THE WORLD METEOROLOGICAL ORGANIZATION

60 YEARS OF SERVICE FOR YOUR SAFETY AND WELL-BEING

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FOREWORD

Sixty years ago, the World Meteorological Organization (WMO) was established with full confidence in its potential contributions to human security and welfare. It was indeed fortunate that its founders chose to build WMO upon the solid base previously laid by the International Meteorological Organization (IMO), which developed from a process launched in 1873. Today, WMO has good reason to celebrate its achievements, since its Convention has succeeded in providing all the strength and flexibility needed by WMO to take appropriate initiatives and to face the challenges it has encountered along the way.

From the beginning, international cooperation has been the hallmark of WMO. The Cold War was no impediment, since meteorology does not recognize political boundaries, so cooperation flourished even during those difficult years, as observational networks were extended to cover almost the entire globe and measurements included all traditional and even some non-traditional environmental parameters, such as radionuclides.

As we look back over the last six decades, there were several positive developments that opened up unprecedented scientific and technological possibilities for the Organization. For example, the launching of artificial satellites and the opportunities that they offered in terms of observations, accompanied by the rapid development of telecommunications and computers, were individual factors that fortunately converged to facilitate real-time international exchange of data and products and the implementation of the World Weather Watch, which soon became the basis for other WMO programmes.

Major contributions to social well-being evolved from marked improvement in weather forecasting, which in 1950 allowed only for 24- to 36-hour predictions of comparable quality to what we have today for seven-day forecasts. This would not have been possible without the international coordinating role played by WMO in observations, research, analysis and modelling, which led to longer-range predictions, now extending from a season to a year ahead.

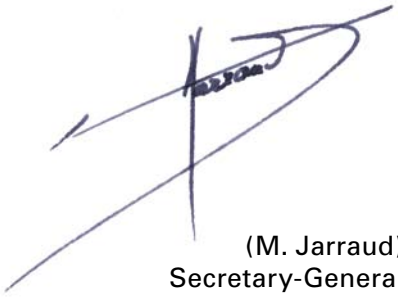
Authoritative observations and research gradually enabled WMO to tackle even bolder initiatives and to contribute to the very survival of our planet. In 1975, the world community was alerted to the thinning of our protective stratospheric ozone layer and, in 1976, it was further alerted by WMO to the potential consequences of the increasing anthropogenic global warming. Since then, climate change projections co-sponsored by WMO have convincingly anticipated the potential adverse impacts on society, ecosystems and our natural resources, to the point that climate change is seen today as a major challenge to human survival, which United Nations Secretary-General Ban Ki-moon has identified as the defining challenge of our era.

Natural hazards pose very serious threats to human security, so WMO has devoted considerable efforts to developing operational warning systems and effective preparedness measures, which have resulted in a considerable decrease in the associated loss of lives. In addition, surface and groundwater monitoring and quality controls have enabled WMO to issue authoritative warnings of dwindling water supplies, especially in view of mounting population pressure and water pollution, while integrated water resources management proposed by WMO is showing the way to optimize the exploitation of our limited freshwater resources.

To ensure that these benefits reach the 189 WMO Members, the Organization has devoted considerable attention to development needs of the National Meteorological and Hydrological Services (NMHSs), in particular in the Least Developed Countries, to guarantee that they have ready access to advanced products and the capacity to use them according to their national requirements and their global commitments, an objective which has always been a cornerstone of the fundamental mission of WMO.

Over the past 60 years, WMO has developed a vigorous system of standardized observational networks, the concept of a free and unrestricted exchange of data and products, and the capacity to promptly deliver the most appropriate services according to its Members' specific needs.

I am convinced that WMO will be even more relevant in serving humanity over the decades to come. For this capability we are all in debt to successive generations of meteorologists and hydrologists from all countries. To all of them we pay tribute on the occasion of the 2010 World Meteorological Day.



(M. Jarraud)
Secretary-General

INTRODUCTION

The World Meteorological Organization (WMO), created in 1950, was established as a Specialized Agency of the United Nations in 1951 in recognition of its potential contribution to world peace and human well-being. Its predecessor, the International Meteorological Organization, a non-governmental organization of meteorological services, had demonstrated the power of meteorology and related geophysical sciences in serving human welfare and security.

In the relatively short period of 60 years, the Organization, with its robust operational system and flexible networking, has come to play an essential role in human affairs, well beyond the expectations of its founders. Throughout the years, policymakers have found in meteorology a rallying point for cooperation. As meteorology does not recognize boundaries between countries, WMO has provided a unique framework for the exchange of weather, climate and hydrological information and services across frontiers.

WMO has been highly successful in organizing international cooperation in gathering observations, conducting research and scientific analysis, and developing forecast models and improving them. The quality of numerical weather prediction for seven days is now comparable to what it was for a 24- to 36-hour forecast 60 years ago, and this was achieved through international cooperation organized by WMO. Every decade, the WMO process has added about one day to the range of practically useful forecasts. This progress has led to the huge benefits that the global community is receiving from meteorology.

The achievements of WMO over the past 60 years have been possible thanks to the Organization's promotion of free and unrestricted exchange of meteorological and related data and products, its initiatives in setting international standards for meteorological and related observations, its work on capacity-building, its promotion of science and technology, and its international leadership in the field of meteorology and the environment.

BUILDING ON A SOLID PAST

The latter half of the eighteenth century and first half of the nineteenth century were marked by major developments in meteorology at the national and international levels. In 1780, the Mannheim *Societas Meteorologica Palatina* established the first international network comprising 40 weather observing stations extending over Europe and North America.

The availability of standardized observations, though limited, led to the development of synoptic weather charts over a large area. Around 1820, based on data from *Societas Meteorologica Palatina* in Mannheim and William Redfield of New York, the insightful weather maps prepared by H.W. Brandes of Leipzig showed the rotational and progressive nature of hurricanes, as well as the patterns of wind, atmospheric pressure and weather. In 1834, the Russian Hydrometeorological Service was established.

The invention of the electric telegraph by Samuel Morse (1843) marked a new era of real-time data collection, with unprecedented progress in weather forecasting and timely dissemination of forecasts.

Subsequently, three developments set the scene for advancement of the science of meteorology: growth in international trade and maritime shipping, accompanied by a corresponding need for its security and efficiency; rapid changes in society in the 1850s, which led to increased requirements for weather information; and industrial development, which placed greater demands on science and technology, and on meteorology in particular.

To help promote safety at sea for commercial operations, Lt Matthew F. Maury convened an international conference in Brussels in August 1853. The conference firmed up international cooperation in the field of marine meteorology and laid the groundwork for development and cooperation in other fields of meteorology. The period leading up to the Brussels Conference and the following two decades saw the establishment and consolidation of several National Meteorological Services.

The UK Met Office was established as a service to mariners in 1854, the same year the Royal Netherlands Meteorological Institute (KNMI) was founded. The Meteorological Service of Canada was established in 1871. In 1872, a law was enacted founding the Weather Bureau of Argentina, the first in the southern hemisphere. In Mauritius, the Observatory was established in 1874 to perform operational meteorological functions and other activities, such as astronomy, seismography and surface ozone monitoring. A disastrous tropical cyclone that struck Calcutta in 1864 and the failures of monsoon rains in 1866 and 1871 led to the establishment of the India Meteorological Department in 1875.

The establishment of National Meteorological Services in different parts of the world ushered in a new era of meteorological activity and cooperation. Networks were set up to issue warnings to allow for safe operations at sea and security on land, and to provide services and advice to a range of users. The scene was set for formalizing cooperation in meteorology across borders. The Vienna Congress, which was attended by representatives of 20 governments, convened in October 1873 and agreed on practical issues such as instruments and methods of observation, and the exchange of observations, as well the establishment of the International Meteorological Organization (IMO).

