WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION

GFCS GLOBAL FRAMEWORK FOR CLIMATE SERVICES

White Paper on the Contribution of the Global Framework for Climate Services to Transforming our World: the 2030 Agenda for Sustainable Development (Agenda 2030)





Chairperson, Publications Board
World Meteorological Organization (WMO)
7 bis, avenue de la Paix
P.O. Box 2300
CH-1211 Geneva 2, Switzerland

Tel.: +41 (0) 22 730 84 03
Fax: +41 (0) 22 730 81 17
E-mail: publications@wmo.int

White Paper on the Contribution of the Global Framework for Climate Services to Transforming our World: the 2030 Agenda for Sustainable Development (Agenda 2030)

Contents

Basic definitions

Climate data. Historical and real-time climate observations along with direct model outputs covering historical and future periods. Information about how these observations and model outputs were generated ("metadata") should accompany all climate data.

Climate product. A derived synthesis of climate data. A product combines climate data with climate knowledge to add value.

Climate information. Climate data, climate products and/or climate knowledge

Climate service. Providing climate information in a way that assists decision-making by individuals and organizations. A service requires appropriate engagement along with an effective access mechanism and must respond to user needs.

Source: WMO, 2014: *Implementation Plan of the Global Framework for Climate Services*, page 2, Box 1.

Executive summary

Transforming our world: the 2030 Agenda for Sustainable Development (Agenda 2030) is a plan of action for people, the planet and prosperity, which seeks to strengthen universal peace in greater freedom. The Sustainable Development Goals (SDGs) identified under Agenda 2030 provide a universal, transformative and integrated ambition that will provide an aligned pathway for the activities of UN Members, international organizations within and beyond the UN system, as well as the entire sphere of entities and individuals having a stake in sustainable development.

Transforming our World: the 2030 Agenda for Sustainable Development brings to the forefront the challenge that sustainable development and climate change, two intertwined issues, represent. Achieving the SDGs will require the mobilization of efforts and capacities of all to implement the full spectrum of internationally agreed objectives, such as the Sendai Framework on Disaster Risk Reduction, the Paris Agreement reached at UNFCCC COP 21 in December 2015, the Small Islands Developing States (SIDS) Accelerated Modalities of Action (SAMOA) Pathway, as well as forthcoming agreements from Habitat III and the United Nations Conference on Housing and Sustainable Urban Development.

The Global Framework for Climate Services (GFCS) was established to strengthen and coordinate existing initiatives and develop new infrastructure where needed in order to meet the following five challenges identified through widespread consultation both at, and subsequent to, World Climate Conference-3 in 2009.

(a) Access to climate services needs to be established and/or improved in all countries;
(b) The capacity to deal with climate-related risks is lacking in many countries;
(c) The availability and quality of climate data are inadequate in many parts of the globe;
(d) Users and providers need to improve interaction; and
(e) The quality of climate services needs improvement to better match user requirements.

Climate service providers and their services are critical in supporting the achievement of the 2030 Sustainable Development Agenda. The majority of the 17 SDGs, many of their 169 targets and activities to be implemented under the internationally agreed objectives are weather- and climate-sensitive. It is therefore crucial to articulate the contribution of the GFCS to supporting the SDGs (through the activities of GFCS partners), focusing on the five priority areas of the GFCS, namely: Agriculture and food security; Disaster risk reduction; Health; Water; and Energy, but also covering the multitude of SDGs that could benefit from enhanced availability and access to climate services. A crosscutting issue is that of urban development and Seventeenth World Meteorological Congress (Cg-17) in 2015 proposed that priority be given to this issue (WMO, 2015, Resolution 68(Cg-17)).

While various definitions of the term exist, climate services under the GFCS[1] are defined as providing climate information in a way that assists decision-making by individuals and organizations. A service requires appropriate engagement, along with an effective access mechanism and must respond to user needs. Climate services develop and provide science-based and user-specific information relating to past, present and potential future climate and address all sectors affected by climate at global, regional and

[1] WMO, 2014: *Implementation Plan of the Global Framework for Climate Services*, page 2, Box 1. http://www.wmo.int/gfcs/sites/default/files/implementation-plan//GFCS-IMPLEMENTATION-PLAN-FINAL-14211_en.pdf
See also *Report of the High Level Taskforce on the GFCS*, page 18: http://library.wmo.int/pmb_ged/wmo_1065_en.pdf.

local scales. They connect natural and socioeconomic research with practice. They help society cope with climate variability and change through the transformation of climate-related data – together with other relevant information – into customized products such as projections, trends, economic analysis and services to user communities in different sectors.

Climate services can be provided through a number of mechanisms, including web portals, for accessing the data and products derived from the data, mobile-phone-based applications, for the delivery of services and web-designed products such as climate statistical tables and maps, depending on the needs and capabilities of the users. Furthermore, other interfaces with users need to be implemented, such as workshops, seminars, open days, feedback sessions and practical exercises. This would include users' dialogue interfaces where products and services can be reviewed, tested and revised and the best delivery mechanisms identified and selected.

