CHAPTER V

CONCLUSIONS

The total spectrum of disaster prevention, mitigation and preparedness is very wide and has numerous inter-related facets. In some portions of the spectrum one or more branches of meteorology are involved. This involvement is in some instances fairly simple and direct, the meteorologist using observational systems and basic data for the preparation of forecasts, warnings and climatological summaries and reports. In other cases, the meteorologist is part of a team participating in joint planning studies with town planners, architects, engineers, economists and others. Such studies are concerned with issues of regional and urban development, agriculture, various forms of industrial activity and other questions.

In all these activities the meteorologist is anxious to make the best possible contribution in the field of natural disasters. He needs to have an improved and more extensive range of basic data and also to have research intensified so that forecasting, warning and climatological studies may be more accurate and valuable. In multi-disciplinary problems he would like his contribution to be comprehensive and effective.

5.1 REQUIREMENTS FOR MORE DATA AND RESEARCH

National meteorological services, separately and in their world-wide integration under the World Meteorological Organisation, are constantly endeavouring to improve the quality and accuracy of the meteorological information which is provided to a wide range of users, including aviation, agriculture,

shipping, industry, commerce and the general public. The development of meteorological services began more than 100 years ago with the primary objective of ensuring that shipping received adequate warning of stormy weather over the oceans. It is in accordance with this tradition that meteorological services continue to give special attention to meteorological phenomena which threaten life and property. Among such phenomena, tropical cyclones must be given a prominent place. Meteorological services are therefore maintaining their intensive efforts of recent decades to extend their knowledge of all aspects of tropical cyclones and to improve the accuracy and timeliness of forecasts and warnings.

The forecasting of meteorological parameters — pressure, temperature, wind, rain, etc. — is firmly based upon the acquisition of basic data. Almost without exception, a meteorologist would not forecast the value of an atmospheric variable without a set of relevant data that would justify, scientifically and technically, making such a forecast. For example, forecasts of winds in the upper atmosphere are provided for aviation upon the analysis of data provided by networks of upper air stations which measure the winds up to a height of about 30 km every day or twice a day. A property of the atmosphere, such as fog, can be forecast because the way in which temperature, humidity and wind combine to produce fog is well understood and these variables are repeatedly measured.

The path of progress, therefore, for meteorology generally and for tropical cyclone forecasting in particular is to increase the quantity and quality of meteorological data and, by intensive research, to improve existing forecasting techniques, develop new techniques and extend the range of accurate and reliable forecasts.

5.1.1 Data Requirements

Various methods are in use for acquiring meteorological data. Apart from ground-based stations with their extensive range of equipment, there are special installations using weather radars; merchant ships are equipped with instruments to make weather reports which are sent to shore stations by radio, and there are the latest devices, i.e., the polar-orbiting and geostationary satellites.

For many areas of the world, notably the oceans and uninhabited desert and polar regions, the satellite is the principal source of specific information about conditions in the atmosphere. For information about tropical cyclones, especially in their early lifetime over the open seas, satellite observations are of supreme importance. Satellite information is already of high quality and is improving, but efforts need to be concentrated on providing more precise data about the position and intensity of a tropical cyclone as it approaches a critical area such as a coastline.

The development of meteorological satellites is continuing and each new system provides more comprehensive data of improved quality, thus offering the prospect that some important gaps in available data may be alleviated in the near future. In order to exploit geostationary satellites fully, some important problems of ground-based interception facilities remain to be solved and are being urgently studied by the World Meteorological Organisation. Individual countries may not, on their own, be able to afford the costly installation required to receive all the data obtainable from a geostationary satellite. Jointly-financed regional stations

with communication links to neighbouring meteorological centres promise to be the most practical and economical system. It is earnestly to be hoped that problems of funding will be overcome since the information is far too valuable to countries vulnerable to tropical cyclones for it to be dispensed with.

Weather radar is already a highly efficient instrument for the detection of rain and cloud systems but it should be brought into greater use in tropical cyclone areas. A chain of radars along the coastline could provide data for a large area and, by regional agreement, there could be valuable exchanges of data among several countries.

5.1.2 Research Requirements

The following are included among the problems needing stronger research efforts :

(i) forecasts of tropical cyclone movement and of changes in intensity;

(ii) storm surges, especially in circumstances when the effects are most pronounced, e.g. in semi-enclosed bays and other sharply-curved sections of a coastline;

(iii) quantitative forecasts of precipitation and other aspects of hydro-meteorology with a bearing on river floods.

