CLIMATE FOR YOU

World Meteorological Organization
Weather • Climate • Water

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FOREWORD

Through a wide variety of proxy records, including ice cores, tree rings, sediments, corals, rocks and fossils, among others, the modern science of paleoclimatology reveals that climate variability and change were present on our planet long before our ancestors. More recently, there are several references in our recorded history to unusual periods in some parts of the world, such as the Medieval Climatic Anomaly and the subsequent Little Ice Age, as well as exceptional events like the "year without a summer" of 1816, attributed to the colossal 1815 Mount Tambora eruption.

Over the past 35 years, the World Meteorological Organization (WMO) has been instrumental in raising our awareness on the anthropogenic impact on natural climate variability and change, which accelerated with the Industrial Revolution. Its impact has become visible in contemporary times. The year 2010 was the warmest year on record, at the same level as 1998 and 2005, while over the last 10 years global temperatures averaged almost half a degree above the 1961–1990 mean, a record for any 10-year period since the beginning of instrumental observations.

Over the past year, the Russian Federation experienced an exceptional heatwave, while different parts of Africa suffered severe droughts or flooding, and Australia, several Latin American countries, China and Pakistan experienced very severe floods, some of which caused deadly landslides and/or mudslides. Although no individual extreme event can be attributed to climate change, the emerging trends are consistent with the findings of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), which projects increased variability in temperature, precipitation, severe weather, widespread melting of ice and snow and rising sea levels.

Reliable and timely climate information will increasingly be required by decision-makers and by all socio-economic sectors, particularly at the regional and local levels, in view of the grave risks associated with a rapidly changing climate.

During 2009, WMO convened the World Climate Conference-3 with the involvement of other partners of the United Nations system. Heads of State and Government as well as Ministers present at the Conference unanimously agreed to establish a Global Framework for Climate Services, to support adaptation and strengthen climate knowledge and applications for all socio-economic sectors. Throughout 2010, a High-level Taskforce has developed recommendations for the Framework structure, priorities and governance, which shall be submitted to the Sixteenth World Meteorological Congress, to be held in Geneva in May/June 2011. This Global Framework will be critical to ensuring access to climate services for all.

Therefore, on the occasion of the sixty-first World Meteorological Day in 2011 and on behalf of WMO, I would like to express our appreciation to all those colleagues across the 189 Members of WMO, not only at the National Meteorological and Hydrological Services, but also throughout academia, research, the media and the private sector, who actively collaborate with WMO in its sustained efforts to facilitate *Climate for you.*

(M. Jarraud)
Secretary-General

IN HARMONY WITH NATURE

Earth's unique climate system nurtures and protects us. At the same time, it is never constant and has always been changing in space and time. Sometimes it is bountiful, sometimes it puts us through constraints and sometimes we are faced with disastrous hazards. Generations of accumulated knowledge and wisdom have helped us to survive and prosper by using climate as a resource and managing climate as a risk. It is our common undertaking to understand how the climate system works, to protect the planet for future generations and to adapt to its changing nature.

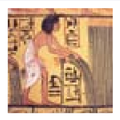
FRED FERAL

Since time immemorial, humans have both feared and revered the weather. The elements dictated human behaviour and activities, as well as welfare and survival. Over the ages, various peoples prospered by adapting to the local climate, which shaped their dietary habits, shelter, lifestyle, folklore and beliefs – in brief, their culture.

In the past, when people migrated, whether due to war or climate conditions such as drought, floods or climate-induced diseases, they adapted gradually to a new environment by learning and applying the knowledge of weather and climate for their security and well-being. For example, monsoons have shaped agricultural practices, culture and the colourful festivals of the peoples of South Asia and West Africa. Indeed, peoples all over the world have prospered through ingenious application of their foreknowledge and experience of the weather and climate. Weather and climate influence socio-economic development, agriculture and cultural identity.

Adapting to climate: a challenge for ancient civilizations

Climate was an important factor in the rise and gradual decline of several ancient civilizations, as seen in the following examples.



Ancient Egypt

A prehistoric climate change in Eastern Sahara resulted in the rise of the Egyptian civilization. From about 10 500 years ago, the wide area now covered by Egypt, the Libyan Arab Jamahiriya, Sudan and Chad is believed to have experienced a sudden onset of humid conditions. For centuries afterwards, the region supported savannahs full of wildlife, lush acacia forests and swamps. From about 5 500 years ago, the Sahara became too dry for human life. Nevertheless, Egyptian civilization thrived, as people could count on the annual flooding of the Nile that brought exceptionally fertile alluvial soils.

Indus Valley civilization

The Indus Valley civilization flourished around the Indus river basin during the Bronze Age, encompassing much of what is now western India, Pakistan and parts of south-eastern Afghanistan and eastern Islamic Republic of Iran. Its decline some 3 700 years ago is attributed to earthquake activity, but also to the drying up of the river system and the failure of monsoons, which had guaranteed water for life.

Mayan society

Mayan society, which appeared around 2000 BC and extended through Central America and Mexico, went into decline following an intense 200-year drought. The civilization was particularly susceptible to long droughts as most of the population centres depended solely on lakes, ponds and rivers for their livelihood.

Climate swings in other societies

Other human societies have succumbed to climate swings. The canal-supported agricultural society of Mesopotamia collapsed after a long, severe drought. With wetter conditions, civilizations thrived in the Mediterranean and West Asia. Catastrophic drought and cooling hurt agricultural production and caused regional collapse.

The societies that survived climate variability and change adapted to them. About 300 years after the Mayan collapse, the Chumash people on California's Channel Islands survived severe droughts by transforming themselves from hunter-gatherers into traders.

DISTURBING THE BALANCE

Recent climate change

Like our bodies, the climate system carries with it the memory of various influences.

The Industrial Revolution led to a tenfold increase in average per capita income, while population increased sixfold. But the improvement in the health and wealth of many people around the globe left its mark in the climate system. Fossil fuels powered economic development but left behind long-lasting greenhouse gases.

Natural resources such as forests, oceans and arable land have been overexploited. The atmosphere became a dumping ground for waste greenhouse gases (GHG). These trends continue to this day and have even accelerated.

Modern society has relied more on technology to control or modify nature to suit lifestyles rather than live in harmony with nature. Gradually, the balance between humans and nature, evidenced by a stable climate, started to change.

Nature speaks out

Over the past three decades, the rise in temperature, increase in the number and severity of extreme events, drying rivers, melting glaciers and the decline of biodiversity have been visible signs of a changing climate. Nature has been reacting, bringing the interaction between people and climate full circle.

Pollutants damage our Earth systems

Gases and aerosols emitted by human activities cause environmental problems. Among them are air pollution, acid rain, a thinning of the ozone layer in the stratosphere and climate change. These problems affect people, plants, animals, ecosystems, buildings and much more.

