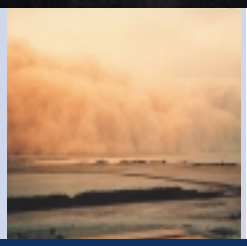
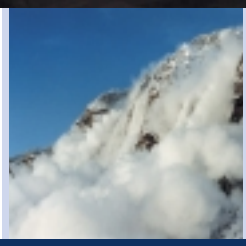
Natural Disaster Prevention and Mitigation Programme

# Working Together for a Safer World





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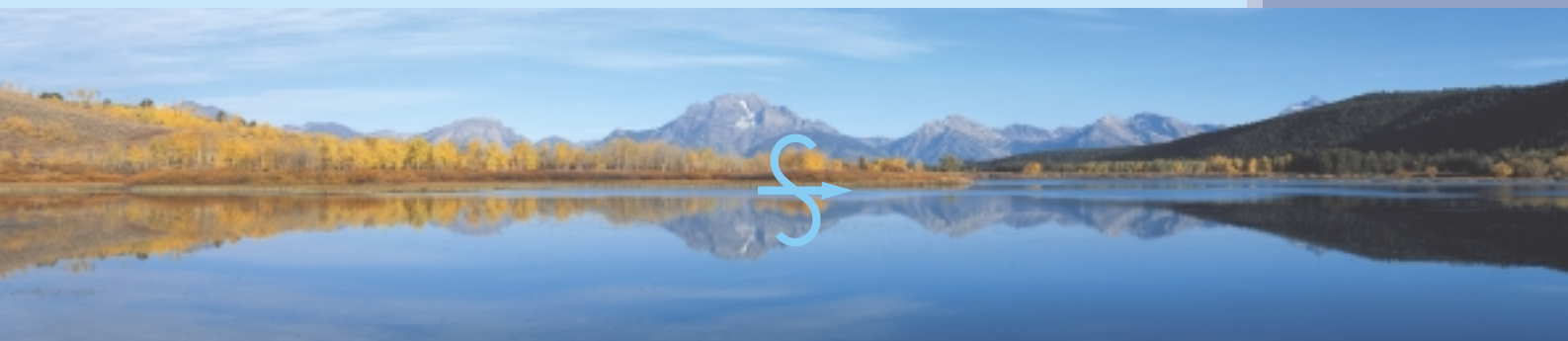


# Foreword

During the period 1992–2001, natural disasters worldwide killed over 622 000 and affected over two billion people. Statistics from the Center for Research on the Epidemiology of Disasters (CRED) revealed that during that period, about 90 per cent of the natural disasters were of meteorological or hydrological origin; their economic losses were estimated at US$ 446 billion, which accounted for about 65 per cent of damages due to all natural disasters. Once again, in 2004, many countries worldwide have been inflicted with considerable loss of life and socio-economic impact as a result of weather-, climate- and water-related hazards. These range from one of the most severe tropical cyclone seasons in the Atlantic and the Pacific, to severe floods in East and South-East Asia. The impact of weather-, climate- and water-related hazards has continued to increase, and scientific assessments indicate that climate change could result in more severe and more frequent natural hazards in the future.

Increasingly, government leaders, civil defence officers, emergency managers, company executives and consortiums of organizations at the national, regional and international levels are recognizing the critical importance of building disaster-resilient communities. This challenging task can be achieved through comprehensive and proactive risk-reduction strategies built on an improved knowledge base, political commitment, strong institutions and public education.

Natural disaster risk management is of particular importance to the World Meteorological Organization (WMO), the authoritative intergovernmental agency on matters related to the Earth's weather, climate and water resources. WMO has — through its scientific and technical programmes and its network of 40 Regional Specialized Meteorological Centres (RSMCs), three World Data Centres (WDCs), and the National Meteorological and Hydrological Services (NMHSs) of its 187 Members — the global infrastructure for the observation, research, monitoring, detection, forecasting, early warning and exchange of information related to natural hazards. The WMO Programmes, the network of WDCs and RSMCs, along with educational and capacity-building services all provide backbone capabilities to enable NMHSs, particularly those within the developing countries, to work at the front line to meet their national needs for hazard information.

WMO is providing the scientific and technical knowledge base that is critical to all stages of natural disaster risk reduction, from hazard assessment, vulnerability analysis and risk assessment, through to disaster prevention, preparedness, response and recovery. While the disaster statistics of the recent decade are sobering, it is important to realize that the loss of life and

property would have been even higher without preventive services, particularly early warnings that are provided through the global network of WMO and the NMHSs.

Promoting a culture of prevention is a key element in WMO's work. One of the most important areas to be addressed is the need to help nations understand the benefits of shifting more investments from post-disaster recovery to risk management and prevention. WMO research programmes further both the understanding of extreme events and the means to predict them. This, in turn, improves the development of end-to-end operational systems for monitoring, detecting and forecasting extreme events with more accuracy and with longer lead-times. There is no doubt that a lot could be achieved by deploying resources to strengthen early warning systems. Increased emphasis on the proactive steps of prevention needs to be placed in many countries, and particularly in the least developed counties.

The linkages between the threat of climate change and the rising probabilities of natural hazards are posing greater challenges for the natural disaster risk management community. Understanding these linkages, mapping the risks and developing seamless early warnings from the next hour to climate change timescales are strategic priorities of WMO.

To enhance its contribution to natural disaster risk reduction, WMO has launched the Natural Disaster Prevention and Mitigation Programme (DPM). This Programme provides an integrated and coordinated framework by which government authorities and the natural disaster risk management community in both the public and private sectors have access to critical scientific and technical information, promptly and effectively.

This publication describes WMO's contributions to natural disaster prevention and mitigation, and highlights future directions of WMO in this area. I am confident that more coordinated efforts with national, regional and international partners and the civil society in the years to come will lead to *A Safer World*.

(M. Jarraud)
Secretary-General

# Why does WMO focus on natural disaster prevention and mitigation?

Every year, disasters caused by weather-, climate- and water-related hazards impact communities around the world, leading to loss of human life, destruction of social and economic infrastructure and degradation of already fragile ecosystems. **Close to 90 per cent of all natural disasters in the last 10 years has been the result of hazards such as floods, droughts, tropical cyclones, heat waves and severe storms** (Figure 1).

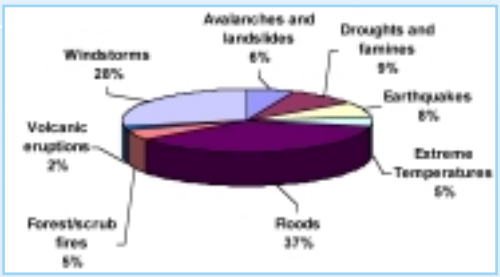



Figure 1 — Weather, climate and water hazards comprise the great majority of natural disasters.

The economic impact of natural disasters shows a marked upward trend over the last several decades (Figure 2). These hazards tend to hit communities in developing countries, especially the least developed countries, the hardest, increasing their vulnerability and setting back their economic and social growth, sometimes by decades (Figure 3).

