Forecasting Natural Disasters to Mitigate their Effects

by

Professor Godwin O. P. Obasi

Secretary-General

World Meteorological Organization

1. INTRODUCTION

As announced, one of the purposes of this conference is "to examine ways to reduce the institutional vulnerability of Member nations" in respect of natural disasters. In this context, it is envisaged that the Conference will consider possible actions that the Inter-American Development Bank (IADB) had proposed to undertake in Member countries. These actions include:

(i) Defining an effective strategy to reduce long-term and recurrent risk;

(ii) Strengthening capacity to implement the strategy;

(iii) Building national systems for disaster prevention and mitigation; and,

(iv) Enhancing inter-agency coordination.

The formulation and implementation of the proposed actions by the Bank, especially in respect of (iii), require the establishment and operation of internationally coordinated national and regional systems for monitoring and forecasting natural disasters. Such systems represent a cost-effective way to reduce vulnerability. In this respect, whilst dealing mainly with natural disasters of hydrometeorological origin, WMO is also engaged in promoting:

(a) The development of integrated systems of disaster management, which include hydrometeorological aspects of disaster preparedness, warning, relief and rehabilitation; and

(b) Scientific studies including comprehensive risk assessment.

It is in this spirit that the partnership of WMO with the IADB, to support the Member countries in Latin America and the Caribbean is being developed.

Forecasting is an indispensable component of preparedness and response phases of natural disaster reduction. In the i.e., preparedness phase (*pre-disaster activities intended to increase the effectiveness of emergency response during a disaster*) forecasts and warnings, if reliable and provided with sufficient advance notice, can obviously play a key role in saving human life and/or reducing property damage. In the response phase i.e., (*activities undertaken immediately prior to and during the impact or the acute phase of an event*) updated forecasts are equally, if not, more important.

In this presentation, the status of the science and operational systems for hydrometeorological disaster forecasting will be summarized, particularly as regards the forecasting of the most frequent and devastating forms of disasters to hit Latin American and Caribbean countries, namely: tropical storms (including hurricanes), tornadoes, floods and droughts. In this respect, special emphasis will be placed on the activities of the national Meteorological and Hydrological Services (NMHSs), which should constitute a critically important part of any national disaster prevention and mitigation system as envisaged by the IADB.

2. HYDROMETEOROLOGICAL DISASTERS: SOME FACTS

Globally, over 70 per cent of natural disasters are related to weather and climate, but in some countries or regions, the disasters of hydrometeorological origin account for the totality of

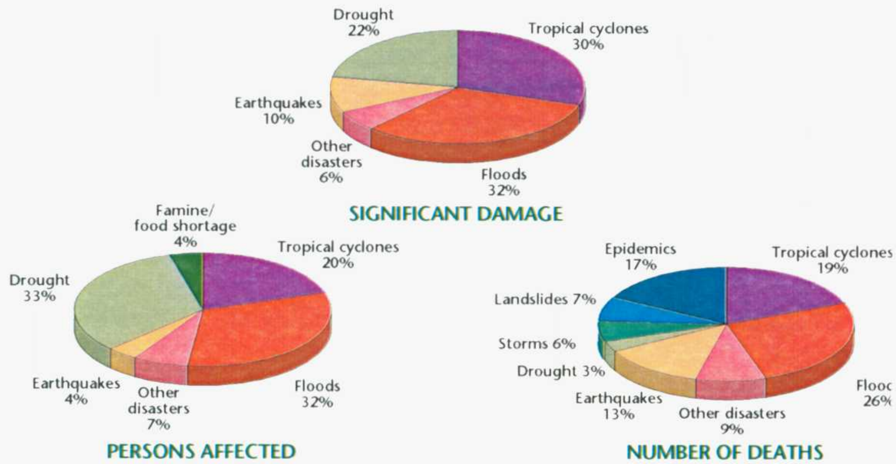

Figure 1 — Major disasters around the world: 1963–1992

natural disasters. As can be seen from Figure 1, during the period 1963-1992 tropical cyclones, floods, landslides and droughts account for more than 50 per cent of fatalities, 80 per cent of persons affected by natural disasters, and over 80 per cent of those disasters responsible for significant damage.

According to the Munich Reinsurance Company (IDNDR, 1999), in only one year (1998), over 14 000 deaths in the Americas were caused by 112 storms and 38 floods, and economic losses resulting from these events exceeded US$ 35 billion. The 1998 Atlantic hurricane season, more active than normal, brought 14 tropical storms (the average number is 10), of which 10 became hurricanes (with wind speed more than 119 km per hour), including three major hurricanes (with wind speeds of more than 178 km per hour). They inflicted US$ 7.3 billion in damages and caused 23 fatalities in the United States alone (US Department of Commerce, 1999). Among the most devastating hurricanes of all times were Hurricanes *Georges* (September 1998) and *Mitch* (October 1998). Hurricane *Mitch* alone led to about 9 000 deaths in Nicaragua and Honduras and seriously affected their development plans. In Guatemala, El Salvador and Costa Rica, the impact was less devastating, but nevertheless very significant.

