



Introduction to Damage and Reconstruction Needs Assessment

Readings

METHODOLOGICAL AND CONCEPTUAL ASPECTS

I. TYPES OF DISASTER AND POST-DISASTER STAGES¹

Disasters can be classified in many different ways. They are usually sudden and unexpected events, often accompanied by a loss of human life, that cause a society – or a part of a society – suffering and harm, a temporary breakdown of existing vital systems, material losses and considerable obstacles to social and economic activities. Disasters whose generation or evolution is slow – such as droughts – also occur with a certain frequency. They also affect societies and economies and, depending on their intensity and duration, can even cause food shortages or the inadequate provision of services essential for the population.

Depending on their origin disasters can be classified in two major groups: those deriving from natural hazards and those brought about by man. In addition, the effects of natural disasters are often magnified or exacerbated by prior human intervention. The most common disasters of natural origin in Latin America and the Caribbean are those caused by tropical storms and hurricanes, floods, droughts, frosts and hailstorms, earthquakes, volcanic eruptions, tsunamis, mudslides, etcetera. The most common man-made disasters are fires, explosions, and oil spills. To a growing degree, some human actions cause or aggravate the action of natural phenomena by improperly using natural resources or by not complying 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 hydrometeorological or geological in origin. Every year tropical storms and hurricanes enter or arise in the Caribbean Sea, and similar events occur in the tropical belt of the Pacific Ocean. The atmospheric and oceanographic modifications that occur in the Pacific – in what is known as the El Niño phenomenon or El Niño Southern Oscillation – induce changes in the characteristics of seawater, and cause floods and drought on land. 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, cause earthquakes and volcanic eruptions.²

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

¹ Excerpt from ‘Handbook’ ECLAC

² Jovel, Roberto, *Natural Disasters and their socioeconomic effects*, in *ECLAC Review*, number 38, ECLAC, Santiago de Chile, 1989.

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

By Gilberto C. Gallopin

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

In the most general terms, the vulnerability of a system is defined here 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 can be applied to any system that interacts with its environment and in particular to 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). The concept is not exclusive to social systems.

Both societal and ecological systems survive thanks to the constant exchange of matter, energy and information with their external environment. That exchange can give rise to change in the functioning or structure of the system. Changes in the system might be triggered off by changes in the system's environment (e.g. the effects of an earthquake on a population), by internal change (e.g. the impact of the 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. On the level of the planetary ecosystem, earthquakes and hurricanes are clearly internal phenomena that form part of its dynamic. However, if the system in question is a Central American village, the same phenomena are obviously external events.

In the case of 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 non-vulnerable.

Vulnerability as propensity (Popper 1990) is not an absolute property but one relative to a system in a given context, and faced with a given kind of change or hazards. In other words, a system can be vulnerable to certain disturbances but robust faced with others. However, some systems might be so fragile that they exhibit vulnerability faced with many types of disturbances, and in that sense, they can be attributed a "generic vulnerability".

According to this general conception, vulnerability is not a negative property in all cases. It is possible to speak of positive vulnerability in cases where change leads to a beneficial transformation (the emergence of a given social group from a situation of 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 and negative as in Table 1, which also differentiates by how gradual or sudden they are.

Table 1. A classification of a system’s transformations or impacts of changes.

Sign of the change		
SPEED OF THE CHANGE	<i>Damage</i>	<i>Benefit</i>
<i>Slow</i>	Deterioration	Improvement
<i>Sudden</i>	Catastrophe, disaster crisis	Anastrophe, of growth

However, for the purposes of this work, hereinafter we will limit the discussion of vulnerability to its negative aspects. To do this, in the definition of vulnerability we limit the phrase “significant transformations” to the particular case of “damage” or “adverse effects”.

The concepts central to the consideration of vulnerability are those of the system in question’s sensitivity and response capacity (target system, unit exposed, or system of reference), the probability of occurrence, 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.

