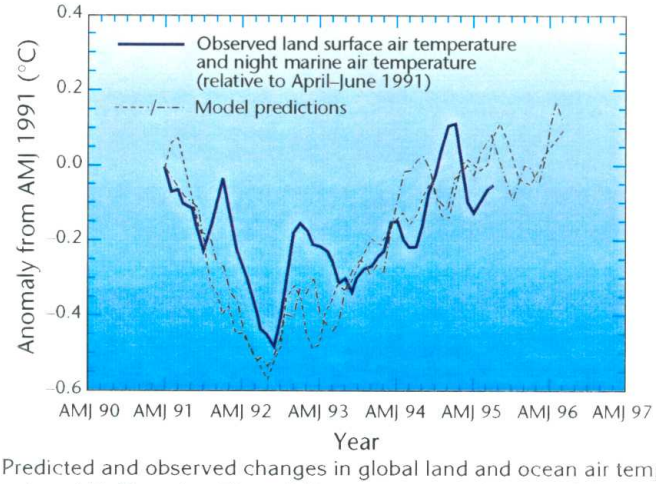

Figure 9 — Predicted and observed changes in global land and ocean air temperature after the eruption of Mt Pinatubo. The solid line represents changes of three-month running mean temperature (April to June 1991 until March to May 1995). The two model lines represent predictions starting from different atmospheric conditions. (*Source*: IPCC, 1995*a*)

conditions or anomalies, and also at taking advantage of any positive impacts (Obasi, 1999). For a number of years, El Niño predictions have been used by several countries in the region and elsewhere to provide early warnings and in disaster preparedness. The following cases are just a few examples:

4.1 The Case of Peru

Figure 10 indicates how El Niño information has been used for sustainable agricultural production in Peru through the alternation of crops during dry years; for example, the alteration between rice and cotton.

4.2 The Case of Brazil

Figure 11 highlights two El Niño cases of 1987 and 1992 where the rainfall deficits were almost the same. Enhanced agricultural production is obtained when El Niño information was used in making specific agriculture-related decisions in 1992 compared to 1987.

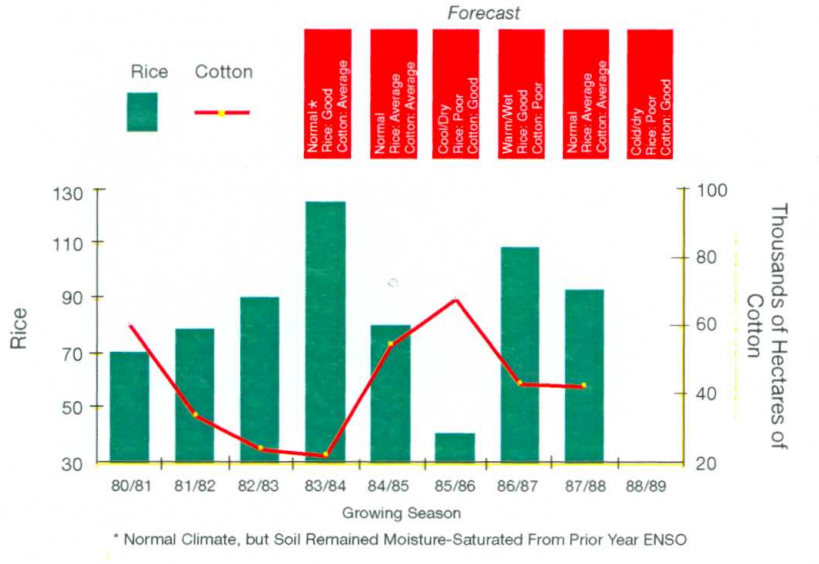

Figure 10. Agricultural area sown in northern coastal region in Peru.
(Source: NOAA)

