Section One

Methodological and conceptual aspects

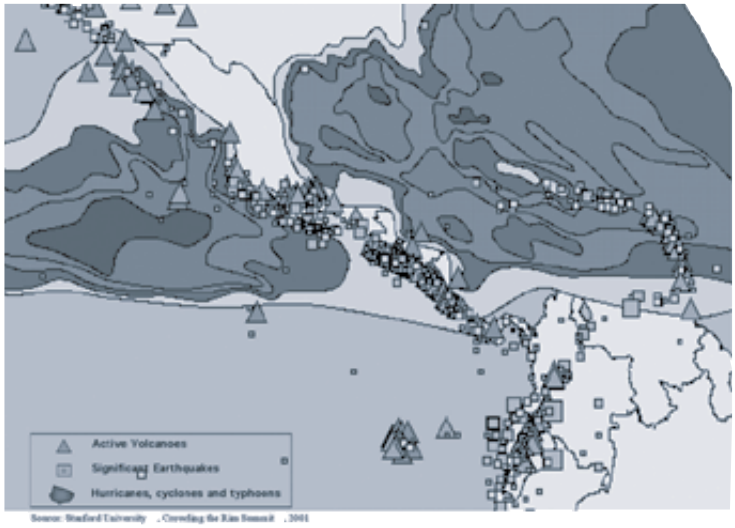
I. TYPES OF DISASTER AND POST-DISASTER STAGES

Disasters can be classified in many different ways. They are usually sudden and unexpected events –often accompanied by a loss of human life– that inflict on all or part of society suffering and harm, a temporary breakdown of existing vital systems, material losses and considerable obstacles to social and economic activities. Slowly evolving disasters, which tend to manifest themselves with fairly frequently, also affect societies and economies and, depending on their intensity and duration, can even cause food shortages or the inadequate provisioning of essential services.

Depending on their origin, disasters can be classified in two major groups: those deriving from natural hazards and those brought about by human activity. In addition, the effects of natural disasters are often magnified or exacerbated by prior human intervention. The most common natural disasters in Latin America and the Caribbean are those caused by tropical storms and hurricanes, floods, droughts, frosts and hailstorms, earthquakes, volcanic eruptions, tsunamis and mudslides. The most frequent man-made disasters are fires, explosions and oil spills. Some human actions increasingly cause or aggravate natural phenomena by failing to properly use natural resources or comply with codes and standards for the design and construction of development works. In other words, human intervention may increase the vulnerability of human settlements, production activities, infrastructure and services.

Natural hazards that cause disasters in Latin America and the Caribbean can be hydro-meteorological or geological in origin. Every year tropical storms and hurricanes move through both the Caribbean and in the tropical belt of the Pacific Ocean. The atmospheric and oceanographic modifications in the Pacific known as the El Niño phenomenon or the El Niño Southern Oscillation induce changes in seawater and cause floods and droughts. In addition, the presence of the "ring of fire" along the continent's Pacific coast, as well as various lines or areas of contact between tectonic plates, lead to earthquakes and volcanic eruptions.[1] The following graph indicates the areas most at risk of seismic, hydro-meteorological and volcanic activity including parts of the Pacific Rim and the Caribbean.

1 Jovel, Roberto, "Natural Disasters and their Socioeconomic Effects", *ECLAC Review*, No. 38, ECLAC, Santiago, Chile, 1989.



2

A SYSTEMIC SYNTHESIS OF THE RELATIONS BETWEEN VULNERABILITY, HAZARD, EXPOSURE AND IMPACT, AIMED AT POLICY IDENTIFICATION

By Gilberto C. Gallopin

A review of the existing literature reveals that there is no consensus on the concept of vulnerability. A systemic approach is proposed here that includes the central elements of the debate (see for example, Clark et al., 2000; IHDP Update, 2001; Rodríguez, 2000), while giving them a systemic framework that raises new questions and lines of attack.

The vulnerability of a system is defined here, in the most general terms, as its propensity to undergo significant transformations as a result of its interaction with external or internal processes. Significant transformation is understood here to mean structural or, at least, relatively permanent and profound change.

The concept of vulnerability is not exclusive to social systems. In fact, it can be applied to any system that interacts with its environment, in particular human systems (e.g., a village, a social group), natural systems (e.g., a forest ecosystem) and socio-ecological systems including human and biophysical components (Gallopin et al., 1989).

Both societal and ecological systems survive thanks to the constant exchange of matter, energy and information with their external environment. Those processes can give rise to modifications in the functioning or structure of the system triggered by changes in the system's environment (e.g., the effects of an earthquake on a population), by internal alterations (e.g., the impact of civil war on a country) or the interaction among external and internal processes (e.g., the effects of a prolonged drought in a country with internal conflicts).

Whether the event/change/hazard is described as external or internal depends on the scale of definition of the system. Earthquakes and hurricanes are clearly internal phenomena for the planetary ecosystem, but they are obviously external events if the system in question is a Central American village.

In human systems, vulnerability is often related to (but is not the same as) poverty or an integrated measure of well-being. Not all poor people are vulnerable and not all non-poor people are invulnerable.

Vulnerability as propensity (Popper, 1990) is not an absolute property, but one relative to a system in a given context, including specific changes or hazards. In other words, a system can be vulnerable to certain disturbances and strong in the face of others. However, some systems might be so fragile that they exhibit "generic vulnerability" to many types of disturbances.

According to this general conception, vulnerability is not always a negative property. It is possible to speak of positive vulnerability in cases where change leads to a beneficial transformation such as the emergence of a given social group from chronic poverty or the collapse of an oppressive regime. Of course, characterizing transformation as positive or negative is inherently a value judgment. In this sense, the "significant transformations" that are part of the definition of vulnerability can be differentiated as positive or negative as in Table 1, which also differentiates how gradual or sudden they are.

Table 1

A classification of systemic transformations or impacts

Effects	Dead	Wounded	Buildings totally destroyed	Buildings partially destroyed	Roads closed	Public services interrupte
	********	********	********	********	********	********

Effects on the Environment

Effects	Air pollution	Water pollution	Land pollution
		**********	

However, for the purposes of this manual, hereinafter we will limit the discussion of vulnerability to its negative aspects, and limit the phrase "significant transformations" to the particular case of "damage" or "adverse effects".