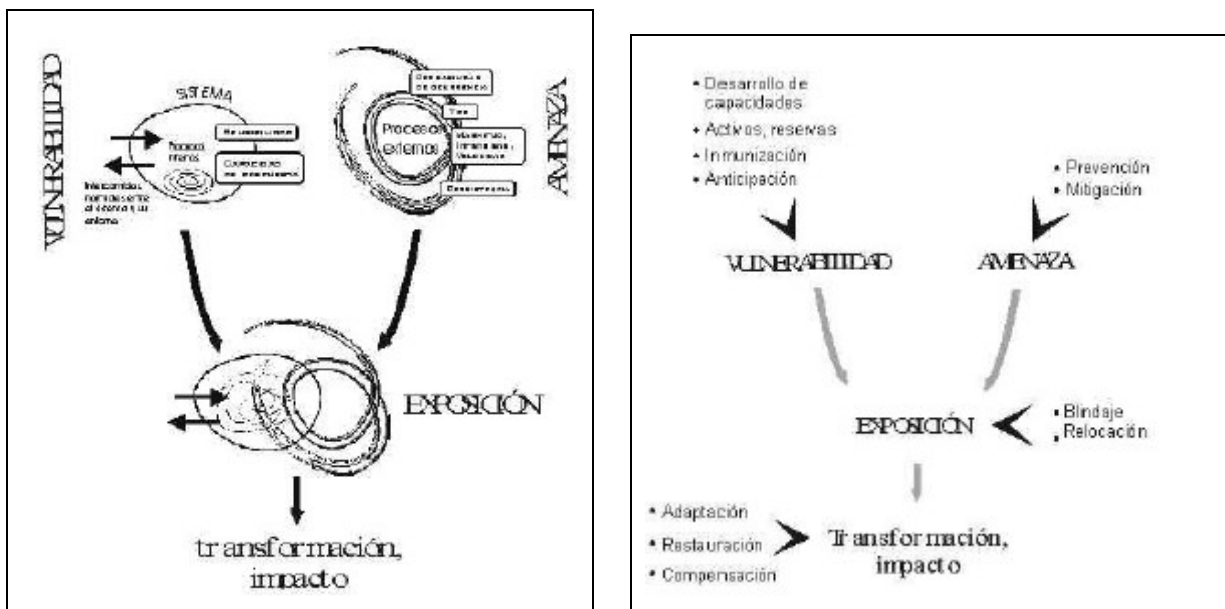
Sensitivity is the degree to which the system is modified or affected by an internal or external disturbance or set of disturbances. Conceptually, it could be measured as the degree of transformation of the system per unit of change in the disturbance (Tomovic 1963), but sometimes it is only specified as whether the system is sensitive or not 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 co-operative 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 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. In this conception, 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 to 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 more badly hit by the effects of the flood than the more solid ones (sensitivity). Oftentimes, the poorest homes are located in the places most susceptible to flooding (exposure). And, finally, the families with the greatest resources have a greater availability of means to repair the damage caused by the water (response capacity). The magnitude of the final impact will also depend on the intensity, magnitude and permanence of the flood (attributes of the event).

Figure 1, left, 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.

The conceptual system developed 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, to reduce the probability or intensity of a natural disaster (if that is possible), to reduce the system's exposure to the hazard, and to mitigate the event's negative impact on the system in question. Figure 2, right, illustrates the type of policies most commonly associated with the different aspects mentioned.

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The **emergency** stage refers to the time 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 utility services and early actions to register victims and record damage to public and private property. This stage may vary in its duration but, in general, it is relatively brief, depending on the magnitude of the disaster.

The **rehabilitation** or transition stage includes activities required to return normality to the affected areas and communities. It includes non-definitive repairs to housing and buildings, and to transport and public utility service infrastructure. Problems related to the emotional and psychological recovery of the inhabitants of the regions affected by the disaster are to be addressed here. Return to work, creation of new jobs, availability of loans and financial resources, and immediate start-up projects related to the consequences of the disaster are among recovery measures that most help the victims and affected communities.

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 have been completed or are nearing conclusion – so as not to interfere with those actions and to ensure availability of the necessary personnel counterpart and basic information – and are intended to provide the identification of needs and priorities for the reconstruction stage.

II. GENERAL METHODOLOGY CONSIDERATIONS

The ultimate goal of the assessment methodology presented herein is the measurement in monetary terms of the impact of disasters on the society, the economy and the environment of the affected country or region. In order to achieve this purpose, use is made of national accounts as a means of valuation, supplemented with procedures to make 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 a tool to define reconstruction requirements. It further enables the identification of the most affected geographical areas and sectors, and corresponding reconstruction priorities. In addition, it provides a way to estimate effects on economic flows, a measure of the affected country's capacity to undertake reconstruction by itself and a means to estimate the requirements for international financial and technical co-operation. Moreover, it allows the identification of changes that should be made to public policies and development programs and plans to deal with needs arising from the disaster, and thereby avoids undesirable effects in economic performance and the well being of the population.

The assessment work must often be carried out quickly to be able to guide reconstruction activities and the support provided by the international community. This is not only because the affected population's pressing needs must be quickly met but also in order to avoid that international attention is diverted to other areas of the world, thereby missing opportunities to obtain co-operation for reconstruction. Therefore, greater importance is assigned to the timely presentation of the assessment rather than to high precision in the analysis's results. Damage figures thus obtained should provide the order of magnitude of damage and losses and of reconstruction requirements.

Details are given heretofore of the methodology and the recommended sources of information for the analysis of each sector, as well as those related to the assessment of overall impacts. Selected criteria that are universally valid to address these questions are also described.