IMO was established as a non-governmental organization. In the early years, Directors of the National Meteorological Services debated the merits of involving governments in the IMO work. By 1935, IMO decided to invite governments to designate Directors of National Meteorological Services to represent them – a practice that led to the designation of Permanent Representatives of Members with WMO as established in the WMO Convention.

In 1935 Regional Commissions, later known as Regional Associations, were established with the African region being the first to adhere to the system. By 1947, the six Regional Associations were in place.

As the Organization had no permanent Secretariat, its work was carried out by Technical Commissions with the participation of experts provided voluntarily by Directors of National Meteorological Services. The Commissions covered a range of activities, including marine, agricultural and aviation meteorology; climatology; global networks; synoptic weather information; and oceanography. They also dealt with other geophysical fields, such as solar radiation, ozone, and terrestrial magnetism and atmospheric electricity.

Research was a key feature of IMO. While undertaking two major research projects in polar regions, IMO collaborated closely with various organizations. IMO brought these unique features to WMO and to the United Nations when WMO became a Specialized Agency of the United Nations in 1951, as its authoritative voice on weather, water and climate. Membership expanded from 37 Members in 1950 to its current 189 Members, including 183 States and six Territories.

WMO PROGRAMMES AT A GLANCE

WMO programmes are developed and implemented by all Members and their National Meteorological and Hydrological Services (NMHSs), which maintain networks for observations and data processing and dissemination, and provide weather and hydrological forecasts, climate predictions and related services and expertise.

Over the years, the WMO programmes have benefited from increasingly sophisticated instruments such as radars, remote-sensing equipment, satellites that double as telecommunications systems, and the increasingly powerful data-processing computers for weather forecasting and climate modelling.

World Weather Watch Programme (WWW)

Established in 1963, WWW combines observing systems on land, at sea, in the air and in outer space with telecommunication facilities and data-processing and forecasting centres to make available meteorological and related environmental data and forecast information and warnings. This information is crucial to ensure security and provide efficient services in all countries to all socio-economic sectors.

World Climate Programme (WCP)

WCP is the authoritative international undertaking aimed at managing climate data, monitoring and improving the understanding of the climate system along with its variability and change, and applying the information for the benefit of society. The Programme was established following the recommendation of the First World Climate Conference held in 1979.

Atmospheric Research and Environment Programme (AREP)

AREP has two main areas of activity: monitoring of and research on the composition of the atmosphere through the Global Atmospheric Watch (GAW), which addresses a variety of issues from climate change to ozone depletion and air quality; and the World Weather Research Programme, which aims

to advance the accuracy and lead time of weather predictions, with a focus on those weather events with large socio-economic impacts.

Application of Meteorology Programme (AMP)

AMP provides services to support the agriculture and food sector, the safety and efficiency of aeronautical operations, and effective marine operations and related oceanographic activities. It promotes observations and analysis of related data and the development of infrastructure, expertise and services for the benefit of the general public and various economic sectors. The Programme was instituted in 1983.

Hydrology and Water Resources Programme (HWRP)

HWRP, established in 1975, gives primary attention to the assessment of the quantity and quality of water resources, both surface and groundwater, in order to meet the needs of society, to permit mitigation of water-related hazards, and to maintain or enhance the condition of the global environment. It provides advice and assistance to countries on flood management policy and integrated water resources management.

Education and Training Programme (ETRP)

ETRP provides assistance to countries, especially developing ones, in obtaining personnel educated and trained to internationally agreed standards in order to carry out the activities and operations of NMHSs. The relevant activities are required at the global, regional and national levels for the effective provision of meteorological, climatological, hydrological, oceanographic and environmental services in support of sustainable development.

Technical Cooperation Programme

The Programme ensures the enhancement and development of the capabilities of NMHSs so that they can contribute to and participate efficiently in the implementation of WMO Programmes, in support of national socio-economic development activities and for the benefit of the global community.

Regional Programme

Tailored to address the specific needs of each of the six Regional Associations of WMO, the cross-cutting Regional Programme is an integral part of WMO's scientific and technical programmes.

Space Programme

The Space Programme coordinates environmental satellite matters and activities throughout all WMO Programmes and provides guidance on the potential of remote-sensing techniques and on continuous improvements in the provision of data, products and services from operational and research and development satellites in meteorology, hydrology and related disciplines and applications.

Disaster Risk Reduction (DRR) Programme

The strategic vision of the Programme is to enhance the contributions of NMHSs, in a more cost-effective, systematic and sustainable manner, to the protection of lives, livelihoods and property, through expanded capabilities and cooperation in the field of disaster risk reduction from the national to international levels.

In recognition of the increasing relevance of WMO programmes and activities to all socio-economic sectors, the preamble to the WMO Convention now emphasizes meteorological, hydrological and related services in support of relevant national and international needs. To help meet this objective, the WMO Strategic Plan shifts the focus from programmes to making a contribution to major societal issues.

SYNERGY AMONG CLIMATE PROGRAMMES

WMO sponsors several climate-related programmes and hosts four of their Secretariats, bringing considerable synergy to the field.

Intergovernmental Panel on Climate Change (IPCC)

IPCC was established in 1988 by WMO and the United Nations Environment Programme (UNEP) as a scientific and intergovernmental body with

responsibility for assessing climate change science, its impacts and policy options. It draws on the most recent scientific, technical and socio-economic information published worldwide. Thousands of scientists from all over the world contribute voluntarily to the work of IPCC.

The IPCC First Assessment Report, published in 1990, contributed to the initiation of the United Nations Framework Convention on Climate Change. The Second Assessment Report, which was issued in 1995, alerted the global community to the possible impact of human activities on climate and led to the adoption of the Kyoto Protocol. The Third Assessment Report (2001) reaffirmed the human impact on climate change and the Fourth Assessment Report (2007) raised the urgency of action to curb greenhouse gas emissions. IPCC was awarded the Nobel Peace Prize in 2007.

World Climate Research Programme (WCRP)

WCRP was established in 1980 by WMO and the International Council for Science (ICSU), and since 1993 it has also been sponsored by the Intergovernmental Oceanographic Commission (IOC) of UNESCO. Its main objectives are to determine the predictability of climate and the effect of human activities on climate.

WCRP organizes international large-scale observational and modelling projects. Its Tropical Ocean Global Atmosphere project (1985–1994) led to the understanding of El Niño and La Niña phenomena and the operational use of this information in mitigating the impacts in extreme events, agriculture and water resource management.