It is important to recognize that the goals in themselves are not independent, i.e. a lack of food security will impact poverty. Similarly, access to water impacts agriculture and too much water can lead to disasters and health issues. Therefore, while we discuss these goals separately, their interdependence should not be overlooked.

In ensuring that countries have access to the climate information required to implement and meet the SDGs through their National Meteorological and Hydrological Services (NMHSs), it is essential that all relevant partner agencies are included in the development of the required climate services and that suitable stakeholder engagement practices and procedures are implemented.

With respect to the **Agriculture and food security goal (SDG 2)**, which focuses on addressing hunger, achieving food security and improving nutrition and promoting sustainable agriculture, climate variability and change have a major impact on food security and sustainable agriculture. The overall availability of food is affected by changes in agricultural yields (impacted by climate and weather), as well as changes in arable land. Changes in food production, together with other factors, could impact food prices, which would affect the ability of poor households to access food markets. Decreased water availability and quality in some areas could result in increased health and sanitation problems such as diarrhoeal disease which, together with changes in vectorborne disease patterns, has the potential to increase malnutrition and negatively affect food utilization.

With respect to the **Disaster risk reduction goal (SDG 11)**, which aims at making cities and human settlements inclusive, safe, resilient and sustainable, being able to better adapt to and manage a variable and changing climate is fundamental to sustainability. There is much to be gained from viewing the 2030 Agenda for Sustainable Development through the lens of disaster risk reduction and the Sendai Framework in particular. Direct references to disaster risk reduction which are examined in this paper can be seen in the sections on declaration and goals and targets, in particular those related to poverty, ending hunger, ensuring healthy lives, education, sustainable management of water, building resilient infrastructure and cities, climate change and marine and terrestrial ecosystems.

With respect to the **Health goal (SDG 3)**, which is focused on ensuring healthy lives and promoting well-being for all at all ages, weather and climate are inextricably linked to some of the most fundamental determinants of human health, such as clean air and water, adequate food and shelter and the distribution and occurrence of disease. Heatwaves and cold spells, tropical cyclones, floods and droughts claim many lives and heighten the transmission of diseases each year. Factors indirectly related to weather and climate – food security and non-communicable diseases, such as cardiovascular and respiratory diseases resulting

from exposure to poor air quality – also cause the death and illness of many people. Furthermore, the proliferation of communicable water- and vectorborne diseases, due to favourable conditions – particularly triggered by climate variability – result in a huge cost to society and the economy.

With respect to the **Water goal (SDG 6)**, which aims at ensuring availability and sustainable management of water and sanitation for all, climate and water have a very close and complex relationship. Although it is recognized that anthropogenic factors have a major impact on water resources, the influence of climate and weather is more significant. The most important impacts of climate variability and change are brought about through the hydrological cycle. For example, floods are the most widespread of natural disasters and droughts represent one of the greatest threats to food security: both floods and droughts impact access to water and sanitation through damage to key infrastructure and services. At the same time, the hydrological cycle is itself an essential component of the climate system, controlling the interaction between the atmosphere and the land surface and providing mechanisms for the transport, storage and exchange of mass and energy.

With respect to the **Energy goal (SDG 7)**, which is aimed at ensuring access to affordable, reliable, sustainable and modern energy for all, energy services and resources are affected by climate variability and change – changing trends, increasing variability, greater extremes and large interannual variations in climate parameters in some regions. Furthermore, climate impacts cross the entire energy supply chain. Existing energy infrastructure, new infrastructure and future planning need to consider emerging climate conditions and impacts on design, construction, operation and maintenance. For example, climate services will play a major role in mapping new sources of energy. Impacts on energy supply and demand are the most intuitive but there are also direct effects on energy resource endowment, infrastructure and transportation and indirect effects through other economic sectors (for example, water and agriculture).

With respect to the **Climate change goal (SDG 13)**, which focuses on taking urgent action to combat climate change and its impacts, the link between climate and climate change is obvious. Living with, and adapting to, climate variability and change is an everyday reality. Society has always had to deal with climate variability, including extreme weather and climate events, but the assumption that past climatic and socioeconomic conditions are indicative of current and future conditions is now not necessarily valid. The combined effects of impacts of climate change on climate variability and of increasing vulnerability and exposure to hazardous conditions due to migration, infrastructural development and changing land use present unprecedented challenges to society.

As indicated above, the 17 goals are not independent and climate has both direct effects and indirect impacts on nearly all the SDGs. Further to the areas which are, at the moment, the high-priority topics for the GFCS, climate has impacts on other goals, such as:

Poverty (SDG 1). End poverty in all its forms everywhere. Climate-related shocks and stresses – already a major obstacle to poverty reduction – will worsen with climate change. Climate change is already preventing people from escaping poverty and without rapid, inclusive and climate-smart development, together with emission-reduction efforts that protect the poor, there could be more than 100 million additional people living in poverty by 2030.