The assessment should begin by gathering all existing quantitative background information to enable both an appreciation of conditions before the disaster and its scope, and the magnitude of damage and losses and their macroeconomic effects. Consultations must be held with government sources and industrial or professional associations (such as engineers or architects societies), service providers, chambers of trade, industry and farmers associations, as well as with 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 information obtained should be verified in the field. Sampling must 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 in the determination of the differential effects of disasters on women.

It must be kept in mind that the assessments for which this manual is designed are a basic tool to assist in the decision-making process to define and assign priority to reconstruction plans and programs. Therefore, proper consideration must be given to the balance between high accuracy in the estimates *vis a vis* the urgent need for the assessment to be able to start programs quickly, as previously stated. Results achieved in the assessment must, as a very minimum, provide an accurate estimation of the orders of magnitude of the disaster's effects, and its geographic and sectoral scope. More accurate calculations of the disaster's results can be provided at a later date when specific investment projects are formulated.

SHADOW PRICES AND DISASTER DAMAGE ASSESSMENT

In terms of economic impact, a disaster may be considered as 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, projects are assessed by comparing their costs to their benefits, as a basis for deciding whether they should be implemented.

In contrast, disasters cause damage to assets (they could be regarded as "disinvestments") and also affect the flow of production of goods and services, in terms of both their availability and the efficiency of production. If the method for project assessment is applied to specific economic sectors, three parameters are needed to assess the economic damage caused by a disaster: (i) the amount of losses of assets (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 over which the markets are disturbed.

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 situations³. 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

³ 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 of this).

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 assessment and social assessment. In the private assessment of projects, the annual returns derive from the sale of products or services, and the costs derive from the purchase of inputs and factor payments. In the social assessment of projects, the annual social benefits are obtained from the increase in national income as a result of a project's implementation, whereas 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.

Both social and private assessment use similar criteria to study project feasibility, although they 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 society⁴. For the social assessment of projects, the three "basic" shadow prices are used: those of 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 and/or services produced and of the inputs involved in production are calculated on the basis of information on current and future supply and demand; this, in turn, 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 to the value of the damage to society caused by the disaster. For example, the damage caused by reduced production of an export item which generates foreign currency for the country may be very different depending on whether it is assessed using private prices or shadow prices, if the shadow price of the currency is significantly different from the private price. Although this approximation might be preferable in theory, the use of private prices is more appropriate in practice, given the amount of information that social assessments require, the number of sectors involved and the short time period usually available for damage assessment.

III. CLASSIFICATION AND DEFINITION OF DAMAGE AND EFFECTS

Natural phenomena do not only have effects that are clearly visible after earthquakes, storms and floods. They also unleash after-effects 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 disaster's damages and effects, that require the application of two criteria: the methodology applied must provide an assessment of the full socio-

⁴ 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 which 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.

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 themselves conventional, and that there can be cases that straddle the border between two concepts, definitions applied here have been derived by the consensus acquired during the three decades during which such assessment activities have been undertaken in the region.

Expressed in the simplest terms, a disaster produces effects on assets (**direct damages**); on the flows for the production of goods and services (**indirect losses**); and on 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, disaster effects may also have a positive result. The assessment will therefore aim to the determination of the net effect, giving due consideration to both negative and positive results.

Direct damages occur practically at the very time of the disaster, or within the first few hours. The last two types of losses occur over a period of time that, according to practical experience and depending on the magnitude of the disaster, may last up to five years. During slowly-evolving or long-duration events – such as droughts or the effects of the El Niño phenomenon – direct damages may occur over an extended time period and may even occur several times over in cases where the affected infrastructure was initially repaired and subsequently became damaged again, such as bridges destroyed by repeated flooding. In these cases, however, the majority of losses will be of the indirect type, since it will be economic flows that are usually affected.

During a fast assessment, identification and evaluation of direct damage is relatively straightforward matter. However, the same cannot be said of a disaster's indirect effects. These indirect losses will only become apparent at different times after the disaster⁵ and are, therefore, more difficult to identify during a rapid assessment. 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 slow-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 in order 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 macro-economic imbalances arising from the event. Macro-economic effects cannot, therefore, 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, etcetera.) are the starting point for any damage estimation. Doing so will permit the adoption of the most suitable valuation criteria in each special case. A detailed description of the damage to be estimated under each category of effects is presented heretofore.

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

1. Direct damages

Direct damages (complete or partial destruction) may be inflicted on immovable assets and on stock (whether final goods and goods in process, raw materials, materials and spare parts).⁶ In essence, this is damage to assets that occurred practically at the time of the actual disaster. 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 production that was 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;⁷ totally destroyed constructions; equipment, and stock. During the quantification of direct damage, the imported component that will be 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 losses of human lives. Setting aside the suffering sustained by families and society in general, losses of life are a direct loss to the society in any country affected by a disaster. They are a loss of human assets. There exist indirect ways to estimate a monetary value of such losses.