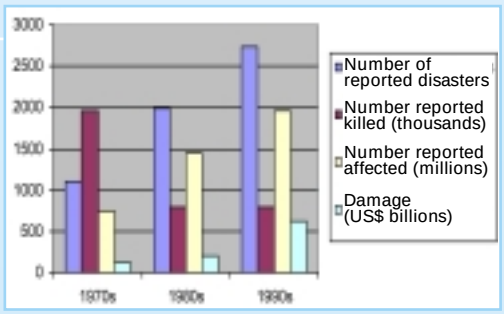



Figure 2 — Over the past decades, natural hazards and their impacts show an upward trend.

Indications are that worse may be in store. According to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), sponsored by WMO and the United Nations Environment Programme (UNEP), climate change could result in more severe and more frequent natural hazards in the future. Projected potential losses associated with climate change include a general reduction in crop yield in most tropical and subtropical regions, increased drought and famine, widespread increase in the risk of flooding and increases in heat stress mortality. Water shortages and quality problems are projected to keep increasing in many water-scarce areas of the world, with several hundred million to a few billion people likely to suffer a supply reduction of 10 per cent or more by the year 2050.

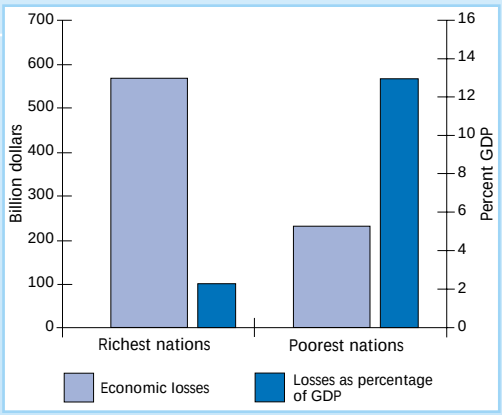



Figure 3 — In the last decade, the developing countries have shouldered a much greater share of the impact on their economies than their developed counterparts (Munich Re).

WMO has — through its scientific and technical programmes and its network of 40 Regional Specialized Meteorological Centres (RSMCs), three World Data Centres (WDCs),

and the National Meteorological and Hydrological Services (NMHSs) of its 187 Members — the global infrastructure that develops and delivers products and services, which are critical for the development of international, regional and national natural disaster risk management and response strategies.

WMO contributes valuable products and services to the disaster risk management decision process (Figure 4), with particular focus on prevention. Understanding the vulnerability of communities to weather-, climate- and water-related hazards calls for multidisciplinary studies using historical records and related sectoral information. WMO has long been recognized for setting a high standard in observing, exchanging, and archiving data globally on the Earth's weather, climate and water resources. Disaster preventive actions can be taken once the nature of the risk is known. WMO's early warning systems can provide communities with the information needed to activate disaster plans in time to protect life and minimize economic losses.

**WMO is committed to enhancing its contributions by ensuring that fully integrated products and services are provided at the national, regional and international levels, to guide decisions for the prevention of, preparation for, response to, and recovery from, the impacts of disasters. WMO has established its Natural Disaster Prevention and Mitigation (DPM) Programme to develop an organization-wide coordinated framework, with the following goals:**

- **(*a*) To promote greater emphasis on proactive strategies for prevention and preparedness;**
- **(*b*) To ensure that WMO core technical and scientific capabilities, particularly early warning systems, are integrated optimally in all relevant phases of disaster risk management at the international, regional and national levels;**
- **(*c*) To promote and enhance the role of NMHSs as critical components of the national disaster risk reduction platforms, particularly within developing countries;**
- **(*d*) Raise awareness of the benefits from investments in natural disaster prevention, particularly in early warning systems; and**
- **(*e*) To work together with international, regional and national partners and the private sector to build *A Safer World*.**

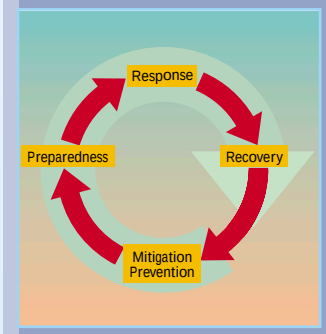
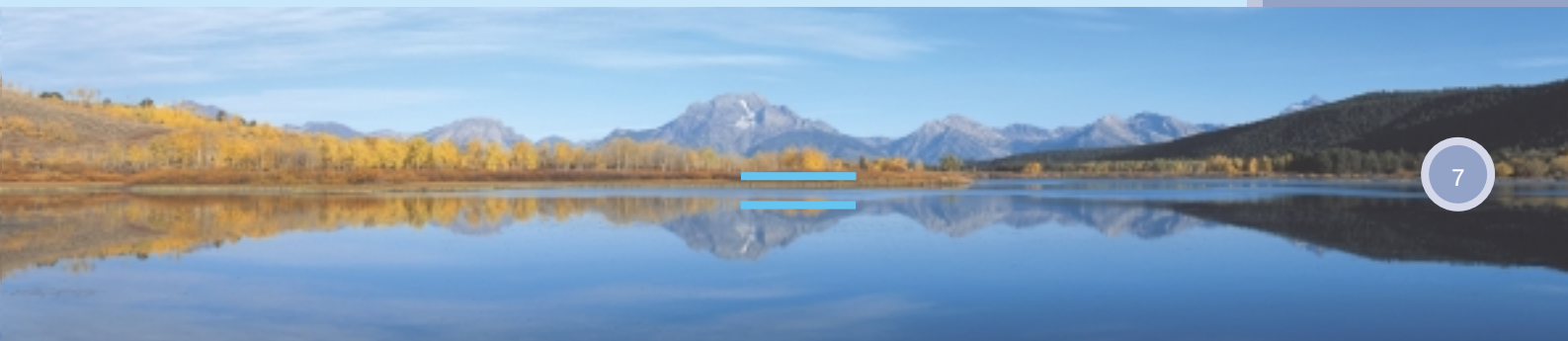



Figure 4 — The cycle of disaster risk management decision process.

**Single tropical cyclones have killed over 100 000 people, with a death toll in one case of 300 000. The economic damage caused by the most destructive tropical cyclone was estimated at US$ 30 billion.**



# Weather-, climate- and water-related hazards and their changing patterns

WMO scientific and technical programmes advance global capabilities for the observation, analysis, detection, forecasting, early warning and information exchange of natural hazards related to weather, climate and water. These range from short-lived, violent events of limited geographical extent such as tornadoes and flash floods to large-scale phenomena such as droughts which can affect the better part of a continent and entire populations anywhere from months to years (Figure 5). Table 1 lists some of these hazards.

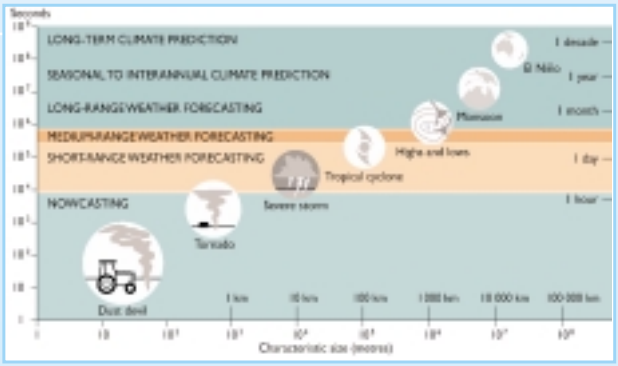



Figure 5— Examples of the range and scales of natural hazards that are observed, detected, monitored and forecast by WMO networks.