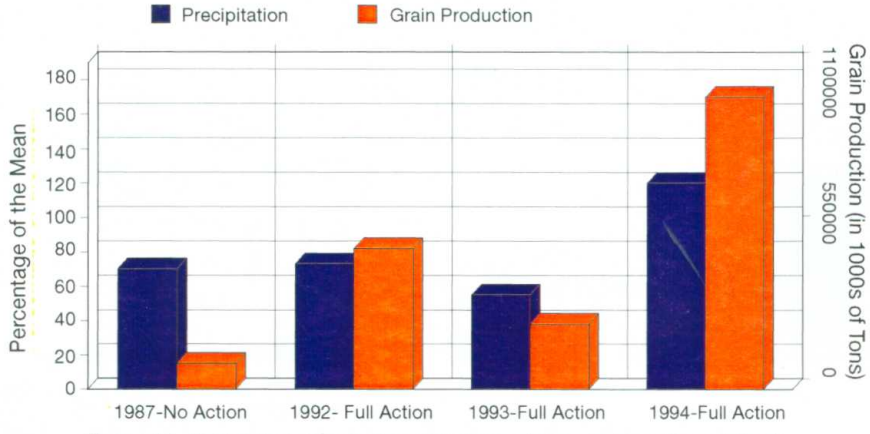

Figure 11. Applications of experimental climate forecasts in north-east Brazil.
(Source: NOAA)

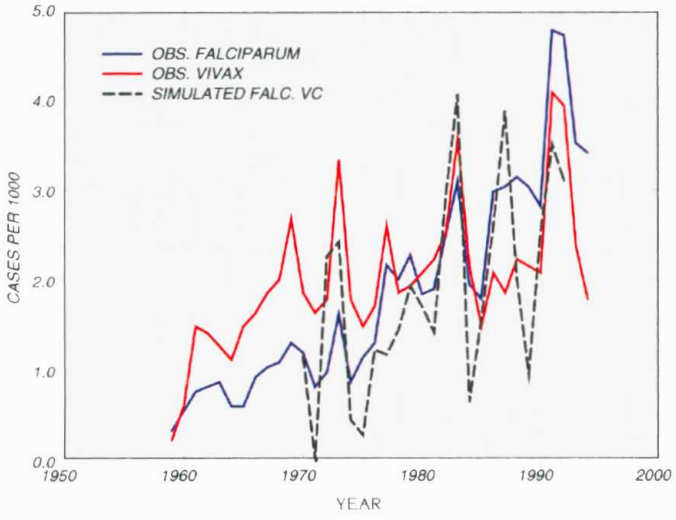

Figure 12. Malaria in Colombia.
(Source: Graham and Poveda)

4.3 The Case of Colombia: El Niño and Malaria Epidemic

Too much or too little rainfall, which are common in some regions during the warm and cold El Niño phases, have been associated with various vector borne and food-related diseases. Similar observations have also been made in other parts of the region and many parts of the tropics. Figure 12 shows the linkages between El Niño and malaria cases in Colombia.

5. DISASTER MITIGATION AND MANAGEMENT POLICIES

The provision of timely warnings and forecasts to the public in safety of life and protection of property is one of the primary roles of all national Meteorological and Hydrological Services (NMHSs). The achievement of optimal results from the forecasts for preparedness and response to natural disasters therefore requires effective coordination and cooperation between NMHSs, the responsible agencies and institutions, the media, political leaders and civil society at local, national and international levels. Timely and effective forecasts and warnings of natural disasters coupled with local capability to take mitigating actions are fundamental for effective disaster reduction.

The NMHSs, in coordination with other national and international organizations concerned, have to be involved in virtually all the activities concerning natural disaster reduction, in particular, risk assessment, detection of disasters causing events, interaction with decision makers and other users, including civil society, as well as participation in public awareness campaigns. This involvement should constitute a framework within which the forecasting and warning capabilities of the NMHSs could be assessed and recommendations made for improvement.

In the area of risk assessment, the NMHSs should provide observational data and statistics required for identifying disaster potential, in particular the intensity and probability of occurrences, and also contribute to planning measures, including early warning, in order to minimize risk.

Detection systems, many of which are managed by NMHSs (for example, the detection and tracking of tropical storms by the National Hurricane Center in Miami), are intimately connected with preparedness systems, providing continuous updating of forecasts and warnings.