Key greenhouse gases influenced by humans include carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, such as CFC-12 and CFC-11, and lesser gases, such as sulphur hexafluoride. The three primary greenhouse gases also have strong interactions with the biosphere and the oceans. Chemical reactions in the atmosphere and in the oceans affect their abundances as well. These gases linger for decades, while others last much longer. Even if these emissions were stopped now, it would take decades for concentrations of GHGs to return to previous levels.

Ozone is also a greenhouse gas. The ozone layer is found in the stratosphere, above where most aeroplanes fly, and protects life on Earth from ultraviolet radiation. Ozone is formed from precursors in the atmosphere and is a short-lived

WMO, a beacon for alerting on the changing climate

Building on centuries of advances in science, technology, meteorology and international cooperation, WMO raised the alarm about the changing climate and the implications. WMO authoritative statements are based on the relentless work of meteorologists and hydrologists worldwide. Intense climate monitoring, research, policy formulation and awareness-building have followed these statements.

A thinning ozone layer

In 1975, WMO issued the first authoritative statement alerting the world on the thinning of our protective stratospheric ozone layer that shields life on Earth from exposure to excessive ultraviolet radiation. It led to the adoption of the Vienna Convention on the Protection of the Ozone Layer in 1985 and contributed to the Montreal Protocol on Substances that Deplete the Ozone Layer in 1987.

More carbon dioxide in the air we breathe

In 1976, WMO issued the first authoritative statement on the accumulation of carbon dioxide in the atmosphere and the potential impact on the Earth's climate. A preliminary assessment of future climate scenarios and their impact on human activities was made using climate modelling techniques.

Strengthening climate research

The First World Climate Conference, convened by WMO in 1979, influenced the establishment of a number of important international scientific initiatives, such as the Intergovernmental Panel on Climate Change, co-sponsored by WMO and the United Nations Environment Programme (UNEP), which won the Nobel Peace Prize in 2007; the WMO World Climate Programme and the World Climate Research Programme (co-sponsored by WMO, the International Council for Science (ICSU) and the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO)).

Confirming global warming

In 1985, WMO, UNEP and ICSU convened the Villach Conference. It confirmed that increasing concentrations of greenhouse gases would likely lead to significant warming of the global climate in the twenty-first century.

At the roots of the international climate agenda

The Second World Climate Conference called for the establishment of a climate convention, adding momentum to international efforts that resulted in the development of the United Nations Framework Convention on Climate Change in 1992. It also led to the establishment of the Global Climate Observing System and to recommendations for future activities of the World Climate Programme.

The World Climate Conference-3 in 2009 decided to establish a Global Framework for Climate Services to strengthen the production, availability, delivery and application of science-based climate prediction and services.

substance. It is highly toxic in the surface layer of the atmosphere and has a strong warming effect.

Other short-lived pollutants that define air quality, such as carbon monoxide, nitrogen oxide and volatile organic compounds, are insignificant as greenhouse gases, but have an indirect impact on global warming due to their interaction with tropospheric ozone, carbon dioxide and methane. Aerosols (suspended particulate matter) are also short-lived pollutants that have a cooling effect.

Carbon dioxide is the single most important human-emitted greenhouse gas, contributing 63.5 per cent to the overall global warming effect since the beginning of the Industrial Age. However, it is responsible for 85 per cent of the increase in the global warming effect over the past decade. Other human-induced greenhouse gases include methane and nitrous oxide, which contribute 18.2 and 6.2 per cent to the overall global warming effect, respectively.

Population growth: the multiplier

The world's population stood at about one billion before the Industrial Revolution got under way. From the middle of the twentieth century, it began a precipitous climb; today's population is nearly seven billion, and is estimated to reach nine billion by 2050.

KNOWING OUR CLIMATE

If we understand climate change and variability, we can better assess the impact of climate on our activities, as well as our own influence on climate. This gives us the capability to make better informed decisions in our private and professional lives.

Life on Earth is sustained by the energy radiated by the sun. A phenomenon known as the greenhouse effect, in which gases such as water vapour and carbon dioxide contribute to retaining some of the energy radiated back from the Earth's surface, allows the temperatures close to the Earth's surface to remain within bearable limits for human beings. Without the greenhouse effect, global mean surface temperature would have been about –19°C instead of the 14°C that prevails at present.

As a consequence of how societies have developed, we have added and continue to add large amounts of greenhouse gases, notably carbon dioxide, methane and nitrous oxide, to the atmosphere. This is making the Earth even warmer and has significant implications for the many aspects of our climate.

The climate system at a glance

The climate system is a complex, interactive system consisting of the atmosphere, land surface, snow and ice, oceans and other bodies of water. The atmospheric component of the climate system most obviously characterizes climate, which is often defined as average weather over time.

Climate is usually described in terms of the mean and variability of temperature, precipitation and wind over a period of time, ranging from months to decades to centuries. Climate is sometimes described as, among others, equatorial, tropical, subtropical, continental, maritime, subarctic, Mediterranean, desert, savannah, steppe and rainforest. Climate may also be described as moist, humid, dry, hot or cold.

To quantitatively characterize the climate including its geographical distribution and variability over time, scientists use an agreed list of 50 Essential Climate Variables. In addition to several basic parameters such as temperature, the Essential Climate Variables include detailed characteristics such as soil moisture, soil carbon and ocean oxygen content and aerosols. This set of variables is constantly reviewed.

Changes in observing systems technologies, progress in science and technology, a greater focus on climate adaptation and mitigation, and the need to constantly refine climate change projections all influence the climate variables to be taken into account in characterizing present and future climate.

Observing our climate: 50 Essential Climate Variables

Climate change and variability are assessed by monitoring 50 Essential Climate Variables, and the interaction between them. This is accomplished with the help of the Global Climate Observing System, which brings together the work of many observation networks for land, air and sea.

Atmospheric	**Surface:** air temperature, wind speed and direction, water vapour, pressure, precipitation, surface radiation budget **Upper-air:** temperature, wind speed and direction, water vapour, cloud properties, Earth radiation budget (including solar irradiance) **Composition:** carbon dioxide, methane and other long-lived greenhouse gases (nitrous oxide (N_2O), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6) and perfluorocarbons (PFCs)), ozone and aerosol supported by their precursors (in particular nitrogen dioxide (NO_2), sulphur dioxide (SO_2), formaldehyde (HCHO) and carbon monoxide (CO))
Oceanic	**Surface:** sea-surface temperature, sea-surface salinity, sea level, sea state, sea ice, surface current, ocean colour, carbon dioxide partial pressure, ocean acidity, phytoplankton **Subsurface:** temperature, salinity, current, nutrients, carbon dioxide partial pressure, ocean acidity, oxygen, tracers
Terrestrial	River discharge, water use, groundwater, lakes, snow cover, glaciers and ice caps, ice sheets, permafrost, albedo, land cover (including vegetation type), fraction of absorbed photo-synthetically active radiation, leaf area index, above-ground biomass, soil carbon, fire disturbance, soil moisture

We influence these variables more than we may realize. When we move to urban areas, use water, clear forests, use fossil fuel-powered transport or consume products and services generated by heavy industries, we influence climate variables. The climate system is dynamic. A shift in one variable influences other variables, triggering yet more changes.