Education (SDG 4). Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. Education and awareness-raising play an essential role in increasing the climate change adaptation and mitigation capacities of communities by enabling individuals to make informed decisions.

Gender equality (SDG 5). Achieve gender equality and empower all women and girls. To adequately serve these users, good climate services need to be sensitive to gender differences.

Economic growth and employment (SDG 8). Promote inclusive and sustainable economic growth, employment and decent work for all. Climate variability and change impact economic growth and will inevitably lead to the loss of jobs in certain sectors. The transition to a greener economy and the emergence of green technologies, however, can generate positive shifts in employment and create opportunities for decent jobs.

Resilient infrastructure (SDG 9). Build resilient infrastructure, promote sustainable industrialization and foster innovation. Our daily lives depend in almost all aspects on reliable transport, energy, water supply and communication systems and those specifically designed for the protection of lives and property from natural hazards.

Reduced inequality (SDG 10). Reduce inequality within and among countries. Some countries are more vulnerable to climate variability and change than others because of their limited national capacities, their markedly volatile or difficult climate – or both. African countries, lesser developed countries, Small Island Developing States (SIDS) and Land-locked Developing Countries (LLDCs) are particularly vulnerable.

Sustainable consumption and production patterns (SDG 12). Ensure sustainable consumption and production patterns. Climate variability and change are two of a number of factors that will influence sustainable consumption and production and thus need to be taken into consideration, as appropriate.

Oceans, seas and marine resources (SDG 14). Conserve and sustainably use the oceans, seas and marine resources. Covering some 70% of the Earth's surface, the world's oceans have a two-way relationship with weather and climate. The oceans influence the weather on local to global scales, while changes in climate can fundamentally alter many of the oceans' properties.

Terrestrial ecosystems (SDG 15). Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss. The terrestrial biosphere interacts strongly with the climate, providing both positive and negative feedbacks due to biogeophysical and biogeochemical processes.

Peaceful and inclusive societies (SDG 16). Promote just, peaceful and inclusive societies. Although many other factors impact peaceful and inclusive societies, the impacts of climate variability and change on water availability and access, food security and disasters have the potential to lead to conflicts between peoples and nations.

Through **Means of implementation (SDG 17)**, revitalize the global partnership for sustainable development. Agenda 2030 recognizes that a successful sustainable development agenda requires partnerships between governments, the private sector and civil society. These inclusive partnerships are built upon principles and values, a shared vision and shared goals that place people and the planet at the centre; they are needed at the global, regional, national and local level.

In the area of climate, the GFCS represents one such partnership, providing a worldwide mechanism for coordinated actions to enhance the quality, quantity and application of climate services.

There is a risk-based element to the achievement of all of these goals: access to high-quality, fit-for-purpose climate information and services will greatly reduce the risks associated with achieving the SDGs and their related targets.

Improved climate services, in support of the SDGs, must provide climate information in a way that assists decision-making by individuals and organizations. A service requires appropriate engagement, along with an effective access mechanism, and must respond to user needs. They will ensure that user communities make climate-smart decisions and that climate information is disseminated effectively and in a manner that lends itself more easily to practical action. Effective development and use of climate services is of great value for decision-making in many economic and social sectors.

Climate information will be essential background information in monitoring the achievement of Transforming our World: the 2030 Agenda for Sustainable Development goals. When the information on the achievement of the targets is compiled, the prevailing climate information will provide context in terms of many of the relevant targets.

The GFCS has a major role to play in the achievement of the SDGs. In particular, it should continue to use its partner agencies and contacts at national and local levels to promote the use of climate information and services in meeting the SDGs and their relevant targets.

Climate service providers at local, national, regional and global levels should use this paper in discussions with those agencies implementing and monitoring the SDGs at their levels to ensure that the roles and responsibilities of the providers are recognized and taken into consideration as the processes to reach the SDGs are planned and implemented.

1. Background/introduction

In New York (USA) in September 2015, the Summit on Sustainable Development adopted Transforming our World: the 2030 Agenda for Sustainable Development (Agenda 2030). Agenda 2030 is a plan of action for people, the planet and prosperity. It also seeks to strengthen universal peace in greater freedom.

Transforming our World: the 2030 Agenda for Sustainable Development articulates 17 SDGs and the corresponding 169 targets (https://sustainabledevelopment.un.org/sdgs). The SDGs seek to build on the Millennium Development Goals and complete what these did not achieve. They seek to realize the human rights of all and to achieve gender equality and the empowerment of all women and girls. They are integrated and indivisible and balance the three dimensions of sustainable development: economic, social and environmental.

The SDGs provide a universal, transformative and integrated ambition that will provide an aligned pathway for the activities of UN Members, international organizations within and beyond the UN system, as well as the entire sphere of entities and individuals having a stake in sustainable development.

This paper enables a better understanding of the value and role of the GFCS in support of sustainable development and adaptation to climate variability and change. It has been developed under the guidance of the GFCS Partners Advisory Committee (PAC). This is the GFCS stakeholder engagement mechanism aimed at ensuring the participation of partners and stakeholders in the work of the Intergovernmental Board on Climate Services (IBCS). In ensuring that countries, through their NMHSs, have access to the climate information required to implement and meet the SDGs, it is essential that WMO continues to partner with these agencies as the application of the SDGs continues into the future. Throughout this process, it is essential that suitable stakeholder engagement practices and procedures are implemented.

