The World Meteorological Organisation (WMO)
Past Achievements and new Challenges

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The World Meteorological Organisation (WMO) is a UN specialised agency for weather, climate and water. Following the signing of its convention 70 years ago, WMO has been remarkably successful in tackling challenges ranging from improving the quality of weather forecasts, support for agriculture, aviation and early warning to addressing poverty, environmental protection and saving lives. As a small organisation, WMO makes use of an elaborated infrastructure of observational, telecommunication and computing facilities, owned and operated by its 191 Members. WMO has developed cross-cutting approaches involving new partnerships as applied to disaster prevention, climate services and support for the UN Sustainable Development Goals (SDGs). WMO is well placed to play an even bigger role in the future.

Introduction: from prehistory to WMO

Human beings have always been fascinated with the weather and its prediction. Witness to this are the innumerable deities associated to weather phenomena in most ancient religions. Indeed, forecasting the weather was often performed by priests, or was sometimes even assimilated to witchcraft. Things started to change with the invention of meteorological instruments in the 17th century: barometer and thermometer in particular, and the development of a scientific approach based on observation and analysis to derive fundamental laws of nature. It became very soon clear that understanding the behaviour of the Earth's atmosphere was only possible through measurements with standardized instruments and international collaboration, since weather would cross any border.

The first international observation network was established in 1654 at the initiative of Ferdinand II of Medicis, but the most notable attempt was that by the Mannheim Societas Meteorologica Palatina which operated a network of 40 standardized meteorological stations in Europe from 1780 to 1795. A key technical development was the invention of the electric telegraph by Samuel Morse in 1837, which allowed real time exchange of meteorological observations, an essential element to enable predictions. This was followed by the establishment of a number of national weather offices in the 19th century and eventually led to the foundation of the International Meteorological Organization (IMO) in 1873. The work of IMO led by a Permanent Committee of the Directors led to a number of decisions which are still at the core of WMO approach. In particular, it stressed the need for comprehensive exchange of standardized observations on a global scale. After the First World War, support to civil aviation became a major activity, alongside the support to agriculture and maritime transport. Activities were coordinated through a number of Technical Commissions and Regional Associations, but it became evident that the non-governmental structure of the IMO was a major limitation. During the Berlin meeting of Directors in 1939, proposals were made for radical changes, including the transformation into an intergovernmental organization. These proposals were to be adopted in 1941, it took until 1947 for 31 States to sign the Convention of the new WMO. After its ratification by 50 States, WMO was established in 1950 on 23 March – now celebrated every year as the World Meteorological Day. In 1951, WMO became a specialized agency in the United Nations System.

The organisation and the early years

WMO includes 185 Member States and 6 territories (as of July 2017). Each Member is represented by the director of its National Meteorological Service. For Germany this is the President of the German Meteorological Service (Deutscher Wetterdienst - DWD).[1]

The World Meteorological Congress is the supreme body of the Organization and meets every four years to determine the scientific and technical programme and associated budget.

The Congress elects the President and three vice-presidents. The main responsibility of the President is to lead and coordinate the work of WMO, on behalf of Members.

They are also part of the Executive Council (EC), which meets annually, and includes 27 additional members elected by Congress and 6 Presidents of Regional Associations. Members of the EC serve in their personal capacity not as representatives of governments. For a governing body, this is unique in the UN system. The governing structure also includes eight Technical Commissions[2].Commissions and Associations report to Congress and the EC.

The Congress also appoints the Secretary-General for four years with a maximum of now 8 years. The Secretary-General is responsible for the programme and management function of the Secretariat. The Secretariat includes around 300 staff. During recent years, the budget remained at approximately 90 million Euro annually. Members which provide the five largest contributions account for about 50 %[3] of the budget, the 10 smallest for 0.2 % (as of 2017).

The work of WMO is based on an elaborate infrastructure of observational, telecommunication and computing facilities. Those are owned and operated essentially by national agencies, not WMO. WMO guides and facilitates cooperation through organising exchange of information and by providing technical assistance.

During the early years, WMO focused on supporting the standardization and exchange of observations through technical regulations and guides. A key initiative was the development of the World Weather Watch (the original WWW!) as a result of a UN resolution in 1963, supported by both USA and USSR on peaceful use of outer space. It confirmed that meteorology could be a model of international cooperation, despite extreme political tensions. As a result, weather observations were exchanged without restrictions with all WMO Members. WWW has now matured to include three programmes. First, the Global Observing System currently coordinates over 11,000 surface weather stations, 1,300 upper-air stations, 7,000 ships, thousands of moored and drifting buoys as well as 3,000 commercial aircrafts and 16 operational and 50 research satellites.

Second, the Global Telecommunication System allows real time exchange of information. Finally, the numerical weather prediction models are used to develop products and services for applications related to weather, climate, water and environment. In addition to national offices, international organizations, such as the European Centre for Medium-Range Weather Forecasts (ECMWF) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) contribute to the WWW. By far the largest WMO programme, WWW is one of the crowning achievements of WMO.[4] International cooperation has made it possible for a five-day forecast to be as reliable as a two-day forecast was 20 years ago.