Getting facts to make decisions

For governments to understand and manage their response to climate change, they need sustained global observations of Essential Climate Variables as a minimum. The need for enhanced systematic climate observation systems is outlined in several Conventions, such as the United Nations Framework Convention on Climate Change, and is addressed by WMO and its network of National Meteorological and Hydrological Services, with partners.

The umbrella for climate observation coordination and establishment of the requirements for measurements of Essential Climate Variables is the Global Climate Observing System.

Sponsored by WMO, the Intergovernmental Oceanographic Commission of UNESCO, the International Council for Science and the United Nations Environment Programme, it helps define the needs for observations that are achieved through the WMO Integrated Global Observing System, the Global Ocean Observing System and other observation systems. It uses the 50 Essential Climate Variables as a benchmark to measure progress of the observing systems over time.

To constitute climate data, weather data from thousands of stations worldwide are collected and averaged for each locality for 30 years. The data are used to create a "climate normal", which is the average of weather values over a 30-year period.

Observing land, atmosphere and oceans

- The WMO Global Observing System, set up in the 1960s, has over 11 000 stations for land-based observations, some 1 300 observing stations that monitor the atmosphere vertically, and about 4 000 ships and 1 200 buoys that observe several atmospheric and oceanic parameters.
- The WMO Global Atmosphere Watch ensures monitoring of greenhouse gases, ultraviolet radiation, aerosols and ozone from 22 global and 300 regional centres, and produces regular updates on the state of greenhouse gases and the ozone.
- The Global Ocean Observing System conducts modelling analysis of ocean variables for operational ocean services. The IOC of UNESCO is the lead, with WMO, UNEP and ICSU as co-sponsors.
- The World Hydrological Cycle Observing System (WHYCOS) is a WMO programme aiming at improving the basic observation activities, strengthening international cooperation and promoting the free exchange of data in the field of hydrology.
- Satellites: the space-based subsystem of the Global Observing System offers meteorological and environmental and continuous coverage, information exchange and research and development. The backbone is the WMO Space Programme.
- The Aircraft Meteorological Data Relay (AMDAR) is a WMO-initiated programme that collects meteorological data worldwide by using commercial aircraft.
- Argo, an international project which is the mainstay for ocean observations, uses 3 000 underwater floats. The WMO co-sponsored World Climate Research Programme is an important contributor.
- The Global Terrestrial Observing System conducts modelling, analysis and information exchange for Earth-based ecosystems. The Food and Agriculture Organization of the United Nations is the lead agency, and WMO, UNEP and UNESCO are co-sponsors.
- Thousands of volunteers also contribute their observations to National Meteorological and Hydrological Services databases worldwide.

BEYOND DAYS AND WEEKS

In the past, humans relied mostly on collective experience to forecast the next day's weather or predict the forthcoming season. In some communities, they relied on specialists that could interpret the alignment of stars and the solar system. Today, societies are much more sophisticated, and there is strong demand for reliable and refined weather forecasts and climate predictions.

There has been a revolution in forecasting, backed by rapid advances in observation networks, weather and climate research, complex numerical models to simulate weather and climate, supercomputers and telecommunications, meteorological theory and a solid track record of international collaboration.

Models that combine atmosphere simulations and ocean simulations, known as ocean–atmosphere coupled models, are used to predict or simulate the climate for months, seasons, years and decades in advance with steadily increasing confidence. They are also used to develop climate scenarios for a century and beyond for various plausible sustainable developmental pathways of society.

Weather forecasts up to two weeks ahead

Today's forecast for seven days ahead is as accurate as a two-day forecast was in the 1970s. People now use weather forecasting data to make decisions related to conditions at sea, the path of forest fire smoke or volcanic ash, road ice conditions, crop viability and the movement of pests such as locusts. Advanced weather forecasting models are being used for virtually all socio-economic sectors.

Seasonal forecasts

Useful information on probable weather conditions for months to a season ahead has now become possible, especially in low latitudes. There is a better understanding and numerical modelling of the interaction between oceans, the atmosphere and land surfaces.

One of the best-known large-scale patterns is described below.

El Niño/La Niña

El Niño and La Niña are among the best-known terms of climate science, used to denote the two opposite extremes of the same phenomenon of coupled air–sea interaction that plays out in the tropical Pacific Ocean. The two events are strongly coupled with changes in atmospheric pressure and the associated large-scale circulation patterns, and are the opposite phases of air–sea interactions, collectively referred to as

El Niño/Southern Oscillation (ENSO). An El Niño or La Niña event occurs once in two to seven years. The phenomenon typically lasts 9 to 12 months, though occasionally it can last for two years. These events disrupt the normal patterns of tropical precipitation and atmospheric circulation, and have widespread impacts on climate in many parts of the world accompanied by the associated climate-related risks.

The term El Niño, which literally means "boy child" in Spanish, was coined by Peruvian fishermen to refer to the phenomenon that appears around Christmas (akin to the appearance of the Christ Child). Every few years, the temperature of the normally cool surface waters of the eastern Pacific Ocean increases, lasting several months. In turn, the warmer waters affect the atmosphere, and rainfall and surface temperatures increase substantially. El Niño has caused drought and even forest fires in Australia, Indonesia and in parts of South America, but also weaker summer monsoons in South Asia and West Africa. El Niño is also associated with heavy rainfall and floods in parts of eastern Africa. However, not all instances of unusual weather during El Niño can be attributed to it. Regional and local conditions can make El Niño impacts worse, or conversely they can block the impacts.

La Niña, a Spanish term that literally translates to "girl child", is characterized by unusually cold ocean surface temperatures in the central and eastern tropical Pacific, and is the opposite of El Niño. During La Niña years, the opposite conditions prevail, even in terms of the impacts. For instance, parts of Australia, India and Indonesia are prone to drought during El Niño, but are typically wetter than normal during La Niña. The severe flooding in Queensland, Australia, in late 2010 and early 2011 is a striking example of the impact of La Niña.

Other examples of important patterns include the North Atlantic Oscillation, Indian Ocean Dipole and Madden–Julian Oscillation.

From weather forecasts to climate change projections

Climate change is the change in average climatic conditions in a place or region over a time period ranging from decades to hundreds of years. Normal weather as defined by WMO is obtained by calculating the average weather parameters such as rain, snow and temperature over a 30-year period.