Climate services and the information provided through them are thus critical for the achievement of the 2030 Sustainable Development Agenda as the majority of the 17 SDGs and many of their 169 targets, as well as activities to be implemented under other internationally agreed objectives, are weather- and climate-sensitive.

While there are various definitions, climate services under the GFCS[2], are defined as providing climate information in a way that assists decision-making by individuals and organizations. A service requires appropriate engagement along with an effective access mechanism and must respond to user needs. Depending on user needs, these data and information products may be combined with non-meteorological data, such as agricultural production, health trends, population distributions in high-risk areas and road and infrastructure maps for the delivery of goods and other socioeconomic variables. Climate services develop and provide science-based and user-specific information relating to past, present and potential future climate and address all sectors affected by climate at global, regional and local scales. They connect natural and socioeconomic research with practice.

---

[2] WMO, 2014: *Implementation Plan of the Global Framework for Climate Services*, page 2, Box 1. http://www.wmo.int/gfcs/sites/default/files/implementation-plan//GFCS-IMPLEMENTATION-PLAN-FINAL-14211_en.pdf. See also *Report of the High Level Taskforce on the GFCS*, page 18: http://library.wmo.int/pmb_ged/wmo_1065_en.pdf.

Following wide consultation during and after World Climate Conference-3 (WCC-3) in 2009, the GFCS was established to strengthen and coordinate existing systems and initiatives and develop new infrastructure where needed in order to meet the following five challenges that were identified:

(a) Access to climate information services needs to be established and/or improved in all countries;
(b) The capacity to deal with climate-related risks is lacking in many countries;
(c) The availability and quality of climate data are inadequate in many parts of the globe;
(d) Users and providers need improved interaction; and
(e) The quality of climate services needs improvement to better meet users' requirements for information.

Transforming our World: the 2030 Agenda for Sustainable Development brings to the forefront, amongst others, the challenge that sustainable development and climate change, two intertwined issues, represent. Achieving SDGs in this regard will require the mobilization of efforts and capacities of all to implement the full spectrum of internationally agreed objectives, such as the Sendai Framework on Disaster Risk Reduction, the Paris Agreement reached at the UNFCCC COP 21 in December 2015, the SIDS Accelerated Modalities of Action (SAMOA) Pathway, as well as forthcoming agreements from Habitat III, the United Nations Conference on Housing and Sustainable Urban Development.

In particular, the Paris Agreement recognized that climate change represents an urgent and potentially irreversible threat to human societies and the planet (including ecosystems) and thus requires the widest possible cooperation by all countries. Their participation in an effective and appropriate international response, with a view to accelerating the reduction of global greenhouse gas (GHG) emissions, will be key.

With this in mind, it is critical to articulate the commitments made by governments towards the GFCS to support the achievements of the SDGs (through the activities of GFCS partners). The progress made in the five priority areas of the GFCS, namely: Agriculture and food security; Disaster risk reduction; Health; Water; and Energy will contribute to the achievement of the SDGs and, in the meantime, people and societies will benefit from enhanced availability and access to climate services.

In the articulation of the role and contribution of climate service providers and the services they provide to sustainable development and adaptation to climate variability and change, special attention should be paid to the most vulnerable people and the risks to which they are exposed, in particular specific challenges faced by SIDS, LDCs and LLDCs.

2. Climate services and the services they provide

The well-known adage "climate is what you expect and weather is what you get" clarifies the difference between climate and weather. Climate information and services prepare users for the weather they will actually experience. A climate service provides climate information in a way that assists decision-making by individuals and organizations. A service requires appropriate engagement along with an effective access mechanism and must respond to user needs. The service component involves appropriate engagement, an effective access mechanism and responsiveness to users' needs.

Such services involve high-quality data from national and international databases on temperature, rainfall, wind, soil moisture and ocean conditions, as well as maps, risk and vulnerability analyses, assessments and long-term projections and scenarios. Depending on user needs, these data and information products may be combined with non-meteorological data, such as agricultural production, health trends, human settlement in high-risk areas, road and infrastructure maps for the delivery of goods, and other socioeconomic variables.

Climate services develop and provide science-based and user-specific information relating to past, present and potential future climate and address all sectors affected by climate at global, regional and local scales. They connect natural and socioeconomic research with practical information. They help society cope with climate variability and change through the transformation of climate-related data – together with other relevant information – into customized products such as projections, trends, economic analysis and services to user communities in different sectors. For example, the provision of more and better climate services supplying comprehensive information will allow farmers to fine-tune their planting and marketing strategies, based on seasonal climate forecasts; empower disaster-risk managers to prepare more effectively for droughts and heavy precipitation; assist public health services to target vaccine and other prevention campaigns to limit climate-related disease outbreaks such as malaria and meningitis; and help improve the management of water resources. These activities all contribute to appropriate adaptation planning in a changing climate.