Central to the consideration of vulnerability are the concepts of the system in question's sensitivity and response capacity (target system, unit exposed or system of reference), the probability of occurrence, the type and magnitude/intensity/speed of the triggering event, exposure of the system to the event (external or internal) and the transformations or impacts the system undergoes.

Sensitivity is the degree to which the system is modified or affected by an internal or external disturbance or set or disturbances. Conceptually, it could be measured as the degree of transformation of the system per unit of change in the disturbance (Tomovic, 1963), but sometimes it only specifies whether the system is sensitive to a given factor.

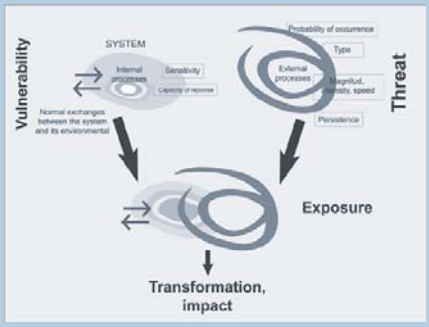
The response capacity is the system's ability to adjust to or resist the disturbance, moderate potential damage and take advantage of opportunities. Various factors play a part in determining response capacity, including resilience, the availability of reserves and information, internal regulation mechanisms and the existence of cooperative links with other systems.

The system's exposure to the disturbance, external or internal change, or hazard is the degree, duration and/or extension of the system in question's contact with the disturbance.

Vulnerability, as understood here, is a system attribute existing prior to the disturbance/change/hazard, although it is often related to the history of disturbances to which the system was exposed in the past (hence the importance of the system's history).

The system's exposure to the disturbance is, however, an attribute of the relationship between the system and the disturbance. As such, it is not an attribute of the system, but note that some authors include exposure as part of the definition of vulnerability (Cutter, 2001).

The impact on the system depends, apart from its vulnerability and exposure, on the event or set of events/changes/hazards, on the type of event (e.g., hurricane, earthquake, economic crash, internal conflict), its probability of occurrence, magnitude, intensity, speed (or gradualness) and persistence.



The difference between sensitivity, response capacity and exposure can be illustrated with a simple example such as a flood's effects on a population. The most precarious homes are harder hit by a flood than more solid ones (sensitivity). Oftentimes, the poorest homes are located in the places most susceptible to flooding (exposure). The families with the greatest resources have a greater availability of means to repair water damage (response capacity). The magnitude of the final impact will also depend on the intensity, magnitude and permanence of the flood (attributes of the event).

The figure above, illustrates the relations between the concepts discussed for the case of an event/change/hazard whose origin is external to the system. A similar diagram could be made for the case of the system's internal disturbances.

When developed, the conceptual system shows the importance of differentiating policies aimed at protecting human populations or natural ecosystems from natural disasters or other harmful events. Differentiated policies are required to reduce the system's vulnerability, the probability or intensity of a natural disaster (if that is possible) and the system's exposure to the hazard, as well as to mitigate the event's negative impact on the system in question.

The next figure illustrates the type of policies most commonly associated with the different aspects mentioned.

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After a disaster occurs, activities are normally grouped together into three different stages: a) emergency, b) rehabilitation and recovery (also called transition), and c) reconstruction.

The emergency stage refers to the period for humanitarian assistance, when steps are taken to save lives and to provide essential supplies to those most affected. It includes such activities as search, rescue, evacuation, provision of shelters, first aid, emergency medical care and protection, temporary restoration of transportation and communication routes, preliminary repairs to essential public services, and initial actions to register victims and record damage to public and private property. This stage may vary in its duration, but it is generally relatively brief, depending on the magnitude of the disaster.

The rehabilitation or transition stage includes activities required to restore normality to the affected areas and communities. It includes temporary repairs to housing and buildings and to transport and public utility infrastructure. Problems related to the emotional and psychological recovery of the inhabitants of the affected regions are also addressed during this phase. The recovery measures most helpful to affected communities are those that allow victims to return to work, help create new jobs, make loans and other financial resources available and launch projects related to other disaster consequences.

Finally, the reconstruction stage includes activities designed to rearrange the affected physical space and environment and enable the allocation of resources in accordance with the new social priorities arising from the effects of the disaster.

Assessment activities described in this Handbook should be carried out when the emergency stage has been completed or is nearing conclusion, so as not to interfere with those actions and to ensure the availability of the necessary personnel and basic information. They are intended to facilitate the identification of needs and priorities for the reconstruction stage.

II. GENERAL METHODOLOGICAL CONSIDERATIONS

The ultimate goal of the assessment methodology presented herein is to measure in monetary terms the impact of disasters on the society, economy and environment of the affected country or region. National accounts are used as a means of valuation, supplemented with procedures for specific estimates such as environmental damages and the differential impact on women.

Application of this methodology provides affected countries or regions with the means to determine the value of lost assets and define reconstruction requirements. It enables the identification of the most affected geographical areas and sectors, together with corresponding reconstruction priorities. In addition, it provides a way to estimate effects on economic flows, the affected country's capacity to undertake reconstruction on its own and the extent to which international financial and technical cooperation are needed. Moreover, it can be used to identify the changes to public policy and development programmes/plans needed to deal with needs arising from the disaster and to avoid undesirable effects in economic performance and public well-being.

It will often be necessary to conduct assessment work quickly in order to guide reconstruction activities and international support. The affected population's pressing needs must be met quickly, and it is essential to exhaust all opportunities to obtain reconstruction assistance before international attention is diverted to other areas of the world. Therefore, the timely presentation of the assessment takes precedence over exhaustive analytical precision, but this initial evaluation must clearly state the magnitude of damage and reconstruction requirements.

The following chapters offer a detailed description of the methodology and sources of information we recommend for the analysis of each sector, as well as those related to the assessment of overall impact. We also describe select criteria that are universally valid for addressing these questions.

The assessment should begin by gathering all existing quantitative background information needed for an appreciation of both conditions before the disaster and the magnitude of damage and losses and their macroeconomic effects. Assessors should consult government sources and industrial or professional associations (such as societies of engineers or architects), service providers, chambers of commerce and industry and farmer associations, as well as resident experts from national and international institutions or bilateral missions who may be in the affected country at the time of the disaster.

The reliability of the information obtained should be verified in the field. Sampling should often be used to determine both the number of units affected and the magnitude or extent of damage, applying appropriate assessment criteria in each case. The latter is especially true when determining the differential effects of disasters on women.