A possible way to approach the estimation of these losses would involve the estimation of the future income – expressed in net present value – which the deceased would generate before reaching the limit of its life expectancy. Therefore, comparing the average age of the deceased population and their corresponding life expectancy – giving due consideration to sex differentials – it would be possible to estimate the time loss for the deceased victims. By combining the resulting number of person-years with the expected average income over the appropriate time period, a rough estimate of human asset losses may be reached.

Such a procedure has its shortcomings, however. As is well known, *per capita* income varies from one country to another. Its adoption as a yardstick to ascertain human asset losses would yield a result that a human life lost in a developing country would be a lower figure than a corresponding death in a more developed nation, even within the same Latin America and Caribbean region. This would be 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 there exist shortcomings based on the fact that values that do not directly apply in the case of the region would be adopted.

A further alternative would be to adopt the average compensation paid by insurance enterprises located in the region for cases of accidental deaths related to hazardous activities. This method, however, cannot be used either because the amounts paid

⁶ Entrepreneurs or owners of companies normally also count as losses those to realizable assets such as accounts receivable destroyed and which, for that reason, 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 be representing an inter-sectoral transfer of revenue and including them would involve double accounting.

⁷ In practice, the sectoral specialist will often value repairs as a percentage of the replacement value of a partially destroyed asset. Although this route has the advantage of speed, it should be improved with estimation techniques closer to the current value of those repairs

depend upon the actual payment capacity of the insured person, which most certainly do not match that of the average victim in a given disaster, and also has the same bias in regard to per capita income.

There exist other ways to arrive at the value of human life that are based on the amount that a person is willing to pay to avoid premature death. For this purpose, use can be made of 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 yield higher figures than the previously discussed alternative procedures. Furthermore, its adoption would 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 described limitations render impractical any attempt to estimate human life loss values.

2. Indirect losses

This effect refers essentially to the flows of goods that will not be produced or services – expressed in current values – that will not be provided over a span of time that begins after the disaster and may possibly last throughout the rehabilitation and reconstruction period. Conventionally, a maximum timeframe of five years has been recommended, although most losses occur during the first two. In any case, the estimation of these effects must be extended throughout the time period required to achieve the partial or total recovery of the affected production capacity.

These indirect losses result from the direct damage that has affected production capacity and social and economic infrastructure. Indirect losses also includes increased current outlays or

costs in the provision of essential services arising from the disaster, as well as diminished expected income in cases where these services cannot be provided under normal conditions, or cannot be provided at all (which fact in turn will be reflected in the macro-economic effects). Examples of indirect effects are losses of future harvests due to the flooding of agricultural land or the occurrence of prolonged droughts;⁸ losses of industrial production due to damage to factories or a lack of raw materials; greater transportation costs due to the use of alternative routes or means of communication that are longer, more expensive, of poorer standards; etc. These are indirect losses for the sector under reference and will also be considered as macro-economic effects when the main economic aggregates are examined.

The assessment specialist must be duly aware that some indirect effects of a disaster might generate some 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 estimate of damages.⁹

Disasters also produce some major indirect effects that may be difficult to identify and impossible to quantify. These are effects that 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 effects 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

⁸ However, if the disaster destroys harvests that are about to be collected, this loss should be considered a direct damage, as mentioned earlier and as will be explained in the chapter on agriculture in Section Two of this handbook

⁹ For example, a long and widespread flood in a South American country caused by the El Niño phenomenon made temporarily fertile a relatively large amount of coastal land that before the disaster was not suitable for farming, when the floodwaters receded. This land was then placed under production by its owners and the harvest thus obtained was deducted, as an indirect benefit, from the loss estimates

always have sufficient time to attempt to place a monetary value on these important effects of disasters, but must be aware that a comprehensive evaluation of the effects of a disaster must include an assessment or at least a global discussion of intangible damage or benefits such as the ones listed above, since they considerably affect conditions or the standard of living.

Finally, there are indirect effects of disasters that can be given a monetary value but whose calculation would be very difficult to undertake due 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, etc.