An effective and interactive system to communicate with users is a vital component of any forecasting activity. Officials and the public must receive information in a timely manner and be able to interpret it correctly. If the predictive capabilities are to be used to maximum advantage, a clearer understanding by all involved in relevant aspects from prediction to application is needed to enable forecasters and users to work together as a team. An effective forecast system requires that the target population understand the content of the message and knows how to react to it. This implies that well-designed forecast and warning systems must include an ongoing public awareness component on potential risks. This will call for the dissemination of information to be carefully coordinated to ensure timeliness and accuracy. While dissemination systems are generally well developed and fairly resilient in developed countries, this is not always the case in many developing nations.

A high level of coordination must therefore exist between the organizations responsible for the detection of, and response to, the phenomenon caused by natural disasters. Of particular importance is the coordination of the issuance of forecasts and warnings. In many countries, the NMHSs have been designated as the *authoritative voice* for this purpose. WMO fully supports and promotes such arrangements which have proved to be effective. NMHSs must be actively involved in inter-agency disaster planning at national and regional levels to ensure a regular flow of reliable information to the public, political leaders, responsible officials and civil society. Coordination with the media must be given a particularly high priority, as it is a vital element in the dissemination of forecasts and warnings.

To assist NMHSs in improving coordination and interaction at the national level, WMO has developed *guidelines on best practices* regarding the relationships between NMHSs and the organizations involved in emergency management. The guidelines recommend, amongst others, the organization of seminars for disaster managers and decision makers, the participation of NMHSs in emergency-related bodies and in preparedness and prevention campaigns, joint missions of forecasters and emergency officers, and the publication of educational material on hydrometeorological aspects of natural disaster management.

In the light of the above considerations, the following are essential for forecasting systems to be effective:

- Access through reliable communications to the data from local, national, regional and global observation networks;
- State-of-the-art predictive capability at national level and, as necessary, guidance and information from specialized regional and global centres;
- Effective local and national dissemination systems capable of alerting threatened populations as frequently as may be appropriate;
- Awareness of the population and local and national authorities, regarding the content and meaning of forecasts and warning messages and how they should react to them; and

- Coordination among all national, and as appropriate regional, agencies involved in disaster reduction, in both the planning and operation phases.

Whilst these requirements are generally satisfied in developed countries, forecasting services in developing countries often experience a lack of resources for acquiring adequate facilities and for human resources development. It is therefore of utmost importance that international agencies, including WMO, provide the maximum possible assistance to those countries concerned to enable them to participate in regional and global efforts aimed at mitigating natural disasters and contributing to national sustainable development.

6. IADB AND WMO COOPERATION

In the area of natural disaster reduction, WMO undertook a number of actions, particularly following its Action Plan on the IDNDR, to assist its Members in the Americas to improve their forecasting and warning services. Some of these actions have been undertaken jointly and with the support of the IADB, and include:

(a) The Ibero-American Climate Project Feasibility Study which was funded by the IADB, Spain, USA, Canada and WMO, and carried out between 1997 and 1999. This study provided feasibility projects to 13 countries in Latin America. The implementation of the project will allow NMHSs of participating countries to provide meteorological and hydrological forecasts to users in order to enable them to prevent and mitigate the impact of natural disasters, as well as make better use of natural resources.

(b) The "Conference on Water Resources Assessment and Management Strategies in Latin America and the Caribbean" which was convened by IADB and WMO in 1996. The main outcome was an action plan which, among its main concerns, included the mitigation of natural disasters. The plan called for the implementation of national and regional studies of hazards of hydrometeorological origin, making it possible to create

early warning systems and disseminate information on disasters;