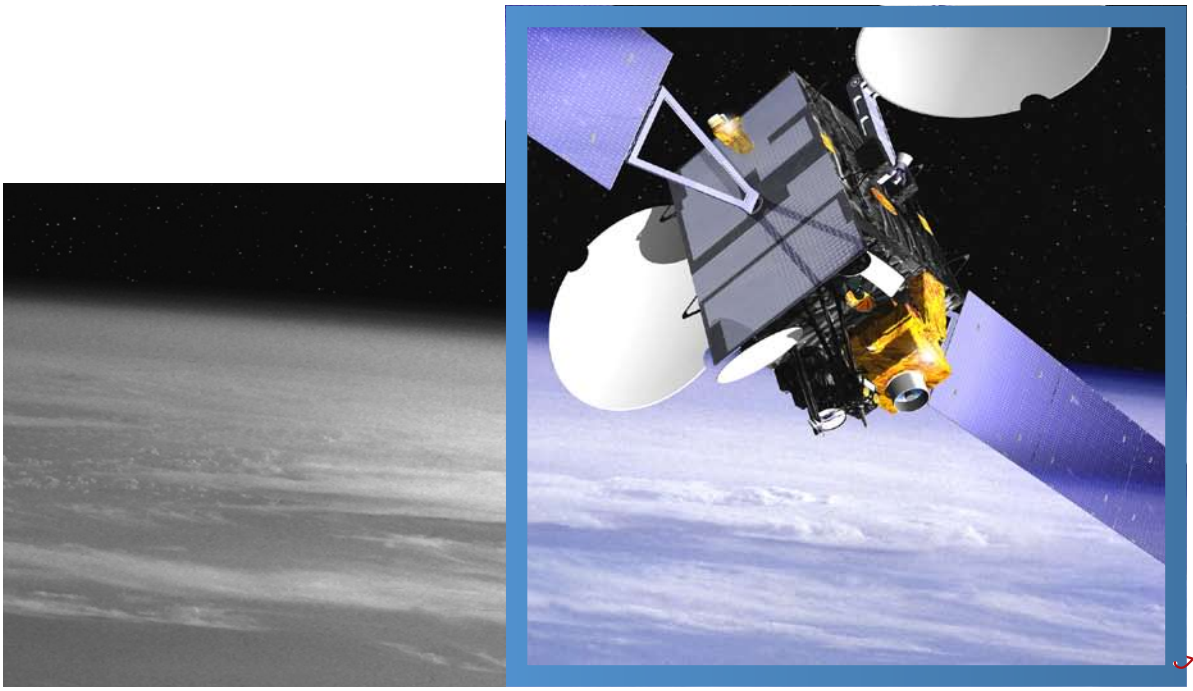
Today, WCRP encompasses four major core projects: the Global Energy and Water Cycle Experiment; Climate Variability and Predictability; Stratospheric Processes and their Role in Climate; and Climate and Cryosphere. These projects and others have enabled WCRP to monitor, simulate and project global climate with unprecedented accuracy.

Global Climate Observing System (GCOS)

GCOS was established in 1992 as a joint undertaking of WMO, the Intergovernmental Oceanographic Commission of UNESCO, UNEP and the International Council for Science. It provides an operational framework for integrating and enhancing observations required for addressing the total climate system, including physical, chemical and biological properties, as well as atmospheric, oceanic, terrestrial, hydrologic and cryospheric components.

GCOS does not directly make observations or generate data and products. It builds upon, and works in partnership with, existing and developing observing systems, in particular the WMO Global Observing System and Global Atmosphere Watch, the Global Ocean Observing System, and the Global Terrestrial Observing System. It includes in situ, airborne and space-based observing components.

The Members belonging to one of the six WMO Regional Associations have committed to the operation of a Regional Basic Climatological Network (RBCN), which is an agreed selection of surface and upper-air meteorological observing stations of the Global Observing System. Worldwide, about 2 600 surface stations and 510 upper-air stations belong to the six RBCNs and the Antarctic Basic Climatological Network. They generate monthly averages of meteorological parameters measured at the surface and in vertical layers of the atmosphere up to 30 kilometres. The data are archived in and made available by the two WMO World Data Centres.



SIXTY YEARS OF SERVICE

The formative years (1950–1963)

The early years were marked by efforts to achieve uniformity of meteorological practices with the publication of technical regulations and the development of guides. For the first time, detailed specifications for national and regional climate atlases were drawn up.

The International Geophysical Year (1957–1958), initiated by the International Council of Scientific Unions (ICSU), now the International Council for Science, was a major landmark for international research collaboration on 11 disciplines in the earth sciences. WMO took the responsibility of developing and implementing the meteorology component of this global research programme, forming the foundation for the Organization's leadership role, and for its tradition of international cooperation and working with non-governmental organizations.

WMO has supported the National Meteorological and Hydrological Services of a growing number of new Members through an active technical assistance programme. Expansion of weather-sensitive activities (such as transportation, energy production and tourism) and the continuous need for improved accuracy of forecasts has prompted an increase in observations at surface and upper levels of the atmosphere. By 1963, more than 3 000 ships were providing observations from the oceans. The advent of radio-teletypewriter, facsimile and other radio transmission stations facilitated the availability of real-time data and the preparation and dissemination of weather maps.

The technological revolution (1964–1970)

Undoubtedly, the most significant development was the World Weather Watch Programme, a concept mentioned by the United Nations in its resolution on the peaceful use of space. The resulting system was unique in its establishment of the Global Observing System (GOS), as well as the Global Data-processing and Forecasting System and Global Telecommunication System, which were made possible by the advances in remote-sensing, satellites, communications and computers.

A system of global, regional and national meteorological centres operated by Members ensured the collection of observations and distribution of data and products that left no country out of the process. The system was developed through cooperation among all nations in the midst of the Cold War. By the end of 1972, there were about 8 500 surface stations, 5 500 merchant and ocean weather ships, and commercial aircraft and meteorological satellites all working together within the framework of the WMO system.

A significant development, called for by the United Nations in 1962, was the initiation of a global weather experiment known as the Global Atmospheric Research Programme (GARP). The programme implemented over the next decade led to considerable advances in weather forecasting and climate prediction, with far-reaching implications for human security and well-being.

During this period, a number of newly independent States joined WMO. In order to complement resources from the United Nations Development Programme (UNDP) and provide effective and timely support, WMO established its own Voluntary Assistance Programme, which was later renamed the Voluntary Cooperation Programme.

Decade of initiatives (1971–1980)

The catastrophic Sahelian drought of the late 1960s and early 1970s led WMO to take decisive action in support of the countries concerned. The AGRHYMET Centre in Niamey, Niger, was established for capacity-building and applying agrometeorology and hydrology to the mitigation of drought and desertification, with a view to promoting food security. In 1977, WMO participated actively in the United Nations Conference on Desertification and developed an Action Plan on drought and desertification, which has provided valuable guidance to other countries.

The loss of more than 400 000 lives in Bangladesh in 1970 led WMO to reinforce its Typhoon Committee, which was formed in 1968 and has been operated in collaboration with the United Nations Economic and Social Commission for Asia and the Pacific. In 1971, WMO established the Tropical Cyclone Project, which was later upgraded to the level of a programme.

Continuing concern about the degradation of the environment led the United Nations to convene the United Nations Conference on the Human Environment in 1972. WMO contributed extensively

Reduction of risk of natural disasters

Between 1980 and 2005, nearly 7 500 natural disasters worldwide took the lives of over 2 million people and caused economic losses estimated at more than US$ 1.2 trillion. Ninety per cent of these natural disasters, 72.5 per cent of the casualties and 75 per cent of the economic losses have been of meteorological and hydrological origin. The number of casualties has decreased significantly, however, primarily as a result of preparedness and prevention efforts, combined with effective early warning systems and emergency management.

WMO collaborates closely with other organizations and is one of the leading agencies in the United Nations for the International Strategy for Disaster Reduction and its predecessor. WMO contributed extensively to the World Conference on Disaster Reduction, which was held in Kobe in 2005 and adopted the Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters. The Framework emphasizes the critical need for disaster early warnings to minimize risk and enable emergency response.

In order to provide an integrating framework for its disaster risk reduction processes related to meteorological, hydrological and climate services, WMO established its Disaster Risk Reduction Programme in 2003 and advocated for multi-hazard early warning systems based on solid operational capabilities.

to the Conference, which resulted in the creation of the United Nations Environment Programme. WMO and UNEP maintain a close partnership, complementing each other in several areas, such as climate change, stratospheric ozone depletion and atmospheric pollution control.

In 1975, WMO issued its first scientific statement on modification of the ozone layer as a result of human activities and some possible geophysical consequences. This statement paved the way for actions including improved monitoring, research, and adoption of a convention and protocols on the protection of the ozone layer in 1985 and 1987, respectively.

