WORLD METEOROLOGICAL DAY 2003

OUR FUTURE CLIMATE

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Every year, World Meteorological Day (WMD) is celebrated to commemorate the entry-into-force, on 23 March 1950, of the Convention of the World Meteorological Organization (WMO). The theme for this year is "*Our future climate*". Climate is vital for sustaining life on Earth as it has a profound effect on food security, security of life and property, water resources, leisure and sustainable development. In addition, climate is known to affect, to a certain extent, the moods of people, influence their character and even their ways of thinking and their culture. However, there is growing evidence that humankind is altering the character of the thin layer of air that surrounds planet Earth, with implications for the climate it generates. The theme for this year's celebration has therefore been chosen to highlight the need to protect climate as a resource for the well-being of present and future generations. WMD also provides an opportunity to draw the attention of the public, decision-makers, the media and civil society to the role of WMO and the National Meteorological and Hydrological Services (NMHSs) in this endeavour.

Changes in climate are known to have occurred in the past. However, such changes were due to natural causes. Recent changes, such as the increase in the mean global temperature of 0.6^0C since instrumental records began in the 1860s, are largely attributable to human activities. In fact, the year 1998 was the warmest on record, with 2001 being the second highest. The 1990s were the warmest decade of the 20th century and it is likely that the rate and duration of warming of the 20th century were larger than at any other time during the last 1 000 years. The warming observed is linked to the growth in the concentration of greenhouse gases in the atmosphere. Carbon dioxide, a major greenhouse gas, has grown from about 280 parts per million by volume (ppmv) in 1750 to 370 ppmv at the end of 2001, an increase of over 32 per cent. Over the same period, atmospheric concentrations of methane and nitrous oxide increased by 151 and 17 per cent, respectively.

As a result of the warming, the global mean sea-level has risen by between 10 and 20 cm. The rise has been estimated to be as much as 10 times the average increase in the last 3 000 years. Over the past 50 years, the extent of sea ice in the northern hemisphere has decreased by about 10 to 15 per cent. The duration of annual lake and river ice was shortened by about two weeks over the last century. There has been a 40 per cent decline in Arctic Sea ice thickness in late summer to early autumn in the past 45-50 years and a widespread retreat of mountain glaciers in non-polar regions was observed in the last 100-150 years.

Over the last 30 years, a number of unprecedented extreme weather and climate events such as floods, tropical cyclones and droughts have occurred in various parts of the world. Globally, over the last 10 years, the number of hydrometeorological disasters has doubled. Worldwide, recurrent drought and desertification seriously threaten the livelihood of over 1.2 billion people who depend on the land for most of their needs. The 1997/1998 *El Niño* event, the strongest of the last century, is estimated to have affected 110 million people and cost the global economy nearly US$ 100 billion. Statistics compiled from insurance companies for the period 1950-1999 show that the major natural catastrophes which are mainly weather- and climate-related caused estimated economic losses of US$ 960 billion. Most of the losses were recorded in recent decades.

Perhaps the most striking evidence of the effects of global warming are the changes in flora and fauna. In parts of the northern hemisphere, the growing season has lengthened by nearly 11 days since the early 1960s. Some of the changes in the growing season are linked to milder winters that have been part of the overall pattern of global warming since around 1970. Other changes include plants growing at higher altitudes in the Alps, birds laying their eggs earlier in spring and butterflies extending their range northward. In the Southern Ocean, vegetation is thriving on the most southerly islands and is expanding on the Antarctic Peninsula. The association of such changes with climate is possible today because of scientific and technical progress over the last century.

Some of the earliest efforts aimed at a systematic study of the Earth climate system dates back to the days of the International Meteorological Organization (IMO), the predecessor of WMO, which, in 1929 instituted the Commission for Climatology. From the 1950s onwards, technological achievements, including radars, satellites and computers contributed to high-quality research, monitoring and multi-disciplinary studies into atmospheric processes. In the late 1960s and early 1970s, the unprecedented drought in the Sahel and the evidence of a period of prolonged cooling raised concern about the future climate. At the same time, observation of expanding amounts of carbon dioxide in the atmosphere led WMO, in 1976, to issue the first authoritative statement on the potential impact of an increasing accumulation of greenhouse gases in the atmosphere on our future climate.

