CHAPTER 18

ASSESSMENT OF DAMAGE

In Chapter 16 it was explained that the effectiveness of action taken during an emergency and its immediate aftermath owes much to the preparation of situation reports based on damage surveys conducted during the occurrence of a disaster. In the appendix to that chapter proposals are given concerning the data and supporting information that should be collected during the survey. These surveys, carried out in the unsettled conditions of the emergency, are necessarily somewhat hurried affairs. The aim is to provide a more or less instant picture of the situation and, since a number of surveys will take place in fairly rapid succession, the lack of completeness of any one survey is not of major importance so long as the main features of the disaster are seen and reported.

These surveys therefore serve an extremely valuable purpose. However, after a disaster, when conditions are more settled, it it essential that a review should be undertaken of all that is involved in the programme of disaster prevention and preparedness. By this means changes, improvements and extensions can be made on the basis of the lessons to be learned. Therefore, soon after the emergency has ended, a comprehensive programme should be set up for the collection of data relating to deaths, injuries and damage which have resulted in various ways from the disaster. If, for example, a tropical cyclone caused the disaster, data should be collected under such headings as violent winds, flooding and storm surge.

It is generally accepted that a severe tropical cyclone has a greater economic and social impact than any other meteorological event. However, unless a well-organized and careful survey of damage is made, it will not be possible to make reliable estimates of the losses that have been sustained. Although the loss-of-life figures may be fairly accurate, except perhaps in heavily populated areas where a storm surge has occurred, estimates of material and economic losses would be little more than guesses on which it would be unwise to base decisions for future action. On the other hand, in certain countries where damage surveys have been well established over many years, it has been possible to prepare accurate estimates of damage disaster apportioned among agriculture, property, industry and so on

A survey of damage should be carried out after each tropical cyclone even if the country concerned has already assembled such information over many years. Where this has been done there will still remain some uncertainties or, at best, provisional estimates which might be improved by additional data.

It is noteworthy that the Office of the United Nations Disaster Relief Co-ordinator has embarked upon a world survey of disaster damage. This survey is very widely based and includes all types of disaster, tropical cyclones as well as other phenomena such as droughts, earthquakes, mining accidents and so on. Questionnaires have been distributed to all developing countries and to a number of industrial countries and the co-operation of international organizations has been invited. A survey of this nature is expected to provide a mass of essential data for United Nations purposes, e.g. in planning the organization of development and the distribution of aid, but it should also prove extremely useful to individual nations which complete the questionnaire because the assembly of the data required should prove highly instructive in regard to national decisions on future development.

Over many years the United Nations Economic and Social Commission for Asia and the Pacific has collated statistics on the damage caused by tropical cyclones and floods in ESCAP countries. The data, analysed on an annual basis, give information on the losses of human lives, the numbers of people injured, areas inundated and/or damaged, and on the numbers of dwellings destroyed or damaged. The assessment of damage to buildings, installations, cultivated areas, etc., can be converted approximately into estimates of the financial losses which a country has sustained each year in consequence of tropical cyclones and floods.

The surveys conducted by UNDRO and by ESCAP allow comparisons to be made, on a world-wide and on a regional scale respectively, between one period and another so that progress may be monitored and any unexpected or other remarkable features may be investigated Comparisons on a national scale are also of obvious importance. In the United States of America, for example, loss of life due to tropical cyclones decreased after special measures had been taken to improve the warning and emergency arrangements from 1935 onwards. These storms killed more than 10000 people in the 30 years 1900-1929, but fewer than 2000 people in the 30 years 1945-1974. This reduction was achieved even though the damage potential had been raised as a result of community developments and large increases in population.

Purposes of a damage survey

There should be a survey of damage whether the tropical cyclone has caused tremendous losses or had little or no effect. The latter case may indeed be of particular importance because unless causes and effects are properly investigated a false sense of security might be engendered only to be shattered by the next tropical cyclone, producing much avoidable as well as unavoidable damage.

A survey of damage enables thorough investigation to be carried out, e g.:

(*a*) An analysis by causes and by area or district may be made of the losses in human lives;

(*b*) It enables a division of the damage into various categories such as agriculture, industry, public works, public utilities, property;

(*c*) It leads to an assessment of the total damage in financial terms which can also be separated into different categories;

(*d*) Comparisons between total losses and the costs of preventive measures would demonstrate that disaster prevention and preparedness pay for themselves many times over;

(*e*) An analysis may be made of the effects of wind, rainfall, floods, storm surges and other factors.

Factors causing damage

A brief discussion of the various factors causing damage when a tropical cyclone affects a country is set out below with the purpose of indicating broadly the effects that should be investigated during a damage survey.