The climate change projections and impact assessments for decades to a century ahead were initially based on atmospheric general circulation models incorporating the impacts of greenhouse gases. Then the oceans were added to the models to represent a coupled ocean–atmosphere system. Today, the most complex models involve interactions among an increasing number of climate system components, including the atmosphere, the oceans, the land and the cryosphere. These models have helped us to better know our climate, our influence on it, and how climate change may affect us.

Further investment in climate services will help us refine climate information including predictions and projections so that all decision-makers can plan timely, locally-based, well-informed and cost-effective mitigation and adaptation measures and mainstream climate risk management.

THE SIGN OF THINGS TO COME

Today there is general agreement on what the global climate might broadly look like over the next several decades. Warming of the climate system is unequivocal, as is now evident from global warming trends, melting ice and snow, and a rise in sea level.

The 100-year (1906–2005) linear trend in global mean temperature is 0.74°C. Global average sea level has risen since 1961 at an average rate of 1.8 mm per year. Satellite data since 1978 show that annual average Arctic sea-ice extent has shrunk by 2.7 per cent per decade. From 1900 to 2005, precipitation increased significantly in eastern parts of North and South America, northern Europe and northern and central Asia, but has declined in the Sahel, the Mediterranean, southern Africa and parts of southern Asia.

Major trends associated with climate change

Greater threat from natural disasters

Over the past 50 years, nine out of ten natural disasters around the world have been caused by extreme weather and climate events. Storms, floods, droughts, heatwaves, duststorms, wildfires and other natural hazards threaten the lives and livelihoods of millions of people worldwide. Climate models suggest that several weather extremes are likely to increase in frequency and/or intensity in a world which experiences increasing greenhouse gas concentrations. Rising sea levels from melting of glaciers and thermal expansion of ocean water threaten coastal communities and small islands. Some countries could lose much land which is now available to grow food, build homes and work. Floods, storm surges and tropical cyclones could force many people to relocate.

Weather and climate extremes affect every sector of society, from agriculture to public health, water, energy, transport and tourism, and overall socio-economic development. A single natural disaster can significantly set back economic progress in any given community. Hurricane *Ivan* in 2004 caused losses in Grenada of about 2.5 times its annual gross domestic product. The floods in Mozambique in 2000 destroyed, in less than 10 days, more than 10 years of development efforts that had led to improved water supply, health services, food security and economic growth.

Communities exposed to the greatest risk are in developing countries, least developed countries and economies in transition. Their populations are concentrated in sensitive coastal areas, and they have less diversified economies and fragile infrastructures, combined with weak capacity for risk reduction and disaster management. The poor are most vulnerable, as they lack resources to protect themselves.

In brief: climate change affects us all

People occupy all regions of the globe, from the tropics to polar regions, rural to dense urban areas, hillsides to large flood plains and deserts, and lakesides and riversides to coastlines and estuaries.

Urban areas

About half of the world's population lives in urban areas, compared with one-third some fifty years ago. Megacities therefore loom as giant potential flood, heat and pollution traps, with implications for the local and global climate. The urban poor live in the most disaster-prone areas, such as slopes prone to landslides.

Coastal and island dwellers

Some 40 per cent of the world population lives within 100 km of the coastline. These include the 60 million inhabitants of small island developing States, who are dependent on ocean resources and tourism. Sea-level rise and changes in ocean temperature and characteristics have a profound impact on their lives and livelihoods.

Indigenous groups

The Inuit people and various nomadic tribes are among the 370 million indigenous people living in some of the most diverse areas of the world. They occupy 20 per cent of the world's land surface. Their way of life and cultures are mostly in harmony with nature and adapted to their environment. Climate change affects their livelihoods, lifestyles and cultures.

Least developed countries

The world's population has surpassed 6.7 billion and is expected to exceed 9 billion in 2050, with most of the growth among the poorest countries. These countries are especially prone to extreme impacts of climate change.

Food insecurity

Today, nearly one billion people suffer from malnutrition. In 2008, when agricultural commodity prices doubled within a few months, food riots occurred in about 30 developing countries. Food-deficit countries are still in a highly vulnerable situation. World food demand is expected to double by 2050, due to population growth and socio-economic development. Climate change will add pressure to the already stressed food market, affecting agriculture, livestock and fisheries.

Agriculture and raising livestock are dominant in the economies of most countries. The croplands, pastures and forests that occupy 60 per cent of the Earth's surface are progressively exposed to increased climatic variability.

As climate patterns change, so do agro-ecological zones, plant diseases and pests, fish populations and ocean circulation patterns. Climate affects soil moisture, sunlight for plants and conditions to which plants are subjected daily. Local climate variability and global climate change are rapidly altering the landscape for food production, bringing soil degradation and erosion in some areas, while expanding growing seasons in other areas. Rising temperatures also bring new threats of diseases and pests to agriculture and forests. The projected rise in frequent, intense droughts, floods, wildfires, heatwaves, frosts, sandstorms

Close-up: from equator to pole

These close-ups from equator to pole illustrate climate change and variability under way, and the sign of things to come.

United Republic of Tanzania

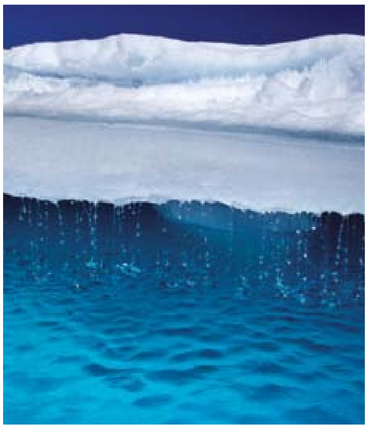
- Mount Kilimanjaro has lost 80 per cent of its glacier cover since 1912, and landslides have been observed in the Kilimanjaro region.
- Malaria has been observed at higher altitudes.
- Rising sea level and saltwater intrusion have led some people along the coast to abandon spring wells. Maziwe Island has been submerged.
- Meanwhile, Lake Rukwa receded by about 7 km in the past 50 years.
- As 60 per cent of the United Republic of Tanzania is prone to desertification, frequent droughts are affecting water catchment areas and other ecosystems.

Solomon Islands

- The country's 500 000 inhabitants depend on agriculture, forestry and fishing for their livelihood.
- A major issue is the relocation of communities as the ocean continues to destroy coastal areas and homes. By 2015 most houses in the shoreline may be washed away. During the 1980s, the cemetery on one island was 50 metres inland, but is now only about 1 metre from the beach and graves have been exposed.
- Taro, a staple root crop, is dying due to swamp salinity. Food insecurity is affecting health.
- On the larger islands, unsustainable logging affects the main source of income.