In 1976, WMO issued the first authoritative statement on the potential impact of an increase in carbon dioxide from fossil fuels. This landmark statement was the first signal of the impending threat of global warming due to human activities. WMO also took the lead in convening the first World Climate Conference in 1979.

During the 1970s, WMO and ICSU partnered to initiate the decade-long GARP, which was the largest and most complex international research project ever launched. In the 1970s, it had two major undertakings. The 1974 GARP Atlantic Tropical Experiment explored the role of the tropics as the primary energy source for global atmospheric circulation. The other, known as the First GARP Global Experiment, or FGGE, was carried out from 1978 to 1979 and contributed to defining the global atmospheric circulation and to developing more realistic mathematical models for medium- and extended-range weather forecasts and for climate projections. Other related regional experiments were MONEX for the Asian monsoon and ALPEX for the Alpine region.

While GARP led to the establishment of a sustained tropical meteorological research effort at WMO, another important initiative was the research and planning of the 1979 weather modification experiment in Spain. It gave rise to improved understanding of processes involved and the authoritative WMO statement on the subject.

Climate and ozone (1981–1990)

Several of the initiatives of the previous years came to fruition in this decade, with numerous actions on the climate and ozone fronts.

The World Climate Programme was established, with its four components related to data, research,

Global Observing System (GOS)

The Twelfth World Meteorological Congress (1995) adopted Resolution 40 "WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities" to facilitate worldwide cooperation in the establishment of observing networks and to promote the exchange of meteorological and related information in the interest of all nations.

As one of the main components of WWW, GOS coordinates the provision of reliable meteorological observations on a global scale. GOS comprises observing facilities on land, at sea, in the air and in outer space, with some 11 000 land stations, 1 300 upper-air stations, 4 000 ships, 1 200 drifting and 200 moored buoys, and 3 000 ARGO profiling floats, as well as 3 000 commercial aircraft, five operational polar-orbiting meteorological satellites, six geostationary meteorological satellites, and several environmental research and development satellites. These facilities are owned and operated by the WMO Members, each undertaking certain responsibilities in an agreed global scheme so that all can benefit from the data and services generated.

impacts and applications. The 1985 Villach Conference assessment of the role of carbon dioxide and other greenhouse gases in climate variations provided the first universally accepted statement on the most likely magnitude of global warming and its consequences.

WMO action led to the establishment of the 1985 Vienna Convention on the Protection of the Ozone Layer and the 1987 Montreal Protocol on substances that deplete the ozone layer. As a result, science-based policy has contributed to the phasing out of ozone-depleting substances, with a return to normality projected over the coming 50-year period.

Natural disasters and sustainable development (1991–2000)

The recurrence of extreme weather events, such as the 1982–1983 El Niño-related disasters, and concern about the continued degradation of the environment gave rise to three major developments during the decade: the 1992 International Conference on Water and Environment; the 1992 United Nations Conference on Environment and Development; and the 1990–1999 United Nations International Decade for Natural Disaster Reduction.

The period also saw the entry into force of the United Nations Framework Convention on Climate Change (UNFCCC) and its 1997 Kyoto Protocol, as well as the United Nations Convention to Combat Desertification in 1994 and the Convention on Biological Diversity in 1993.

The Intergovernmental Panel on Climate Change issued its groundbreaking First and Second Assessment Reports in 1990 and 1995. The latter report concluded that the "balance of evidence suggests a discernible human influence on global climate".

Climate change (2001–2010)

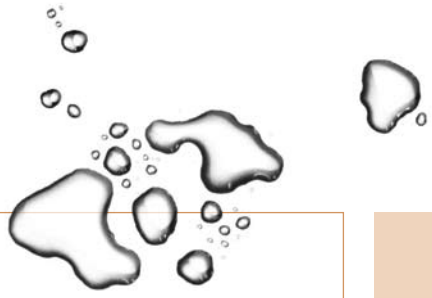
The WMO authoritative statement in 1976 on the impact of the observed greenhouse gas increase on climate is a milestone in history. It marked the beginning of climate protection activities. It was the steady perseverance of climate scientists, supported by the activities of WMO and other partners, that ultimately brought climate change to the forefront of the global agenda.

The turn of the century has been dominated by the overriding concern about climate change. The 2001 IPCC Third Assessment Report concluded: "there is now stronger evidence for a human influence on the global climate". The initial scepticism gave rise to genuine concern for the Earth's climate and life as it is known today. The 2007 Fourth Assessment Report states that "warming of the climate system is unequivocal" and that "most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations."

Successful cooperation with airlines

Since the early days of WMO, collaboration with civil aviation has been mutually beneficial to the Organization and the industry. The need for weather services for aviation triggered the establishment of a considerable number of National Meteorological Services. Improved capability in monitoring and predicting weather conditions, especially those hazardous to aeronautical operations, contributes to the safe and efficient operation of aircraft.

An important area of cooperation has been the Aircraft Meteorological Data Relay (AMDAR), in which aircraft collect meteorological data, such as air pressure, temperature and wind, and transmit this information to the WMO network. Between 2004 and 2008, AMDAR reports increased from 139 000 to 260 000 per year.



Provide hydrological foundations

For more than 70 years, WMO and its predecessor have supported National Hydrological Services, river basin organizations and other institutions in enhancing water management capability. WMO provides the framework for assessment of the quantity and quality of water resources, both surface sources and groundwater, for meeting the needs of society. It contributes to the mitigation of water-related hazards and improvement of the global environment.

WMO gives high priority to standardization of various aspects of hydrological observations and the organized transfer of technologies. WMO implements the World Hydrological Cycle Observing System (WHYCOS) in various parts of the world to promote cooperation in the collection, analysis, exchange and use of weather-related information.

In 1999, WMO adopted a policy of free exchange of data in the field of hydrology. As water cuts across many of the activities of other organizations, WMO actively promotes international cooperation and participates in UN-Water, the United Nations mechanism to coordinate water-related activities across the United Nations System.

Satellite observations and services

The use of meteorological and environmental satellites to observe Earth from space is one of the key tools in monitoring weather, climate and hazards worldwide. This 24-hour global coverage provides a never-ending stream of information that is critical for modelling and forecasting. The data that are collected are used for monitoring the atmosphere, providing information on temperature and humidity, identifying cloud types, measuring wind, tracking tropical cyclones, and monitoring ozone, atmospheric composition, aerosols and the radiation budget. Down at the Earth's surface, satellites help to monitor sea level, wave height, sea-surface temperature and salinity, and the presence of phytoplankton. Over land, satellites are used in the observation of snow and ice cover, vegetation status, soil temperature, and albedo, which are other key parameters for climate monitoring.

WMO ensures cooperation so that countries operating satellites provide for global coverage on a continuous, long-term basis and make essential products in weather forecasting, disaster mitigation, and climate monitoring available in a free and unrestricted manner to all nations.

WMO Information System (WIS)

WIS is an overarching system that is to be used for the collection and sharing of information for all WMO and related international programmes. WIS will tremendously expand the capacities of information flow, which was in past decades supported by the Global Telecommunications System of WWW. It will provide three fundamental types of services to meet the different requirements: routine collection and dissemination service for time-critical and operation-critical data and products; data discovery, access and retrieval service; and timely delivery service for data and products. WIS implementation will build upon existing WMO information systems in a smooth and evolutionary process.

World Climate Conferences

First World Climate Conference (1979)

The first Conference helped to focus world attention on the state of our climate and the means required to answer a growing number of questions on climate variability and change and their impacts on society. Four major programmes were identified to address issues related to data, applications, research and impact. Together with ICSU, WMO took responsibility for the first three areas, which involve observations and research, while UNEP took the lead on the impact programme.