The assessments for which this manual is designed are a basic tool in the decision-making process of defining and assigning priorities for reconstruction plans and programmes. As suggested earlier, proper consideration must be given to the balance between estimate precision and the urgency of completing an assessment in order to launch programmes. Assessment results must, at a very minimum, provide an accurate estimate of the disaster`s impact, including its geographic and sectoral scope. More precise calculations can be provided later as specific investment projects are formulated.

SHADOW PRICES AND DISASTER DAMAGE ASSESSMENT

In terms of economic impact, a disaster may be considered the opposite of an investment project. Projects, whose results often take a physical form, involve decisions regarding the use of resources with a view to increasing, maintaining or improving the production of goods or the provision of services. The three basic parameters of an investment project are the amount of the initial investment, the lifetime of the project and the flow of costs and benefits generated by the project over its lifetime. From an economic standpoint, project viability is assessed by comparing costs to benefits.

In contrast, disasters cause damage to assets (they could be regarded as "disinvestments") and affect the production of goods and services, in terms of both their availability and the efficiency of production. If the method of project assessment is applied to specific economic sectors, three parameters are needed to assess the economic damage: (I) the amount of asset losses (or disinvestments); (II) the impact, in terms of prices and quantities, on the flow of goods and services in the relevant sector; and (III) the period in which markets are disrupted.

Like the methods for project assessment, the process of identifying the damage caused by a disaster involves comparing the "non-disaster situation" and the "disaster situation", rather than the "pre-" and "post-" disaster situations.[2] Otherwise, the damage caused by a disaster may be overestimated (in the case of production that was already tending to decline) or underestimated (if production was increasing), or damage may be attributed solely to the disaster when it may be due to other factors, as well.

There are two types of project assessment: private and social. In private assessment, annual returns derive from the sale of products or services, and costs derive from the purchase of inputs and factor payments. In social assessment, annual social benefits are obtained from the increase in national income generated by a project, while the costs refer to the income sacrificed by implementing that particular project rather than another one. Private investments may have social profit levels that are very different from the profits obtained by private investors themselves.

Social and private assessment use similar criteria to study project feasibility, but differ in their valuation of the variables determining the associated costs and benefits. Private assessment works with market prices, whereas social assessment uses "shadow", or social, prices. The latter take into account the indirect effects and externalities that affect the well being of society.[3]

2 With regard to assets, the "pre-disaster" and the "non-disaster" situation are the same when the disaster takes the form of an event of short duration (hurricanes, floods, earthquakes); there may be differences in the case of slowly evolving disasters (such as droughts). Economic assessment of changes in the flow of goods and services, however, requires the projection of a "non-disaster situation" in order to compare it to a "disaster situation" so that the damage will be correctly attributed to the disasters (the case of tourism in Belize is a good example).

3 Some types of projects have private prices that are very different from their social prices: (I) those which generate public goods, where the private price is equivalent to zero; (II) those implemented where there are market imperfections (monopoly, monopsony); (III) those implemented where there are taxes, subsidies or quotas that make the prices of products and inputs different from what they would have been in a situation of perfect competition; and (IV) those implemented where there are externalities.

Social assessment uses the three basic shadow prices: foreign currency, manpower and the social discount rate. The social prices of the goods and services generated by the project also have to be calculated, as well as those of the inputs used in production. The three basic shadow prices are generally calculated at the national level. The shadow prices of the goods or services produced and of production inputs are calculated with information on current and future supply and demand; this requires specific studies that may be rather complex.

In theory, the methodology for the social assessment of projects may be adapted to the assessment of economic damage caused by disasters, and shadow prices may be used to obtain a close approximation of the value of damage to society. For example, the damage caused by reduced production of an export item that generates foreign currency for the country may vary greatly depending on whether it is assessed using private prices or shadow prices. Although this approximation might be preferable in theory, the use of private prices is more practical given the amount of information that social assessments require, the number of sectors involved and the short time usually available for damage assessment.

III. CLASSIFICATION AND DEFINITION OF DAMAGE AND EFFECTS

Natural phenomena such as earthquakes, storms and floods not only produce immediately apparent effects, but they also unleash aftereffects that evolve slowly or emerge a relatively long time after the disaster has occurred, such as crop destruction due to the emergence of pests related to the event, or the shortage of essential products several months after the actual disaster.

This Handbook describes a proposed classification of a disaster's damages and effects that requires the application of two criteria: the methodology applied must provide an assessment of the full socio-economic and environmental effects at the time the disaster occurs as well as during its aftermath, and it must be able to do so at different geographical levels and sectors.

Granting that all definitions are by their nature conventional and that some cases may straddle the border between two concepts, the definitions applied here derive from the consensus achieved during the three decades in which such assessment activities have been undertaken in the region.

Expressed in the simplest terms, a disaster affects assets (direct damages); the flow for the production of goods and services (indirect losses); and the performance of the main macroeconomic aggregates of the affected country (macroeconomic effects). For convenience, use is made of the term damage or loss; however, disasters may also have a positive result. The assessment is therefore aimed at determining the net effect, giving due consideration to both negative and positive results.

Direct damages occur at the moment of the disaster or within the first few hours. Depending on the magnitude of the disaster, the latter two types of losses can extend over a period of up to five years. During slowly evolving or long-duration events –such as droughts or the effects of El Niño– direct damages may occur over an extended period and recur several times if the affected infrastructure was initially repaired and subsequently damaged anew, as in the case of bridges destroyed by repeated flooding. However, most losses will be indirect owing to the impact on economic flows.

During a quick assessment, identification and evaluation of direct damage is a relatively straightforward matter. The same cannot be said of a disaster's indirect effects. These indirect losses will become apparent at different times after the disaster and are, therefore, more difficult to identify during a rapid assessment.[4]

In fact, most of these indirect effects are not evident when the assessment is carried out, and although they can be identified when the damage is estimated, it is not always possible to measure them in monetary terms. In this respect, indirect effects in cases of slowly evolving disasters (such as droughts or extended flooding) will occur for as long as the causing phenomenon lasts.

The first two types of effects (direct damages and indirect losses) can be added together to obtain an order of magnitude of the total amount of damage, provided that it is duly indicated that the summation includes both assets and economic flows. The macroeconomic effects represent a different view of the assessment, however, since they describe the effects of the disaster on the functioning of the economy and the resulting macroeconomic imbalances arising from the event. Therefore, macroeconomic effects cannot be added to the other two categories of damages because that would involve double accounting.