In 1979, WMO convened the first World Climate Conference, leading to the establishment of the World Climate Programme (WCP) and its component parts. WMO invited other organizations such as the United Nations Environment Programme (UNEP) to take the lead on the impacts and the International Council for Science (ICSU) to collaborate with WMO in research. In 1988, in the light of growing concern about the impact of human activities on climate and the potential impact of climate change on the national economies, especially on those of developing countries, WMO, in collaboration with UNEP, established the Intergovernmental Panel on Climate Change (IPCC). The Panel’s tasks include assessment of scientific information on climate change and its environmental and socio-economic impacts, as well as the formulation of appropriate response strategies. Since its establishment, IPCC has issued three assessment reports. The First Assessment Report (1990) led to the commencement by WMO and UNEP of negotiations for a Framework Convention on Climate Change, which was signed in Rio during the United Nations Conference on Environment and Development (UNCED) in 1992. Thereafter, the Conference of the Parties was set up. The Second Assessment Report (1995) contributed to the negotiation of the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC).

In its Third Assessment Report issued in September 2001, the IPCC concluded that "*There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities*." Such conclusions, as well as future climate projections, are based on the output of complex atmosphere-ocean general circulation models and on scenarios of energy use and greenhouse-gas emission projections. While there are many uncertainties in future projections, the confidence in the ability of climate models to provide useful estimates has improved significantly. This is demonstrated by the satisfactory model simulations of current climate, *El Niño*/Southern Oscillation (ENSO) and monsoons, as well as of certain periods of past climate such as the impact of the 1994 Pinatubo volcanic eruption on the global mean surface temperature.

The Third IPCC Assessment Report indicated that the global mean surface temperature would rise by 1.4 to 5.8^{0}C over the period 1990 to 2100. This projected rate of warming is much higher than the observed changes during the 20th century and is very likely to be without precedent during at least the last 10 000 years. Sea-level was estimated to rise by 9 to 88 cm between 1990 and 2100. This would have significant socio-economic impacts as flat islands, harbours, some agricultural lands, freshwater resources, tourist areas and productive coastal lands would all be threatened.

Precipitation is projected to intensify during the 21st century. At low latitudes, there would be decreases in some regions and increases in others. In middle to high latitudes, precipitation events would be intensified. Droughts and floods may become more prevalent.

Current projections show little change or a slight increase in the amplitudes of *El Niño* events over the next 100 years. But with higher temperatures, the extremes of floods and drought generally associated with *El Niño* events would be more severe. It is also likely that there would be greater Asian monsoon precipitation variability.

Northern hemisphere snow cover and sea-ice extent are projected to diminish further and glaciers and ice caps will continue to retreat. Indeed, it has now been observed that the ice cap on Mt. Kilimanjaro close to the Equator has been receding in recent years.

Climate change will also affect human health through multiple pathways, including direct effects (e.g. reduced cold stress in temperate countries but increased heat stress) and indirect effects that operate through changes in the ranges of disease vectors (e.g. mosquitoes), water-borne pathogens, and water and air quality. While some species may grow in quantity or range, climate change will exacerbate the risk of extinction of some more vulnerable species and loss of biodiversity. Coral mortality could exceed 95 per cent regionally with extinction of certain species.

While these projections are for the next 100 years, a greater concern is that human-induced climate change will persist for many centuries, even if emissions of greenhouse gases into the atmosphere were totally curtailed today as some of the greenhouse gases such as carbon dioxide are long-lived. This would be similar to the effect of phasing out chlorofluorocarbons which are responsible for the depletion of the ozone layer.