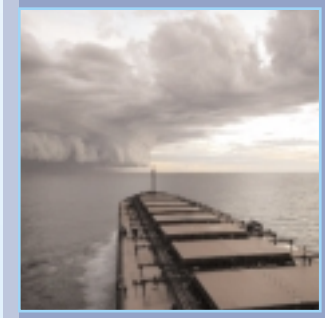
Many international and national forums have stressed the need for better understanding the climate system and development of capabilities for predicting natural climate variability and human-induced climate change. Strong support for research programmes in these areas has been one of the core strengths of WMO in the past, and continues to be in the future. Along with understanding how and why natural hazards happen, **WMO's climate research programmes are advancing our knowledge of natural climate variations, human-induced climate change and their relation to the changing trends in the type, frequency, severity and impacts of hydrometeorological hazards**.

## Climate variability

Statistical analyses of important atmospheric elements, such as pressure, temperature and precipitation, show recurring patterns of natural variations in climate, termed oscillations. When these occur, they lead to changes in the patterns of extreme events around the world. The strongest year-to-year variations of climate are linked to *El Niño*/Southern Oscillation (ENSO). An ENSO event originates in the equatorial Pacific Ocean but affects climate conditions over many parts of the world, bringing heavy rain and flooding to some regions and heat and drought to others. WMO played a critical role in coordinating the 10-year international research collaboration on the Tropical Ocean and Global Atmosphere (TOGA) Programme that established the physical basis for predicting ENSO from a season to more than a year in advance. The TOGA data and research have been crucial in advancing the development of skilful forecasts on seasonal to inter-annual timescales. Early

warning of the 1997–1998 *El Niño* event was vindication of the investment in the research and observing systems.

In addition to ENSO, WMO research programmes are investigating longer lasting North Atlantic and North Pacific oscillations and their implications for the changing patterns of natural hazards around the world.



## Climate change

**Through WMO co-sponsored research programmes, thousands of scientists around the world are advancing the understanding of climate change and its implications for natural hazards.** Analysis of observational records indicates that, as a consequence of increasing industrialization, the global annual emissions of carbon dioxide due to human activities have increased from about 0.1 GtC[1] in 1860 to near 10 GtC by the end of the twentieth century. Over the same period, the atmospheric concentration of carbon dioxide has increased from about 280 ppmv[2] to about 375 ppmv and the global temperature of the Earth has increased by about 0.6°C. In 1988, WMO and UNEP established IPCC with the goal of assessing both available scientific information on climate change, and its environmental and socio-economic impacts. The Third Assessment Report of IPCC in 2001 concluded that the duration, location, frequency and intensity of extreme events are likely to change, with more hot days and heat waves and fewer cold and frost days over nearly all land areas, and increases in the amplitude and frequency of extreme precipitation events over many areas.

[1] GtC: gigatonnes of carbon.
[2] ppmv: parts per million by volume.

**The implications of climate change are critical for Small Island Developing States (SIDS).**

# Table 1
# Examples of hazards related to weather, climate and

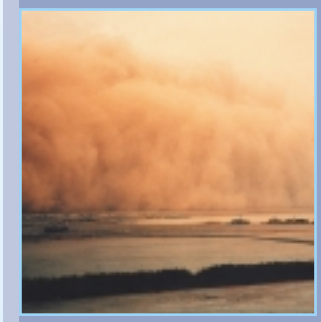
| *Hazard* | *What is it?* |
|---|---|
| **Severe thunderstorms** | Tornadoes, lightning, hailstorms, high wind, dust storms, waterspouts and heavy rainfall are among examples of these events. |
| **Mid-latitude storms** | Low-pressure systems that occur throughout the middle latitudes. Generally most frequent and intense during winter; gales last up to several days and extend to 1 000 km or more. |
| **Cold spells** | Prolonged periods of extreme cold temperatures from days to weeks during colder months. |
| **Heat waves** | Prolonged period of extreme temperatures and humidity over a period of a few days to weeks during warmer months. |
| **Tropical cyclones, hurricanes and typhoons** | Warm tropical oceans spawn most formidable storms. The strongest have sustained winds greater than 195 km/h and wind gusts greater than 280 km/h. Some can grow to a radius of more than 300 km before they decay, over either land or cooler water. |
| **Floods** | Several types of hydrometeorological systems lead to flooding, including severe thunderstorms, mid-latitude storms, tropical cyclones and monsoons. Floods are among the most common and most devastating natural disasters. |
| **Mudflows and landslides** | Heavy rain or snowmelt often trigger mudflows and landslides, and steep terrain is usually involved. Landslides send large amounts of earth, rock, sand or mud flowing swiftly down mountainsides, especially those denuded by wildland fires. Mudflows are essentially super wet, fast-moving landslides. |
| **Droughts** | The primary cause is deficiency and timing of rainfall, distribution and intensity of this deficiency in relation to existing reserves and water use. Temperature and evapotranspiration aggravate the severity and duration. Takes place over months to years. |

**In addition to these hazards, storm surges, avalanches, sand storms, wildland fires and locust swarms are other hazards**

# water investigated by WMO

| ***Most vulnerable regions and examples of their impact*** |
|---|
| Most common in North America, tornadoes have killed people on every continent except Antarctica. Hailstorms in Sydney, Australia, in 1999, and Dallas-Fort Worth, USA, in 1995, each caused over US$ 500 million in damages; hailstones the "size of eggs" in Zejiang Province, China, killed eight and injured 160 in 1976. |
| Widespread property damage and death through wind damage and flooding. In December of 1999, winter storms *Lothar* and *Martin* in western Europe caused economic losses of some US$ 12 and 6 billion, respectively. |
| Maximum temperatures of 4 to 5°C below normal resulted in more than 2 500 fatalities in India in December 2002. Cold spells in Mongolia killed over 750 000 cattle during the winter of 2001–2002. |
| Most deadly in mid-latitude regions, especially urban areas. Much of western Europe was affected by heat waves during the summer of 2003 (June, July, August). Seasonal temperatures warmest on record: 40°C or greater. In France, Italy, the Netherlands, Portugal, Spain and the United Kingdom: over 21 000 additional deaths reported. |
| In 1998, Hurricane *Mitch* struck Nicaragua, Honduras and Guatemala: 11 000 dead and widespread flooding. In 2004, four major hurricanes in little more than one month: *Charley*, *Frances*, *Ivan* and *Jeanne* killed scores of people and led to over US$ 23–35 billion of property damage. |
| Extensive heavy rains in the South-west Pacific, struck eastern and southern Asia during the summer of 2004, resulting in widespread flooding in Bangladesh, China, India, Japan, Nepal, the Philippines, Viet Nam and the Korean Peninsula. Floods in Mozambique caused by Tropical Storms *Elyne* and *Gloria* in 2000 led to losses of US$1 billion, over three times the country's 1999 export earnings. |
| Worst natural disaster ever in Venezuela occurred in 1999: landslides and mudflows shot down Avila Mountain, washing away towns, killing an estimated 15 000 to 20 000 people, and resulting in almost US$ 2 billion in damages. |
| Can happen almost anywhere, but arid and sub-humid drylands with their fragile ecologies and marginal economies are the most vulnerable. Widespread droughts in the Sahel and eastern and southern Africa in the 1970s and 1980 made the world aware of the link between climate extremes and famine. |

**that are analysed, detected and monitored by WMO.**



# WMO contributes to all phases of natural disaster risk reduction

## WMO facilities and capabilities

**WMO has — through its scientific and technical programmes and its network of 40 RSMCs, three WDCs, and the NMHSs of its 187 Members — the infrastructure to generate and deliver products and services to enable nations to reduce risks of weather-, water- and climate-related hazards.**

### WMO facilities and capabilities

**WMO major Programmes:**
The World Weather Watch Programme, the World Climate Programme, the Atmospheric Research and Environment Programme, the Applications of Meteorology Programme, the Hydrology and Water Resources Programme, the Natural Disaster Prevention and Mitigation Programme, the Space Programme, the Education and Training Programme, the Regional Programme, and the Technical Cooperation Programme.