Physical units (number of damaged or destroyed units, square meters of construction, hectares, tons, and so forth) are the starting point for any damage estimate. Using them will permit the adoption of the most suitable valuation criteria in each special case. Let us now turn to a detailed description of the damage to be estimated under each category of effects.

1. Direct damages

Direct damages (complete or partial destruction) may be inflicted on immovable assets and on stock (including final goods, goods in process, raw materials, materials and spare parts).[5] In essence, this category consists of damage to assets that occurred rigth at the time of the actual disaster.

4 The time period to be considered in estimating indirect losses is equal to that required to achieve "normalcy" or a situation equal to the one prevailing before the disaster.

5 Entrepreneurs or owners of companies normally also count as losses those to realizable assets, such as destroyed accounts receivable which, will not be collected. However, from a macroeconomic viewpoint, such losses should not be included as direct damage because if said collections did take place they would represent an inter-sectoral transfer of revenue and including them would involve double accounting.

The main items in this category include the total or partial destruction of physical infrastructure, buildings, installations, machinery, equipment, means of transportation and storage, furniture, damage to farmland, irrigation works, reservoirs and the like. In the special case of agriculture, the destruction of crops ready for harvest must also be valued and included as direct damage.

As will be seen in the sectoral chapters, a distinction should be made between public and private sector damage in order to determine where the weight of the reconstruction effort might fall.

The same is true in the case of repairs,[6] totally destroyed structures, equipment and stock. During the quantification of direct damage, the imported component necessary to replace the damaged or destroyed asset must be estimated as well, since this will have an effect on the balance of payments and trade.

THE VALUE OF A LOST LIFE

Disasters often result in the loss of human life. Setting aside the suffering sustained by families and society in general, fatalities are a direct loss to the society in any country affected by a disaster. They are a loss of human assets. There are indirect ways to estimate a monetary value of such losses.

A possible approach to estimating these losses would involve calculating the future income –expressed in net present value– that the deceased would otherwise have generated assuming that each had fulfilled her or his normal life expectancy. By comparing the average age of those killed by a disaster against their life expectancy –giving due consideration to sex differentials– it is possible to estimate the time loss for the deceased. A rough estimate of human asset losses may be reached by combining the resulting number of person-years with the expected average income over the appropriate time span.

Such a procedure has its shortcomings, however. As is well known, per capita income varies from one country to another. Using it as a yardstick to ascertain human asset losses would suggest that a human life lost in a developing country would be worth less than a life in a more developed nation, even within the Latin America and Caribbean region. This is morally unacceptable.

An alternative way of assigning a value to the loss of life would be the adoption of the amount paid by insurance companies in cases of airline-related accidents, as set forth by the Warsaw convention of the International Civil Aviation Organization (ICAO). However, here again shortcomings arise since the relevant values may vary by region.

6 In practice, the sectoral specialist will often value repairs as a percentage of the replacement value of a partially destroyed asset. Although this approach is expeditious, it should be enhanced by including estimation techniques more in keeping with the current value of those repairs.

A further alternative would be to adopt the average compensation paid by insurance firms in the region for accidental deaths related to hazardous activities. This method, however, cannot be used because the amounts paid depend on the actual payment capacity of insured persons, which most certainly do not match that of the average victim in a given disaster; it is also skewed by the same bias in regard to per capita income.

Other ways to arrive at the value of human life are based on the amount that a person is willing to pay to avoid premature death. For this purpose, one can use valuation methods based on a worker's annual contribution –determined through actual surveys– in cases of hazardous activities. This type of approximation has the advantage of reflecting costs not exclusively related to losses in production, but it yields higher figures than the previously discussed alternative procedures. Furthermore, it does not eliminate the problem related to differences in per capita income.

In brief, while there exist methods that might be adopted for the purpose, the above limitations render impractical any attempt to estimate the value of human loss of life.

2. Indirect losses

This effect refers essentially to the flows of goods and services –expressed in current values– that will not be produced or rendered over a time span that begins after the disaster and may extend throughout the rehabilitation and reconstruction periods. Convention calls for a maximum five-year time-frame although most losses occur during the first two. In any case, the estimate of these effects must be extended throughout the period required to achieve the partial or total recovery of the affected production capacity.

These indirect losses result from the direct damage to production capacity and social and economic infrastructure. Indirect losses also include disaster-induced increases in current outlays or costs in the provision of essential services, as well as diminished expected income in cases where these services cannot be provided under normal conditions or at all (which in turn will be reflected in macroeconomic effects). Examples of indirect effects are losses of future harvests due to flooding or prolonged droughts;[7] losses in industrial production due to damage to factories or a resulting shortfall in access to raw materials; and greater transportation costs as the need for alternative routes or means of communication imply longer, more expensive, poorer-quality options. These are indirect losses for the sector in question and will also be considered as macroeconomic effects when the main economic aggregates are examined.

7 However, if the disaster destroys crops that are about to be harvested, this loss should be considered direct damage, as mentioned earlier and as will be explained in the chapter on agriculture in Section Two of this Handbook.

The assessment specialist must be aware that some indirect effects of a disaster might generate benefits to society, instead of damage, costs, harm or losses. Indeed, indirect effects sometimes produce major benefits that can be estimated and must be deducted from the total damage estimate.[8]

Disasters also produce some major indirect effects that may be difficult to identify and impossible to quantify. These effects lead to "intangible" damage (or benefits) such as human suffering, insecurity, a sense of pride or antipathy at the way in which authorities have faced the disaster's consequences, solidarity, altruistic participation, the impact on national security and many other similar factors that have an effect on well-being and the quality of life. The assessment specialist will not always have enough time to attempt to place a monetary value on these important effects of disasters. However, he or she must be aware that a comprehensive evaluation of the effects of a disaster must include an assessment or at least a global discussion of such intangible damage or benefits, since they considerably affect living conditions and standards.

Finally, some indirect effects of disasters can be given a monetary value but are very difficult to calculate owing to the limited time available for the assessment. This category of effects includes the estimate of lost opportunities due to the impact of the disaster on the structure and functioning of economic activities, distributive and redistributive effects, losses in human capital represented by victims and so forth.