In order to enhance scientific knowledge, the first Conference launched the World Climate Programme and the World Climate Research Programme.

Over the next decade, considerable progress was made at the national and international levels. The processes set in motion ultimately led to the 1985 landmark Villach Conference and the establishment of the IPCC.

Second World Climate Conference (1990)

In the light of these momentous developments over the 1980s, WMO took the initiative with its partners to convene another global conference at the high political level. The Conference called for increased support for enhanced climate monitoring and research, recognized the special needs of developing countries, and advocated measures for the stabilization of greenhouse gases and urgent negotiation of a framework convention on climate change. As a result, WMO and its partners established the Global Climate Observing System. The Conference also provided decisive momentum leading to the creation of the UNFCCC.

World Climate Conference-3 (WCC-3) (2009)

WCC-3 addressed the issue of climate prediction for decision-making. Its High-level Segment, attended by high-level dignitaries from 160 countries, decided to establish a Global Framework for Climate Services to strengthen the production, availability, delivery and application of science-based climate predictions and services. The Framework will spur the development of climate information required by decision-makers and the public at global, regional and local levels.

COOPERATING INTERNATIONALLY

WMO has collaborated broadly across the United Nations System and across regions to promote monitoring, research, prediction, projection and assessment of the Earth system.

United Nations System Delivering as One

The United Nations System has provided outreach, recognition and improved capabilities to WMO to undertake its mission. On several occasions, WMO has been called upon to take the lead on climate knowledge and to collaborate with other organizations in the implementation of global initiatives.

WMO participated in the United Nations technical assistance programme for developing countries and organized its first technical assistance mission in June 1952. In the following year, the first WMO fellow commenced his study abroad. Since then, WMO has developed a strong technical cooperation programme, often with funding from the United Nations Development Programme.

In 1954, the United Nations Economic and Social Council called upon organizations to collect hydrological data for urgent water resources assessment. As there was no organization that was focused entirely on water problems, WMO assumed the responsibility for collecting hydrological data and for standardization.

A United Nations Resolution in 1961 on international cooperation in the peaceful uses of outer space considered atmospheric sciences, weather forecasting and related questions. It had a profound impact on WMO, marking the beginning of a process that led to the establishment of the World Weather Watch Programme.

In 1962, the United Nations called upon the International Council for Science to develop an expanded programme of atmospheric science research as a complement to the WMO programmes. This resolution led to the Global Atmosphere Watch, which has greatly influenced weather and climate forecasting and subsequent research activities.

In 1970, following the catastrophic cyclone in Bangladesh, the United Nations called upon WMO to mobilize scientists and technologies to mitigate harmful effects of tropical cyclones. This resolution led to further strengthening of cooperation with the United Nations Economic and Social Commission for Asia and the Pacific, and subsequently led to the formation of the WMO Tropical Cyclone Programme in 1979.

WMO also collaborated actively in the 1972 United Nations Conference on the Human Environment, which resulted in the establishment of the United Nations Environment Programme. At the request of the United Nations, WMO contributed extensively to the preparation and implementation of the Conference and various follow-up initiatives, including several that WMO and UNEP undertook jointly.

The Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollution in Europe (EMEP) was established in 1978 under the auspices of the United Nations Commission for Europe with the assistance of WMO and UNEP. After adoption of the Convention on Long-range Transboundary Air Pollution in Geneva on 13 November 1979, EMEP was implemented.

In the area of natural disaster mitigation, WMO made significant contributions to the development and implementation of the International Decade for Natural Disaster Reduction in the 1990s, the successor 1999 International Strategy for Disaster Reduction, and the 2005 Hyogo Framework for Action 2005–2015.

The establishment of the Joint Commission on Oceanography and Marine Meteorology (JCOMM), sponsored by WMO and IOC of UNESCO, is a unique cooperative venture within the United Nations system. It has brought together the marine meteorological and oceanographic communities, both nationally and internationally, and has integrated operational marine activities, including efforts aimed at significant advancement of the Global Climate Observing System.

As of 2008, WMO and UNESCO have been leading the coordinated action of the United Nations System to Deliver as One on Climate Knowledge. WMO participates in most of the United Nations System interagency mechanisms and has developed extensive partnerships with many United Nations System organizations, including the Food and Agriculture Organization; the World Food Programme; the International Maritime Organization; the International Civil Aviation Organization; the United Nations World Tourism Organization; the Universal Postal Union; the United Nations Environment Programme; the International Telecommunications Union; the United Nations Industrial Development Organization; the World Health Organization; Secretariats of the UNFCCC, the United Nations

AGRHYMET

In 1974, following the harrowing drought of the late 1960s and early 1970s, nine Sahelian countries established the AGRHYMET Centre in Niamey, Niger, as a specialized institution of the Comité Permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel. Its objectives are to contribute to food production and security, improve management of natural resources and undertake training in related fields. As a centre of excellence, AGRHYMET provides for the monitoring of agrometeorological, hydrological and natural resources and the dissemination of information, with follow-up advice to farmers and policymakers. The Centre maintains a databank and a laboratory for the maintenance of equipment and instruments, and it provides training in relevant fields. WMO contributed to the establishment of the Centre and continues to support its activities.

Convention to Combat Desertification and other related conventions; the World Bank; and many other intergovernmental and non-governmental organizations.

Regional Cooperation

Regional cooperation has been the cornerstone of WMO policy for the development of facilities and capacities. Developing countries in particular require some measure of support, especially until they are able to take over the operation of the institutions themselves. For all regions, WMO remains a core mechanism for initiating cooperation and enabling regions to operate in the wider regional or global context, while closely collaborating with the regional economic bodies.

Regional Training Centres (RTCs), located at more than two dozen sites worldwide, provide institutional and human resources development in meteorology, hydrology and climate. The RTCs promote the exchange of research and operational resources.

WMO designates Regional Specialized Meteorological Centres (RSMCs) with different areas of specialization in terms of geographical coverage and activities, including tropical cyclone forecasting and environmental emergency responses, as well as special centres such as drought monitoring centres and the African Centre of Meteorological Applications for Development (ACMAD).

ACMAD was created in 1987 by the Conference of Ministers of the United Nations Economic Commission for Africa. It was initiated by WMO in response to the severe drought of the early 1980s. The Centre has developed a framework for collaboration with African NMHSs involving operational activities that generate prediction products and information. It is also engaged in research and development efforts, including regional capacity-building and training on weather and climate for meteorological personnel and other stakeholders.

WMO drought monitoring centres have been established in Slovenia (the Drought Management Centre for Southeastern Europe), in Harare, Zimbabwe (the South African Development Community Drought Monitoring Centre, serving Eastern and Southern Africa), and in Nairobi, Kenya (the Intergovernmental Authority on Development Climate Prediction and Applications Centre, or IPAC).

IPAC was formed in 1989 by WMO to serve 24 countries in Eastern and Southern Africa. In October 2003, the Intergovernmental Authority on Development (IGAD), the economic community of the Greater Horn of Africa, adopted it as a specialized institution and the Centre was renamed IGAD Climate Prediction and Applications Centre. Its activities include the provision of climate early warning information and support for various sectoral applications to enable the region to cope with climate variability and change.

International Research Centre on El Niño

Understanding the El Niño phenomenon and the associated pressure see-saw between northern Australia and the Pacific that occurs every two to seven years has contributed significantly to seasonal weather prediction and the forecasting of its global impact. El Niño causes drought conditions with accompanying forest fires in Southern Africa, Australia and Indonesia; flooding in Peru; and a decline in the number of tropical cyclones in the Atlantic. In recent times, the most intense episodes have been those in 1982–1983 and 1998, which resulted in the highest global average surface temperature ever recorded.