The last Atlantic hurricane season, which closed on 30 November 1999 was marked by an above average number of tropical storms (12), five of which became major hurricanes. Among these, hurricanes Floyd (September 1999) and Irene (October 1999) caused widespread and severe flooding.

Large areas of the Americas are prone to extremely heavy rainfall and associated landslides. Table 1 highlights the regional and global impacts of the strong 1997–1998 El Niño event. For example, in December 1997 and January 1998, that is during the 1997-1998 El Niño, the coasts of Ecuador and northern Peru received 350-775 mm of rain, compared to the normal 20-60 mm. Torrential rains were recorded in southern Brazil, south-eastern Paraguay, most of Uruguay, and parts of north-eastern Argentina (UNEP, 1999). Devastating floods and mudslides in the Caracas area in Venezuela caused over 20 000 deaths in December 1999.

In addition the impacts of droughts, including those in central USA, northern Mexico, northeast Brazil and Guyana, as well as large-scale forest fires in Colombia, Brazil, Central America and Mexico should be mentioned.

Table 1

Global and regional impacts of the 1997-1998 El Niño event (NOAA/OGP 1998)

Region	*Direct loss US$ (in millions)*	*Mortality*	*Morbidity*	*Affected*	*Displaced*
AFRICA	118 m	15 246	107 301	10 400 000	2 217 200
ASIA	3 220 m	6 018	124 647	33 719 719	318 700
ASIA PACIFIC	5 331 m	1 317	57 546	66 113 666	90 000
NORTH AMERICA	6 462 m	542	Incomplete	41 100	400 000
SOUTH AMERICA	18 068 m	997	243 743	723 033	363 000
TOTAL	33 199 m	24 120	533 237	110 997 518	3 388900

Overall, the frequency and impacts of natural disasters are estimated to be increasing. Losses from natural disasters over the decade 1986–1995 were eight times higher than in the 1960s; and unless major efforts are deployed to counteract the impact of such disasters, this tendency will most probably continue. Within these efforts, forecasting of the occurrence, intensity, time and space scales of hydrometeorological disasters should be given priority attention.

3. SCIENCE AND TECHNOLOGY OF DISASTER FORECASTING

The impacts of natural disasters related to meteorological and hydrological phenomena can be regional or even global in scope. The spatial and temporal scales of these disasters vary widely from short-lived, violent phenomena of limited extent, including tornadoes, flash floods and severe thunderstorms, through to large systems, such as tropical and extratropical cyclones with life cycles of several days. At the largest scale are widespread droughts, which may affect large areas for months to years. Forecasting of these phenomena therefore requires techniques applicable to very short-term forecasts, for example, for less than one hour for tornadoes, and even nowcasts, to those for seasonal and inter-annual time scales for droughts and major floods which may be associated with the El Niño phenomenon.

The establishment of major weather forecasting centres and the systematic monitoring of the atmosphere and, to a certain extent the oceans, have enabled national Meteorological and Hydrological Services (NMHSs) to provide information related to the threat of weather- and climate-induced disasters such as hurricanes, floods, droughts, severe storms, forest fires, frosts, heat waves and cold spells (Obasi, 2000). In the United States, for example, improved forecasts of hurricanes with effective dissemination and wider awareness and preparedness have led to significant reductions of loss of life (Figure 2).

The prediction of small or meso-scale meteorological/hydrological events such as tornadoes, severe thunderstorms, squalls and flash floods requires the early detection of precursors. Forecast techniques are based on continuously updated observational information

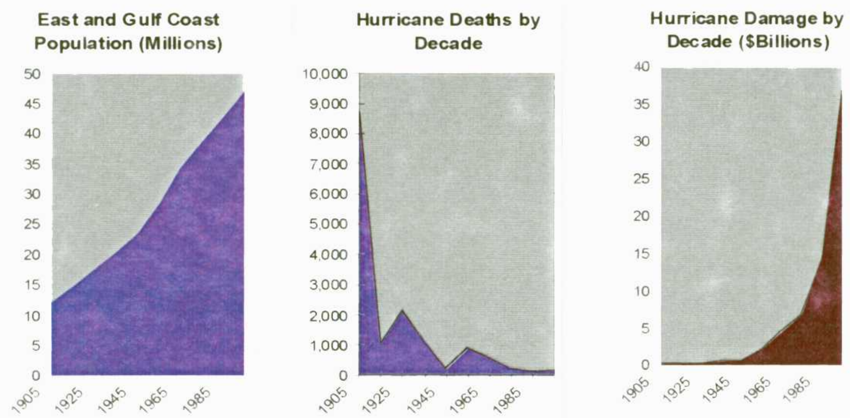

Figure 2 — Trends of Coastal Population versus Hurricane Deaths and Damage (1900-1996)

on storm movement, rainfall intensity, and/or river stage from real-time observations from satellites, radars, stream gauges, automatic weather stations and observers. The greatest difficulty in providing effective warnings of these small-scale events is the usually very short lead-time available to warn the public. The establishment of a comprehensive system for the issuance of forecasts and warnings, which comprises observing and data collection systems, visualization, analysis and modelling tools and adequate telecommunication networks, is therefore absolutely essential.

