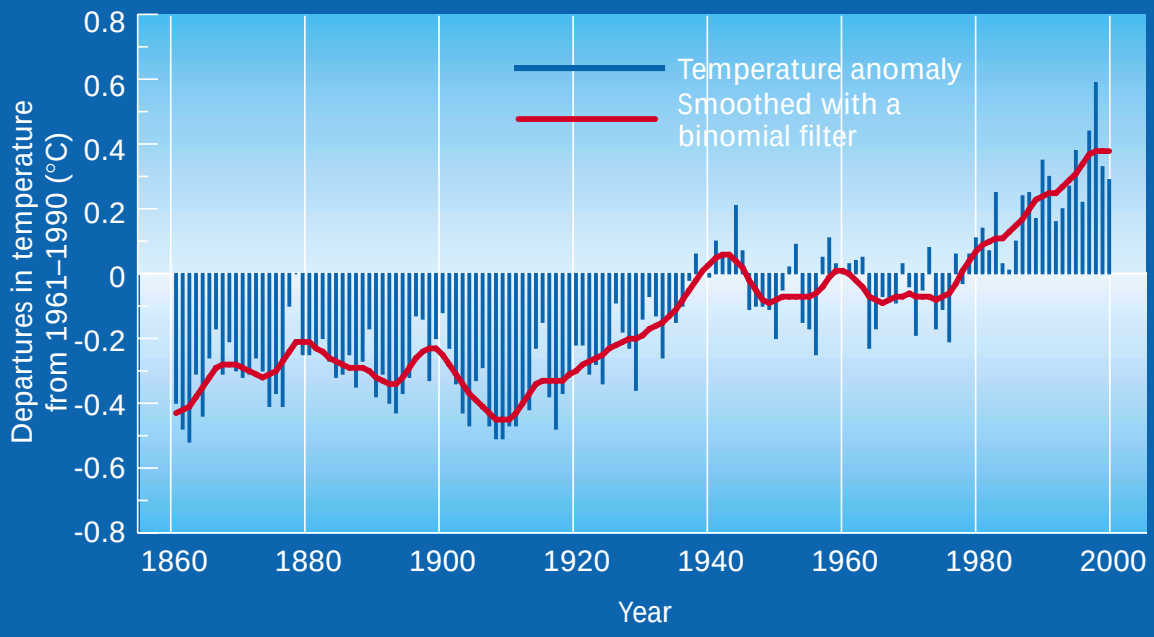
WEATHER AND CLIMATE: THEIR VARIABILITY AND CHANGE

Sustainable development beyond 2002



World Meteorological Organization – Geneva – Switzerland

Meteorology and operational hydrology in support of sustainable development

Weather and climate-related natural disasters continue to cause loss of life, set back food and fibre production, contaminate food and water reserves, and result in destruction of buildings and public infrastructures. The World Meteorological Organization (WMO), through its meteorology and operational hydrology programmes, supports planning and early warning. Its scientific programmes underpin many of the important issues of sustainable development.

AGENDA 21

The message of the Earth Summit

The protection of the environment and the achievement of sustainable development are shared global responsibilities. The ongoing commitment of WMO and its Members to meeting the objectives of Agenda 21 is reflected in the Geneva Declaration adopted by the Thirteenth World Meteorological Congress in 1999.

The challenge of climate change

WMO, through its lead role for observing and researching the climate system and its support to the WMO/United Nations Environment Programme (UNEP) Intergovernmental Panel on Climate Change (IPCC), has been at the forefront in alerting the world to the vulnerability of humankind to the threats posed by climate change.

ISSUES

Protection of the atmosphere

The atmosphere is the essential physical and chemical environment for land-based life, including a significant proportion of the biosphere on which human life depends. Changes, anthropogenic or otherwise, to the physical and chemical properties of the atmosphere have the potential of affecting directly the quality of life and even the very existence of some forms of life.

Protection of freshwater resources

Already half of the world population lives in cities and relies on distant sources for their water supplies. There is an escalating water crisis due in large part to water shortages, pollution and unsatisfactory sewage conditions. The water crisis is aggravating the socio-economic, health and environmental conditions of large cities.

Protection of the ozone layer

Ozone strongly absorbs ultraviolet radiation from the Sun in the high atmosphere and provides protection against damage to skin tissue and other dangerous health effects. There are natural processes for the formation and destruction of ozone, but increasing concentrations of chlorine and bromine from anthropogenic sources point to the ongoing problem of enhanced ozone destruction and depletion.