Climate services can be provided through a number of mechanisms, including:

(a) Direct access (for example, via the Web) to climate databases, with the ability to download specific datasets, as required;
(b) Direct access to climate products derived from the data, such as, for example, rainfall intensity-frequency-duration data and maps;
(c) Publication of climate data statistics, including, for example, both tabular and map format over the Web;
(d) Targeted climate products, such as El Niño updates, through subscriber services and smart phone applications; and
(e) Targeted products delivered via the most appropriate media.

3. Sustainable Development Goals and the GFCS Priority Areas

3.1 Agriculture and food security (SDG 2) - End hunger, achieve food security and improved nutrition and promote sustainable agriculture

3.1.1 The connection between SDG 2 and climate

Agriculture and food security in the 21st century face multiple challenges. Climate change is expected to affect all the components that influence food security: availability, access, stability and utilization. The overall availability of food is affected by changes in agricultural yields, as well as changes in arable land. Changes in food production, together with other factors, could impact food prices, which would affect the ability of poor households to access food markets. Decreased water availability and quality in some areas could result in increased health and sanitation problems such as diarrhoeal disease which, together with changes in vector- and waterborne disease patterns, has the potential to increase malnutrition, and negatively affect food utilization. Extreme weather effects disrupt the stability of food supply, as well as people's livelihoods. Increases in extreme weather as a result of climate change, such as floods and droughts, would exacerbate this trend and could have a negative impact on livelihoods that depend on climate-sensitive activities such as rainfed agriculture and livestock rearing.

Agriculture has to produce more food and fibre to feed a growing population, more feedstock for a potentially huge bio-energy market, contribute to overall development in the many agriculture-dependent developing countries, adopt more efficient and sustainable production methods, adapt to climate change and find effective ways to combat uncertainties. Agriculture is a high-risk sector, subject not only to the adverse influence of natural hazards but also challenged by the risk of market price fluctuations, policy changes and ecology deterioration. With global climate change, the risk of climate variability and shifting cropping areas is an important issue for food security and ending hunger.

Extreme weather disasters and higher volatility in food prices in global markets during recent years have highlighted the importance of stable agricultural production and global food security. Limited water resources, drought, desertification, land degradation, erosion and natural hazards are major risk factors affecting agricultural sectors (crop, livestock, fishery and forestry). In the past three centuries, the total area of cultivated land has increased more than 450%. Currently, 68%–69% of global land area is for agriculture, rangeland and forestry. In particular, 30% of the land is for forest and woodlands, 12% for arable and permanent crops and 26% for permanent meadows and pasture. In most developing countries, three out of four people live in rural areas and are highly dependent on agricultural sectors for their food security and livelihoods. It is estimated that, by 2050, arable land in use needs to increase by more than 70 million ha from adjusted 2005 totals, without accounting for biofuel production. According to some estimates, 60% more food will be needed by 2050 (FAO, 2009).

Fish comprises about 20% of the animal protein in the diets of more than 2.8 billion people. The contribution of fish to dietary animal protein can reach 50% in the world's poorest regions, and up to 90% in SIDS. The important role of fisheries is threatened by changes to the environment associated with increased emissions of GHGs, including higher water temperatures and increases in ocean acidification, which change marine fish distribution. To that may be added the stress from overfishing and land-based pollution dead

zones from land-based pollution, all of which reduce fish abundance and species diversity. Aquaculture, one of the fastest growing animal food-producing endeavours, is affected by warming temperature, which displaces species such as freshwater molluscs. Fisheries play a crucial role in providing food security and opportunities to earn income, particularly in developing countries.

Climate change and variability are likely to modify the productivity and distribution of oceanic fisheries. In particular, the productivity of colder water species may be reduced in subtropical waters and the distribution of spawning areas and fisheries may be affected: such species are unlikely to be able to extend their ranges further polewards due to the lack of suitable habitat. On the other hand, the productivity of warmer water species may be enhanced in subtropical waters and distribution of more tropical species may expand southwards. Increasing climate variability will make fisheries management – and the forecasts of fisheries production – more challenging. A better understanding of climate and its impacts on oceanic fisheries is critical to the future management of these valuable resources for subsistence and market-based economies and cultures. Developing countries and SIDS will need special assistance in adapting to the effects of climate change.

Forestry likewise plays a crucial role in improving livelihoods, especially of rural farmers, providing fuelwood and animal fodder, besides fruits and nuts. Animal husbandry and agro-pastoralism provide important food sources through meat, milk and eggs. Climate change can affect the production and health of animals, as well as the suitability and range of pasture lands. Livelihoods can be lost when herds of livestock are affected by heatwaves or floods.