**WMO World Data Centres:**
Melbourne
Moscow
Washington

**Regional Specialized Meteorological Centres:**
GEOGRAPHICAL

Algiers
Beijing
Brasilia
Buenos Aires
Cairo
Dakar
Darwin
Exeter
Jeddah
Khabarovsk
Melbourne
Miami
Montreal
Moscow
Nairobi
New Delhi
Novosibirsk
Offenbach
Pretoria
Rome
Tashkent
Tokyo
Tunis/Casablanca
Washington
Wellington

**Specialization:**

**TROPICAL CYCLONE FORECASTING**

Nadi
New Delhi
Miami Hurricane Center
La Réunion
Honolulu
Tokyo Typhoon Center

**GLOBAL MEDIUM-RANGE WEATHER FORECASTING**

European Centre for Medium-Range Weather Forecasts

**TRANSPORT MODEL PRODUCTS, ENVIRONMENTAL EMERGENCY RESPONSE**

Beijing
Exeter
Melbourne
Montreal
Obninsk
Tokyo
Toulouse
Washington

# Overview of WMO basic systems

**The WMO Global Observing System (GOS) enables the observation and collection of weather, water and climate information from around the globe.** Through this system, data are collected from 14 satellites, hundreds of ocean buoys, aircraft, ships and nearly 10 000 land-based stations. NMHSs make and collect observations in their countries. More than 50 000 weather reports and several thousand charts and digital products are disseminated daily through the WMO Global Telecommunication System (GTS), which interconnects meteorological centres around the globe. **The WMO Global Data-Processing and Forecasting System (GDPFS) ensures the cooperation of world, regional and national centres to process data and provide routinely countries with analyses and forecasts, including early warnings of severe events.** Based on the analyses and forecasts provided by WDCs and RSMCs, NMHSs develop and provide early warnings adapted to local conditions and needs, when natural hazards threaten their country (Figure 6).

WMO is further enhancing its GTS and other information systems into a single coordinated global information infrastructure called the Framework for the WMO Information System (FWIS). This would provide for the collection and sharing of relevant environmental information for all WMO and other international programmes.

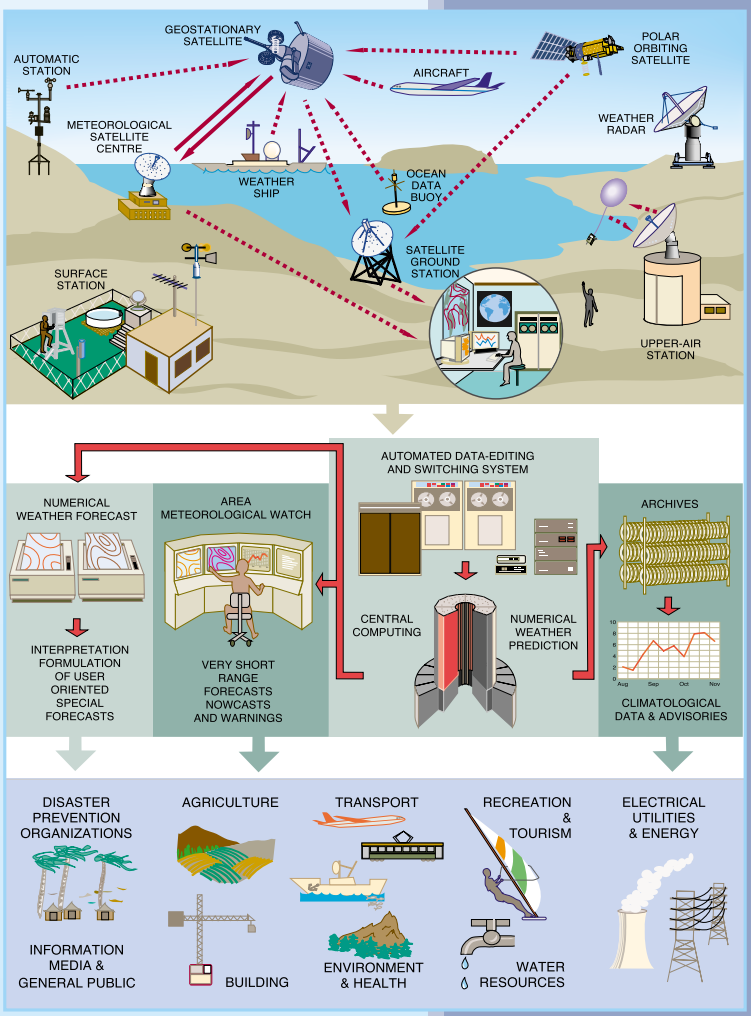



Figure 6— WMO's basic systems.

# WMO databases support natural disaster risk assessment, prevention, response and recovery

Preventive measures are critical in reducing natural disaster risks.

**In assessments of the sensitivity and vulnerability of communities to weather-, climate- and water-related hazards, historical meteorological and hydrological records are of vital importance.** WMO's historical databases are critical for quantifying the intensity and frequency of the events, for characterizing the potential damage of extreme events, and for predicting expected damage by generating future scenarios. Systematic studies of meteorological and hydrological observations of hazards — such as tropical cyclones, severe storms and floods — and their impacts form a rich knowledge base for risk managers at all levels to develop effective proactive risk management strategies to reduce the impacts of natural disasters.

**WMO has a long history of observing, exchanging and archiving data on the Earth's weather, climate and water resources.** Through technology transfer, capacity-building services, data rescue and data management programmes, WMO works tirelessly to ensure that all NMHSs, particularly those in the developing countries, have the capability to observe, archive and disseminate systematically critical hazard-related data. Real-time monitoring services of the NMHSs allow for timely information on the latest pre- and post-disaster conditions, enabling the emergency response and recovery teams to map potential risks and direct their activities to areas and communities that have been worst hit.

**WMO is advancing global capabilities for land- and space-based observing systems and is playing a key role in the international initiative for developing the Global Earth Observation System of Systems (GEOSS).**

### Cooperation projects regarding satellite surveillance

WMO has established partnerships to cooperate in such projects as the Preparation for the use of Meteosat second generation in Africa (PUMA) to keep the NMHSs' surveillance capabilities at high levels. Through PUMA, WMO and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) have developed partnerships with major economic development organizations in Africa to ensure the successful transition from the EUMETSAT meteorological satellite to Meteosat second generation (MSG), and to develop the uses of applications that exploit MSG's capabilities for the NMHSs to use in monitoring natural hazards.

# Early warnings are critical for natural disaster prevention

**One of the most effective measures for disaster preparedness is a well-functioning early warning system that delivers accurate information dependably and in a timely manner.** Therefore, it must rely on:

(*a*) Advance, accurate, detailed and understandable forecasts of hazardous conditions;
(*b*) Rapid, dependable distribution system for forecasts, advisories, watches and warnings to all interested parties; and
(*c*) Prompt, effective response to warnings at the national to local levels.

