in an effort to identify the use and non-use values of ecosystems, a meta-analysis approach has been used to arrive at an assessment of their environmental services, which has also been applied to the different ecosystems associated with the various Holdridge life zones. The results are shown in table XVIII.7, which gives the average values for ecosystemic services in each life zone in United States dollars (at 2000 prices) per hectare per year.

Table XVIII.7
Average values of ecosystemic environmental services in the Holdridge life zones (HLZ)
(Dollars at 2000 prices per hectare per year)

Ecosystems	Average value
Polar desert	94.22
Boreal rainforest	106.25
Cool temperate desert	56.09
Cool temperate desert scrub	117.00
Cool temperate steppe	90.73
Cool temperate rainforest	86.32
Cool temperate wet forest	62.77
Warm temperate thorn scrub	108.86
Warm temperate dry forest	171.46
Warm temperate wet forest	130,58
Subtropical thorn woodland	128.56
Subtropical dry forest	196.84
Subtropical moist forest	263.70
Subtropical wet forest	77.06
Tropical very dry forest	77.16
Tropical dry forest	101.32
Tropical wet forest	149.72

Source: Jonathan Mawdsley, Robin O'Malley and Dennis S. Ojima, "A review of climate-change adaptation strategies for wildlife management and biodiversity conservation", *Conservation Biology*, vol. 23, No. 5, October 2009.

The averages shown in table XVIII.7 could be used as a frame of reference for arriving at indirect estimates of the value of the environmental services of supply, regulation, support and non-material benefits, particularly in the case of forest, savannah, prairie and shrubland ecosystems.

Box XVIII.1
Estimated value of environmental services according to The Economics of Ecosystems and Biodiversity (TEEB) study (2010)

The estimated per-hectare monetary values of the different ecosystems and of the environmental services that each ecosystem provides vary a great deal (see the table below). For example, the values given in 101 case studies on coral reef ecosystems range from US$ 14,000 per hectare per year to nearly US$ 1,200,000 per hectare per year. Such wide variations are accounted for by the extremely high value of tourism-related environmental services and by the different relative importance of the many attractions for tourists offered by the various reefs covered in those case studies. The potential for tourism in coral reef ecosystems is largely determined by the socioeconomic context of the areas where tourism infrastructure is located; the higher the income levels in the countries offering tourism activities connected with coral reefs are, the higher the peak per-hectare values of the related environmental services will be.

The different environmental services provided by ecosystems cover a fairly wide range. For example, the supply services provided by tropical forests include raw materials, genetic resources, medicinal resources, followed by food and fresh water. Important regulation services include erosion prevention, followed by maintenance of soil fertility and the water cycle. Trees have an important influence on air quality, the regulation of the climate, water purification and the treatment or absorption of organic waste. Support services include the conservation of genetic resources, while non-material services include the recreation and tourism opportunities offered by tropical forests.

This type of analysis can be carried out for each of the ecosystems included in the following table in order to determine what factors can be useful in estimating the importance of each type of environmental service provided by the various ecosystems.

Table
Monetary value of the environmental services provided by different ecosystems [a]
(Dollars at 2007 prices per hectare per year)

Main ecosystems	Number of studies examined	Minimum value	Maximum value	Supply services	Regulation services	Support services	Non-material services
Tropical forests [b]	140	91	23 222	9 384	7 135	5 277	1 426
Temperate forests [c]	40	30	4 863	1 136	456	2 575	96
Grasslands and pastures [d]	25	297	3 091	715	2 067	298	11
Coastal systems [e]	32	248	79 580	7 549	30 451	164	41 416
Coral reefs [f]	101	14	1 195 478	20 892	33 640	56 137	1084 809
Savannahs, brushland and scrubland [g]	18	16	1 950	862	1 088	0	0
Inland wetlands [h]	87	981	44 597	9 709	23 018	3 471	8 399
Rivers and lakes [i]	12	1 779	13 488	5 776	4 978	0	2 733

Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of The Economics of Ecosystems and Biodiversity (TEEB), "Appendix C: Estimates of monetary values of ecosystem services", *The Economics of Ecosystem and Biodiversity: Ecological and Economic Foundations*, London, Earthscan, 2010.