Wind damage

As the force exerted by the wind is proportional to the square of its speed, the total damage may be expected to increase fairly rapidly with the more violent tropical cyclones. For each sector of the community, e.g. agriculture, buildings, public utilities, there is probably a threshold level below which damage caused by wind is fairly small and above which it is considerable. In the case of agriculture the threshold speed would be relatively low, for buildings it would depend on the type of construction and on the appropriate engineering design criteria used.

A significant proportion of the total damage may be caused less by the direct force of wind or its suction effects on buildings than by the fracture of structures by flying debris which may include uprooted trees and bricks and other objects from houses which have already disintegrated.

The pattern of damage will be widespread downwind and it will probably be found that even the most stoutly designed buildings cannot withstand the impact of heavy objects moving through the air at high speed. Once a structure has been breached, the subsequent wind and rain damage can be extreme. Removal of outdoor objects to the degree possible upon receipt of a warning should be a part of the preparedness plan.

Wind and flying objects may cause serious loss of life on land, but generally on a smaller scale than floods or storm surges. At sea, however, the total loss of life may be entirely due to the effects of winds and waves on shipping and particularly on small craft

Rain damage

Losses to the contents of buildings due to rain increase rapidly once a break in the structure has occurred Electrical goods and wiring, office and household furniture, internal paintwork and plaster, personal belongings all contribute to the total damage that is sustained. When such damage is integrated over thousands of households and other buildings, it may be seen to amount to a substantial percentage of the total losses of the community as a whole.

Flood damage

The preceding section has been concerned with direct rainfall damage. Floods are a consequence of excessive rainfall – and may also be associated with storm surges – and in most major cyclones the greatest loss of life occurs from the flooding which follows the rains Flood damage may take different forms in various countries. In some, loss of agricultural products may predominate whilst, in others, the major losses may be in public works, industry highways and property. These differences may reflect the amount and type of protective measures that have been taken in one country compared with another

In general terms, however, abnormally high flood levels can lead to widespread property damage, destruction of crops and drowning of livestock, damage to roads, bridges, etc. Very high-intensity rainfall, resulting in flash-floods, is mainly responsible for the high losses in human lives and livestock. In the larger river systems which adjoin extensive community developments, heavy flooding may cause severe property damage and disruption of community activities but, if a good warning service exists, loss of life may be low.

Storm-surge damage

A storm surge is the piling up of sea-water as a tropical cyclone reaches the coast. The effects are most pronounced in a wide and shallow bay, such as the northern part of the Bay of Bengal. Some of the world's greatest human disasters are directly attributable to storm surges.

A damage survey related to the storm-surge factor must take into account the values of the relevant meteorological elements, the topography of the sea bed and coastline and the state of the tides. Unless these data together with measurements of the height of storm surges are available the damage survey will not provide a reliable basis for designing embankments, shelters and other protective measures.

Wave damage

Marine installations and water-front buildings may suffer severe damage not only from storm surge but also from heavy wave action and from wind-blown sea spray Breaching of sea walls and harbour installations, the undermining of foundations due to wave erosion, wave damage to small craft at anchor or to shipping and its cargo at sea may constitute a substantial part of the total damage.

Some economic and social consequences

The factors discussed above – damage from wind, rain, flood, storm surge and sea waves – may be regarded as representing the direct impact of tropical cyclones upon a country. The losses and damage attributable to these factors can be assessed in terms of deaths and injuries to the population, buildings and installations destroyed or in need of repair, destruction of crops and livestock, and so on However, there are additional, perhaps indirect, consequences

which cause losses to individuals or to industry or to a community or to the whole nation. The magnitude of these effects can be very large and they should not be ignored in a survey of disaster damage. Some of these aspects are discussed briefly below.

Losses in productivity

A tropical cyclone can lead to disruptions to the work force and to other activities and result in substantial losses in productivity. Factories and warehouses may be out of commission for varying periods and many man-hours may also be lost because of breakdowns in land, sea and air traffic, which would impede the movement of people and supplies, and because of diversion of labour to disaster relief and restoration. In agriculture there can be large losses in primary production on account of delays in the recovery of arable land that has been inundated.

Personal and domestic losses

A tropical cyclone can cause many losses of a personal and domestic nature. Information on the detail and extent of these losses should be collected since they concern items which are important to the state of morale of the people. The loss of personal belongings, such as clothing and furniture, can be a specially severe blow to families whose financial reserves are small. In the domestic area, breakdowns in public utilities can lead to important losses. For example, an electricity failure which puts refrigerators out of action might result in the loss of perishable food. All these losses, great in some homes, small in others, when aggregated can amount to a substantial financial penalty to a whole community.

The vulnerability of a community

The data collected in a damage survey should enable an assessment to be made of the degree of independence of various communities. As a guide in planning and as an indication of where emergency action may be required on a future visitation by a tropical cyclone, estimates should be made of the degree and nature of the help that must be provided from external sources and of the likely period of such dependence. These estimates should be prepared in accordance with the guidance given by UNDRO in connexion with its world survey of disaster damage.