WMO's programmes related to monitoring the atmosphere, oceans and rivers provide the crucial time-sequenced information that underpins the forecasts and warnings of hydrometeorological hazards. WMO's global network of RSMCs and WDCs

## Table 2
## Recorded losses after four huricannes (numbers refer to deaths at that location)

| 2004 HURRICANE SEASON |
|---|
| ***Charley*** (Category 4 hurricane)<br>Affected Jamaica (1), Cuba (4) and Florida, USA (33)<br>Property damage: US$ 7 billion |
| ***Frances*** (Category 4 hurricane)<br>Affected Bahamas (2), Turks and Caicos Islands, Florida, South Carolina and Georgia, USA (35)<br>Property damage: US$ 5 billion |
| ***Ivan*** (Category 5 hurricane)<br>Affected Barbados, Granada (37), St. Vincent and the Grenadines, Tobago (1), Haiti (3), Venezuela (5), Dominican Republic (4), Jamaica (21), Cayman Islands (1), Cuba, St. Lucia and USA (38)<br>Property damage: US$ 5 to 15 billion |
| ***Jeanne*** (Category 3 hurricane)<br>Affected US Virgin Islands, Puerto Rico (2), Dominican Republic (27), Haiti (near 3 000), south-eastern Bahamas (9) and Florida, USA (6).<br>Property damage: US$ 6 to 8 billion |

**Communities taking measures to mitigate the impacts of natural hazards.**

provides critical data, analysis and forecasts that enable the NMHSs to provide early warning systems and guidelines for various natural hazards such as tornadoes, winter storms, tropical cyclones, cold and heat waves, floods and droughts.

For example, **WMO's network proved to be highly effective in 2004, during one of the most intense hurricane seasons in the Atlantic and Caribbean regions** (Table 2). Atmospheric data collected via in situ and space-based instruments were transmitted to the United States National Hurricane Center, one of WMO's RSMCs (RSMC-Miami), where forecasts and hurricane

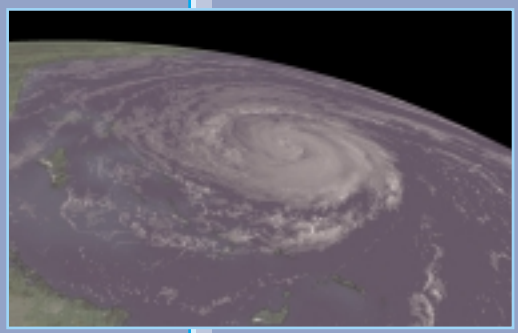
## Enabling proactive response to reduce the impacts of wildfires in South-East Asia

Fire, climate and human actions are highly interactive. South-East Asia witnessed one of the worst smoke and haze episodes in autumn 1997 due to forest fires that were exacerbated by the *El Niño*-related drought. It was estimated that the over two million hectares of forests burned in Kalimantan and Sumatra emitted the same level of carbon dioxide as a whole year of emissions over Europe. Economic losses were estimated at US$ 9.3 billion. Civil aviation operations, maritime shipping, agricultural production and the tourist industry were especially hard hit. The fires also affected the health of the population in the region. As a consequence, the member countries of the Association of South-East Asian Nations (ASEAN) agreed to implement a Regional Haze Action Plan (RHAP) to address the problem of recurring forest fires and the resulting transboundary smoke and haze pollution. WMO joined with ASEAN to establish the ASEAN Regional Specialized Meteorological Centre in Singapore. This Centre provides smoke/haze information and forecasts to NMHSs to assist in environmental emergency situations. It also displays weather and hot spots using satellite images on its Website, which is open to the public. Satellite imagery can provide information on the dryness of vegetation, location and size of major fires and smoke plumes, energy released by fires, and air pollutants in the smoke plumes.

WMO, the World Health Organization and the United Nations Environment Programme have also developed a joint report that provides comprehensive guidelines for governments and responsible authorities on actions to be taken when the population is exposed to smoke from fires.

advisories were developed around the clock. These advisories were transmitted through the GTS, facsimile and Internet at intervals of three to six hours to the NMHSs of countries at risk. The forecasters at the NMHSs used these hurricane advisories to produce their national hurricane warnings, which were dispatched immediately to newspapers, radio and television stations, emergency services and other users. In response to this information, many lives were spared through timely evacuations. There is no doubt that a lot more could be achieved by deploying resources to strengthen further early warning systems. The challenge is to ensure that all countries, particularly the least developed countries, have the systems,

## WMO's space-based surveillance and communications



WMO is rapidly enhancing its integration of observations from space-based sensors and land-based observations to enhance early warnings. In the near future, it will contribute to mitigating the impact of a hurricane similar to Hurricane *Mitch*, as shown in this example: "Dateline Geneva 12 August 2014: WMO's analysis of atmospheric and oceanic environmental data from in situ AMDAR measurements (meteorological observations that are sent automatically from commercial aircraft) and space-based hyperspectral sounders and instruments from the National Polar-orbiting Operational Environmental Satellite System showed that the weak tropical storm that formed in the Caribbean Sea on Friday had a high probability of becoming a minimum-intensity hurricane making landfall along the coasts of Honduras and Guatemala two days hence. While the computer models projected the wind speeds to be in the medium intensity range, the forecast also predicted great rainfall potential. Other space-based sensors detected abnormally high soil moisture on certain slopes of the Honduran and Guatemalan highlands. With that data, hydrologic models called for massive runoff, flooding and mudslides for a 300-km band, 18–24 hours following landfall. Meteorologists and hydrologists in the RSMC for regional environmental prediction and warnings in Central America issued to NMHSs integrated forecasts and advisories of wind, rainfall and streamflow for all affected river basins in the two countries, four days in advance. Because relief agencies and inhabitants took action, population relocations and reinforcement of infrastructure were completed with hours to spare. The storm barely reached hurricane strength, but rain totals of 64 cm in six hours over the steep, higher elevations sent rivers rampaging, uprooting trees and destroying many hundreds of homes, but thousands of lives and considerable property were saved by the ample warnings."

infrastructure, human capacity and organizational structures to develop and utilize early warning systems to reduce risks of natural disasters.

**Beyond short-term early warnings of specific events, WMO is working towards the development of new products that provide information with longer lead-times on the state of the climate and natural hazards.** When there is evidence of developing ENSO conditions, WMO coordinates a global scientific consensus, involving a collaborative process to review best available evidence and predictions. The outcome is an *El Niño* Update, a unified global statement on the expected evolution of ENSO for months ahead, which is issued to NMHSs and to the world at large.

WMO is working with a number of NHMSs and regional and international institutions to support Regional Climate Outlook Forums (RCOFs). These Forums are held regularly in regions that are affected by ENSO and there is reasonable skill to forecast ENSO impacts. In Africa, three regional centres

## Monitoring and early warning systems for locust swarms

Desert locusts inflict damage in Africa, the Middle East and Asia. When weather and ecological conditions favour breeding and force the insects into a small area, they stop acting as individuals and start acting as a group. Within a few months, huge swarms form and fly downwind in search of food. Swarms can be dozens of kilometres long and travel up to 200 kilometres a day. A small part of an average swarm (or about one tonne of locusts) eats the same amount of food in one day as 10 elephants or 25 camels or 2 500 people, thus jeopardizing the life of millions of farmers and herders in already fragile environments.