Melting of ice in the Arctic

- Sea-ice loss accelerated dramatically over the last decade: about 2 million km^2 of sea ice melted in summer seasons.
- As sea ice melts and thins, air, water and tundra warm up, vegetation alters and the loss of permafrost threatens human habitat, fauna and flora and the release of trapped greenhouse gases, which may increase further the warming trend.
- Over Arctic Canada and the Russian Federation, vegetation and the insect population are moving farther north. In northern Canada, the movement of vegetation is disrupting traditional feeding and calving grounds of caribou herds.



CHRISTIAN MOREL

and duststorms affects agriculture, livestock, forests and fisheries.

In developing countries, 11 per cent of arable land could be affected by climate change, with reduced cereal production in many countries. Crop productivity is projected to increase slightly in some countries at mid-to-high latitudes and decrease at lower latitudes. Thus some areas may find opportunities, although the overall impact is likely to be negative.

Scarce freshwater

Water has emerged as a flashpoint in the balance between people and climate. Freshwater sources are rapidly declining and degrading. The rapid rise in population, coupled with the increasing use of water per capita, is a key factor.

From drinking supplies to irrigation to hydropower, water is essential for our day-to-day needs. Freshwater is essential to food supplies; agriculture consumes over 75 per cent of freshwater resources worldwide. Climate conditions also affect the amount of water available to hydroelectric energy developers and managers.

Balancing such needs will be more challenging with climate change. Higher water temperatures and more frequent, intense floods and droughts affect water quality and availability. Floods trigger contaminants and create stagnant water conducive to water- and vector-borne illnesses. Rising seas cause salt water to seep into groundwater aquifers on islands and near coastal areas, where almost half of the world's population lives. Arid regions with already scarce water resources will suffer as desertification extends. High-altitude regions that rely on summer snow or ice melt will also be affected.

At the most basic level, people need freshwater drinking supplies. These are increasingly scarce in some areas, such as arid parts of South America and Africa, and inland areas of Asia and Australia.

New energy challenges

Climate affects energy in many ways. The energy sector balances multiple demands, from industry and agriculture to homes and public works. With continued population growth and industrial development, global energy demand is expected to exceed supply by 20 per cent by 2030. Inadequate estimates for electricity demand can result in power disruptions, such as blackouts in the United States of America and Canada in August 2003, where summer peak energy demand exceeded supply.

For traditional oil and gas sources, climate variability and change threaten key infrastructures. In the Arctic, higher temperatures cause melting of permafrost, threatening roads, aircraft landing strips, oil and gas pipelines, electrical transmission towers and natural gas processing plants. Along coasts, storms endanger offshore oil and gas rigs and related infrastructure. Meanwhile, carbon capture and sequestration (collecting the carbon dioxide from combustion and putting it into geologic storage under the ground) is being explored as a way of mitigating greenhouse gas emissions.

Water is essential to the operations of hydroelectric and power plants. Decreased precipitation and increased evaporation due to higher temperatures and wind speeds lowers water levels in reservoirs, lakes and rivers, and can significantly reduce the output of hydroelectric power stations. Recent droughts in Africa triggered power shortages, resulting in large losses in industrial production. A 2001 drought in Brazil crippled hydroelectric operations and led to widespread blackouts in the country, which generates 85 per cent of its electricity from hydroelectric power. Conversely, increased snowmelt or precipitation can boost hydroelectricity production.

Climate also influences wood energy, an important resource in developing countries; changes in temperature and precipitation affect forest areas and vegetation. Warming temperatures and associated changes in rainfall patterns could boost corn and sugar crops used for biofuels in the short term, but water shortages and weather extremes could reduce yields in other areas. When developing biofuels, it will be critical to avoid competition with food security requirements. New opportunities are also emerging for wind and solar power, which are less affected by climate extremes than hydroelectric power and biofuels.

Regional climate change projections for the twenty-first century

Africa

- By 2020, between 75 and 250 million people are projected to be exposed to increased water stress due to climate change.
- By 2020, in some countries, yields from rain-fed agriculture could be reduced by up to 50%. Agricultural production, including access to food, in many African countries is projected to be severely compromised. This would further adversely affect food security and exacerbate malnutrition.
- Towards the end of the 21st century, projected sea level rise will affect low-lying coastal areas with large populations. The cost of adaptation could amount to at least 5 to 10% of Gross Domestic Product.
- By 2080, an increase of 5 to 8% of arid and semi-arid land in Africa is projected under a range of climate scenarios.

Asia

- By the 2050s, freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease.
- Coastal areas, especially heavily populated megadelta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some megadeltas, flooding from the rivers.
- Climate change is projected to compound the pressures on natural resources and the environment associated with rapid urbanisation, industrialisation and economic development.
- Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in the hydrological cycle.

Australia and New Zealand

- By 2020, significant loss of biodiversity is projected to occur in some ecologically rich sites, including the Great Barrier Reef and Queensland Wet Tropics.
- By 2030, water security problems are projected to intensify in southern and eastern Australia and, in New Zealand, in Northland and some eastern regions.
- By 2030, production from agriculture and forestry is projected to decline over much of southern and eastern Australia, and over parts of eastern New Zealand, due to increased drought and fire. However, in New Zealand, initial benefits are projected in some other regions.
- By 2050, ongoing coastal development and population growth in some areas of Australia and New Zealand are projected to exacerbate risks from sea level rise and increases in the severity and frequency of storms and coastal flooding.

Europe

- Climate change is expected to magnify regional differences in Europe's natural resources and assets. Negative impacts will include increased risk of inland flash floods and more frequent coastal flooding and increased erosion (due to storminess and sea level rise).
- Mountainous areas will face glacier retreat, reduced snow cover and winter tourism, and extensive species losses.
- In southern Europe, climate change is projected to worsen conditions (high temperatures and drought) in a region already vulnerable to climate variability, and to reduce water availability, hydropower potential, summer tourism and, in general, crop productivity.
- Climate change is also projected to increase the health risks due to heat waves and the frequency of wildfires.

Latin America

- By mid-century, increases in temperature and associated decreases in soil water are projected to lead to gradual replacement of tropical forest by savanna in eastern Amazonia. Semi-arid vegetation will tend to be replaced by arid-land vegetation.
- There is a risk of significant biodiversity loss through species extinction in many areas of tropical Latin America.
- Productivity of some important crops is projected to decrease and livestock productivity to decline, with adverse consequences for food security. In temperate zones, soybean yields are projected to increase. Overall, the number of people at risk of hunger is projected to increase.
- Changes in precipitation patterns and the disappearance of glaciers are projected to significantly affect water availability for human consumption, agriculture and energy generation.