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, inventories or losses of production and income. For example, losses in sales of perishable goods or those that could not be timely stored 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 complete term of classes in formal education; costs of not being able to comply with export contracts; etc.
- III. Additional costs incurred due to the need to resort to alternative means of production or provision of essential services. For example, greater costs incurred due to the use of longer or lower standard road detours and the construction of emergency roads.
- IV. Greater costs due to budgetary re-orientation or reassignment.
- V. Income reduction due to the non-provision or partial provision of services by public utilities (power and drinking water utilities); losses of personnel income due to loss of employment or to forced part-time working.
- VI. Costs incurred in the attention of the affected population during the emergency stage, by all parties involved.
- VII. Additional costs to deal with new situations arising from a disaster, such as the cost of health campaigns to prevent the occurrence of epidemics.
- VIII. Lost production or income due to "chain-link" effects, similar to those that occur during a recession, which can be "forward" or "backward". For example, due to the destruction of a factory, reductions in 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; in other words, any repercussion or side effect of the disaster 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 brigades and workers, 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. The assessment specialist, when identifying and assessing them, should ensure that no double accounting results. For example, if effects are calculated on the side of production, they must not again be included on the side of income; 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 the estimation of the time-frames required to re-establish services, lost production volumes, greater costs that must be incurred to provide services, and the corresponding reductions in income. An analysis must also be made of the operating results of public utilities to estimate their possible losses while rehabilitation is ongoing, as well as the prices and yields of agricultural and industrial products that were lost. This handbook provides step-by-step procedures to undertake these estimates for of the sectors that may be affected.

The concepts outlined above are quite broad. It is advisable to adopt some restrictions so that no too time-consuming quantification are undertaken by the assessment specialists 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 dealt with, or even certain drastic economic measures that might have been taken or that form part of it. The idea is, therefore, of measuring only the most important indirect effects that could also be called **primary** or **first-round** effects.

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

3. Macro-economic effects

Macro-economic effects reflect the manner in which the disaster shall modify 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. Rather, the estimation of macroeconomic effects is a complement to the assessment of direct damages and indirect losses, although considering them from a different perspective. Quantification of the macroeconomic effects is usually done for the national economy as a whole. Sectoral specialists, drawing on their expertise, must provide the required information for the macro-economist specialist to put together the integrated view of the effects on the main economic variables. While the country will be used as the basic unit for this analysis, similar undertakings can be made in cases of disasters affecting smaller areas or regions – a province, state, department or municipality – provided that the required basic information is available.

A valid estimation of the macro-economic effects of a disaster requires the availability of a reliable forecast of how each of the variables assessed would have performed had the disaster not occurred. In fact, that would be the baseline to ascertain the degree to which the disaster disrupted the results that would have been achieved otherwise and the extent to which the deterioration recorded in the main variables has affected the country's ability to meet rehabilitation and reconstruction requirements and is able to define new international co-operation requirements, especially financial.

The most important macro-economic effects of a disaster are those that have a bearing on the level and the growth rate of the global and sectoral gross domestic product; the balance of trade (due to changes in exports, tourism and services and outflows to pay for imports and foreign services, etc.); the level of 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 also relevant. In addition, national credit rating, liquidity and domestic interest rates may also be affected, and should be looked into.

Gross domestic product can be undermined by reductions in the output of the individual sectors affected, and may also be increased by the greater activity of reconstruction. In some cases when production diminishes, exports are likewise reduced and goods may have to be imported to satisfy domestic demand, with the corresponding effect on the balance of trade and of payments. Public

sector spending will increase due to disbursements made during the emergency and rehabilitation stages or to subsidies granted to significantly affected population groups. Fiscal revenue might drop due to decreased tax collection resulting from falls in production and exports, or even due to the temporary abolition of selected taxes, decreed to relieve pressure on significantly affected sectors. The combination of the above situations could cause or aggravate existing fiscal deficits.

On the other hand, prices of goods might rise in response to shortages brought about by special demands imposed by reconstruction or by speculation, thus increasing inflation rates. Depending on how the country's economy was performing before the disaster, if its magnitude and effects were sufficiently severe, the level of international reserves or the country's ability to meet its foreign debt servicing commitments might also be compromised.

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

Sectoral specialists must make estimates on foreseeable losses in production (of goods or services) during the time-period that recovery of farmland, production equipment or physical and social infrastructure is expected to require, enabling the calculation and global consolidation of macro-economic effects. They must also obtain background information that will enable an assessment of the impacts on other macro-economic variables that have been mentioned (employment, income, exports, imports, gross investment, tax collection, etc.) and, as background information, each specialist must prepare an appreciation of how the sector was expected to evolve before the disaster, within recent performance or in accordance with goals established in each sectoral plan set forth before the disaster occurred.

The time frame for which macro-economic effects are to be estimated must be defined on a flexible basis, based on the magnitude of the disaster. Experience shows that normally a "reasonable time" would be the remainder of the year in which the disaster occurs (short term) plus one or two and, exceptionally, five additional years (medium term).

It must be borne in mind that the estimate of macro-economic effects only shows what would happen should the authorities of the country or region affected do not modify current public policies and programs. Therefore, the projection of macro-economic performance provides a tool for these authorities to re-orient policies and plans in light of post-disaster reconstruction needs.