In 1997, the United Nations called for international cooperation to reduce the impact of the El Niño phenomenon. An international centre was established in 2003 in Guayaquil, Ecuador, and WMO played a major role in its formation. The Centre provides sea-surface temperature analysis, seasonal forecasts for western South America, a regional climate database, health–climate information and climate-based agriculture risk maps.

Regional Climate Outlook Forums (RCOFs) are operational in several parts of the world and they are responsible for producing and disseminating assessments of the state of the regional climate for the upcoming season. NMHS experts, working with users of climate information at the RCOFs, produce and distribute regional, consensus-based climate predictions for the upcoming season. Built into the RCOF process is a regional network of the climate service providers and user-sector representatives, within which users can interact with climate experts and discuss technical information and products (such as analyses, forecasts and probabilities) with the information providers from NMHSs.

A new development is the establishment of Regional Climate Centres. They are designed to assist WMO Members in a given region in the delivery of better climate services and products, including regional long-range forecasts, and to strengthen their capacity to meet national climate information needs.

EMPOWERING ALL NATIONS

The success of WMO is undoubtedly due to its commitment to ensuring universal involvement in its activities. To achieve global participation, WMO has developed a strong technical cooperation programme, which complements the support provided by developing countries to their NMHSs. Through a range of collaborative efforts with development agencies, including the United Nations Development Programme, the World Bank, the World Food Programme and the European Commission, WMO provides assistance to countries to ensure efficient and reliable operation of National Meteorological and Hydrological Services in support of their national sustainable development activities. This allows countries to contribute to, and participate in, the implementation of WMO Programmes, for the benefit of the global community.

Capacity-building

Human resources development was considered essential by the International Meteorological Organization in order to support the work of its commissions and the expansion of observing networks. Since its inception, WMO has placed high priority on education and training. The emergence of NMHSs, especially those of newly independent countries in Africa, required urgent action aimed at building their capacity.

A guide to professional training was developed, along with the intensification of training activities and the awarding of fellowships. In 1965, the first of the 23 Regional Meteorological Training Centres that operate today were established. Manuals were developed starting in 1966 for the training of personnel in various disciplines. A library with a wide range of texts, publications, journals and films was set up in the WMO Secretariat in 1967.

WMO attaches great importance to training because it is vital for the maintenance and operation of the global monitoring and early warning systems and for the delivery of services at the national level, which are designed to ensure the security and well-being of all nations.

WORLD METEOROLOGICAL ORGANIZATION
60 YEARS OF SERVICE FOR YOUR SAFETY AND WELL-BEING

SIXTY WAYS WMO MAKES A DIFFERENCE

CONTRIBUTING TO PEACE AND SECURITY

1 Contributing to peace

In 2007, the United Nations Security Council discussed climate change as a potential threat to peace and security. Other potential causes of conflict could arise from inequitable sharing of water from transboundary rivers and the damage resulting from pollutants travelling across frontiers. Weather, climate and water information from WMO ensures transparency and contributes to building mutual trust and maintaining peace. The 2007 Nobel Peace Prize was awarded to the WMO/UNEP-sponsored Intergovernmental Panel on Climate Change in recognition of its work related to climate change over two decades.

2 Safety from radioactive fallout

WMO, in close collaboration with the International Atomic Energy Agency, monitors and exchanges information on the transboundary movement and intensity of radionuclides in air and water, including those arising from nuclear accidents. This information is also used in preventive diplomacy and other forms of pre-emptive actions that defuse potential conflicts.

TAKING THE PULSE OF EARTH SYSTEMS

3 Observing our planet for a better future

WMO and its predecessor have ensured the systematic monitoring of weather, climate, surface and groundwater, the oceans, and constituents in the atmosphere for over 150 years. These data are standardized and quality controlled and serve as authoritative information for numerous applications worldwide. Satellite measurements of the parameters of the Earth's weather systems, ocean and land surface, radiation balance and composition of the atmosphere are an integral part of the WMO Global Observing System.

PRESERVING HUMAN HERITAGE

4 Preserving data

Weather, climate, water and environmental data, some generated for over a century, are compiled and archived nationally and internationally according to international standards and agreements established by WMO. The information is complemented by proxy and paleoclimate data and is stored in WMO World Data Centres.

IMPROVING WEATHER AND CLIMATE FORECASTS

5 Improving weather forecasts

A major achievement has been the continued improvement in weather forecasts through models that represent more accurately the physical and chemical processes that underlie the evolution of weather. Cooperative efforts have made it possible for a five-day forecast to be as reliable as a two-day forecast was 20 years ago.

6 Improving climate predictions for a season to a year

Over the past 30 years, scientific research sponsored by WMO and its partners has led to considerable improvement in understanding the climate system and in providing predictions for a season to a year ahead, accompanied by a projection of impacts. The most successful effort has been the prediction of El Niño and La Niña phenomena.

7 Predicting climate at the regional scale

While considerable progress has been made in global climate projections, climate change requires society to have reliable regional climate predictions to plan efficiently and adapt in areas such as food production, water resources, coastal protection, energy, environment and health. WMO is addressing regional-scale prediction as a priority.

8 Knowing our future climate

In 1976, WMO issued the first authoritative statement on global climate change as a result of the observed increase in greenhouse gases. Considerable progress in climate modelling, with the aid of the most powerful computers, means that it is possible to make climate projections several decades to a century ahead and to predict the potential implications for Earth systems. This has led to the recognition that humans are contributing to global climate change.

ACCESSING VITAL INFORMATION

9 Providing local access to a global network

WMO provides a unique system for the real-time exchange and availability to all nations of weather data and products, including information from satellites over its dedicated telecommunications network. These products are used in daily forecasts and warnings, and in numerous socio-economic activities and environmental monitoring. This operational system enables all nations to access information related to other hazards such as tsunamis, seismic activity and transport of radioactive or chemical pollutants.

10 Free and unrestricted exchange of data and products

A major contribution to the safety and well-being of humanity is the increasing availability of weather, climate, water and related environmental and other data and products at global and national levels. This arrangement has been at the core of real-time weather services, increasingly accurate warning systems with longer lead time, climate projections on timescales of a season to a year to a decade, climate change detection and attribution, and a wide spectrum of environmental programmes.

USING CLIMATE INFORMATION

11 Applying climate information to sustainable development

Climate information aids in planning and decision-making related to socio-economic activities, environmental protection and disaster mitigation. In particular, this information is used in the management of health, energy, urban development, water, agriculture and food security, and tourism.

WMO facilitates the development and sharing of guidance on the use of such data.

PROTECTING OUR ENVIRONMENT

12 Observing our climate

WMO systematically monitors concentrations of atmospheric gases, including carbon dioxide, methane and nitrous oxide. The First World Climate Conference, convened by WMO, led to alerts about climate change and resulted in the creation of the World Climate Programme, the World Climate Research Programme and IPCC, which was given responsibility for assessment activities. The Second World Climate Conference led to the UNFCCC and the Kyoto Protocol. WCC-3 is leading to the establishment of the Global Framework for Climate Services.

13 Timely advisories and early warnings on air quality

The World Health Organization estimates that about 2.3 million people die each year from air pollution. To address this problem, WMO Members monitor air quality by measuring oxides of sulphur, nitrogen and carbon, surface ozone, volatile organic compounds, and particulates, as well as levels of pollen and dust. These measurements are used in issuing timely warnings about the nature and concentration of pollutants that can cause asthma, other respiratory illnesses, and heart problems.

14 Preserving the ozone layer

By monitoring the protective ozone layer some 20 to 30 kilometres above the Earth's surface, since 1975 WMO has been instrumental in alerting the global community to the danger of an 'ozone hole'. As a result, the Vienna Convention on the Protection of the Ozone Layer (1985) and its Montreal Protocol on Substances that Deplete the Ozone Layer (1987) were adopted and nations have been phasing out ozone-depleting chemicals.