In brief, disasters often include one or more of the following types of indirect losses, which can be measured in monetary terms:

i) Higher operational costs due to the destruction of physical infrastructure and inventories or losses to production and income. For example, losses in sales of perishable goods or those that could not be stored in time and thus went unsold; unexpected costs incurred in the replacement of lost records in the health care system (clinical files in health centers).

ii) Diminished production or service provision due to the total or partial paralysis of activities. For example, damages due to the loss of a full school term; the costs of not being able to comply with export contracts.

iii) Additional costs incurred due to the need to resort to alternative means of production or provision of essential services. For example, the greater costs arising out of the use of longer or low standard roads (detours) and the construction of emergency roads.

iv) Greater costs due to budgetary reorientation or reassignment.

8 For example, once waters receded from widespread floods caused by the El Niño phenomenon in a South American country, a relatively large amount of coastal land that had previously been unsuitable for farming was temporarily made fertile. The owners cultivated this land, and the resulting harvest was deducted from the loss estimates as an indirect benefit.

v) Income reduction due to the non-provision or partial provision of services by public utilities (power and drinking water); reduction in personal income owing to loss of employment or being forced to work part-time.

vi) Costs incurred by all parties involved in attending to the affected population during the emergency stage.

vii) Additional costs for dealing with new situations arising from a disaster, such as the cost of health campaigns to prevent epidemics.

viii) Lost production or income due to linkage effects, similar to those that occur during a recession, which can be "forward" or "backward". For example, the destruction of a factory, reduces the economic activities of suppliers who have no alternative markets or of clients who have no other suppliers.

ix) The costs or benefits of external factors; namely any disaster repercussion or side effect whose costs (or benefits) are absorbed by third parties who are not direct victims (or beneficiaries) of the disaster. This concept is quite broad since it includes effects such as the benefit of training for emergency workers or brigades, some environmental pollution costs, greater traffic congestion and other similar repercussions of a disaster. The assessment specialist should only consider relevant external factors that significantly modify the estimate of the amount of damage.

Not all types of effects are mutually exclusive, and the assessment specialist should ensure that no double accounting takes places. For example, if effects are calculated on the production side, they must not be included again on the income side; if the effects of budgetary reassignment to deal with the rehabilitation stage are identified, the spending it financed must not be taken into account later as an indirect cost.

In light of the above difficulties, estimates of indirect losses should best be undertaken in close consultation with the respective authorities or experts. This co-operation is essential in cases such as estimating the time needed to reestablish services, lost production volumes, greater costs incurred in the provision of services and the corresponding reductions in income. An analysis must also be made of the operating results of public utilities so as to estimate their possible losses while rehabilitation is ongoing, as well as of the prices and yields of lost agricultural and industrial products. This Handbook provides step-by-step procedures for undertaking these estimates for each of the affected sectors.

The concepts outlined above are quite broad. We recommend that assessment specialists narrow their focus so as not to waste too much time in quantifications that do not yield applicable results, such as the intangible effects of the disaster on human production capacity, or the indirect effects resulting from how the emergency process was handled, or even certain drastic economic measures that might have been taken. The idea therefore, is, to measure only the most important indirect effects, which could also be called primary or first-round effects.

Adding the direct and indirect effects indicated so far will provide an estimate of the total losses caused by the disaster.

3. Macroeconomic effects

Macroeconomic effects reflect the manner in which the disaster modifies the performance of the main economic variables of the affected country, provided the proper national authorities make no adjustments. Since they reflect the repercussions of direct damages and indirect losses, they must not be added to those lists. Rather, macroeconomic effect estimates are a complementary way to assess direct damages and indirect losses from a different perspective. Quantification of macroeconomic effects is usually done for the national economy as a whole. Sectoral specialists must provide the macroeconomist with the information needed to achieve a comprehensive view of the impact on the main economic variables. While a country serves as the basic unit for this analysis, similar exercises can be conducted for disasters affecting smaller areas or regions –a province, state, department or municipality– provided that the necessary information is available.

A valid estimate of the macroeconomic effects of a disaster requires a reliable forecast of how each of the variables would have performed had the disaster not occurred. Such a projection serves as the baseline for ascertaining the degree to which the disaster disrupted results that would have been achieved otherwise and the extent to which the deterioration in the main variables has affected the country's ability to meet rehabilitation and reconstruction requirements and to define international cooperation requirements, especially of a financial nature.

The most important macroeconomic effects of a disaster are those that have a bearing on growth in gross domestic product and in sectoral production; the current account balance (due to changes in the trade balance, tourism and services, as well as outflows to pay for imports and foreign services, etc.); indebtedness and monetary reserves; and public finances and gross investment. Depending on the disaster's characteristics, an estimate of the effects on price increases, employment and family income is often relevant, as are changes to sovereign debt ratings, liquidity and domestic interest rates.

Gross domestic product can be undermined by reductions in the output of affected sectors, and it can be increased by reconstruction. When production is impaired, exports may narrow and goods may have to be imported to satisfy domestic demand, thus eroding both the trade balance and the balance of payments. Public sector spending generally increases as a result of disbursements made during the emergency and rehabilitation stages or to subsidies granted to significantly affected population groups. Fiscal revenues might drop due to decreased tax collection resulting from diminished production and exports, or even from a decision to temporarily lift some taxes to relieve pressure on significantly affected sectors. The combination of the above situations could provoke or expand fiscal deficits.

At the same time, prices may rise in response to shortages brought about by special demands stemming from reconstruction or by speculation, thus fanning inflation. The level of international reserves or the country's ability to meet its foreign debt servicing commitments might also be compromised depending on how the country's economy was performing before the event or the magnitude and effects of the disaster.

Macroeconomic effects to be gauged also include any deterioration in the affected population's living conditions as a result of obstacles to supply sources, reductions in the availability of essential services and, especially, the loss of employment and the corresponding fall in income. Although an erosion of the quality of life cannot be expressed in monetary terms, the effect of a disaster on a population or the drop in income caused by the partial, temporary or total paralysis of activities can be quantified.

To assess and globally consolidate macroeconomic effects, sectoral specialists must calculate foreseeable losses in the production of goods or services for the period they estimate is needed to recoup farmland, production equipment or physical and social infrastructure. They must also obtain background information that will enable an assessment of the impacts on other macroeconomic variables that have been mentioned (employment, income, exports, imports, gross investment, tax collection, etc.). Each specialist must prepare background information on how the sector was expected to evolve before the disaster based on recent performance or in accordance with goals established in each sectoral plan that officials adopted before the disaster.