Forecasts of the behaviour of larger, synoptic scale weather systems such as tropical storms and extratropical cyclones are now made available several days in advance. Prediction of these systems and of the associated phenomena is made using numerical computer models. Weather forecasts of up to eight days in advance can now be provided for the middle latitudes countries. As regards hurricanes, scientific and technological advances (satellites, reconnaissance aircraft, modern computer systems and sophisticated numerical models) make it possible to detect most hurricanes at an early stage of formation, to monitor them throughout their life cycle and to provide forecasts of their tracks and intensity. The accuracy of forecasts and hence the reliability and timeliness of warnings has been steadily improving (Figure 3).

Flood forecasting models have only recently been developed and used on a routine basis. Many existing hydrological models must be adjusted in real time as information arrives at the forecasting centre. Progress has been made in the development of methodologies for flood and even flash flood forecasting and nowcasting, especially using new tools such as the Geographic Information System (GIS).

Drought prediction requires, among others, monitoring the patterns of monthly and seasonal rainfall, reservoir and ground water levels, soil moisture and snow cover. Progress in developing predictive skill for large geographical regions on seasonal time scales makes it possible to provide increasingly useful forecasts of the onset, severity and duration of drought.

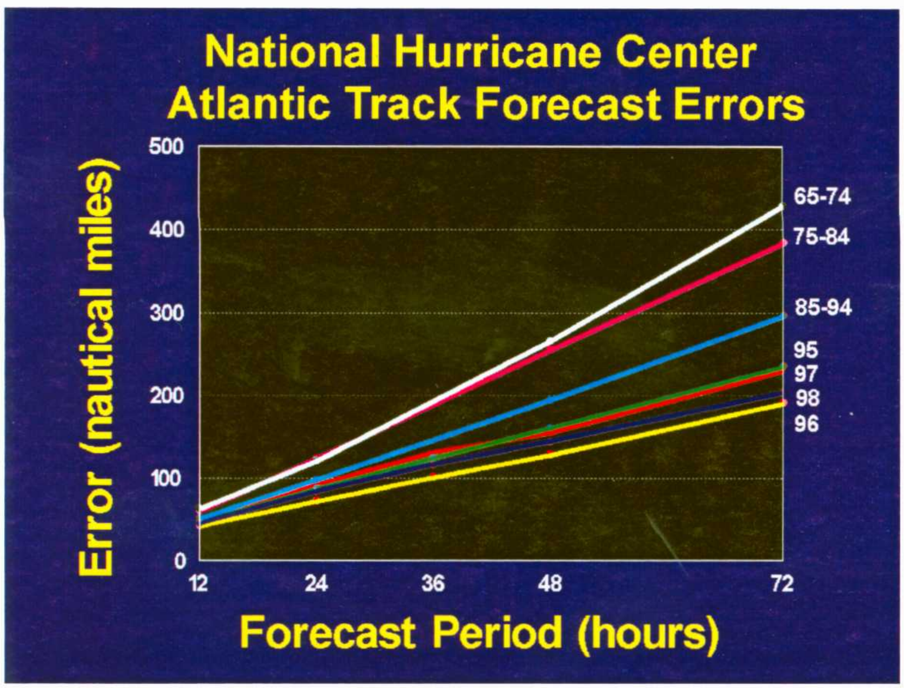

Figure 3 — Forecast Accuracy. The lines give the error in the track forecast of Atlantic hurricanes for various forecast periods over the years from 1965 to 1998

Further progress in the provision of useful natural disaster forecasting services is based on three main pillars:

- Maintenance and enhancement of observational network and data collection systems;
- Further technological advances in data processing and dissemination; and
- Continuing development of methodologies, including advanced weather and climate models.

Bearing this in mind, WMO promotes and implements a number of major international programmes and projects to coordinate and stimulate national, regional and international actions in these domains.