The NMHSs in affected countries are actively involved in locust control operations, monitoring and forecasting meteorological elements such as precipitation, temperature, humidity, and wind speed and direction. WMO and FAO are collaborating in the preparation of guidance material for NMHSs and national locust control centres for more effective monitoring of this pest.

supported by WMO and the relevant economic development commissions catalyse and coordinate the climate Forums. The Drought Monitoring Centre (DMC) in Harare, Zimbabwe, the Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications Centre (ICPAC) in Kenya, and the African Centre of Meteorological Applications for Development (ACMAD) in Niger, develop and disseminate climate outlooks, particularly related to drought monitoring and drought alerts, to each of the NMHSs, and arrange for interactive discussions and interpretations with representatives in the disaster risk management community and other sectors.

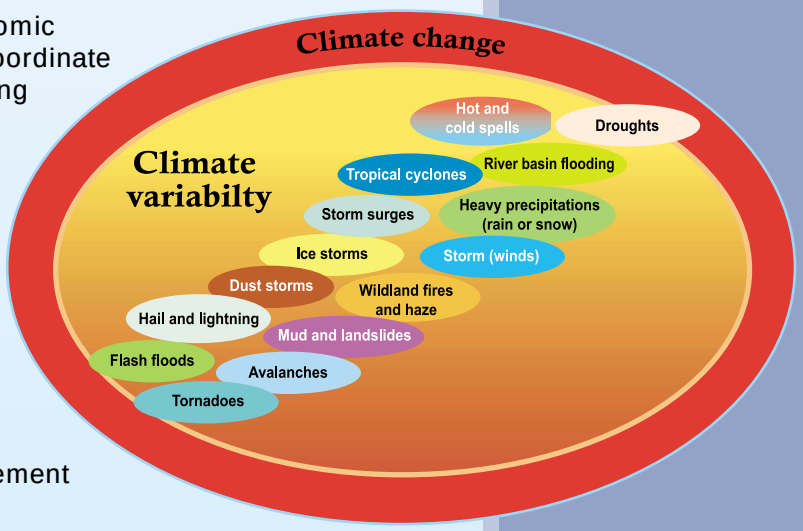
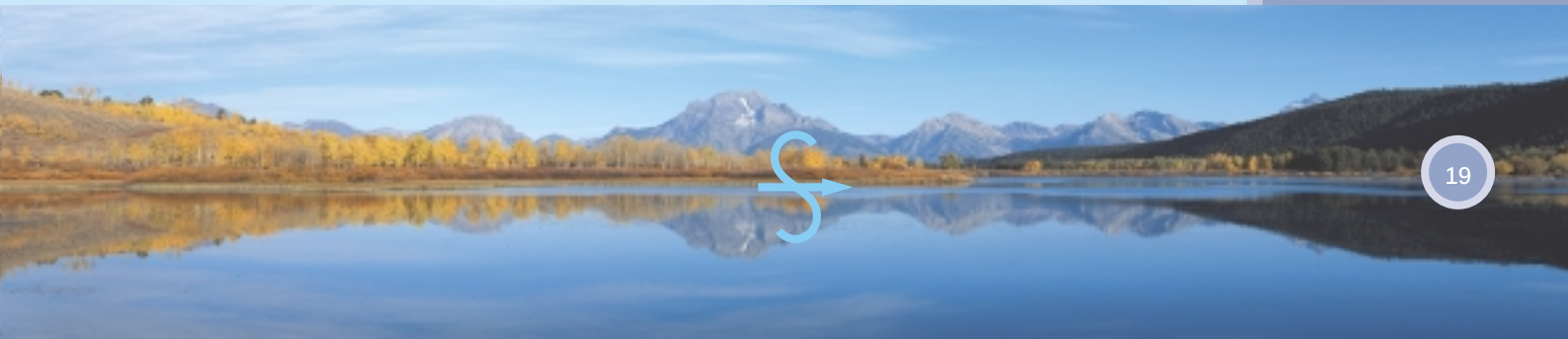



Figure 7— Seamless forecasts of all hazards from next hour to climate change timescales.

WMO is working to develop comprehensive Climate Watch programmes in NMHSs around the world. NMHSs will use climate forecasts and outlooks generated by RCOFs to inform countries whenever significant climate anomalies are foreseen. They will also add value by providing alerts tailored for specific end-users, to help them better prepare for the negative impacts of natural hazards.

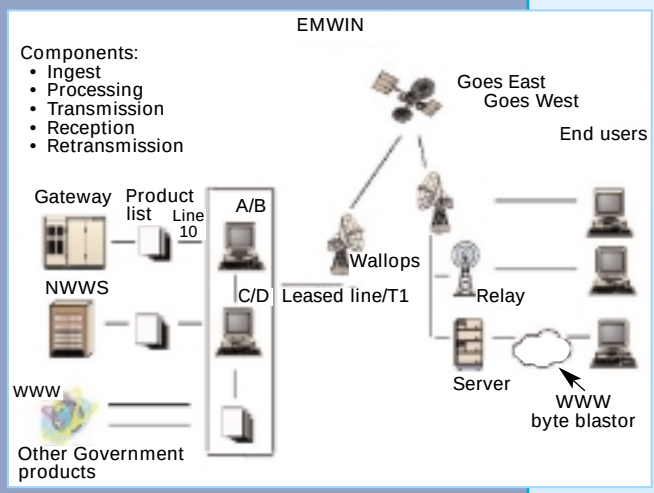
There is a great need for sector-specific climate information and early warnings. Collaboration of WMO with the World Health Organization (WHO) to develop Heat-health Warning Systems for coping with deadly heat waves, and with the Food and Agriculture Organization of the United Nations (FAO) for monitoring and developing early warnings of locust swarms, are among examples of such activities.

Beyond these activities, **the premise of WMO research in weather, climate and water is to develop seamless end-to-end operational systems for early warnings of natural hazards from next hour to climate change timescales** (Figure 7). WMO research programmes are extending the range of skilful forecasts to timescales of value to decision-making. WMO's international research programme on weather (THORPEX: a Global Atmospheric Research Programme) and the World Climate Research Programme new climate strategy (the Coordinated Observation and Prediction of the Earth System (COPES)) over the next 10 years are aimed to accelerate improvements in the accuracy of one-day to two-week high-impact weather forecasts, and to develop prediction capabilities at longer lead-times, supported by soundest scientific basis.



## Effective and timely communication is a critical component of an early warning system

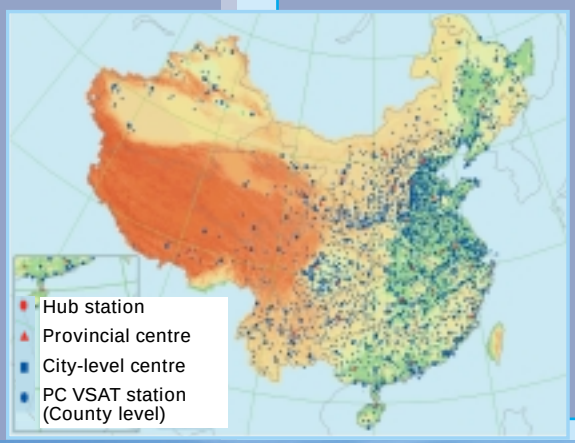
Efficient international and national satellite-based data-distribution systems, operated by NMHSs under the aegis of WMO Programmes, provide timely and reliable access to weather, water and climate information. Two examples among many others are the Emergency Managers Weather Information Network (EMWIN) operated by the National Weather Service of the United States and the satellite-based telecommunication system operated by the China Meteorological Administration (CMA).