The magnitude of the disaster is important for defining the time-frame for which macroeconomic effects are to be estimated. Experience shows that a "reasonable" time is normally the remainder of the year in which the disaster occurs (short term) plus another one, two or, under exceptional circumstances, five years (medium term).

It is important to keep in mind that the estimate of macroeconomic effects only shows what would happen should the authorities of the affected country or region not modify current public policies and programmes. Performance projection this provides these officials with a tool for reorienting policies and plans in light of post-disaster reconstruction needs.

Although this subject is addressed more broadly in the corresponding section of the Handbook, some general methodological aspects that are frequently used for estimating some of the most important macroeconomic aggregates are described below.

a) Gross domestic product. The macroeconomic specialist must estimate at constant prices disaster-induced losses in the production of goods and services for the recovery period, including the time needed to recoup lost capacity. Such projections require information from sectoral specialists, who must also define how the sector was expected to perform in the year the disaster occurred based on pre-disaster forecasts. This estimate is the basis for projecting losses to obtain the pre- and post-disaster results. The macroeconomic specialist should also take into account the possible positive effect on GDP of increased construction activity owing to reconstruction.

b) Gross investment. Losses in stock, computed as direct damage, will not be reflected in gross investment for the year because this involves the destruction of pre-existing assets. Depending on the availability of resources and the country's engineering and construction capacity, gross investment should increase the following year as asset restoration gets underway.

In the year of the disaster, this variable will reflect two types of effects: the suspension or deferral of development projects underway prior to the disaster, and losses of stock. The sectoral specialist should supply the macroeconomist with this data, together with a five-year estimate of the investment each sector will need for repairs.[9]

c) Balance of payments. The macroeconomic specialist must estimate the current account of the balance of payments for the year of the disaster on the basis of sectoral reports on the following: i) any decline in exports of goods and services as a result of losses that curtailed tourist activity, or impaired either the merchant fleet or the capacity of companies that export services, such as engineering firms.; ii) increased imports required for the two- to five-year recovery and reconstruction stage such as fuels, food (lost harvests), and building materials or equipment; iii) relief donations in cash or kind; iv) reinsurance payments from abroad; and v) any reductions in foreign debt servicing resulting from post-disaster agreements with creditors.

The balance -of- payments capital account must be estimated largely on the basis of the medium- and long-term external financing requirements of priority investment projects that will form part of the reconstruction process over, say, the five years following the event,[10] and the foreign financial complement required in view of a possible deterioration of the current account balance.

d) Public finances. This is another of the macroeconomic aggregates that must be quantified because the budget approved for the year the disaster occurs (as well as those in succeeding years) will most probably undergo major changes. In this regard, it is necessary to analyze the following possible macroeconomic effects: i) any shortfall in government revenues owing to reduced income from public sector companies, or declining tax receipts due to decreased production of goods and services and an erosion of income and consumer spending; ii) increased current spending related to the emergency, especially humanitarian relief and the urgent repair or rehabilitation of damaged public services; and iii) the investment demands of the reconstruction stage. The macroeconomist will have to try to make sense of the potentially contradictory data obtained from diverse sources. Then he or she will prepare public finance deficit estimates for the reconstruction years in order to better anticipate public sector financial requirements.

e) Prices and inflation. Although it is not always feasible or justifiable to measure general inflation levels before and after the disaster, a "sectorally" informed overview is needed of how supply limitations –arising out of the destruction of crops, manufactured goods, sales channels, transportation routes, etc.– might affect the price of certain goods and services that would have to be supplied by alternative means.[11] The influence of these variables on general and relative prices must be estimated and included among macroeconomic effects.

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9 Or whatever period the sectoral specialist and the macroeconomist deem most suitable for reconstruction.

10 See the previous note.

11 Prices may decrease if the substitute good that is imported or otherwise obtained from a non-habitual source is obtained at a lower price.

f) Employment. Sectoral estimates must be made of the overall effects on employment deriving from the destruction of the production capacity of social infrastructure and new demands for personnel arising during the emergency and rehabilitation process.

Finally, the experience gained from assessments by national and international institutions over the last 30 years makes it possible to draw certain relationships between the type of disaster and the nature of its damage. The most important of these are as follows:[12]

- Disasters of hydro-meteorological origin –such as floods, hurricanes and droughts– generally affect a wider geographical area than disasters of geological origin;

- In areas with similar population density, the number of victims in geological natural disasters –such as earthquakes– will very probably be higher than in the case of hydro-meteorological events;

- The destruction of capital stock in physical and social infrastructure resulting from earthquakes is generally much greater than that caused by floods;

- Production and other indirect losses, on the other hand, will probably be much greater in the case of floods and droughts; and

- A phenomenon of geological origin that causes floods or mudslides normally causes much greater production and other indirect losses than do other kinds of geological disasters.

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

- A variable number of victims;

- A significant reduction in the availability of housing, health and education facilities that expands pre-disaster deficits in developing countries;

- A temporary decrease in the income of the most disadvantaged social strata, and a corresponding increase in the already high rates of underemployment and joblessness;

- Temporary interruptions in water and sanitation, electricity, communications and transport services;

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

- A tendency for small businesses and providers of personal services to be among the first to recover regardless of the amount of damage sustained;

12 Jovel, Roberto, op. cit., 1989.

- In countries with predominantly dual structures, a greater severity and duration of the loss of employment in the modern sector than in traditional sectors and in the industrial sector as opposed to agriculture, commerce and services;

- A modification of the employment structure during the rehabilitation and reconstruction stages as construction of housing and public works increases;

- A reduction in the volume of exports and an increase in imports; and

- A trend toward public deficits because increased social spending and greater investment is normally accompanied by lower tax collections and fiscal revenues in general.

4. Damage valuation criteria

Objective and accurate criteria are needed to assess the impact of disaster damage and losses. A true assessment will provide the basis for defining rehabilitation and reconstruction programmes.

Assessment experience in the past 30 years reveals the importance of adopting more than one alternative for the monetary estimate or valuation of disaster damage and losses and the impact to the economy of the affected country or region. This is true because damage valuation criteria depends on how the results of the evaluation are to be used. Moreover, the diversity of the goods affected by a disaster (housing, roads and highways, transportation, pipelines, sewers, drinking water and electricity networks, crops and agricultural land, manufacturing enterprises, commercial and recreational centers, etc.) requires the use of many sources and information that are not always comparable.