Organization of damage assessment

It would obviously be best for a survey of damage to be conducted by standard procedures for data collection so that comparison between one town and another or between one region and another can be made in a realistic fashion. In the case of meteorological, hydrological and related technical data, the acquisition, collection and analysis of data are carried out in accordance with procedures agreed internationally and are therefore already well co-ordinated and standardized. In the case of other quantities, notably material losses, the data could lose much of their value unless steps are taken for systematic procedures to be brought into general use. The nature of the data to be collected in a damage survey, with a broad indication of the detail required, is set out in the appendix to this chapter.

A Damage Assessment Agency

In considering the machinery for carrying out a survey of damage, countries might consider expanding their statistical organization or might, preferably, consider the establishment of a Damage Assessment Agency within the department or ministry which bears the primary responsibility for disaster prevention and preparedness. The agency would be a central one at the national level but it would have links to regional and local levels. It would provide general guidance and detailed instructions on how damage surveys should be carried out, would provide training in the methods to be adopted and, after each tropical cyclone incident, would exercise direct responsibility for the surveys to be undertaken in the different areas of the country. The agency would issue an annual report, which would contain tables of statistics as well as textual material.

The agency should be consulted on all new developments in the country, for example, by town planning authorities. In this connexion it is noteworthy that in many countries affected by tropical cyclones the urban population is increasing more rapidly than the rural population. In these countries the growth and development of urban areas take place at the expense of paddy fields and of unsettled land in the flood plains which have served as inundation areas in times of tropical cyclone visitations. Thus, in flood-prone areas, increasing urbanization, accompanied by population growth and by property and industrial development, leads to an increase in the damage potential. This aspect is extremely important and, in due course, the agency would be able to give reliable estimates of the penalties to be faced as urbanization continues. Such advice would not necessarily cause urban development to be stopped but would help to indicate the additional protection that must be provided if disaster is to be avoided.

Flood plains are not the only areas where development leads to an increase in potential hazard. Human settlements also tend to encroach upon hilly or fairly mountainous areas and, when this begins to occur, consideration should be given to the probability of rainfall of very high intensity, which might well occur in a tropical cyclone and might lead to flash floods and landslides. The agency, once it has built up a bank of statistical data, would be able to give extremely valuable advice on such aspects as these.

APPENDIX

ASSESSMENT OF DAMAGE CAUSED BY TROPICAL CYCLONES

Illustrative outline scheme for damage survey

1. *Objectives*

   (*a*) To collect accurate data concerning the various aspects of the losses and damage caused by a tropical cyclone.

   (*b*) To classify the losses and damage into the different causes, e g wind, rain, flood and storm surge.

   (*c*) To classify the losses and damage by administration units, e.g. regions, towns, villages.

   (*d*) To express damage and associated aspects in financial terms.

   (*e*) By comparison with data and analyses referring to earlier tropical cyclones, to evaluate the measures taken for disaster prevention and preparedness and to assess the further measures required.

2 *Categories of losses and damage*

   (*a*) Wind

   (*b*) Rain (in areas where floods and storm surges did not occur)

   (*c*) Flooding.

   (*d*) Storm surge.

   (*e*) Waves (at sea and along coasts).

3. *Main factors in above categories*

   – e.g. in the case of floods, one or more of: rivers overflowing, landslides, fracture of river walls, failure of dams, etc.

4. *Elements of survey*

   (*a*) Human casualties – deaths, missing, seriously injured, injured, etc.

   (*b*) Areas affected (hectares) – agricultural land, residential areas, etc.

   (*c*) Houses, buildings.

   (*d*) Domestic property, personal possessions.

   (*e*) Crops and livestock.

   (*f*) Public works, buildings, installations – includes rivers, dams, bridges, drainage facilities, water supply, roads, etc.

   (*g*) Transport, communication and power facilities.

5. *Financial estimates* based on current costs of damage in categories (*b*) to (*f*) of section 4 above.

6. *Allocation of responsibilities* for conduct of survey and inter-departmental co-operation.

7. *Organization of survey*

8. *Collection of data, analyses and preparation of reports*

(*Note*. It is emphasized that the above is, at best, an outline giving a broad guide to the requirements for a damage survey. Considerably more detail, including diagrams and maps, would be involved in the instructions for the conduct of the survey. These details and supporting aspects would largely be an expansion of the above sections together with additional sections to meet particular, e g national, requirements.)

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(*Note* It would not be practicable to provide a comprehensive bibliography on all matters within the scope of this publication. However, the encouragement of further reading must be one of the objectives of a publication of this general nature The following list is therefore designed to help those who wish to study in greater depth one or more of the major topics involved in tropical cyclone disasters Most of the publications mentioned in the list contain an appropriate bibliography.)

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