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[1] Federal Republic of Germany joined on 10 July 1954 and the German Democratic Republic[1] on 23 May 1973.

[2] Commission for Aeronautical Meteorology; Commission for Agricultural Meteorology; Commission for Atmospheric Sciences; Commission for Basic Systems; Commission for Climatology; Commission for Hydrology; Commission for Instruments and Methods of Observation; Joint WMO-IOC Commission for Oceanography and Marine Meteorology.

[3] United States (21.67%), Japan (9.54%), China (7.8%), Germany (6.3%), France (4.8%).

[4] Detlev Frömming, „Die Weltorganisation für Meteorologie“, *Geowissenschaften in unserer Zeit*, Vol. 3, No. 2, 1985, pp. 58-63.

In response, the interest of the public and its confidence in weather forecasts grew considerably: for example, weather bulletins are in most countries the most watched TV programme. Forecasts for planning personal activities are now part of everyone's expectation. Furthermore, other major sector of applications developed, for health, energy, tourism, retail industry, and sporting events. The list is now almost endless, since most socio economic activities are to varying extent weather sensitive and as such benefit from increasingly accurate predictions. These services are coordinated by WMO under the general umbrella of the Public Weather Services Programme.

Applications of meteorology, hydrology and research

In parallel with the progress in the quality of weather forecasts, the number of applications exploded. This included traditional ones which remain at the core of the mission of most weather services such as those for agriculture where almost all decisions are weather related or for aviation with the optimization of fuel planning and safety of flights. In addition, several others applications emerged. The recurrent droughts in the Sahelian region as well as devastating tropical cyclones (a cyclone in what is now Bangladesh caused more than 400 000 deaths in 1970) led WMO to put priority on natural disaster prevention in general and on improved early warning systems in particular. Also the Chernobyl accident led to the development of a system for predicting atmospheric trajectories of radioactive or chemical substances, in close cooperation with the International Atomic Energy Agency (IAEA). The efficiency of this system was demonstrated during the Fukushima accident.

Furthermore, WMO is the UN specialised agency responsible for operational hydrological activities and has been coordinating the development of hydrological observing networks worldwide since 1972. The development of early warning systems for water related disasters is done through its Hydrology and Water Resources Programme, in close coordination with the UN Educational, Scientific and Cultural Organization (UNESCO).

The socio-economic benefits of these products are considerable. In addition to the many tens of thousands of lives saved every year as a result of improved early warnings better integrated in disaster prevention management, the benefit to cost ratio of investments in meteorology is often greatly in excess of 10 to 1 both in developed and in developing countries. This was highlighted in a major conference on the subject convened by WMO in Madrid in 2007.

None of this progress would have been possible without a strong support to research activities. In the area of atmospheric science, WMO has been coordinating research activities in the fields of atmospheric composition, weather modification, numerical weather prediction, and urban issues. In particular, through the Global Atmosphere Watch (GAW), essential information on the depletion of the ozone protective layer was provided. The first assessment of the state of global ozone was published in 1976 and led to the Vienna Convention on the protection of the ozone layer (1985) and its Montreal Protocol (1987)[5].

In 1967, the decade-long Global Atmospheric Research Programme was launched. Led by WMO and the International Council of Scientific Unions (ICSU), this programme was perhaps the largest global scientific experiment in all disciplines. It organised several field experiments, explored the role of the tropics and contributed to better understand the global atmospheric circulation, its interactions with the oceans, and to developing more realistic numerical models.

Climate

[5] The Vienna Convention for the Protection of the Ozone Layer, http://ozone.unep.org/en/handbook-vienna-convention-protection-ozone-layer/2205 https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-2&chapter=27&clang=_en

Climate can be seen as the average weather condition in an area over a long period of time. A major evolution started in the mid-1970s. WMO organised the 1st World Climate Conference (WCC-1) in 1979. This led to the launch of the World Climate Programme in 1980 to facilitate the analysis of earth system variability and change for use in a range of practical applications. The World Climate Research Programme, cosponsored by ICSU and UNESCO, encourages research of the climate system and the effects of human activities on climate.

WCC-1 also led to the creation of the Intergovernmental Panel on Climate Change (IPCC), by WMO and UNEP in 1988. IPCC provides decision makers with authoritative assessments of climate change about every 6 years. The Panel received the Nobel Peace Prize in 2007 for "their efforts to build up and disseminate greater knowledge about man-made climate change".[6]

The second World Climate Conference (WCC-2), organised by WMO in 1990 launched the Global Climate Observing System in 1992, to provide better observations of the climate system with a strong space based component. Observations involve physical, chemical and biological properties, covering atmospheric, oceanic, hydrological, and terrestrial processes.

Despite the considerable progress in observations and scientific understanding of the climate system, it became clear that the practical application of this knowledge was limited in a very large number of countries. This is why in 2009 the third WMO World Climate Conference (WCC-3) approved the development of a Global Framework for Climate Services (GFCS). Applying science-based climate knowledge, prediction and services are provided on agriculture and food security, water management, energy, health and disaster prevention.