Consequently, criteria for the valuation of disaster damage and losses may vary over a range or variety of situations within the extreme situations that are described here in.

The depreciated value of lost assets (or "book value") might be used to evaluate disaster damages. This involves estimating the value of the lost or damaged asset in its pre-disaster condition, taking its age into account in order to arrive at the value of its remaining useful life. This valuation method would be suitable for fixed production assets and others that, while not necessarily used in production processes, are subject to depreciation and obsolescence.

In countries that still have high inflation rates, the book value is not representative of an asset or good’s actual market value. In such cases, an attempt could be made to estimate its original value and adjust it for inflation from the year in which the good was acquired and the year in which it was destroyed. However, this process is complicated by the long-term changing trends in the physical characteristics of price index components. In this case, there would be no alternative but to use the replacement cost (with or without depreciation).

At the other end of the scale, damage valuation can involve an estimate of the lost asset's replacement cost that includes future disaster mitigation elements. In other words, the replacement cost of a lost asset would include not only certain technological advances (because of its age, it is unlikely that an identical product would still be on the market), but also features making it more resistant to the impact of future natural or man-made phenomena.

Other, intermediate valuation options exist. As stated above, their application depends on the needs of the analysis, the characteristics of the asset being valued, the availability of information at the time the valuation is made and, most importantly, the time the sectoral specialist has available to carry it out.

Thus, an intermediate position would involve valuing asset damage on the basis of its replacement cost with the same characteristics as its original design and without deducting the asset's depreciation over its useful life. This valuation would be useful in determining the financing needs of the state or the private sector to replace their destroyed or damaged assets.

Replacement costs should be determined with or without mitigation because they will provide the basis for the definition of the country's financial requirements and possible foreign credit needs for rehabilitation and reconstruction of production units or services affected during the disaster.

Regardless of the valuation option that is adopted, damage to assets should initially be quantified in physical units (number of pieces of machinery and production equipment as appropriate, square meters of construction destroyed, bridges, kilometers of highways by class, hectares of crops affected, tons of agricultural products lost, etc.). This will facilitate defining the most appropriate valuation criteria.

Concurrently, illustrative price lists must be available for different goods and services, such as the cost of a square meter of construction for housing of different characteristics, industrial facilities, steel bar and other construction materials, current prices of the main agricultural products, and so on. These can be derived from information generally available on the components of consumer, wholesale or producer price indices. It is often advisable to employ the prices of capital goods or construction materials used in investment projects the government might have in its portfolio or might have executed recently, since they carry updated prices and characteristics.

The assessment specialist will often have to adopt intermediate criteria, such as between the value of a square meter of construction for a destroyed marginal village and the type of permanent housing solution the government intends to provide for the victims (which will undoubtedly imply a qualitative upgrading of housing), or between the value of a destroyed textile machinery that was close to obsolescence and the cost of replacing the unit with a technically more advanced one. In all cases, the value used should be that of the equipment functionally closest to the equipment destroyed, and its cost or characteristics should fall within what can actually be found in the market and financed.

Indirect damage stemming from the interuption of the production or service flows over a given period must be valued at producer or market prices, as appropriate. In the case of production sectors, losses must be assessed at producer prices because they represent the value of what was not produced as a result of the disaster. In the case of interrupted service production (days or months of classes, the number of medical consultations, transportation costs increased due to detours, etc.) the most suitable approach (and perhaps the only feasible one) is to value services not generated as a result of the destruction of infrastructure, based on the prices or fares paid by the final consumer or end user.

Costs and prices must be considered in "real" terms (the use of production resources, goods and services). In other words, financing costs would not be brought into the damage assessment. Such costs refer to commissions, interests, discounts, insurance and reinsurance, subsidies, and all free forms of post-disaster financing, paid or free of cost, domestic or foreign. (Note that costs or prices in the real economy are considered paid in cash). Transfers within the economy are also excluded from the disaster's costs (or benefits) because they are transactions that do not use resources or produce goods and services.

When calculating indirect effects –that is, the interruption or reduction in the production flows of goods and services– it is advisable to try to estimate them both with and without the disaster; in other words, to make a comparison between what outputs would have been obtained if there had been no disaster and what was actually produced with the effects of the disaster. However, it may not be feasible to apply this approach to most sectors when the goal is a rapid assessment of damage.

Finally, calculations of direct and indirect damage and losses should be carried out in local currency. However, it is often useful to convert these figures to United States dollars for the purpose of comparison and better understanding by the international community. Prices should be expressed directly in foreign currency in the case of export products or goods that have to be imported from abroad.

5. Sources of information

Disasters commonly obstruct normal channels of information, especially if the capital city or other political and administrative centers of a country have been significantly hit. Many public agencies and services will be impaired as they struggle to work out of provisional or temporary locations after being forced to evacuate their regular offices. Officials and experts might be engaged in fieldwork or drafted onto special commissions coordinating rescue efforts, thereby blocking access to several normal sources of information.

Assessment specialists must quickly evaluate their possibly far-flung sources of information. For example, if the offices of the national statistics institute are temporarily closed, an analyst may have to turn to other specialized centers or institutes for demographic and population data. Background information on victims is best obtained from the ministries of health or the interior, while information on damage to schools can be found at the education ministry or an agency in charge of the construction of educational facilities. National women's organizations must be approached for relevant information, and so forth for each specific piece of information needed. Moreover, background information can often be found only at the disaster site rather than in the capital city.