15 Safeguarding life from ultraviolet light exposure

As a result of the continuous monitoring of the thickness of the ozone layer by WMO, its Members are able to issue UV Index information around the globe for the protection of citizens. Ultraviolet radiation has harmful effects on human, plant and aquatic life. Prolonged exposure may cause skin cancer and cataracts and may adversely affect the human immune system.

16 Protecting from sand- and duststorms

Early warnings of sand- and duststorms are helpful in mitigating their health impacts, as well as damage to property, ecosystems, agriculture and transport. The WMO Sand and Dust Storm Warning and Assessment System is being implemented through collaborative efforts in the regions concerned.

17 Dealing with acid rain

Acid rain due to chemicals from fossil fuel burning has negative consequences for plants, freshwater fish populations and the built environment. WMO maintains a constant watch on the components that cause acid rain. The Convention on Long-range Transboundary Pollution in Europe, initiated by WMO, has been effective in decreasing emissions of sulphur dioxide. The problem of acid deposition is increasing in the developing world.

PROVIDING ENVIRONMENTAL WARNINGS

18 Issuing volcanic ash alerts

WMO issues advisories regarding volcanic ash and its movements in the atmosphere following eruptions that spew voluminous amounts of ash. The ash poses a threat to aircraft operations and human health, and may cause a temporary drop in global temperatures.

19 Warning of the movement of oil spills at sea

In the event of oil spills, the WMO system provides warnings of their movement with projections of landfall. Suitable mitigating measures may thus be undertaken ahead of time in the threatened regions.

20 Warning of forest and wildfires

Devastating fires are often triggered by lightning or human actions, especially under dry conditions.

They may destroy not only forests, grasslands, crops and wildlife, but also settlements, and they may put human lives at risk. The WMO system monitors drought conditions and provides advance warnings of areas at risk. WMO also develops wildfire warning systems in the regions concerned.

21 Underpinning international laws on environment

A number of environmental laws, including those on the thinning of the ozone layer, transboundary transport of pollutants and the increase in greenhouse gases, were promulgated on the basis of observations made by the WMO systems. Compliance, control and further refinements of these laws require constant monitoring and the availability of authoritative data provided by WMO.

STRENGTHENING INTEGRATED WATER MANAGEMENT

22 Assessing water resources

Freshwater resources are diminishing and deteriorating under demographic and climate pressures. Knowledge of available water resources at the national level is essential for the management of domestic and industrial water use, irrigation, and hydropower generation. WMO provides for the monitoring of surface and groundwater, data exchange, and the application of data to water resources management.

23 Integrated water resources management

WMO ensures the preparation of suitable forecasts needed to plan water storage, agricultural activities, urban development, the prevention of flood-related disasters, and public health measures involving water quality. This effort contributes to an integrated, multidisciplinary approach to managing water resources.

PROTECTING THE OCEANS

24 Keeping coastal communities safe

Over half of the world's population lives near the coast. WMO advisories and warnings of tropical cyclones, high waves, storm surges and coastal flooding contribute to the safety of people living in coastal communities. In many countries, tsunami warnings are provided by NMHSs.

25 Contributing to safe ocean drilling and mining

The efficient and safe operation of offshore oil and gas installations relies on knowledge of marine forecasts of extreme weather events. Ocean mining requires similar information to ensure safety. The WMO network allows for the delivery of such information.

26 Ensuring secure pollution clean-up and search-and-rescue operations

An increase in the pollution of oceans and coastal waters has been observed recently. Sound information about the weather and the state of the sea from the WMO system is vital for safe clean-up operations. Search-and-rescue efforts also rely on the ready availability of such information.

TOWARDS A SAFER WORLD

27 Vulnerability and risk reduction

An important dimension in building risk-resilient communities is the assessment of their vulnerability and ensuring their preparedness. WMO contributes to this effort by making the relevant data on hazards available. WMO is a major pillar of the United Nations International Strategy for Disaster Reduction and the Hyogo Framework for Action 2005–2015.

28 Cyclone preparedness and damage prevention

Natural hazards of hydrometeorological origin such as tropical cyclones, droughts, floods and tornadoes are a constant threat to human security, economic development and well-being. A major contribution of WMO has been its system of early warnings as a key for preparedness and damage prevention. The WMO Tropical Cyclone Warning Centres have proved their effectiveness in significantly reducing the loss of life.

29 Early warning against drought

Drought is an insidious natural hazard that has implications for human activities and the environment. In addition, more than 250 million people are directly affected by desertification. Some 1 billion people in over 100 countries are at risk. WMO takes the lead in monitoring the phenomena through the timely collection of climatological and hydrological data and by issuing early warnings. It also actively supports the United Nations Convention to Combat Desertification (UNCCD). Several specialized regional drought monitoring centres have been established by WMO in collaboration with UNCCD.

30 Warnings of floods

Floods threaten human life and property worldwide. Some 1.5 billion people were affected by flooding in the last decade of the twentieth century. Climate change may lead to more frequent occurrences of catastrophic flooding. The WMO system allows for the prediction and monitoring of potential flood conditions and the delivery of advance warnings.

31 Warning of other hazards

Specialized centres operated by WMO provide early and timely warnings of all other weather- and climate-related hazards, such as forest fires, heatwaves and cold spells, land- and mudslides, storm surges, lightning, fog, flash floods, blizzards and avalanches.

32 Protecting from heatwaves

Heatwaves, higher maximum temperatures and an increase in the number of hot days have become common occurrences. They are associated with significant risks to health from pollution and heatstroke, which kills or affects more people than tornadoes, earthquakes or tropical cyclones. The prediction of heatwaves and their intensity and duration by WMO enables health authorities to take suitable preventive measures.

33 Providing tsunami warnings

WMO has been contributing to tsunami warnings by making its Global Telecommunications System available for the dissemination of warnings to countries likely to be affected by tsunamis. This process was facilitated by the lead role played by many of the NMHSs in issuing tsunami warnings. In other countries, NMHSs were assigned this responsibility because of their 24-hour operational capability.

CONTRIBUTING TO FOOD SECURITY

34 Providing agrometeorological services

Timely and accurate weather and climate information is critical to the agricultural community to sustain agricultural production and increase crop and livestock yields, to plan and manage planting and harvest time, and to control pests and diseases. Such information is essential for insurance against crop failure and for agricultural futures trading. WMO also helps developing countries to modernize and improve agriculture and forestry in ways that conserve natural resources and improve nutrition.

35 Contributing to sustainability of fisheries

Fish are a major source of nutrition around the world. Information on weather, including temperature, wind, and ocean waves and currents, provided through WMO, is routinely used in commercial fishing operations.

36 Early warning and control of locust swarms

Every year, desert locusts in Africa, Asia and the Middle East inflict immense damage on agriculture. Between 2003 and 2005, the damage was estimated at US$ 400 million and affected 8.4 million people. On the basis of weather information provided by WMO, such as precipitation, temperature, humidity and wind, locust swarms are controlled thanks to prior knowledge of favourable sites for breeding and the subsequent directions of their movement.

37 Soil

The health of the soil is crucial to life as it supports organisms at the bottom of the terrestrial food

chain – worms, insects, fungi and vegetation. It plays an essential role in the hydrological cycle and in the biogeochemical cycle. Deforestation, erosion, pollution and acidification are causing catastrophic damage and degradation affecting some 2 billion hectares of land. WMO monitors several of the parameters essential in maintaining healthy soils.