[a] The figures shown in this table are based on an economic meta-analysis that included an analysis of socioeconomic variables, types of biomes, ecosystems and the services that they supply, the assessment and localization methods used, and other data provided by a number of different case studies. The author converted local currencies into United States dollars at 2007 prices using the GDP deflators and purchasing power indicators contained in *World Development Indicators 2007* published by the World Bank.

[b] These forests include: wet forests, rainforests, and tropical montane forests.

[c] These forests include temperate rainforests made up of deciduous and evergreen trees (conifers and hardwoods).

[d] These ecosystems include tropical savannahs, montane grasslands and Andean plains.

[e] Seagrass meadows, rocky coastal zones, coastal beaches and tidal areas (up to 200 miles out to sea).

[f] There are two types of ecosystems: tidal wetlands and mangrove swamps.

[g] Areas with different types of plant cover (mixtures of grasses and bushes falling into the categories of savannahs, brushland and scrubland).

[h] Wet freshwater plains, flooded plains, inland wetlands and swamps.

[i] Freshwater lakes.

7. Total estimated values for damage, losses and additional costs

As has been discussed in this chapter, a lack of information may make it difficult to calculate how much damage a natural disaster has done to environmental assets or to the environmental services that have been eliminated. That is why it is important to include the most thorough inventory possible of the environmental impacts of a natural disaster. These records can be useful in the preparation of the corresponding estimates.

If the requisite information is available, it is suggested that the team prepare a separate summary table showing the damage, losses and additional costs caused by the disaster in each of the different environmental categories in order to provide a clear picture of the scale and implications of the environmental impacts generated by the disaster. Ideally, the figures should be broken down by region or by administrative or departmental district.

Another part of the table should include the relevant environmental services, divided into the four functional categories mentioned above (supplies, regulation, support and non-material services). Within each of these categories, specific environmental services can be identified that may lend themselves more readily to quantification in physical and monetary terms. Depending on what information is available, the content of the table may be limited to the headings for which sufficient (reasonably substantiated and carefully screened) data can be compiled in the course of the work done to estimate environmental damage and losses.

This chapter has included various examples of appraisals of environmental damage and losses in different types of areas that illustrate the types of procedures that can be used for this purpose. Programmes and projects designed to restore environmental assets or repair environmental damage are another source of information, and the investments made in those initiatives can be used to arrive at indirect, approximate estimates of those impacts. Lastly, it is important to remember that: (i) the environmental damage and losses that are recorded in the accounts for economic sectors should not be duplicated in the environmental accounts; and (ii) estimated losses in natural ecosystems that are not being taken advantage of should not be added to the total losses caused by the disaster when calculating the estimated impact on GDP.

D. Mitigation and restoration measures

Earlier sections of this chapter have provided a fairly detailed discussion of the seriousness of the different types of physical and economic damage that natural disasters may cause. Over the long term, a correlation can be detected between environmental deterioration and natural disasters. Deforestation, soil erosion, and the degradation of coastal, forest and other natural areas increase the likelihood that extreme events will occur, and those events, in turn, exacerbate or accelerate environmental degradation.

In cases where efforts to lessen the vulnerability of different ecosystems to natural disasters have been successful, the adaptability and sustainability of development processes have increased significantly. It has been demonstrated that the environmental damage and losses caused by natural disasters can be reduced through the implementation of risk-reduction, mitigation and management strategies that are based on a sound understanding of the threats posed by each type of natural hazard and the incorporation of those strategies into a country's social and economic programmes.

The number of natural disasters and the severity of their impacts have been on the rise in recent decades. This may have hindered the development process in many cases, inasmuch as economic resources have had to be reallocated to emergency and relief measures and to reconstruction or reclamation works. The scenarios used to analyse the possible implications of climate change indicate that droughts may become more severe and hurricanes may become more frequent, that areas of arable land may shift or be otherwise altered, and that the sea level may rise. All of this underscores the need to factor in risk management considerations when taking decisions about expenditure and investment on the basis of suitable policies and preventive and mitigation actions.

The main reason why development programmes have not incorporated appropriate measures for preventing natural disasters and mitigating their impacts is that there has been a failure to fully understand the contribution to national development that can be made by actions for reducing the damage sustained by natural capital and the loss of environmental services. In addition, the national institutions that should assume this operational task have not yet been fully developed and thus lack suitable tools and procedures for gathering, processing and interpreting the necessary information on the likelihood of future natural disasters and on the physical, economic and social implications of the impacts that they have. This situation is compounded by the fact that national or sectoral policies on the mitigation of the impacts of natural disasters have either not been developed or are not being implemented on a coordinated basis.