North America

- Warming in western mountains is projected to cause decreased snowpack, more winter flooding and reduced summer flows, exacerbating competition for over-allocated water resources.
- In the early decades of the century, moderate climate change is projected to increase aggregate yields of rain-fed agriculture by 5 to 20%, but with important variability among regions. Major challenges are projected for crops that are near the warm end of their suitable range or which depend on highly utilised water resources.
- Cities that currently experience heat waves are expected to be further challenged by an increased number, intensity and duration of heat waves during the course of the century, with potential for adverse health impacts.
- Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution.

Polar Regions

- The main projected biophysical effects are reductions in thickness and extent of glaciers, ice sheets and sea ice, and changes in natural ecosystems with detrimental effects on many organisms including migratory birds, mammals and higher predators.
- For human communities in the Arctic, impacts, particularly those resulting from changing snow and ice conditions, are projected to be mixed.
- Detrimental impacts would include those on infrastructure and traditional indigenous ways of life.
- In both polar regions, specific ecosystems and habitats are projected to be vulnerable, as climatic barriers to species invasions are lowered.

Small Islands

- Sea level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards, thus threatening vital infrastructure, settlements and facilities that support the livelihood of island communities.
- Deterioration in coastal conditions, for example through erosion of beaches and coral bleaching, is expected to affect local resources.
- By mid-century, climate change is expected to reduce water resources in many small islands, e.g. in the Caribbean and Pacific, to the point where they become insufficient to meet demand during low-rainfall periods.
- With higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands.

SOURCE: IPCC, 2007: *CLIMATE CHANGE 2007: SYNTHESIS REPORT.* CONTRIBUTION OF WORKING GROUPS I, II AND III TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE. IPCC, GENEVA, 104 PP.

Environmental threats to our health

Climate change affects our health, as the environment changes around us. Climate plays a powerful role in the spread of disease, in regional air quality and in weather extremes that dramatically change day-to-day living. It can trigger a rise in malnutrition, respiratory infections, cholera, malaria, as well as deaths and injury from natural disasters. In general, climate-related health risks have the greatest impact in developing countries and small island States, as well as communities not historically acclimated to warmer temperatures.

As the global climate changes, people in many areas are at an increasing risk of vector-borne diseases, such as malaria, West Nile virus and dengue fever. The mosquitoes that carry many of these diseases tend to thrive in warmer, wetter climates. Likewise, scientists are concerned about a heightened risk of water-borne diseases due to warmer temperatures that may change the development of pathogens, coupled with increased rain and flooding, which have an impact on contaminants.

A warmer, drier climate increases the frequency of sandstorms and duststorms, which trigger respiratory and cardiovascular problems, as well as transporting some viruses. Heatwaves and urban pollution affect air quality, particularly for children, the elderly and people with vulnerable immune systems.

Biodiversity impacts

Ecological systems are extremely sensitive to changes in climate conditions. Even the slightest changes can put a species over the edge and in danger. From the skies to the land, oceans and glaciers, all animals and plants, as well as their habitats, are at risk from global warming and the associated changes. Regional climate variability and change affect biodiversity everywhere.

Damage to rivers, wetlands and lakes threatens freshwater diversity. Norwegian lemmings depend on dry winters for survival into the spring, and climate change is bringing wetter winters to their habitat in southern Norway.

Perhaps nowhere is the biodiversity threat greater than in the world's oceans. The oceans are a natural "sink" for carbon dioxide, continually absorbing the gas from the atmosphere. Coral reefs, referred to as the tropical rainforests of the ocean, are facing unprecedented threats because of warming, acidification of oceans and increasingly severe tropical cyclones. About 20 per cent of the original area of coral reefs has been lost, with a further 25 per cent threatened in the next century by climate change.

Weather extremes also threaten coastal ecosystems, bringing increased erosion and salt water, and threatening wetlands and mangroves. In Ecuador, about 1 400 kilometres of mangrove swamps and a large number of species, particularly fish, are in danger of disappearing. Over 100 estuaries, which host rich ecosystems, now have dead zones due to chemical fertilizers that discharge massive amounts of nitrogen in rivers and nitrous oxide in the atmosphere.

Forests – a third of our land surface – are rich in wildlife, wild plant genes for new food crops or medicines, ecosystems, water and fertile soil. They are at risk from drought and other climate extremes that degrade soil and expand drylands. For example, by the end of the century, 43 per cent of 69 tree plant species studied could become extinct in Amazonia. Trees from polar latitudes may be crowded out by species from temperate zones, affecting plants and animals as they migrate. Meanwhile, the clearing of forests for agricultural and other uses causes 10–20 per cent of our planet's carbon dioxide emissions each year.

Societal change in response to climate

Our societies have evolved with and rely on particular ecosystems. We have over time developed seasons, festivals, food and clothing fashions in line with the seasons. Changes in climate will affect all aspects of human endeavour including migration of communities in search of better opportunities. Poor communities will be especially vulnerable, as their capacity to adapt is limited.

Access to reliable climate information and services will be important for governments and communities to make decisions on the best available options.

LIVING WITH CLIMATE VARIABILITY AND CHANGE

Adequate understanding of climate change trends is essential to address the challenge. All of us have a role, whether we are in business, government, non-governmental organizations, education, the media or any other part of society.

Mitigate and adapt

Climate change is now inevitable. Greenhouse gases will persist over long periods of time and the atmosphere will warm progressively. This affects other climate variables, such as those describing the ocean.

There is a societal need for mitigation and adaptation to climate change. Mitigation includes actions such as energy efficiency that reduce our contribution to the causes of climate change such as emissions of greenhouse gases. Adaptation refers to adjustments of natural or human systems in response to actual or expected climate.

Prepare for climate change

Some adaptation is already under way. Drip irrigation where water is scarce, renewable energy sources, building codes for energy efficiency, dikes to ward off the rising sea level, risk management insurance schemes and drought-resistant crops are examples, but much more needs to be done.

These actions will be more effective as they become more widespread, and as detailed knowledge about local climate and its evolution is built into decision-making. The sample of measures below demonstrates the use of climate information and services to mitigate and adapt to a changing climate and to manage related risks.

Natural disasters – risk insurance

Climate risk insurance will grow for natural disasters. Weather-based information is already supplied by National Meteorological and Hydrological Services and the insurance industry is looking at models for climate change risks. Examples of public and private sector responses to a changing climate are given below.

The World Bank enables developing countries to take out insurance against the increased risk of climate change-related storms and extreme weather events. Payouts in the aftermath of natural disasters are triggered as soon as a predetermined index, based on rainfall amount and variation of temperature or wind speed, is reached. The scheme was first implemented in Ethiopia in 2006 in collaboration with the World Food Programme and the National Meteorological Services Agency of Ethiopia, and successfully established contingency funding for emergency drought response in the form of a weather-index insurance.