The vulnerability of agricultural systems and food security depends on many factors. Increases in global population produce greater demand for food. Dwindling resources due to competition for land (urban settlements, environmental resources, energy) create additional stress on food security. Increased frequency, severity and intensity of weather and climate extremes have contributed to food deficits and failure to prevent widespread famine in many high-risk areas. Climate change will act as a hunger-risk multiplier, exacerbating the risk factors that impact food security. Without significant efforts to improve livelihoods and build resilience, climate change is projected to increase the number of people at risk of hunger by 2050. A combination of increasing frequency of hazardous climatic extremes (IPCC, 2012), diminishing agricultural production in vulnerable regions, expanding health risks, decreasing water availability and heightened conflicts over scarce resources will intensify existing threats to food security and livelihoods, leading to new humanitarian crises, as well as increasing population displacement.

Climate–agriculture and food-security link: seasonal climate outlooks, Australia

In Western Australia, the seasonal climate outlook (SCO) is a monthly newsletter that summarizes climate outlooks for the next three months. It is produced by the Western Australian Department of Agriculture and Food's Statistical Seasonal Forecast (SSF) system specifically for the Western Australian wheat belt and by the Australian Bureau of Meteorology. It provides a review of recent climate indicators, including El Niño-Southern Oscillation, the Indian Ocean Dipole, the Southern Annular Mode, as well as local sea-surface temperature and pressure systems. At appropriate times of the year it also includes an overview of the rainfall outlook for the growing season produced by SSF. The seasonal outlook information can then be incorporated into on-farm decision-support systems.

3.1.2 The relationship between climate and SDG 2 targets

The agriculture and food security targets are very much focused on addressing hunger, achieving food security and improving nutrition and promoting sustainable agriculture.

There is an opportunity to incorporate climate information into agricultural development through a holistic integration of climate services into practices and policy for development decisions in agriculture and food security. Achieving this decision-making capability calls for accelerated development of climate services applications to support such integration, while also adapting to climate extremes and change.

3.2 Disaster risk reduction (SDG 11) - Make cities and human settlements inclusive, safe, resilient and sustainable

3.2.1 The connection between SDG 11 and climate

Transforming our World: the 2030 Agenda for Sustainable Development recognizes and reaffirms the urgent need to reduce the risk of disasters. There are several ways to address disaster risk reduction – for example, by reducing exposure and vulnerability of the poor to disasters, building resilient infrastructure and implementing effective early warning systems.

The world is becoming increasingly urban; population growth and urbanization are projected to affect more than two thirds of the world's population. Increasing population density can lead to creation of risk, especially when urbanization is rapid, poorly planned and occurring in a context of widespread poverty. Furthermore, the growing concentrations of people and economic activity in most cities are seen to overlap with areas of high-risk exposure. Estimates suggest that, by 2050, the urban population exposed to cyclones will increase from 310 million to 680 million. Urban development investment is also set to increase from US$ 7.2 trillion in 2011 to US$ 12 trillion by 2020 (UNISDR, 2015). The exposure of urban assets to sea-level rise and flooding could reach US$ 35 000 billion by the 2070s, which is 10 times more than current levels.

3.2.2 The relationship between climate and SDG 11 targets

The aim of the SDG 11 targets is to make cities and human settlements inclusive, safe, resilient and sustainable. There are also several goals that can contribute to reducing disaster risk and building resilience, even where disaster risk reduction language is not explicit. These include targets related to promoting education for sustainable development, building and upgrading education facilities and ensuring healthy lives.

In order to achieve these targets and the overall goal, the Sendai Framework recommends strengthening disaster risk modelling, assessment, mapping, monitoring and multi-hazard early warning systems; promoting the conduct of comprehensive surveys on multi-hazard disaster risks and the development of regional disaster risk assessments and maps, including climate change scenarios; and maintaining and strengthening in situ and remotely sensed Earth and climate observations. The Sendai Framework also calls for the integration of disaster risk reduction measures into multilateral and bilateral development assistance programmes related to climate change adaptation, which includes the need for capacity development.

Climate–disaster risk reduction link: flood and drought monitoring in Africa

Following capacity development of the Intergovernmental Authority on Development (IGAD) in East Africa by UNITAR–UNOSAT, an interactive web-map was set up by IGAD's Climate Prediction and Applications Centre (ICPAC) to provide real time information on El Niño conditions in East Africa during the second half of 2015 until the event faded in 2016. The live web-map included flood modelling and early warning, drought monitoring using satellite imagery and automatic inclusion of photos showing El Niño effects in local communities. The map was continuously updated and shared with IGAD Member States.

With 60% of what will be urban in 2030 still to be built, urban growth presents an unparallelled opportunity to reduce disaster risk in cities by reflecting resilience and disaster risk reduction in policy, planning, design and investment decisions over future urban development and to avoid past development mistakes.

3.3 Health (SDG 3) - Ensure healthy lives and promote well-being for all at all ages

3.3.1 The connection between SDG 3 and climate

Weather and climate are inextricably linked to some of the most fundamental determinants of human health, such as clean air and water, adequate food and shelter and the distribution and occurrence of disease. Heatwaves and cold spells, tropical cyclones, floods and droughts claim many lives and heighten the transmission of diseases each year. Factors indirectly related to weather and climate – food security and non-communicable diseases, such as cardiovascular and respiratory diseases resulting from exposure to poor air quality – also cause the death and illness of many people. Furthermore, the proliferation of communicable water- and vectorborne diseases, due to favourable conditions particularly triggered by climate variability, result in a huge cost to society and the economy.