Although this subject is dealt with more broadly in the corresponding section of the handbook, some general methodological aspects are described below that are common to the estimates of some of the most important macro-economic aggregates.

- a) Gross domestic product. The macro-economic specialist must estimate losses in the production of goods and services due to the disaster over the recovery time period for each sector under reference on the basis of information provided by each sectoral specialist. For this purpose data are required that will enable an estimate of the foregone GDP, at constant prices, especially the volume of forecast reductions projected throughout the period required for recovery of the affected production capacity. The sectoral specialist must also define how his sector's GDP was expected to perform in the year when the disaster occurred on the basis of pre-disaster forecasts. This estimate will provide the basis for the projection of losses to obtain the "before" and "after" results of the disaster. It will have to take into account the possible positive effect on GDP due to the growth in the construction sector due 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 preexisting assets. As the

process to restore assets is carried out and depending on the availability of resources and the country's engineering construction capacity, gross investment will have to increase during the following year. In any case, in the year of the disaster, the magnitude of this variable will reflect two types of effects: i) suspended or delayed development projects already under execution, because of the disaster, and ii) losses of stock. These data, together with an estimation of sectoral investment requirements to repair damages over the following five years,¹⁰ should be provided by the sectoral specialist to the macroeconomist.

- c) Balance of payments. The current account of balance of payments for the year of the disaster must be estimated by the macro-economic specialist on the basis of sectoral reports on the following main items: i) diminished exports of goods and services (if the country suffered losses cutting back its tourist activity or affecting its merchant fleet or the production capacity of companies that export services, such as engineering services, etc.); ii) greater imports required for the recovery and reconstruction stage (such as fuels, food because of lost harvests) over a time period that may last from two to five years; imports related to the reconstruction process should be estimated by sectoral specialists on the basis of the imported components of each of the main building materials or equipment; iii) donations in kind or money received because of the emergency, iv) reinsurance payments from abroad, and v) any reductions in payments of foreign debt interest obtained through post-disaster agreements with creditors. The balance of payments financial account must be estimated basically on the basis of the medium and long-term external financing requirements for priority investment projects that will form part of the reconstruction process over, say, the five years following the event¹¹ and also the foreign financial complement required in view of a possible deterioration in the current account imbalance as a result of previous projections.
- d) Public finances. This is another of the macro-economic aggregates that must be quantified because the approved budget for the year of the disaster will most probably undergo major changes during the year and those immediately following. In this regard the following possible macro-economic effects must be analyzed: i) lower tax revenue due to decreased production of goods and services, losses in income and less consumer spending, and lower income of public service companies; ii) increased current spending related to the emergency, especially to attend to the affected population's humanitarian needs and the urgent repair or rehabilitation of damaged public services; and iii) higher than expected investment spending required for the reconstruction stage. The macro-economist will have to try to bring coherence to information available from various sources that might be contradictory. Then he or she will prepare public finance deficit estimates for the current and following years. Based thereupon, the public sector's financial requirements in that time frame should be determined.
- e) Prices and inflation. Although it is not always feasible or justifiable to measure general inflation levels before and after the disaster, at least an overview must be formulated, based on sectoral reports, of the effect that limitations on supply – due to the destruction of harvests, manufactured goods, sales channels, transportation routes, etc. – might have on the price of certain goods and services¹² that, in such case, will be supplied by alternative means. The influence of these variables on the general level and on relative prices must be estimated and included among the macro-economic effects of the disaster.
- f) Employment. Sectoral estimates must be made in order to provide an idea of the overall effects on employment deriving from: i) the destruction of the production capacity of social infrastructure, and ii) new demands for personnel arising during the emergency and rehabilitation process.

¹⁰ Or another period whose duration can be established by the sectoral specialist and the macroeconomist as the most suitable to complete reconstruction

¹¹ See the previous note.

¹² 11 In some cases these could even represent a decrease, if the substitute good that is imported or otherwise obtained from a non-habitual source is obtained at a lower price

Finally, experience from assessments by national and international institutions over the last 30 years allows certain relationships to be drawn between the type of disaster and the nature of its damage. The most important of which are as follows:¹³

- 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 due to 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 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, increasing pre-disaster deficits in developing countries;
- A temporary income decrease for the most disadvantaged social strata, and a corresponding increase in the already high rates of under and unemployment in same countries.
- Temporary interruptions in water supply and sanitation, electricity, communications and transport services;
- Temporary shortages of food and raw materials for agricultural and industrial production;
- Regardless of the amount of damage sustained, small businesses and personal services activities will be expected to recover most quickly.
- In countries with predominantly dual structures, the severity and duration of the loss of employment due to the disaster is greater in the modern sector than in traditional sectors; and in the industrial sector greater than in agriculture, commerce and services;
- In the rehabilitation and reconstruction stages, the employment structure is modified, as housing and public works construction activities increase.
- A reduction in the volume of exports and an increase in imports should normally be expected;
- Likewise, public finances will evolve toward a deficit because of increases in all kind of social spending, reassignment of spending in time and greater investment will normally be accompanied by lower tax collection and other fiscal revenue.