The experience that ECLAC has gained in analysing the environmental impacts of many different natural disasters indicates that the scale of a disaster is not always closely related to the scale of the natural event in question. In many cases, a majority of the people who were affected were living in high-risk areas, such as riverbeds, steep slopes or areas with fragile soils that were being used inappropriately. It is also quite common for unsuitable methods or activities to be used that exceed an ecosystem's carrying capacity. This degrades the physical and biological environment and makes the areas concerned, along with the people who live in them, more vulnerable to the effects of hydro-meteorological events, especially hurricanes and tropical storms.

Generally speaking, experience shows that preventive measures are more efficient and effective and less costly than reclamation or restoration works. The cost of replacing assets that have been destroyed is greater than the cost of technical preventive measures or of governmental preventive action in the form of training and institutional coordination.

It is generally agreed that floods are the most destructive type of natural disaster in terms of natural assets and that they have the highest death tolls. Some of the most common flood-mitigation measures are: the preparation of risk maps based on hydrological data and other well-documented analyses in order to arrive at an assessment of the level of risk in a given area; regulation and monitoring of land use in floodplains and any other areas subject to flooding based on the principle that such land should be converted into ecological reserves; construction of flood control works that do not alter the way in which the ecosystem functions; the design and construction of other types of physical protective works and the installation of floodgates; and the introduction of early warning systems for the population groups living in areas subject to flooding.

Glossary [225]

Additional costs

Additional outlays required to produce goods and provide services as a result of the disaster. At the national level, these costs translate into increased production in a different sector.

Biological hazard

Process or phenomenon of organic origin or conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances that may cause loss of life, injury, illness or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Capacity

The combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals.

Capacity development

The process by which people, organizations and society systematically stimulate and develop their capacities over time to achieve social and economic goals, including through improvement of knowledge, skills, systems, and institutions.

Climate change

(a) The Inter-governmental Panel on Climate Change (IPCC) defines climate change as "a change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use".

(b) The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods".

Damage

The cost of replacing destroyed assets with others that have the same physical and technological characteristics. Damage occurs during the event giving rise to the disaster. It is measured in physical units destroyed and a monetary

[225] Most of the terms and definitions found in this glossary come from the document entitled Terminology on Disaster Risk Reduction, published by the United Nations International Strategy for Disaster Reduction (UNISDR) (2009).

value is subsequently assigned based on the prevailing replacement cost at the time the disaster occurred. Destruction may be partial or total.

Disaster

A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.

Disaster risk

The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period.

Disaster risk management

The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.

Disaster risk reduction

The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Early warning system

The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss.

Effects of a disaster

Damage, losses and additional costs resulting from the total or partial destruction of assets.

El Niño-Southern Oscillation phenomenon

A complex interaction of the tropical Pacific Ocean and the global atmosphere that results in irregularly occurring episodes of changed ocean and weather patterns in many parts of the world, often with significant impacts over many months, such as altered marine habitats, rainfall changes, floods, droughts, and changes in storm patterns.

Environmental degradation

The reduction of the capacity of the environment to meet social and ecological objectives and needs.

Financial needs for reconstruction

These are the sums needed to rebuild assets that have been destroyed. The financial needs for reconstruction are equivalent to the estimated value of replacing the destroyed assets, plus the additional cost of making quality improvements, upgrading production technology and adopting measures to reduce disaster risk. The latter could include the relocation of certain key activities to safer zones, the implementation of construction and design standards that ensure greater resilience to extreme events, and other prevention and mitigation measures to improve building construction. The cost of the reconstruction needs is usually higher than the estimated value of the damage.

Financial needs for recovery

These are the sums that will be needed to help the economy and society return to normal. The amount corresponding to recovery needs is usually a fraction of the value of the losses caused by the disaster. There are three main kinds of recovery needs: (i) the funds needed to implement temporary food-for-work programmes in order to provide a minimum income to those who have lost earnings or been left jobless; (ii) the amounts required to provide inputs and working capital so that production levels can be restored (in the production sectors of agriculture, stockbreeding, fishing, manufacturing and commerce); (iii) the amounts required to restore provision of and access to basic services for the population (health care, education, temporary housing, transport, water and sanitation, and power).