Forecasting the movement of a tropical cyclone is the most important problem and should be accorded appropriate priority. The reason is that all other tropical cyclone forecasts are

dependent on an accurate prediction of the path of the storm. Forecasts of the height of a storm surge and which portion of the coast will be affected and forecasts of rainfall amount are made with regard to the position of the centre of the tropical cyclone. These and other forecasts may be dangerously in error if the forecast of the movement of the tropical cyclone is inaccurate.

The smaller circulations in the atmosphere, like those of a tropical cyclone, are to a great extent controlled by the meanderings and fluctuations of the long waves of the general circulation. More accurate prediction of these long waves, which is one of the objectives of the WMO/ICSU 14/ Global Atmosphere Research Programme, would clearly be of great value in tropical cyclone forecasting.

Storm surge prediction techniques are for the most part based on simple empirical formulae because the available data are quite inadequate for anything more refined. The development of numerical techniques for computer application is similarly handicapped. To assist research work the additional data required includes not only meteorological parameters but also accurate maps of the topography of the ocean floor within about 300 km of the coast and research into the influence of the sea bed. Studies are also required to enable the effects of bays and other coastal inlets to be incorporated into theoretical storm surge models.

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Quantitative prediction of rainfall is a difficult problem but one that might respond to additional data from denser raingauge networks and to further research in the use of radar to measure and integrate rates of rainfall over an area. The use of radar in this manner is still largely in a research stage and requires teams of highly-qualified experimental physicists.

5.2 TRAINING

In recent years some remarkable advances have been made in meteorology, and it is essential that full information about them should be made widely available to professional meteorologists. The seminars and symposia organised by WMO serve a very valuable purpose and especially so when courses are conducted in tropical cyclone areas where so many developing countries are located. There are two main training requirements, namely, to give instruction in the interpretation and application of new forms of data, such as satellite data, and to ensure that the fruits of research in the form of improved and new forecasting techniques can be understood and applied in appropriate conditions.

5.3 DAMAGE SURVEYS

After a disaster, or an incident which might have amounted to a disaster, it would be normal practice for a review to be undertaken of all aspects of the programmes for disaster prevention and preparedness. Such reviews, which would include the assembly of all kinds of data, qualitative as well as quantitiative, can be of

the greatest value in suggesting improvements to existing elements of disaster prevention and preparedness and in identifying the need for new measures.

The surveys of damage that are made after an occurrence of meteorological origin can highlight useful lessons for the meteorologist and perhaps improve co-operation with the authorities involved in the emergency operations. These surveys can have obvious advantages in such matters as reviewing hazard potentials and in establishing zoning criteria, but they might also indicate some aspects for which special forecasts would be of service and some areas in the disaster field for which research in applied meteorology is required.

5.4 GENERAL ASPECTS

Measures for both disaster prevention and disaster preparedness should be based on detailed studies and, when appropriate, should preferably be incorporated in the normal development planning procedures. If planning and implementation are to be effective, the large number of interests involved — administrators, financiers, engineers, architects, scientists and others — should be well versed not only in the subjects on which they provide specialist material but also in a much wider context so that they will appreciate the implications of their own contribution, notably its impact on other facets of each project.

In the fields of geophysics and the earth sciences considerable effort is being devoted to the various phenomena which can cause natural disasters. Valuable results are emerging from programmes of investigation and research which are being conducted at national scientific establishments and universities throughout the world. However, there appears at present to be an important gap between research into natural hazards and the application of the results to development planning in disaster-prone countries. If this gap could be closed, for example, by vulnerability analysis and other projects of applied research, there would be obvious benefits to planning for disaster prevention and preparedness and, in addition, research workers would be greatly aided in identifying problems of major practical importance. A sector in which a great deal of work remains to be done is composite vulnerability analysis which, as the Office of the United Nations Disaster Relief Co-ordinator (UNDRO) has constantly stressed, should be a fundamental component of long-range development planning.

Meteorologists would wish to participate in all appropriate ways in joint studies undertaken in the preparatory stages leading to decisions on policies and programmes for disaster prevention and preparedness. Apart from purely scientific and technical investigation, there are aspects where the meteorological community in a country could help in promoting the government's objectives in the struggle against natural disasters. Some examples, covering scientific and other questions, are summarized below:

(a) Research into wide-ranging problems concerned with natural disasters would be multi-disciplinary, involving planners, engineers, economists and others, as well as meteorologists and other scientists and technologists;

(b) Meteorologists should take part in all programmes for educating and training adults and school children in the dangers from natural disasters and in the action to be taken to safeguard life and property;

(c) Any natural disaster should be followed by surveys of the losses and damage incurred. By taking part in such surveys, meteorologists would have much to contribute and much to learn.

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