Individual and population health and safety are closely linked to weather and climate conditions through extreme events such as heatwaves, cyclones, floods and drought. Weather and climate conditions also have strong influences on the occurrence and distribution of some of the most important infectious disease burdens, particularly of poorer populations, such as diarrhoea, malaria and other vector- and waterborne diseases. More fundamentally, climatic conditions affect the natural and managed ecosystem services that underpin population health, including the availability of freshwater and agricultural production, as determinants of food and potable water security and shelter. Extreme weather, climate variability, and long-term climate change pose important challenges to the performance and management of health systems and health-care services.

Understanding the relationship between climate and health is fundamental when taking preventive action against climate-related health risks. It is a challenge for the health community to access, recognize, understand, interpret and apply available climate information. Similarly, the climate services community often does not fully appreciate all public health concerns and needs nor the role climate services can play in support of public health.

3.3.2 The relationship between climate and SDG 3 targets

The SDG 3 targets are focused on ensuring healthy lives and promoting well-being for all at all ages.

Achieving these targets will require the development of reliable health and climate-related tools and services for various timescales – from months to seasons, decades and longer. These services will support health priorities such as improving disease surveillance and extending the lead time to prevent and prepare for climate-related outbreaks and emergencies.

The aim is to improve health outcomes and enhance the management of climate-related risks to health by pursuing, inter alia, the following four specific objectives:

(a) Strengthened communication and partnerships among climate and health actors at all levels for the promotion of effective utilization of climate information within health policy, research and practice;

(b) Improved health and climate research and evidence of the linkage of climate and health;

(c) Increased capacity of the health sector to effectively access, understand and use climate and weather information for health decisions;

(d) Climate and weather data effectively mainstreamed to health operations.

Climate–health link: malaria in Africa

Along the margins of endemic malaria, there are geographical zones where malaria transmission is "unstable" or prone to epidemics. Malaria in these areas is also related to climate but, in this case, at least one of the essential variables – precipitation, temperature or humidity – is not consistently sufficient for transmission. The high interannual variability of climate in these regions, however, means that the climatic conditions favourable for malaria transmission do occur in some years and epidemics of the disease may result.

3.4 Water (SDG 6) - Ensure availability and sustainable management of water and sanitation for all

3.4.1 The connection between SDG 6 and climate

Climate and water have a very close and complex relationship. The most important impacts of climate variability and change are brought about through the hydrological cycle. For example, floods are the most widespread of natural disasters and droughts represent one of the greatest threats to food security: both floods and droughts impact on water access and sanitation through damage to key infrastructure and services. At the same time, the hydrological cycle is itself an essential component of the climate system, controlling the interaction between the atmosphere and the land surface and providing mechanisms for the transport, storage and exchange of mass and energy.

Along with other factors, weather and climate have a significant influence on access to freshwater resources. It is recognized that anthropogenic factors, including, but not limited to, land use, water-regulation systems, etc., have a significant impact on water resources. While humankind has, through both engineering and environmental approaches such as dams, water-delivery systems and cropping practices, attempted to provide access to safe freshwater resources and sanitation services, the availability and distribution, as well as the construction, management and operation of water supply, sanitation systems and services are directly impacted by weather and climate. Increasing access to climate information for women and girls will also enable them to improve sanitation and hygiene.

While mention has already been made of the engineering works constructed to provide such services as adequate water supplies and protect against flooding, it is important to recognize that almost all development projects risk critical impacts on a region's water resources and potential for flooding. For example, urban and industrial development can include the diversion of rivers and streams and the replacement of natural vegetation with impervious surfaces which can increase the risk of flooding and starve groundwater resources of their natural recharge. Such developments can also lead to serious pollution of neighbouring water supplies. Efforts to ameliorate the situation in one location can also cause greater harm to those downstream. All of this goes to emphasize the need to take a holistic approach working at the river basin and aquifer levels to ensure that all the complex interactions are taken into account. This in turn induces a demand for ever more detailed and timely information on the hydrological and climatic conditions which control the whole system.

Without climate and water information services there is an increased risk of failure of water supply and sanitation systems and thus these services are fundamental to the sustainable management of our valuable and susceptible water resources both now and for future climate scenarios. This leads to an essential need for the maintenance and expansion of systems for the collection and storage of hydrological and related data and increased investment in research aimed at improving our understanding of the hydrological cycle and its interaction with other elements of the climate system.

3.4.2 The relationship between climate and SDG 6 targets

The SDG 6 targets are aimed at ensuring availability and sustainable management of water and sanitation for all.

Climate is a key determinant with respect to the availability, quantity and quality of, and access to, safe freshwater resources, whether these are surface water supplies, such as tanks, weirs, dams and reservoirs, or underground supplies such as springs, wells and bores.