EMWIN is a wireless, priority-driven computer weather data broadcast system that provides rapid satellite dissemination of alerts/warnings, forecasts, graphics and imagery. It is a free service, designed to use low cost, readily available technology. EMWIN has thousands of users and is of crucial importance for NMHSs in the Caribbean and Pacific small islands States.

The satellite-based telecommunication system of CMA forms a wide area network covering the whole country, communicating with very small aperture terminals (VSATs) via the geostationary telecommunication satellite AsiaSat II. The system is used for collecting observation data and for distributing weather, water and climate information, forecasts and warnings to more than 2 300 remote stations all over China and in some neighbouring countries.

Layout of the CMA VSAT system stations.



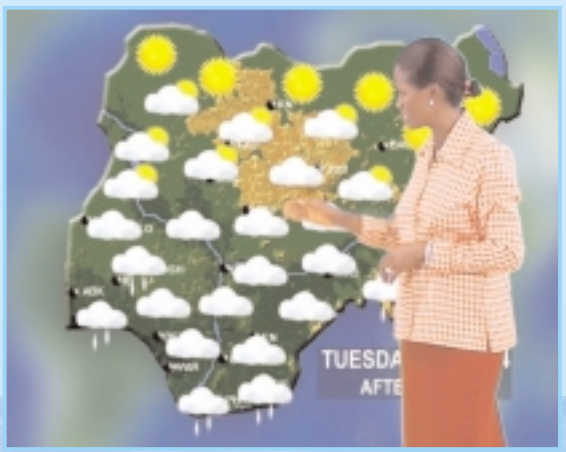
However, while our technical and scientific capabilities are advancing year-to-year, it is clear that there is a need for stronger, more coordinated activities among government leaders, risk managers in both the public and private sectors, organizations at the national, regional and international levels and the scientific community, to develop capabilities to support proactive strategies for natural disaster risk reduction.

## Enabling nations to adopt proactive strategies for natural disaster risk reduction at the community level

By providing relevant and timely products and services, NMHSs provide critical information to enable their governments and risk managers at the national to local levels to develop both traditional and innovative proactive strategies to mitigate the impacts of natural disasters.

**Local hazard maps are critical in building disaster awareness at community level.**

**WMO activities are directed towards an integrated approach for an effective NMHS strategy to empower and influence the target audiences to take action.** The NMHSs use various formal and informal mechanisms, from traditional approaches to more advanced technologies, to disseminate information to authorities and the general public, particularly the public at risk. While in some countries NMHSs rely on public broadcasting systems by using such means as Internet, television and radio, in others, sirens, balls, flags and beacons are most effective in warning those communities that are remote or do not have access to the latest technology. However, this information is only effective if there is capacity to respond to the information through prevention, preparedness and response activities at the national and community levels.



## Broadcast media — WMO valued partners in communication of forecasts and warnings

WMO has been working in strong partnership with the media to establish the authority of the NMHSs as the ''single official voice'' for issuing forecasts and warnings. WMO has coordinated the development of two Websites to provide access to the media and the public to official weather forecasts and warnings:

- The World Weather Information Service (WWIS) Website, http://www.worldweather.org providing climatological information and official medium-term global city weather forecasts; and

- The Severe Weather Information Centre (SWIC) Website, http://severe.worldweather.org which is a pilot project to develop a centralized source of official tropical cyclone warnings and information around the globe.

## Saving lives through a community-based approach to flood management

Along with initiatives in flood forecasting and the short- and long-term Global Forecasting Project, WMO, through its Associated Programme on Flood Management (APFM), has been developing strategies for effective community preparedness in several countries. WMO is supporting a regional pilot project in Bangladesh, India and Nepal on Community Approach to Flood Management through field activities in selected communities at the sub-district level and has supported its implementation during the recent 2004 floods in some of the villages. As an output of the project, manuals on community approach to flood management have been developed that cover various aspects such as flood preparedness, rescue and relief, agriculture and livelihood planning, health and sanitation, and the role and responsibilities of the communities. The project also addresses issues related to public awareness and capacity development. An evaluation of the applicability of community-based flood management manuals during the 2004 monsoon season revealed that the approaches adopted proved to be effective and efficient in strengthening the self-help capacity and resilience of the affected communities.

# Future direction for WMO and natural disaster risk reduction

**WMO has established its Natural Disaster Prevention and Mitigation (DPM) Programme to develop an organization-wide coordinating framework to enhance further WMO's contributions to the natural disaster risk reduction activities at the international, regional and national levels. To this end, DPM will work towards the following strategic goals:**

## GOAL 1: Promote greater emphasis on proactive strategies for prevention and preparedness

WMO will pursue this in three ways: through coordinated enhancements in internal programmes; through intergovernmental programmes in partnership with international organizations; and through its own information and public awareness activities. It will demonstrate the benefits of the NMHSs' capabilities of all stages of a proactive risk management strategy — especially the benefits of early warning systems at the national level. As part of WMO's participation in the International Strategy for Disaster Reduction (ISDR), it will promote raising awareness at the ministerial level of the relation between preventive, proactive risk management strategies and economic development. It will also increase awareness among the public and decision makers of the causes and consequences of natural hazards.

## GOAL 2: Ensure that WMO core technical and scientific capabilities, particularly early warning systems, are integrated optimally in all relevant phases of disaster risk management at the international, regional and national levels

Through a user-driven approach and in partnership with key organizations, WMO is analysing the scientific and technical information needs of various components of the disaster risk management decision-making chain. It is identifying and strengthening the relevant capabilities and activities within its own programmes. In conjunction, WMO is establishing a comprehensive set of best practices, related to utilization of scientific and technical information in disaster risk reduction. It will factor those results into development of integrated products and services for the various stages of disaster risk management. WMO will do this through close collaboration with the natural disaster risk management community.

## GOAL 3: Promote and enhance the role of NMHSs as a critical component of the national risk reduction platforms, particularly within developing countries

WMO will implement result-driven end-to-end projects in different regions for different hazards. These activities will be carried out by working with RSMCs and NMHSs, leveraging WMO's current activities as well as new

initiatives. WMO will use its circulars and brochures, Website, broadcasts and direct communications to demonstrate the potential benefits in disaster risk management of its scientific and technical capabilities that can be implemented through NMHSs at the national level. Through activities such as sharing of best practices, technology transfer, training and capacity-building, WMO will help the NMHSs deliver products and services in an effective and timely manner to meet national needs for hazard information.

## GOAL 4: Raise awareness of the magnitude of cost-benefits from investments in natural disaster prevention, particularly in early warning systems

WMO will conduct further socio-economic studies to demonstrate more clearly the minimal resources needed in natural disaster prevention, in comparison to the much larger magnitude of funding involved in response and recovery efforts. The studies will also address the social costs, such as those related to deaths and damages, societal impacts of retarded economic growth, lost years of normal educational activities, etc. These activities will be carried out in partnership with major economic development commissions, insurance and re-insurance organizations, international development banks, relevant non-governmental organizations, the United Nations Development Programme, UNEP and other international, regional and national organizations.