¹³ Jovel, Roberto, Op. Cit. 1989

4. Damage valuation criteria

Objective and accurate criteria are to be adopted in the assessment of the impact of damage and losses caused in a disaster. A true assessment will provide the basis for the definition and adoption of rehabilitation and reconstruction program decisions and priorities.

Experience acquired in assessments undertaken during the past 30 years advises adopting more than one alternative for the monetary estimate or valuation of damage and losses caused in a disaster and its effects on the economy of the country or region affected. This is true because criteria adopted for the valuation of damage is related to the use to be made of the results of the evaluation. 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.

That is the reason why criteria for the valuation of disaster damage and losses may vary, over a range or variety of situations within extreme situations that are described heretofore.

The **depreciated value of lost assets** (or "book value") might be used to evaluate disaster damages. This would estimate the value of the lost or damaged asset in its pre-disaster condition, and would take 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 which, 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 a case, an attempt could be made to estimate its original value and adjust it for inflation occurred between the year of acquisition of the good 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 could use an estimate of the lost asset's **replacement cost** that include future disaster mitigation elements. In other words, the lost asset would be valued not only in terms of a new one, which obviously 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 onslaught 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 that the valuation is made and, most importantly, on 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. In other words, 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 be initially be quantified on the basis of physical units (number of pieces of machinery and production equipment as appropriate, total or partial damage, 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. Sometimes it is often advisable to utilize 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 an intermediate criterion. For example, between the value of a square meter of construction for a destroyed marginal village and the type of permanent housing solution the government of the country affected intends to provide for the victims that used to live there (which will undoubtedly imply a qualitative upgrading in the type of housing), or between the value of a destroyed textile machinery that was close to obsolescence and the cost to replace the unit with one that undoubtedly will be technically more advanced. This means that in all cases the value used is that of the equipment functionally closest to the equipment destroyed and, in turn, that its cost or characteristics should fall within what can actually be found in the market and financed.

Indirect damage, referring to the production or service flows interrupted over a given time 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 because 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 “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 goods and services production flows – it is advisable to try to estimate them “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 is not always 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. In the case of export products or goods that have to be imported from abroad, prices should be expressed directly in foreign currency.

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 affected. Many public buildings might have been evacuated and their functions will be only partially carried out, and then in provisional or temporary locations. Officials and experts might be employed in fieldwork or may have been drafted onto special commissions co-coordinating or programming rescue efforts, thereby blocking access to several normal sources of information.

Assessment specialists must quickly evaluate their possible sources of information. In all likelihood, these will be spread out over a sizable geographical area. For example, demographic and population

data should be obtained from the National Statistics Office. However, if this office is temporarily closed, data must be obtained from specialized centers or institutes. Background information on victims probably should be obtained from agencies at the Ministries of Health or of the Interior. Information on damage to schools should be obtained in Ministry of Education or educational establishment construction offices. The National Women organization must be approached in order to obtain appropriate information. And so on for each specific information needed. Moreover, the background information can often only be found in the very places affected by the disaster and not in the capital city.

In most cases, assessment specialists must conduct an independent estimate of damage or carry out a technical review of the assessments already made by authorities or rescue agencies. They will have limited time available and they must act in the conditions to be expected of a territory that is just emerging from an emergency. On the basis of ECLAC's experience on the subject, some information gathering techniques are briefly described below.

a) Strategic sources

The assessment specialist, no matter if the emergency and rehabilitation organization is centralized or decentralized, must locate a network of national organizations, national and international agencies, research centers, and "key" people capable of providing the data required and which may have sufficient authority to request and obtain documents and reports on the disaster. Despite the urgency, assessment specialists must only use documented facts and data, their own observations or those that can be derived from oral reports or summaries of the situation prepared by different sources. 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, nor of harmonizing different opinions or contradictions.

b) The press

From the day the disaster occurs, the press publishes news that the assessment specialist may find useful. Newspaper clippings must be classified into easily manageable categories. A file must be kept up-to-date since it is of capital importance in four aspects of the assessment process: i) as a reference source 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 have not been covered by analyses already performed; and iv) to provide data and figures that might complement the background information obtained from other sources.¹⁴

c) Maps

Maps are an essential aid to the assessment specialist and must be obtained since the very start of the assessment mission. Maps with information on the catastrophe's effects that have been made after the disaster are particularly useful. However, if they do exist, they are usually difficult to obtain because they are subject to a continuous process to update them. On the other hand, even basic maps are not easily available in central institutions and must be tracked down.