In most cases, assessment specialists must conduct an independent estimate of damage or a technical review of the assessments already made by authorities or rescue agencies. Their time will be limited and they must act in the adverse conditions of a territory that is just emerging from an emergency. We now describe some of the information gathering techniques derived from ECLAC's experience to date.

a) Strategic sources

Regardless of whether the emergency and rehabilitation organization is centralized or decentralized, the assessment specialist must locate a network of national organizations, national and international agencies, research centers and key people capable of providing the necessary data and authority to request and obtain additional documents and reports on the disaster. Despite the urgency of the situation, assessment specialists must only use documented facts, their own observations or those that can be derived from credible oral reports or summaries of the situation. In almost every case, without the support of such strategic sources, the assessment specialist will have no way of judging the validity and reliability of information or of harmonizing different opinions or contradictions.

b) The press

From day one, the press publishes news of the disaster that the assessment specialist may find useful. Newspaper clippings should be classified into easily manageable categories. The file must be kept up-to-date since it is of capital importance in four aspects of the assessment process: i) to locate names of potential strategic sources and useful documents; ii) to provide an independent opinion confirming the consistency and coherence of available official and unofficial information; iii) to draw attention to geographical areas and types of damage that may not have been covered by previous analyses; and iv) to provide data and figures that might complement the background information obtained from other sources.[13]

13 The assessment specialist must take due care to identify –and assign relative weight to– "sensationalist" information sometimes provided by the press.

c) Maps

Maps are an essential aid to the assessment specialist and must be obtained from the outset of the assessment mission. If they exist, post-disaster maps detailing the catastrophe's effects are particularly useful, but they are usually difficult to obtain as they are constantly being updated. It may be difficult to track down even basic maps from central institutions.

d) Reconnaissance missions

Such missions may be carried out by land, air or water. If, as is commonly the case, the assessment specialist can only conduct one reconnaissance mission, it should be undertaken after an initial desk assessment of information sources has been completed. This will help ensure that additional information not available from previously consulted sources can be collected during the field mission. In isolated or difficult to reach areas, the reconnaissance mission will often be the only possible way to gather information. This mission will provide the assessment specialist with the elements necessary to judge the quality of the information sources to be handled throughout the damage assessment process, and it also will make it easier to apply one's criteria in prioritizing disaster effects. Finally, such a mission is a unique opportunity to directly observe major damage that might not be included in any documented source.[14]

e) Surveys

Undertaking the detailed surveys needed for the rehabilitation and reconstruction stages, is only possible toward the end of the emergency phase, long after initial damage assessments are made. Three types of surveys can be very useful: i) studies carried out by offices and agencies that perform "rapid appraisal" surveys such as onsite inspection of the number and extent to which houses were damaged or destroyed, or local assessments of the number of victims and the morbidity structure; ii) broader studies that offer comparisons against pre-disaster conditions such as employment and unemployment surveys in the main cities (these tools are very useful in several sages of the damage assessment process and are analyzed below as an integral part of the secondary analysis of data); and iii) the rapid appraisal surveys the assessment specialist(s) can conduct, especially during reconnaissance missions (these should be viewed as a last resort whenever no better sources of information are available).

Surveys required to ascertain the differential effects on women pose a special challenge since there is no indirect way to obtain data on the increased workloads on productive work and on the assets and income losses in the backyard economy that women sustain in the wake of a disaster. A field survey of women temporarily living in shelters should be undertaken, whenever possible, to obtain such information.

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14 This is often true in assessing damage to social sectors and the affected population, but it applies to all sectors. For example, while an initial assessment of an earthquake suggested that most of the damage was confined to the destruction of several kilometres of an oil pipeline, an air reconnaissance mission revealed major damage to agriculture due to landslides, something not initially taken into consideration.

f) Secondary data analysis

Publications, documents and reports containing background information prepared by secondary sources (institutions or persons other than the assessment specialists) can be fundamental sources of information. Regardless of the damage assessment methodology adopted, it will require a comparison of the post-disaster situation with a pre-disaster one. Secondary sources are the assessment specialist's best alternative when it comes to ascertaining pertinent values and the situation prior to the disaster. Moreover, pre-disaster background information will provide the starting point for an assessment of the disaster's effects. Without it, an objective damage assessment is impossible.

Reliable and valid data on the physical characteristics of the affected territory and its population (size, distribution, sex, age, density, economic, cultural and ethnic characteristics, etc.) must be obtained. When the assessment falls within the responsibility of government institutions or international organizations, the assessment specialist must use official sources or documents based on official sources to the fullest possible extent.

Population and housing censuses are particularly useful, as are sectoral censuses (agriculture, manufacturing, mining, etc.), statistical year books, statistics and census office reviews, any publications by research centers in the country affected and surveys carried out by official agencies, university centers or other authoritative bodies. In the immediate post-disaster stage, documents will be scarce and of the nature described above: partial surveys carried out by public offices and international agencies, together with internal reports by the institutions most closely involved in the emergency and rehabilitation stages.

g) Interpersonal communications

Assessment specialists often have friends or colleagues who are living within or near disaster areas. Contact with these reliable sources –by telephone, the Internet, radio or telegraph– is very useful for obtaining background information. Given that one of the first activities is to re-establish communications, it is highly likely that one of these systems will be working. Once contact is made, assessment specialists should make sure they clearly request specific information, which must then be verified by carefully comparing it against any independent sources that might be available.

h) Remote sensing data

Images obtained by means of remote sensors, especially those taken by satellites, can be extremely useful in damage assessment. However, their application faces certain important limitations.

First, there are obvious advantages to using satellite images for assessing the impact of phenomena such as floods, hurricanes, mudslides, earthquakes and volcanic eruptions, forest fires and oil spills. However, these images usually lack the resolution needed to identify physical damage to infrastructure. For example, from the air, a building may seem to be intact and yet have been earmarked for demolition because of internal structural damage. These sources cannot identify the injured or wounded, damage to sewers and underground pipelines, or internal damage to factories and commercial establishments.

These limitations may be overcome once a detailed geographic referencing system becomes available, but in the meantime, satellite images can be used to identify areas at risk in hazard mitigation and prevention work.

Second, acquiring images to be used in disaster assessment may be too expensive for most developing countries. Therefore, their use will likely be restricted to relatively more developed countries or to those cases where a developed country may decide to donate images to an affected country.

As we have previously noted, satellite-imaging techniques are a powerful tool in pre-disaster stages, especially in planning, early warning and vulnerability analysis. They can also be of obvious use during the reconstruction stage, when large amounts of satellite data can be rigorously classified and analyzed.

When available, aerial photography can be a powerful aid, but its importance can be overestimated. Experience shows that non-professional photography that is not systematically conducted will contain little information of use to the assessment specialist. However, the opposite is true when aerial photography is part of an aero-photogrammetric system, thus providing the assessment specialist with all the elements needed for a correct interpretation of the nature and magnitude of damage. When possible, therefore assessment specialists should make their estimates and calculations in close cooperation with personnel specialized in aero-photogrammetric analysis.