(c) The Study on the Prediction and Amelioration of Socio-economic Impacts of El Niño Southern Oscillation (ENSO) in Latin America and the Caribbean (LAC) which was initiated by WMO and IADB in September 1999. The Study will respond to the request expressed by the LAC countries through the Guayaquil Declaration (November 1998) and to the long-term objectives of the UN Resolution 52/200 on "International Cooperation to Reduce the Impact of the El Niño Phenomenon"; in the context of the ENSO Study, the development of early warning systems, including forecast components, will be analysed in selected countries and sub-regions from the technical, economical, social, environmental, legal and institutional points of view. The Study therefore includes evaluation of the existing institutional and technical forecasting capabilities in Latin American and Caribbean countries, as well as the formulation of project proposals and the analysis of the economic value of improved early warning systems; and

(d) The project "Support to Natural Disaster Prevention and Water Resources Management" based on the modernization of the NMHSs affected by Hurricane Mitch, which was prepared by WMO in collaboration with the NMHSs of the four affected countries, namely, Honduras, Nicaragua, Guatemala and El Salvador. Similar proposals are being formulated for the other Central American countries.

7. OTHER INTERNATIONAL COLLABORATIVE EFFORTS

In addition to the above, WMO is also involved in several other projects in the region.

The Project entitled "Radar Network Warning System for the Protection and Sustainable Development of the Caribbean Countries" is funded by the European Union. It will provide an advanced weather warning system, and relevant data to weather sensitive sectors in the countries covered by the radars.

Other project proposals under consideration include a Flash Flood Threshold Pilot project which would cover certain areas in Central and South America and would assess the ability of modern remote-sensing and computer technology to provide warnings of flash floods in areas with scarce data; a tropical cyclone landfall project and another on urban flooding and environment in Sao Paulo, Brazil are planned under WMO's World Weather Research Programme.

A Memorandum of Understanding signed a few months ago by the World Bank and WMO will further contribute to developing synergies between relevant programmes of the Bank and those of WMO in areas of common interest, such as natural disaster prevention and mitigation, climate change, and the El Niño event.

In this context, the proposal for the establishment of the El Niño Centre in Guayaquil, Ecuador, should be highlighted as a follow-up to the UN General Assembly Resolution 54/220 on International Cooperation to Reduce the impact of El Niño phenomenon.

Furthermore, partnership with the private sector and commercial activities are also expected to grow in the new millennium due to the increase in benefits that can accrue from meteorological and hydrological information and prediction services. In this regard, WMO will continue to work with Member countries, relevant international organizations and non-state entities in natural disaster mitigation activities in the context of International Strategy for Disaster Reduction (ISDR). It is essential that the future Strategy would include, as a major thrust, scientific and technical activities and ensure the continued involvement of scientific and technical organizations like WMO.

WMO also participated, with other institutions such as the IADB, in the launching of the ProVention Consortium — a global partnership of all stakeholders, including Governments, international organizations, academic institutions, private sector and the media, aimed at reducing the risk of disasters in developing countries, and at making disaster prevention and mitigation an integral part of development efforts.

8. ROLE AND PLACE OF FORECASTS IN THE PROPOSED IADB ACTIONS

The actions proposed by the IADB in support of Members relate to hydrometeorological disaster monitoring, forecasting and early warning and should involve and be built upon existing cooperation among the NMHSs.

It is therefore imperative that when formulating and implementing its action plan, the IADB take the following into consideration:

- The definition of an effective strategy to reduce risk would include the recognition of, and measures to satisfy, the need for adequate support to existing viable national institutions such as NMHSs, and the strengthening of regional and international centres, projects and programmes on scientific and technological aspects of natural disaster reduction;
- The building of technical, scientific and operational capacity including human resources within the NMHSs would be the most cost-effective way to realize their potential to contribute to the implementation of the strategy related to natural disaster reduction at national, regional and global levels;
- National and regional systems for natural disaster prevention and mitigation would embrace components based upon the facilities and capability of the NMHSs. These should be integrated, as appropriate, with other systems related to preparedness, public awareness, decision-making, and relief and rehabilitation;
- National and/or regional coordination between the NMHSs and the civil defense organizations responsible for disaster prevention and coordination with the media for dissemination of forecasts are also important; and
- Inter-agency coordination would take into full account the existing and planned scientific and technical programmes and activities of regional and international organizations, including WMO, especially in the context of the International Strategy for Disaster Reduction (ISDR).

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