The new context and associated challenges

When the UN system developed in the late 1940s and early 50s specialised agencies were set up with very specific sectoral mandate: WHO for health, FAO for food and agriculture, WMO for meteorology and so on. Counterpart organisations were also in place at national level. Such an approach served society well for several decades. However, lately it became increasingly clear that many issues were cross-cutting and that the sectoral approach had triggered the creation of formidable silos, with fierce competition for visibility and resources. WMO was not immune to this syndrome: for example, different observing systems had been developed independently for traditional weather observation, for the chemical composition of the atmosphere, for the hydrological parameters, for the cryosphere, and for climate data. Activities linked to disaster prevention were scattered across programmes: Agro-meteorology for drought, WWW for tropical cyclones, Hydrology for floods, and Climatology for heat waves.

To address these structural shortcomings and to put its own house in better order, WMO increasingly developed cross-cutting approaches. Key examples are the programme on disaster prevention, as well as the WMO Integrated Global Observing Programme covering and integrating various WMO observing systems. The WMO Information System provides an integrated approach for WMO programmes in the area data management and telecommunications, moving weather, climate and water information.

Regional activities, education and training and more generally technical cooperation are cross-cutting by nature. A major challenge is indeed to train experts to get out of their box and to dialogue and cooperate with other disciplines.

At the UN system level, the trend towards cross-cutting approaches gathered considerable momentum over the last 20 years. In particular, in order to accelerate progress on the Millennium Development Goals (MDGs), the Secretary-General of the UN, Ban Ki-moon, promoted the concept of the various parts of the UN *Delivering as One*[7]. Despite a number of practical obstacles, significant progress was achieved. The development by WMO

[6] Nobel Peace Prize 2007 Press Release https://www.nobelprize.org/nobel_prizes/peace/laureates/2007/press.html

[7] Delivering as one: Report of the High-level Panel on United Nations System-wide Coherence in the areas of development, humanitarian assistance, and the environment, Einheit in der Aktion: Bericht der Hochrangigen Gruppe für Kohärenz des Systems der Vereinten Nationen auf dem Gebiet der Entwicklung, der humanitären Hilfe und der Umwelt, UN-Dok: A/61/583 v. 20. November 2006)

and key partners of the GFCS (see above) was an important contribution to it. In that context, 2015 turned out to be an exceptional year in terms of international cooperation, with the adoption of the Agenda 2030 and the associated Sustainable Development Goals (SDGs), the Sendai agreement on Disaster

Chief Executive Board (CEB) of the UN system held in WMO (2012)

prevention, the Addis agreement on financing for development and last but not least, the Paris agreement on climate change. All these issues are inter-connected and cannot be solved in isolation. For example, there cannot be any sustainable development, without reducing the impact of natural disasters or without keeping climate change to a minimum level. Furthermore, all the SDGs are connected and have therefore to be addressed in a cross cutting manner. No organisation can successfully address any of them by itself. This represents new challenges for all actors, at the international level of course, but also at the national or local level. All UN agencies have to reinvent their modus operandi and develop new forms of partnerships, involving not only governments, but also other key actors including regions, cities, NGOs, and the private sector.

WMO has started to do it, but it will need to go much further. It contributes to more than 12 of the SDGs. Special partnerships have started to develop around various nexus: climate and health, water and food security, water and energy, disaster reduction and development. WMO can use solid foundations to make significant contributions. It has also a solid record of being a strong and reliable partner.

A successful example is UN Water,[8] the UN mechanism to ensure coordinated action of the UN system in all water related issues, including 36 Agencies and Programmes, as well as more than 30 other major partners. This experience could be applied to some other cross cutting issues. A step in this direction was made in 2008, with WMO and UNESCO coordinating action of the UN system to Acting on Climate Change: the UN System Delivering as One[9].

Concluding comments

WMO is a small UN specialized agency placed in central position for addressing key global challenges ranging from poverty, environmental protection to saving lives. There has been remarkable success not only limited to WMO´s core responsibilities related to weather, climate and water, but more so when operating in a cross-cutting and collaborative fashion. A significant, and increasing part of our lives is weather and/or climate sensitive. But for WMO to address the societal challenges effectively, a significant evolution will be required. In particular, it will require, at both international and national level, the elaboration of new partnerships, across varied disciplines, with new actors. It will require the development of new forms of governance, with a place for non-traditional actors.

Ultimate success will also require significant change in decision making approach: the traditional one is often based on short term considerations and on past experience. However, in a fast changing context (for example climate change), the predictive value of the past is getting weaker and even increasingly misleading. Furthermore, the decisions taken now (or worse decisions not taken now) will have irreversible consequences for decades or even centuries. Unlike in the past, we have the knowledge. Ignorance can no longer be used as an excuse for inaction. WMO, through its various activities is well placed to play an even bigger role in the future. Cooperation is more important than ever!

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[8] . Michel Jarraud, Secretary-General Emeritus, WMO, and one of the co-authors, was Chair of UN-Water from 2012 to 2015.
[9] https://unterm.un.org/UNTERM/Display/Record/UNHQ/NA?OriginalId=9054f12efa7639538525761d005a2c36