Geological hazard

Geological process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Greenhouse gases

Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds.

Hazard

A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Hydrometeorological hazard

Process or phenomenon of atmospheric, hydrological or oceanographic nature that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Impact of a disaster

The consequences of a disaster's effects for social and economic variables such as household income, unemployment, GDP growth and the fiscal deficit.

Land-use planning

The process undertaken by public authorities to identify, evaluate and decide on different options for the use of land, including consideration of long-term economic, social and environmental objectives and the implications for different communities and interest groups, and the subsequent formulation and promulgation of plans that describe the permitted or acceptable uses.

Level of exposure

People, assets, systems, or other elements present in hazard zones that are thereby subject to potential losses.

Losses

Goods that go unproduced and services that go unprovided during a period running from the time the disaster occurs until full recovery and reconstruction is achieved.

Mitigation

Set of structural and non-structural measures that limit the adverse impacts of natural hazards, technological hazards and hazards related to environmental degradation. They include:

Structural mitigation measures

Hydraulic structures for the prevention of floods and droughts (such as reservoirs, river defences and retaining walls) and studies on the vulnerability of key facilities and lifelines or plans to carry them out.

Non-structural mitigation measures

Set of non-engineering activities that lessen vulnerability to hazards, such as land-use regulations; the creation and enforcement of building codes; zoning; reforestation of coastal areas, hillsides and mountain slopes; training and education provided by the government; and public participation in mitigation works.

Natural hazard

Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Preparedness

Set of activities and measures carried out ahead of time in order to respond effectively to the impact of disasters, including providing timely and effective early warning information and temporarily evacuating people and goods

from at-risk areas. Preparedness thus refers to observation, forecasting and warning systems, networks for measuring hydrometeorological, geological and anthropogenic hazards, and reliable communication systems able to reach even the remotest communities.

Prevention

Set of activities designed to avoid the full impact of hazards and technological, ecological and biological disasters. Depending on the social and technical feasibility and cost-benefit considerations, investment in prevention measures may be justified in areas suffering from frequent disasters. From the perspective of public awareness and education, prevention involves changing attitudes and behaviour, culminating in a culture of prevention.

Prospective disaster risk management

Management activities that address and seek to avoid the development of new or increased disaster risks.

Recovery

The restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors.

Resilience

The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.

Response

The provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.

Response capacity

The ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters.

Risk assessment

A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, assets, services, livelihoods and the environment on which they depend.

Risk transfer

The process of formally or informally shifting the financial consequences of particular risks from one party to another whereby a household, community, enterprise or state authority will obtain resources from the other party after a disaster occurs, in exchange for ongoing or compensatory social or financial benefits provided to that other party.

Social vulnerability

Exposure of human settlements to damage from specific hazards based on socioeconomic, psychological and cultural factors. Social vulnerability to natural hazards is greater among low-income groups in developing countries as they lack the necessary information and resources to take measures to safeguard their lives and their health. Children, women and older persons are the most vulnerable groups.

Socio-natural hazard

The phenomenon of increased occurrence of certain geophysical and hydrometeorological hazard events, such as landslides, flooding, land subsidence and drought, that arise from the interaction of natural hazards with degraded land and overexploited or destroyed environmental resources.

Structural and non-structural measures

Structural measures: Any physical construction to reduce or avoid possible impacts of hazards, or application of engineering techniques to achieve hazard-resistance and resilience in structures or systems;

Non-structural measures: Any measure not involving physical construction that uses knowledge, practice or agreement to reduce risks and impacts, in particular through policies and laws, public awareness raising and community organization, training and education.

Sustainable development

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Value or exposure

Size and cost of goods that are subject to potential damage and losses from a hazard. This includes infrastructure, people, the economy and production.

Vulnerability

The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. There are many aspects of vulnerability, arising from various physical, social, economic, and environmental factors. Examples may include poor design and construction of buildings, inadequate protection of assets, lack of public information and awareness, limited official recognition of risks and preparedness measures, and disregard for wise environmental management. Vulnerability varies significantly within a community and over time. This definition identifies vulnerability as a characteristic of the element of interest (community, system or asset) which is independent of its exposure. However, in common use the word is often used more broadly to include the element's exposure.

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