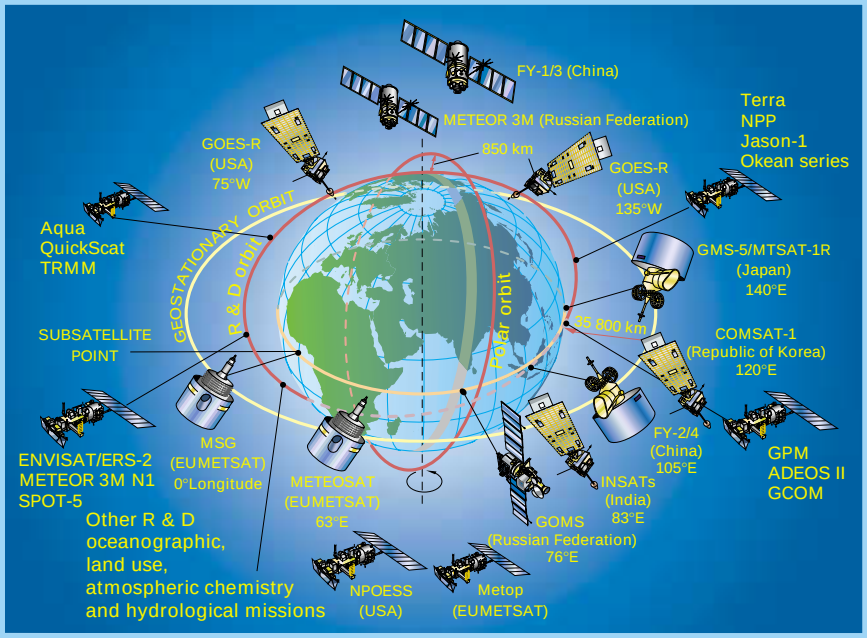
## GOAL 5: Work together with international, regional and national partners and the private sector to build *A Safer World*

WMO, as a major partner in the ISDR, is addressing the weather, climate and water issues at the core of the culture of prevention with all the organizations within the ISDR. WMO has also cemented partnerships with other organizations within and in addition to the United Nations system, in specific sectors such as health, transportation, energy, agriculture and forestry, water resource management and tourism. WMO and other organizations collaborate to develop preparedness and response strategies related to extreme meteorological and hydrological events. DPM will work to strengthen the existing partnerships and develop new ones.

**It is crucial to underscore the importance of investments in hydrometeorological services, particularly early warning systems.**

# What will WMO deliver?

***Hazard monitoring in real time*** — WMO's extensive observational networks use the latest technologies and telecommunication capabilities. Every day, at any hour of the day, it monitors hazards and disseminates relevant information. Up-to-the-minute satellite images and coordinated scientific assessments alert the public at risk as well as leaders in the public and private sectors to imminent hazards, whether they be floods or droughts, blasting sand storms or creeping temperature. WMO will work with its partners to ensure that the contents and formats of its hazard monitoring data sets optimally match those needed in risk assessment modelling.




***Early warnings*** — Scientific and technological advances are leading to new early warning systems for hazards that have not been adequately covered in the past, and are underpinning new capabilities to extend early warnings of hazards, from the next hour to longer, climate-change timescales. WMO will work to ensure access to increasingly accurate forecasts and warnings with longer lead-time, and will help countries adapt them to local conditions and to the needs of local populations.

***Risk-identification tools*** — Through collaboration and partnerships, WMO will work toward creating user-friendly risk-identification products, such as digital multi-hazard maps using technologies that allow for easy updating and delivery. It will ensure that the tools are usable within decision support systems of disaster risk managers at the national, regional and international levels.

**Space- and land-based observations are critical for risk assessment, detecting, monitoring and early warnings of natural hazards.**

***Historical climate records*** — Historical observations form a critical component for risk assessment, disaster preparedness and early warning. WMO will advise disaster risk managers on the development of relevant tools and facilities that make it possible to estimate the ranges of intensity and probabilities of occurrence of various hazards. Within that activity, WMO will assist them in acquiring relevant data, in recognizing and dealing with gaps and inhomogeneities in the data, and in understanding how the procedures and instrumentation that were used in making the observations affect their applicability to specific decision support processes.

***Expert advice on risk management applications*** — WMO provides expert advice and other appropriate technical support on issues relating to sector-specific disaster risk management. This may include, among other things, implementing sector-specific observation and analysis systems, defining and arranging for early warning dissemination methods, and enhancing data inputs for development of innovative risk management tools, such as financial instruments used to offload or offset risk.

***Capacity-building and training*** — Through further strengthening of its capacity-building and training activities, WMO ensures that the NMHSs, particularly those of developing countries, can address effectively their national needs. WMO will collaborate in the sector-specific training activities of its partner organizations, at the international, regional and national levels.

**WMO's training and capacity-building activities enable NMHSs to respond effectively to their national needs for hazard information.**

***Public information*** — WMO provides a wide array of educational products and services to increase public awareness on the causes and consequences of natural hazards and on how to prevent and mitigate their impacts. Local disaster risk managers can request assistance through their NMHSs. Public awareness activities carried out jointly with NMHSs are especially effective prior to the onset of the seasons of elevated risk of specific hazards of weather, climate or water origin.

***WMO-DPM Website*** — Links are provided to operational forecasts, alerts and warnings, to WMO Programmes and networks, their relevant activities and contributions, and to other relevant information (**http://www.wmo.int/disasters/**).

*Photo credits*: E. Al-Majed/WMO, J.-P. Gaucher/Météo-France, Kund Falk/Danish Red Cross, Kydo News/Japan, Météo-France, M.C. Larsen/USGS, Nigerian Meteorological Agency, NOAA/USA, P. Johnson/FAO, Y. Boodhoo. Despite our efforts, we were unable to identify the photographers of some of the photos. Their photos have been included in the belief that they would want to share their work with WMO.

But hazards only become disasters when people's lives and livelihoods are swept away…

*"Natural hazards are a part of life. But hazards only become disasters when people's lives and livelihoods are swept away… let us remind ourselves that we can and must reduce the impact of disasters by building sustainable communities that have long-term capacity to live with risk."*

Kofi Annan
Secretary-General of the United Nations
Message on the occasion of the International Day for Disaster Reduction
8 October 2003

*"Today, about three-quarters of all natural disasters are related to weather, climate and water and their extremes.... Progress in the meteorological and hydrological sciences shows that the impacts of natural hazards can be reduced through preparedness and mitigation.*

*In order to be prepared and to take action to meet the risk posed by disasters, it is imperative to be informed of the risks involved, and of possible options to mitigate the risk.*

*It is WMO's ambition to halve the number of deaths due to natural disasters of meteorological, hydrological and climatic origin over the next 15 years."*

Michel Jarraud
Secretary-General of WMO
Message on the occasion of World Water Day
22 March 2004

*Storm surge*

*Electric storm*

*Forest fire*

Natural Disaster Prevention and Mitigation Office
World Meteorological Organization
7 bis, avenue de la Paix
P.O. Box 2300
CH-1211 Geneva 2, SWITZERLAND
Tel: (+41-22)730-8006
Fax: (+41-22)730-8181
Email: disasters@wmo.int
http://www.wmo.int/disasters/

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