3.1 Observation and Data Collection Networks

Observational data requirements for natural disaster forecasting are provided by meteorological and hydrological observing systems, primarily in the context of WMO's World Weather Watch (WWW) (Figure 4) and its Hydrology and Water Resources Programmes (HWRP). The establishment of the operational World Weather Watch in 1963 was instrumental in the development of the present worldwide network of about 10 000 surface stations, 700 ocean buoys, 7 300 ships and 1 000 upper air stations, complemented by some 75 000 observations daily from commercial aircrafts, and a constellation of nine geostationary and polar-orbiting meteorological satellites.

The hydrological data collected by NMHSs, for use in flood and drought forecasting, is complemented by the World Hydrological Cycle Observing System (WHYCOS) (Figure 5) whose regional components including the CARIB-HYCOS is being developed by WMO in cooperation with countries of the Caribbean Basin. CARIB-HYCOS will enhance the ability of these countries to assess their freshwater resources, and provide valuable data useful for mitigating flood-related disasters and for better understanding of the impacts of El Niño on the hydrological regime of the region.

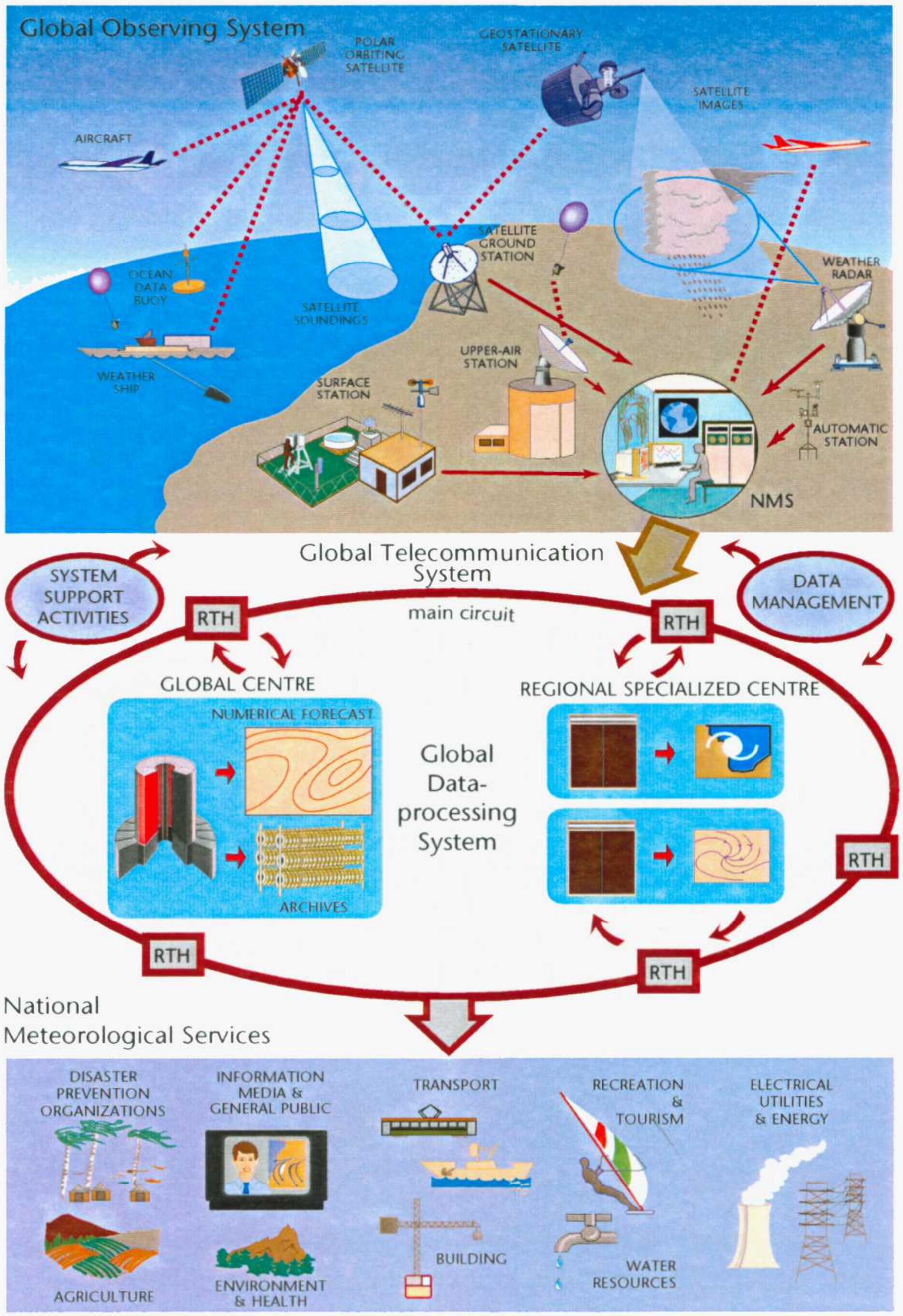

Figure 4 — World Weather Watch