The atmosphere is threatened as both combustion, particularly for heating and transport, and the emission of a chemical cocktail of gaseous and particulate materials raise the local, regional and global concentrations of pollutants.
(Photo: Balloon Sunrise)

Protection of the oceans, seas and coastal zones

The oceans provide the environment for a substantial proportion of the Earth's biodiversity and are a source of food resources. Coastal zones are the regions of the Earth where the atmosphere, ocean and land processes interact and together have a direct impact on human existence.

The United Nations Framework Convention on Climate Change (UNFCCC)

A stable climate is the necessary basis for developing the economic and social systems for a sustainable future. Carbon dioxide, methane, oxides of nitrogen and ozone are naturally occurring greenhouse gases whose concentration in the atmosphere has been significantly increased by human activity. The objective of the Convention is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system.

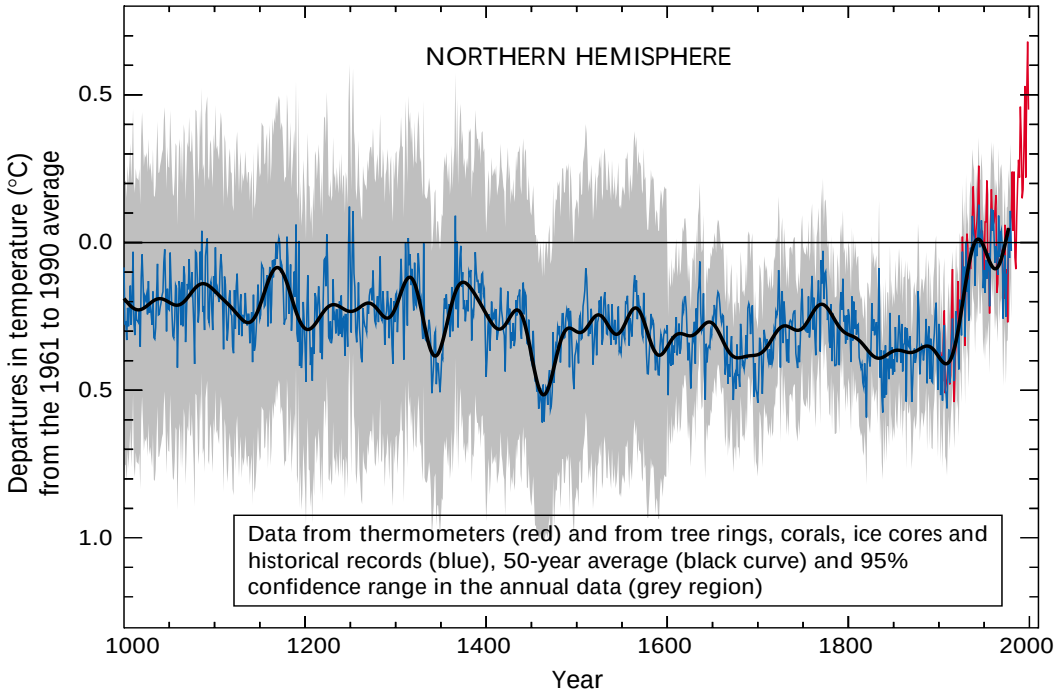
The Convention to Combat Desertification (UNCCD)

Climate and its variability have a major impact on dryland soils, water resources and land use. Research has demonstrated that the effects of bio-geophysical feedback mechanisms that alter the surface terrestrial features can lead to an intensification of desertification processes and trends. Conversely, appropriate land use strategies can work with climate processes to shrink desert margins.

EXTREME METEOROLOGICAL AND HYDROLOGICAL EVENTS

Impacts of climate variability

Communities and their infrastructures have evolved and generally prospered within a pattern of local climate variability to which they have adapted. Extreme meteorological and hydrological events, especially droughts, storms and floods, can produce catastrophic failure of environmental, economic and societal systems. Sustainable social and economic systems must be planned to withstand current and future meteorological and hydrological extremes and be resilient for rapid recovery following failure.



*The rate and duration of warming of the surface temperature of the northern hemisphere during the twentieth century is likely to have been much greater than in any of the previous nine centuries. Most of the observed warming of the Earth's surface over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations in the atmosphere. (*IPCC Third Assessment Report, *2001)*

Actions for a better society

Applications serving societal needs — now and into the future

Communities benefit from the application of meteorological and hydrological information and services to planning and decision making. Inter-agency cooperation and coordination between National Meteorological and Hydrological Services (NMHSs) and responsible agencies of Government ensure that the information and service needs of different sectors are identified and that the format, content and timing of services are of maximum benefit.