38 Biodiversity

Biodiversity plays a vital role in regulating the composition of the atmosphere, the hydrological cycle, and soils, as well as the pollination of crops and absorption of pollutants. WMO provides data for several of the parameters that are essential in monitoring and in reversing biodiversity loss and it supports many of the actions called for under the Convention on Biological Diversity.

39 Protecting natural resources

Natural resources are essential for meeting human needs and for human survival. Better management of these resources contributes to human security, including sustainable livelihoods, resilience to disasters, disease prevention, and conflict avoidance and peacebuilding. WMO provides information on weather, climate and environmental conditions that helps to optimize the use and protection of these resources.

PROMOTING CLEAN ENERGY

40 Using energy economically

Energy availability determines to a large extent the economic well-being of a population. Information on current and forecast weather, the climate, and water resources helps to optimize energy consumption. WMO facilitates the generation and exchange of such information, which aids in planning and meeting energy demands, in developing energy systems, and in ensuring compliance with environmental requirements.

41 Assisting in the generation of clean energy

The optimal development of renewable energy resources, such as hydropower and wind, solar and biological energy sources, requires regular and reliable information on weather, climate and water. WMO ensures that such information is readily available to all nations involved in developing renewable energy sources.

PROTECTING HEALTH

42 Protecting health

WMO provides weather and climate services in support of human health. Early warnings of disease epidemics, disaster prevention and mitigation, and air quality services contribute to the protection of public health. Malaria surveillance in Africa, heat health advisories and warnings, and the UV Index are a few of the information services available routinely to international, regional and national health partners.

ENSURING SAFE AND SECURE TRANSPORT

43 Ensuring the safety of air transport

The aviation sector requires a range of information on weather conditions, including wind and wind shear, visibility, turbulence, fog, precipitation, and icing conditions. WMO ensures the worldwide provision of cost-effective meteorological services in support of safe, regular and efficient aviation operations, as well as for the launch and landing of spacecraft.

44 Ensuring the safety of marine transport

Over 95 per cent of goods by tonnage are shipped over the oceans efficiently. Safety of such transport is assured by the provision of up-to-date information on adverse weather conditions and the state of the sea, a specialized service made possible by the WMO network of weather monitoring and dissemination systems.

45 Safety of road and rail transport

The economic well-being of a nation relies to a significant extent on the safe and economical transport of people and goods by road and rail. Weather and climate are determining factors in the efficiency and security of such transport. WMO devotes special attention to providing

suitable and timely information to all operators and users of ground transport.

46 Pipeline transport

WMO provides information about conditions in the surrounding environment, including permafrost and groundwater drainage, which is essential for the safe operation of land-based pipelines, and it also supplies information on marine conditions for underwater pipelines.

ENSURING THE SAFETY OF THE URBAN ENVIRONMENT

47 Safety of the urban environment

Half of humanity now lives in cities, and within two decades nearly 60 per cent of the world's people will be urban- dwellers. Environmental aspects are of paramount importance given this scenario. Increased incidence of pollutants, such as surface ozone, nitrous oxide, carbon monoxide and pollen, poses a growing threat. By providing timely warnings on air pollution, natural hazards and weather conditions, WMO makes it possible for suitable safety measures to be taken.

SUPPORTING LEISURE

48 Supporting leisure and tourism

Leisure and tourism are among the largest economic activities in the world, and as such they are a major source of income and employment. Tourism is the most significant element in the sustainable development of Small Island Developing States. By supporting the delivery of relevant information about weather and climate conditions, WMO actively supports the development of ecotourism.

CONTRIBUTING TO DEVELOPMENT

49 Promoting development

WMO has devoted considerable attention and resources to promoting security, living standards and human skills. It established a technical assistance programme in 1952 and a unique system of self-help among its Members known as the Voluntary Assistance Programme in 1967, which was renamed the Voluntary Cooperation Programme in 1979. It has been a significant source of support for maintaining many of the essential services in developing countries.

50 Focusing on African development

Since the 1960s and 1970s, when a large number of African countries became independent, WMO has paid special attention to the needs of Africa, targeting projects on the development of NMHSs and human resources. A number of regional institutions dealing with drought, water and related activities were established. The 2002 New Partnership for Africa's Development is the main framework for channelling international support to Africa.

51 Meeting the specific needs of developing countries

WMO established a special programme for the 49 Least Developed Countries in 2003. WMO also gives special attention to the vulnerable countries, such as landlocked or low-lying ones, as well as to the needs of Small Island Developing States, which are highly vulnerable to natural hazards, long-term climatic variations, impacts of sea-level rise and environmental degradation.

52 Supporting regional initiatives

WMO's six Regional Associations cater for the special needs of the regions. WMO supports regional economic organizations in the formulation and implementation of sustainable development strategies that relate to warnings against tropical cyclones, drought and other weather extremes, management of water resources, food security, and transport. It also collaborates with regional banks, research institutions and United Nations regional commissions.

53 Supporting international programmes

WMO has close working relationships with most of the agencies, funds and programmes of the United Nations System and many other international organizations, and it contributes to the formulation and implementation of the relevant initiatives and policies in the areas of weather, water, climate and related environmental issues.

SUPPORTING CAPACITY-BUILDING

54 Building capacity to cope and sharing expertise

WMO contributes to human resources development through training, provision of training materials, and fellowships. Its network of 30 Regional Training Centres, along with a network of universities and training institutions, contributes to this global effort. WMO promotes technology transfer and exchange of experts among NMHSs and institutions in related disciplines and in academia.

55 Promoting science and technology

Through its scientific and technical commissions, WMO ensures that developments in science and technology, such as sensors, computers, communication and information technology, satellites and new numerical methods, contribute to the monitoring, collection, processing and distribution of geophysical data and products for sustainable development and research activities. It also undertakes to make these accessible to developing countries as effectively as possible.

FOSTERING RESEARCH

56 Assessing the Arctic and the Antarctic

The Arctic is experiencing some of the most rapid climate change currently under way across the globe. Changes are also occurring in the Antarctic. The changes will have implications for climate the world over. WMO monitors the meteorological conditions and alerts the global community to the rapid changes. WMO and its predecessor the IMO sponsored three International Polar Years: 1882–1883, 1932–1933, and 1957–1958. In partnership with the International Council for Science, it sponsored the most recent International Polar Year 2007–2008, which contributed to major advances in polar knowledge and understanding and in assessing the implications of polar changes for the rest of the planet. This effort also left a legacy of enhanced observing systems, facilities and infrastructure.

57 Advising on weather modification

Nearly 70 countries perform various kinds of weather modification, such as rain enhancement, fog dispersal and hail suppression. In 1979, WMO undertook the first international weather modification experiment in Spain. WMO issued its authoritative Statement on Weather Modification and its Guidelines for the Planning of Weather Modification Activities.

58 Improving the understanding of weather, water and climate processes and advancing their prediction

WMO organizes and supports international research that has enabled improvements in weather, climate, water and environmental observations, in the prediction of weather and seasonal and interannual climate variations (such as droughts and El Niño), and in climate change predictions. WMO research also supports scientific assessments of regional and global environmental conditions and relevant international environmental conventions.

PLANNING FOR THE FUTURE

59 Supporting economic and financial services

The insurance sector takes into account climate change scenarios in risk assessment. Financial and development institutions need the weather, climate and water data provided by WMO, as well as short- and long-term projections, when investing in infrastructure-building.

60 Long-term strategic planning

In 1981 WMO formally introduced a long-term planning process based on those of national services and developed through its regional bodies and scientific and technical commissions. The plans enable not only the Organization but also the NMHSs to chart their future course in the light of evolving national requirements and regional and international commitments for weather, water, climate and environmental information. The new Strategic Plan recognizes the importance of results-based management for focusing WMO activities on issues with major societal benefits.

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