d) Reconnaissance missions

Such missions may be carried out by land, air or water. If the assessment specialist can only carry out one reconnaissance mission, which is commonly the case, it should be undertaken after a first desk assessment of information sources has been completed. This will ensure that additional information not available in 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

¹⁴ The assessment specialist must take due care to identify – and assign relative weight – to "sensationalist" information sometimes provided by the press.

information. For the assessment specialist this mission will provide the necessary elements to judge the quality of the information sources that will be handled throughout the damage assessment process, and also will enable a prioritization of the effects of the disaster in accordance with its own criteria. Finally, because it is the only opportunity to observe major damage which might not be included in any other documented source.¹⁵

e) Surveys

Only towards the end of the emergency phase it becomes possible to undertake detailed surveys are the perfect way to obtain data required for the rehabilitation and reconstruction stages. Such surveys do not exist when the objective is a rapid assessment of the damage, something typically done toward the end of the emergency stage. There are three types of surveys which can be very useful: those carried out by offices and agencies that perform "rapid appraisal" surveys of damage such as, for example, by means of a simple eye-witness inspection of the number and condition of houses damaged or destroyed; or of partial aspects of the damage, such as, for example, of victims and the morbidity structure according to a health office. For example, employment and unemployment surveys in the main cities. These tools are very useful in several stages of the damage assessment process and will be analyzed below as an integral part of the secondary analysis of data. And the rapid appraisal surveys the assessment specialist (or a group of them) can carry out especially during reconnaissance missions. These should be done whenever there are no better sources of information.

A special case is that of surveys required to ascertain the differential effects on women, since there is no alternative 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 after disasters. A field survey of women temporarily living in shelters should be undertaken, whenever possible, to obtain such information.

f) Secondary analysis of data

This refers to the analysis and use of publications, documents and reports containing background information, prepared by different institutions or persons. For the assessment specialists they are "secondary" inasmuch as they do not have to generate them, and their importance can be fundamental. Regardless of the damage assessment methodology adopted, it will require a comparison of the post-disaster situation with a pre-disaster one. This is the assessment specialist 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 them, an objective damage assessment will not be achieved.

Reliable and valid data on the physical characteristics of the territory affected 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, to the extent possible, official sources or documents based on official sources.

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 acknowledged 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, and internal reports by the institutions most closely involved in the emergency and rehabilitation stages.

¹⁵ This often happens in the assessment of damage to social sectors and affected population. However, the comment is valid for all sectors. For example, in the assessment of damage caused by an earthquake, most of the damage was concentrated in the destruction of several kilometers of an oil pipeline. An air reconnaissance mission enabled the detection of major damage to agriculture due to landslides, something not initially taken into consideration

g) Inter-personal communications

Assessment specialists often have friends or colleagues who are living within or close by the areas affected by a disaster. In order to obtain background information contact with these reliable sources – by means of telephone, the Internet, radio or telegraph – are very useful. Given that one of the first activities is to re-establish communications, it is highly likely that one of these systems will be working. In any case, assessment specialists must ensure that requests for information made using such means of communication are very clear and specific, and they must also very carefully examine any information thus obtained, by comparing it with available independent criteria, to ensure its reliability.

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, it must be recognized that satellite images offer advantages in the assessment of disasters caused by such phenomena as floods, hurricanes, mudslides, earthquakes and volcanic eruptions, forest fires and oil spills. However, their resolution is not normally sufficient to enable the identification of 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; the injured and wounded population cannot be identified; damage to sewers and underground pipelines cannot be detected; and internal damage to factories and commercial establishments cannot be identified. When a detailed geographic referencing system becomes available, the aforementioned limitations may perhaps be overcome. Meanwhile, satellite images can be used to identify and define areas at risk in mitigation and prevention work.

Second, the cost of acquiring images to be used in disaster assessment may be too expensive for most developing countries. Therefore, their use will perhaps 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 was said above, satellite-imaging techniques will obviously prove to be a powerful tool in pre-disaster stages, especially in planning, early warning, and vulnerability analysis. Their use can also be anticipated in the reconstruction stage, when large amounts of information collected by satellites can be rigorously classified and analyzed.

Aerial photography can become a powerful aid, if available. However, its importance can be overestimated. Experience shows that isolated photography, not carried out systematically or provided by professionals will contain little information of use to the assessment specialist. However, when aerial photography is part of an aero-photogrammetric system, the opposite is true and the assessment specialist will find all the elements for a correct interpretation on the nature and magnitude of a large part of the damage. In these cases, assessment specialists should carry out their estimates and calculations in close co-operation with personnel specialized in aero-photogrammetric analysis.