There is a long history of cooperation as well as of the provision of tailored meteorological and hydrological services in agriculture, water management (including freshwater supplies, flood mitigation and warning), aviation and marine transport.

There is a growing recognition that tailored meteorological and hydrological services can also provide public benefits in other sectors, including health, urban planning, building design and commerce. Multidisciplinary studies, particularly those associated with the WMO/UNEP-supported IPCC process, are defining better the extent of community and industry sensitivity to weather and climate in all sectors, and new applications and services are evolving.

Monitoring and predicting weather and climate

The WMO Public Weather Services (PWS) Programme supports NMHSs, particularly through the early warning of extreme meteorological and hydrological events, therefore enhancing public safety and welfare.

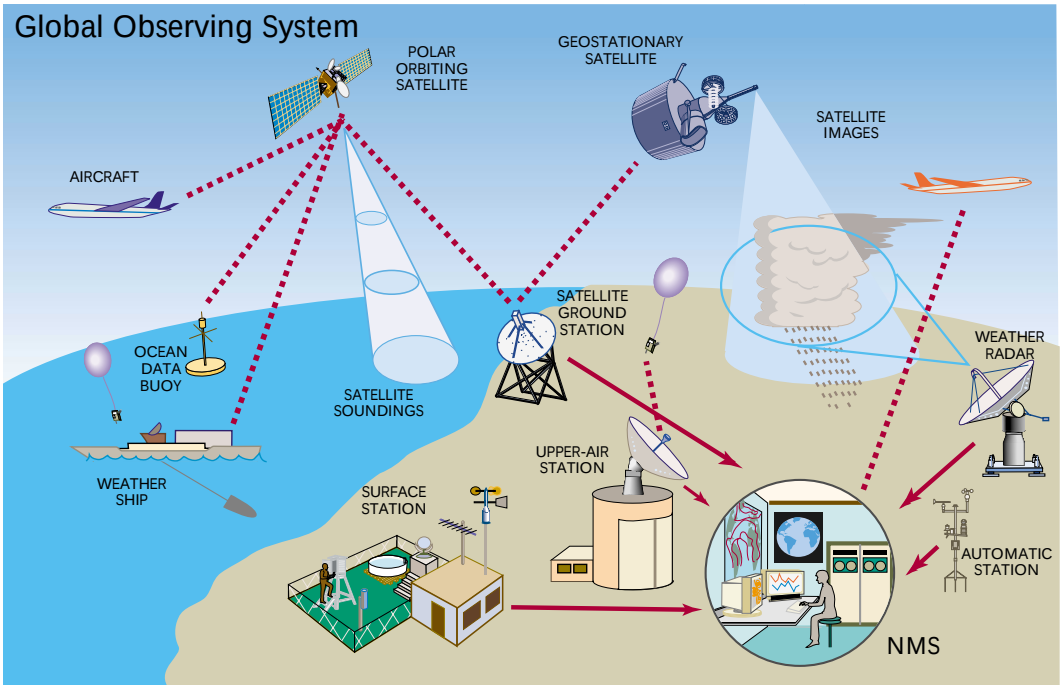
The WMO Climate Information and Prediction Services (CLIPS) project encourages the use of new capabilities for climate prediction that have shown skill in some parts of the world, particularly the early warning of significant seasonal and longer climate events associated with the *El Niño* and related phenomena. CLIPS is also an initiative to promote the use of climate information for planning and for the development of practical services based on historical climate records and regional and global climate monitoring.

Observing the climate system

The World Weather Watch (WWW) is the foundation for international cooperation in operational meteorology, and is a worldwide system for the collection, analysis and dissemination of meteorological data and products which are required by NMHSs to fulfil their functions. The Global Observing

"..... there is a need for additional systematic and sustained observations, modelling and process studies."

(IPCC Third Assessment Report, 2001)



A variety of instruments on the land, oceans, aircraft and in space are used to measure characteristics of the atmosphere and the oceans and to monitor weather systems.

System (GOS) comprises instruments deployed on land, at sea, in the air and in near outer space.

The Global Climate Observing System (GCOS) builds on the WWW but expands the coverage of observations to include the oceans and the land surface to provide the comprehensive observations required:

- To monitor the climate system;
- To detect and attribute reasons for climate change;
- To assess the impacts of climate variability and change; and
- To support research towards improved understanding, modelling and prediction of the climate system.

The World Hydrological Cycle Observing System (WHYCOS) is a developing programme for the measurement, processing and international exchange of water-related information, including water level, river flow, water quality and related weather information.

The Global Atmosphere Watch (GAW) provides data and scientific assessments on changes in the chemical composition and physical characteristics of the atmosphere.