Mauritius operates an insurance scheme for sugarcane against cyclones, droughts and torrential rain. Farmers pay an annual premium. The loss in a given year is reimbursed based on weather information and the loss incurred, compared with the previous period. Thailand has a pilot for flood-index insurance. Viet Nam is setting up a major weather-index insurance programme.

Rising seas – protective action

By the end of the century, the sea level is predicted to rise by 28 to 58 cm. But it could be even higher, up to one metre, if continental ice sheets melt faster as temperature rises. The impact of rising seas will be felt most acutely along coasts and islands that may be far away from melting polar ice. Adaptation will require further investment in coastal protection, relocation and other measures, based on improved projection of sea-level rise and extreme events.

In The Netherlands, a centuries-old system of dikes keeps the sea at bay, supplemented in recent decades by an elaborate network of floodgates and other barriers.

One of the cities in the Middle East most at risk from rising seas is Alexandria, Egypt; more than 58 metres of coastline have vanished since 1989. The city is an industrial centre with 4 million people and a port that handles four fifths of the country's trade. Meanwhile, more than half of the people live within 100 kilometres of the coast. Rising seas could trigger migration of tens or hundreds of thousands of people if the fertile Nile Delta is submerged. Salt water seeping into the city's underground reservoirs is a concern, as is the threat to over 100 endangered species due to ocean acidity. An adaptation strategy is being carried out, including the creation of coastal barriers to reduce the impact of floods.

Much of Kiribati is no higher than five metres above sea level. The seas around the island have been rising at about 5 mm per year since 1991, and villagers have been forced to move inland. Coastal floods, less rainfall, diminished freshwater supplies and coral reef bleaching threaten the island. Kiribati is following in the steps of the Maldives and Tuvalu by preparing for the relocation of its people as the sea level threatens to submerge the nation.

Viet Nam has a climate change plan targeting reforestation of the Mekong Delta mangrove forests, which have been disappearing to agriculture and aquaculture. The country is also reinforcing and raising sea dikes to keep salt water from flooding agricultural and other land. New zoning plans, more resilient construction and infrastructure and watershed management are also planned, building on climate model data and hydrometeorological stations in the country.

WMO ARCHIVES

Many countries are vulnerable to rising seas.

Food security – revisiting farming practices

Sustainable land management, disaster risk management and new green technologies will be among the solutions to help address food security. Some farmers in Iraq are switching to Indian pea instead of rice, as duststorms and scarce rains stifle efforts to revive farming. Wheat and rice production suffered from severe drought in the past two years, while the Tigris and Euphrates rivers have dropped to less than one third of normal capacity.

In Zimbabwe, climate change is weakening agricultural productivity. In the last century, over half (51.4 per cent) of rainy seasons had below normal rains. Droughts are more frequent, rains start sooner and there are more heavy rains and tropical storms, giving rise to floods. Farmers are planting more maize, grain and sorghum, which are drought-tolerant. Adaptation measures include vulnerability assessment of farmers, rainwater harvesting and traditional farming methods that help boost yields. There is need for fertilizers and seed varieties with shorter vegetation periods, crop rotation and educational programmes to adapt to climate change.

In Honduras, farmers grow crops among the trees to control soil erosion, and increase soil fertility and moisture. The technique releases less carbon dioxide, stabilizes river flows and reduces floods. This practice results in higher and more stable yields.

Scarce water – harvesting rain

In the Republic of Korea, Star City in Seoul is a complex with over 1 300 apartments. The rainwater catchment area –- 6 200 m^2 of rooftop and 45 000 m^2 of terrace – is used for gardening and public toilets. Some 3 000 cubic metres of water are stored under the building in three tanks of 1 000 m^3 each. Two tanks collect rainwater and one stores tap water for emergencies. Collecting the water also mitigates local flooding during the monsoon season.

MAKING THE BEST CHOICES

Our changing climate makes the need for climate information more acute than ever. The information needs to be packaged in ways that we can understand and act upon. Climate information has to be relevant to our needs, based on where we live and work. The foundation of climate information is based on harnessing quality observations and creating reliable seasonal to multi-decadal predictions and projections, specific to regions and sectors.

Increasingly, managers from many sectors recognize they are vulnerable to climate variability and change, and are working with scientists to contribute data from their own sectors and networks. The transport sector, for example, is already actively involved in mitigation efforts, and contributes to climate observations through a network of ships and aircraft.

The following are some examples of how climate information can help us make the best choices.

Managing our energy resources

Climate information is needed to assess risk from a changing climate in the energy sector, which powers industrial development, agriculture, tourism and much more. More frequent and intense storms, for example, can damage energy grids, and floods can damage oil and gas infrastructure located along coastlines or river valleys.

Energy managers need information to avoid power shortages, and manage shifting daily requirements as well as long-term energy investments and planning, especially with more heatwaves expected in the future. Renewable energy industries also need climate information. The wind industry is poised for growth and technological developments such as better turbines are giving the industry a boost. But wind energy is sensitive to climate change as well. Damaging high winds can be problematic, as can be windless days that create a drop in energy. Predictions from climate models will help investors and managers with site selection and management.

Development planners and water supply managers need regional climate information to plan for anticipated seasonal shifts in hydroelectric energy/power supply and demand. More hydroelectric power transmission lines can be built to connect projected water-rich areas to drought-prone ones. Most importantly, regions need information as a basis for regional cooperation to diversify energy portfolios, protect against shortfalls of a single energy source and stop dangerous depletion of water tables. Better management of water levels in reservoirs, rivers and streams helps moderate the impact of droughts and floods, benefiting the energy sector as well as ecosystems.

Improving our food supply

Knowing about the rainy or dry season ahead helps farmers plan their crops. Climate predictions enable farmers to adjust planting dates, crop varieties and irrigation strategies based on the projected water availability. They also give advance warning of climate patterns such as El Niño and La Niña, which bring droughts to some areas and floods to others.

Protecting forests and fisheries

Many countries seek to expand their forest management practices, using climate information to shift harvesting patterns, change the mixture of hardwood and softwood species, and plan landscapes to minimize fire and insect damage. Fishery managers use climate information to alter catch size and breeding conditions to sustain yields of fish stocks.

Conserving biodiversity

Climate information helps identify regions and wildlife most at risk and allows for the development of conservation strategies tailored to particular areas.

Improving public health and humanitarian assistance services

Closer collaboration between the meteorological, hydrological and public health sectors provides communities and health and humanitarian agencies with tools to identify elevated risks, take preventive measures and plan effective responses. Working together will also make climate information tools increasingly accurate in time and space, and allow for cost-effective prevention, preparedness and mitigation measures. Projection of climate and local impact helps refine assessments of the scale of forced migration due to long-term environmental changes and extreme weather and climate events.