However, the most immediate threats to humankind relate to increased variability in the intensity and frequency of storms and other extreme weather- and climate-related events such as floods and droughts, more heat waves in major urban areas and the impact of sea-level rise on low-lying coastal regions. While detailed local- or basin-level climate-change predictions are not yet available, it is still wise to assume that the changes observed over the last decades will continue, presenting urgent and growing challenges to many aspects of our lives. Planning to meet the threat of climate change requires the mapping of a range of possible future events and identifying policy options that might best meet those challenges. In the future, the accelerating pace of technological advances will lead to a narrowing of the uncertainties and thus exert a profound influence on the way we handle climate issues. In this regard, better understanding of climate processes and ever-expanding computer and satellite capabilities could lead to improved predictions at local and regional levels. Scientists are also working on technological solutions to mitigate global warming. In many cases, the real issue is whether they are both economically viable and environmentally acceptable. At present, renewable energy sources are among the most promising ways of reducing carbon dioxide emissions.

The measures contemplated in mitigating climate change so far are inadequate to protect our future climate. The international community should commence action now through the UNFCCC and its Kyoto Protocol to adequately curtail the emission of greenhouse gases into the atmosphere, and other measures to reduce uncertainties in climate projections. For these purposes, WMO and the NMHSs will continue to take a lead role in addressing key scientific and technical issues.

The first of these issues relates to systematic observations, which need to be improved, and to the reconstruction of past climate periods. Despite advances in observations from meteorological and environment satellites and from those for research and development, there has been a degradation of essential *in situ* observational networks in many parts of the world, particularly in developing countries and most significantly in the least developed among them. There is also a need for more data from polar and oceanic areas, for better quantitative assessments of climate extremes. To meet these challenges, WMO has continued to strengthen its World Weather Watch Programme for monitoring weather and climate, its Global Atmosphere Watch for the chemical composition of the atmosphere, and its hydrological monitoring networks.

The second issue relates to the need to address the uncertainties which are inherent in long-term prediction. For this purpose, considerable efforts are underway, particularly under the WMO-sponsored World Climate Research Programme (WCRP) to improve climate prediction capability through improved modelling. Such efforts aim at a better understanding of climate processes relating, among others, to the role of the entire cryosphere, the distribution and projection of future emission of greenhouse gases and their sinks and sources, and the role of biota, land and ocean surfaces and deep oceans. There is also a need to study the effects of clouds on radiation. The Climate Variability and Predictability (CLIVAR) project is the main focus in WCRP for studies of climate variability, extending effective predictions of climate variation and refining the estimates of anthropogenic climate change. In addition, climate models must be further developed to better simulate regional and local impacts of climate change and extreme weather events.

The third issue relates to the need for all countries to benefit from advances in climate science. In this regard, the WMO Climate Information and Prediction Services (CLIPS) project is designed to assist countries in the application of climate data and seasonal forecasts in areas such as water management, agriculture and disaster mitigation.

Finally, to assist in addressing climate change, the international framework for the coordination of national and international efforts should be strengthened so that research results, observational data and information and other resources may be used to the greatest overall advantage. In particular, NMHSs should receive the necessary support in their mission of understanding weather and climate and in providing necessary services.

Progress in addressing these issues should enable the IPCC to answer some of the outstanding questions in its Fourth Assessment Report which is scheduled for 2007. Among others, the IPCC report will focus on reducing uncertainties and providing improved forecasts at national, and, if possible, at basin levels. In this regard, it is recalled that the World Summit on Sustainable Development (WSSD) held in 2002 in Johannesburg, South Africa, called for renewed commitments to addressing the challenges related to poverty alleviation, changing consumption and production patterns, natural disaster mitigation, as well as the protection and management of the natural resource base for economic and social development.

As we move forward in the millennium, it is my hope that national and local authorities, academia, the private sector, the general public and the media fully appreciate the important contributions being made by WMO and NMHSs in addressing the climate change issue. WMO will continue its efforts in an unflinching manner to contribute to a better understanding of our climate and the potential threats to it and collaborate with the world community to ensure its protection and preservation for future generations.