The Global Ozone Observing System (GO_3OS) of ground-based and satellite observations of ozone continues to provide the essential scientific underpinning of actions to protect the ozone layer.

The Integrated Global Observing Strategy (IGOS) partnership was established in 1998 as a strategic planning process for global environmental observations. The IGOS takes a strategic view across all Earth observing system requirements, evaluates capabilities of current and planned observing systems, and obtains funding commitments for addressing critical gaps in observations.

Researching climate processes

International cooperation in research has been essential for extending the boundaries of meteorological science.

The WMO Atmospheric Research and Environment Programme (AREP) is a comprehensive programme but with two components having priority:

- The World Weather Research Programme (WWRP) to improve weather forecasting performance;
- The Tropical Meteorology Research Programme (TMRP) for tropical weather systems, particularly cyclones.

The World Climate Research Programme (WCRP) aims at developing the fundamental scientific understanding of the physical climate system and climate processes needed both to determine to what extent climate can be predicted and the extent of human influence on climate. The WCRP encompasses studies of the global atmosphere, oceans, sea and land ice, and land surface, which together constitute the Earth's physical climate system. A broad-based, multidisciplinary science strategy has been formulated that offers the widest possible scope for investigation of all physical aspects of climate and climate change.

The 22 Earth observatories making up the Global Atmosphere Watch network. Data collected from the monitoring stations have been crucial in understanding the relationship between changing atmospheric composition and changes in global and regional climate. The data also contribute to understanding the long range transport and deposition of potentially harmful substances over terrestrial, freshwater and marine ecosystems, and the natural cycling of chemical compounds in the global atmosphere / ocean / biosphere system.

Natural disasters set back development

Weather and climate hazards

Few countries or communities are immune from weather and climate extremes, although some communities are more vulnerable to particular events and suffer more frequently than others. Notwithstanding the climatological risk that is related to geography, the extent to which an extreme event becomes a disastrous event has a lot to do with planning, early warning, protective measures taken and resilience, i.e. the ability of a community to recover after the event.

The IPCC process has stimulated studies that have identified potential impacts of climate extremes across sectors and has formulated possible adaptation and response strategies, particularly in the context of climate change.

Planning and early warning

National strategies for sustainable development must include provision for disaster reduction and mitigation through planning, early warning and emergency response. An effective NMHS, capable of providing both information for planning and timely early warning services, is an important component to any natural disaster reduction strategy and an essential component of sustainable development.

The mitigation of the impacts of extreme weather and climate events has been achieved through building robust public infrastructures and resilient societal systems. Local climate data, including hydrological records, are the basis for effective standards, planning controls and other regulations that ensure that buildings can provide safety for both its occupants and contents.

Many communities have evolved in geographic locations, such as river flood plains and deltas, which are naturally vulnerable to meteorological and hydrological hazards. Here, protection against extreme events is achieved through early warning services for the protection of lives and where the impacts are mitigated through the implementation of integrated plans that have at their focus the security of vital resources, including essential public infrastructures and food and water reserves.

Public infrastructures that can withstand the impacts of extreme weather events are important for sustainable development. NMHSs provide data and information which are essential for the planning and good design of transport and communications systems that are vital for trade and commerce. (Photo: T. Nebbia)

Technology transfer to developing countries

WMO provides support to the NMHSs of developing countries through transfer of knowledge, proven methodologies and equipment. In the field of operational hydrology, this is accomplished through the WMO Hydrological Operational Multipurpose Systems (HOMS).

The Education and Training Programme promotes efforts to ensure that the necessary body of personnel trained in meteorology, hydrology, engineering and other necessary aspects of infrastructure management and early warning is available. The Technical Cooperation Programme promotes the organized transfer of meteorological and hydrological knowledge, proven methodologies and essential equipment. Emphasis is on the development of a wide range of early warning services (related to weather prediction, climatology and operational hydrology) and the development and operation of key World Weather Watch infrastructures and regional components of the World Hydrological Cycle Observing System.

The World Meteorological Organization

WMO is the United Nations specialized agency with responsibility for meteorology and operational hydrology and is made up of 185 Member States and Territories. Its purposes are generally directed to coordinating the international systems for the observation, collection, processing and dissemination of meteorological and related data and products, implemented within the framework of the World Weather Watch and hydrological data collected by National Hydrological Services. WMO also plays a leading role in promoting and coordinating international research for the advancement of meteorology and related sciences.