An example from Bangladesh is the cost of adaptation in the health sector over the period 2010 to 2021. The country expects to spend over US$ 2 billion to tackle the probable consequences of climate change including the health risk to 30 million people who would be affected. It is also estimated that by 2030, if no action is taken, over 130 countries may be considered as being highly vulnerable to climate impacts.

Managing tourism opportunities

Accurate, reliable climate information can help manage tourism opportunities. Ski resorts can better plan where to build new ski lifts, which last 25 years, based on climate models of temperature changes over 30 years. Coastal resorts can shore up areas that are vulnerable. Sporting events can use climate predictions to better manage their water resources.

SCIENCE FOR USE

Climate science is essential to information and planning.

The main greenhouse gases in 2010 reached the highest levels recorded since pre-industrial times. Ice cores in Antarctica reveal that present concentrations of carbon dioxide are well beyond the range of variations during the past 800 000 years. Even if the most stringent mitigation measures were put in place today, the impacts of climate change would continue for centuries. Decision-makers in all sectors increasingly have to manage the risk of the adverse impacts of climate variability and change, but often are not getting information they need to do so, and to do so efficiently. The impacts of climate change go beyond national borders, politics and timelines, and beyond socio-economic status. There is a need for all nations and all disciplines to work more closely together to develop more accurate and timely climate information that can be integrated into planning, policy and practice.

We all share the same planet, the same oceans, the same atmosphere and the same multifaceted climate. Changes in the climate affect all communities, everywhere in the world. A multilateral platform for the collection and exchange of observations and data is a must. Unilateral or bilateral actions would be utterly insufficient. Only through a multilateral platform can nations acquire the information their people need to protect their lives and livelihoods and adapt to new climatic circumstances. No country, not even the largest ones, can produce such climate information on its own. The multilateral platform needs to be intergovernmental, as governments have the ultimate responsibility to protect the security and survival of their people against natural disasters and other extreme consequences of climate change.

A Global Framework for Climate Services

Against that background, Heads of State and Government, Ministers and high-level policymakers at the World Climate Conference-3 in 2009 decided to establish a Global Framework for Climate Services. The Framework should serve as an efficient mechanism for the generation, delivery and application of climate services. Various components are already in place or are being established.

A unique global network

Under the aegis of WMO, 189 National Meteorological and Hydrological Services monitor, collect, control quality, process, exchange and archive standardized climate data. They form a unique network. Most of these Services operate a Climate Watch System to warn against extreme climate events that affect health, agriculture, water resources, tourism and energy. However, present capabilities to provide climate services fall short of meeting present and future needs, and therefore these Services are not delivering their full and potential benefits. This is particularly the case in developing and least developed countries.

To support climate services, high-quality observations are required across the entire climate system and for relevant socio-economic variables. Gaps in observation networks are especially critical in developing countries, where some areas have less than five per cent of desired observation coverage. At least 70 countries do not have basic climate services and 6 countries have no climate services whatsoever. Capacity-building will be a central component of the Framework.

Regional climate providers for climate services

Regional cooperation is a cost-effective way to build climate capability and services. WMO Regional Climate Centres are centres of excellence that help deliver operational climate products such as regional-scale climate monitoring, long-range forecasts and related data. These Centres work in close cooperation with National Meteorological and Hydrological Services to meet national needs. Regional Climate Outlook Forums bring together regional and national stakeholders to coordinate contributions and develop consensus-based early warnings, seasonal forecasts and climate change adaptation and mitigation measures, and facilitate capacity-building.

Reaching you

The Framework aims to enhance climate observations and monitoring, transform that information into sector-specific products and applications and disseminate those products widely. This will allow us to better manage the risks generated by climate variability and change.

Understanding of the climate system is advancing quickly, but is not being effectively translated into services that can inform decision-making. In particular, climate prediction should be improved and efforts made to help users incorporate its inherent uncertainty into their decision-making. The needs of the user community are diverse and complex. A novel feature of the Framework is its users' interface to strengthen the dialogue between the climate service providers and users of climate services.

Action is especially needed to translate climate observations, research and predictions into services for those most vulnerable to climate and weather hazards. Over the next six years, the aim is to facilitate access to better climate services in four initial priority sectors, namely agriculture (food security), disaster risk reduction, health and water. Over the next ten years, the aim is to extend access to better climate services to more sectors.

A planetary joint venture

WMO is leading this endeavour of the United Nations system to support adaptation by strengthening climate knowledge and its applications across all sectors and disciplines. The involvement of United Nations agencies and programmes and all other relevant partners is a prerequisite for the implementation of the Global Framework for Climate Services and for its potential benefits to fully materialize.

TOGETHER WE CAN

Climate change is the most complex challenge that humankind has had to face in recent times. With each successive generation, redressing the imbalance will be more difficult. The UN System Delivering as One mobilizes the extensive expertise available within and beyond the United Nations system on science, telecommunications, agriculture, health, culture, human rights, transport, trade, forestry, disaster risk reduction and more, as well as related financial institutions. It brings together the capacities of the United Nations system to help communities and countries mitigate and adapt to climate change.

The world has faced environmental challenges before. The leadership of the United Nations has assisted in raising the issues, galvanizing action from different stakeholders, including the public, and reversing the adverse impacts. An example is the ozone layer and the environmental impact, including on humans. From the time WMO first drew attention to ozone depletion related to human activities in 1989, the annual ozone hole in the southern hemisphere has stopped increasing in size, and recovery starts to be noticeable. The Vienna Convention on the Protection of the Ozone Layer and the subsequent Montreal Protocol on Substances that Deplete the Ozone Layer have been a model for effective international action.

The same concerted effort is required to address climate variability and change for mitigation and adaptation efforts. Gaps in our knowledge of long-term predictions will need to be improved, as well as observations to improve our environmental simulations. The impacts on society and the environment will need to be better understood including on economic activities that drive societal development. Governments and communities will need the capacity to understand this information, work with it in decision-making and provide feedback to the scientific and research community for further improvements. Information and services need to be accessible to all, in particular the most vulnerable.

In short, the Global Framework for Climate Services is the modern day answer to an age-old challenge – how we, as a modern civilization, use the best available information at our disposal to adapt to a variable and changing climate.

Online resources

The United Nations System and related organizations have a wealth of online resources about climate. For more information on Climate for you, please see the sites below.

United Nations – Gateway to the United Nations system's work on climate change

www.un.org/wcm/content/site/climatechange/gateway

United Nations Volunteers – International Year of Volunteers +10

www.worldvolunteerweb.org

The celebration of the tenth anniversary of the International Year of Volunteers in 2011 is a new opportunity for the WMO community to increase awareness of the invaluable contribution of volunteers to meteorology and hydrology.

WMO – World Meteorological Day 2011

www.wmo.int/worldmetday

The World Meteorological Day pages of the WMO Website include the present brochure, accompanied by an online collection of resources of the United Nations system and related international organizations.

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