National Meteorological and Hydrological Services

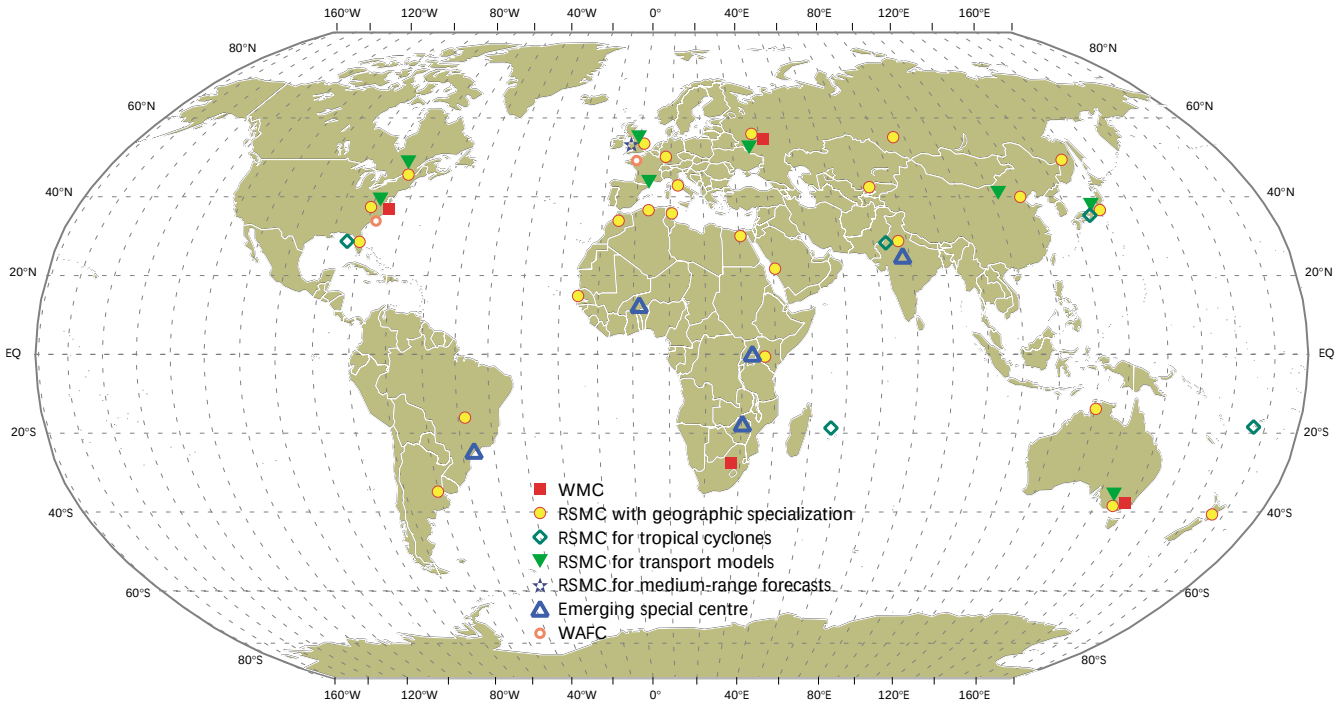
The respective missions of NMHSs include observing and understanding weather and climate and providing meteorological, hydrological and related services in support of national needs. These needs relate especially to protection of life and property, safeguarding the environment and contributing to sustainable development.

As providers of specialized services, NMHS have an important national role in the development of all sectors of society. Each country needs an effective NMHS with a sound meteorological and hydrological infrastructure and a capacity to deliver or support services targeted to meet the full range of community needs if it is to achieve a path of sustainable development.

The WMO/UNEP Intergovernmental Panel on Climate Change

Together, WMO and UNEP established the IPCC in 1988 to study all aspects relating to climate change. The action was endorsed in 1988 by the forty-third session of the United Nations General Assembly through Resolution 43/53 — Protection of global climate for present and future generations of mankind. The IPCC First Assessment Report was delivered in 1990, the Second in 1995 and the Third in 2001.

Location of the World Meteorological Centres (WMCs) and Regional Specialized Meteorological Centres (RSMCs) of the WMO World Weather Watch. Centres within the Global Data-processing System make available weather and climate analyses and predictions to enable NMHSs to provide high quality forecast, warning and information services.



The first decade since the Earth Summit of 1992 has further demonstrated the benefits of a strong foundation in science for promoting sustainable development policies. Social and economic systems must be robust to withstand meteorological and hydrological extremes and be resilient for rapid recovery following disasters.

Understanding, monitoring and predicting weather and climate, and their extremes, are essential to sustainable development.

In the planning of social and economic systems, decision makers must be mindful of the potential impact on the climate system and avoid dangerous climate change.

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