Climate data and information are essential knowledge to aid the determination of the quantity, quality and location of freshwater. Such data and information are used to determine catchment yields: that is, water availability, including risk of supply aspects. Climate and weather data are also required for the design of water holding and retaining structures, to ensure that they meet adequate safety requirements.

Also, there will be climate-related impacts on small and large sanitation and hygiene infrastructure and services. A further issue is related to pollution from sanitation systems and design and siting will thus require access to climate- and water-related services to ensure water sources are not contaminated. Climate information, such as evaporation and rainfall data, is also important in the design of larger sewerage systems.

Climate information (rainfall, temperature and evaporation), in particular, will be required in the design of many systems that will be used to reduce pollution and treat wastewater. The efficiency of such systems will depend to a great extent on their design criteria related to the climate conditions.

Climate–water link: rainfall-runoff modelling

Long time series of climate data and climate statistics are used to estimate long time series of streamflow data for potential water-supply catchments. These derived data contribute to the information sets that help policymakers make informed decisions on water availability, planning and management. A range of methods is available to estimate streamflow data for potential water-supply catchments, using observed data wherever possible or estimating by empirical and statistical techniques and, more commonly, using rainfall-runoff models. A comprehensive dataset would include long-term rainfall observations and evapotranspiration data collected at one or more locations within the catchment along with land-use coverage, vegetation cover and impervious area information, including changes over time using Earth observations and in situ data. Furthermore, the scenario data produced from climate modelling can be incorporated into hydrological models and used to predict possible future impacts of a changing climate on water resources availability and distribution. Climate data services and climate statistics are considered essential contributions to effective water resources management.

The efficiency of water use can be greatly improved through the use of climate information and services. In particular, the use of climate data and statistics in the design of water supply and delivery systems will ensure that they are constructed to operate in the prevailing climate regimes. Similarly, climate data and services will greatly assist those sectors that use water in their operations to make optimal use of the resource. Climate data and statistics are also essential to design effective flood and drought mitigation strategies and decide on the most appropriate mix of measures to protect lives and support livelihoods and ecosystem functions. The use of seasonal and subseasonal climate outlooks and similar services will enable systems to be operated in a more optimal manner and thus greatly increase efficiency of operations.

The Integrated Water Resources Management (IWRM) approach is a holistic approach to water management aimed at the efficient, equitable and sustainable development and management of the world's limited water resources and for coping with conflicting demands. In implementing IWRM, water resources management institutions and professionals deal with a highly variable environment, in terms of, inter alia, weather, climate, land use and natural vegetation. They must be aware of, and manage, the response of a particular water regime to climatic and human interventions on hydrological regimes and water courses, including land-use changes and changes in water-use patterns, as well as the construction and management of dams and embankments and changes in the freshwater-ocean interfaces. Water managers have developed a range of standard methods to assess and manage water-related risks. Climate- and water-related data and information are essential for informed decision-making for water management and minimizing uncertainties. It follows that, for transboundary cooperation, a common and agreed understanding of the availability and distribution of freshwater resources will be essential to foster the required trust and cooperation. Availability of, and access to, a wide range of climate information and services will thus also be essential.

3.5 Energy (SDG 7) - Ensure access to affordable, reliable, sustainable and modern energy for all

3.5.1 The connection between SDG 7 and climate

Energy services and resources are affected by climate variability and change – modifying trends, increasing variability, greater extremes and large interannual variations in climate parameters in some regions. Although energy systems already take account of some climate risks in their operation and planning, adaptation measures can further reduce their vulnerability to environmental change by building capacity and improving information for decision-making and climate risk management. Moreover, climate impacts cross the entire energy-supply chain. Existing energy infrastructure, new infrastructure and future planning need to consider emerging climate conditions and impacts on design, construction, operation and maintenance. Impacts on energy supply and demand are the most intuitive but there are also direct effects on energy resource endowment, infrastructure and transport and indirect effects through other economic sectors (for example, water, agriculture).

Climate–water link: seasonal climate outlooks

Longer-lead (seasonal and multi-seasonal) climate forecasts can significantly benefit the operation of regional water-management systems that include lakes and storage reservoirs for flood control, water supply, energy and environmental enhancement. Management of complex water resources systems requires a multi-objective approach that considers water supply for urban and agricultural users in the region and the restoration and management of environmental systems. Recent advances in computer technology and the improved understanding of global climate phenomena are providing valuable seasonal and multi-seasonal climate outlooks that can be incorporated into operational planning of water systems.

Examples of specific vulnerabilities of the power sector to projected climate changes are:

(a) Higher air temperatures will reduce generation efficiency and output, as well as increase customers' cooling demands, stressing the capacity of generation and grid networks;

(b) Changes in precipitation patterns and surface water discharges, as well as increasing frequency and/or intensity of droughts may adversely impact hydropower generation and reduce water availability for cooling purposes at thermal and nuclear power plants;

(c) Extreme weather events, such as stronger and/or more frequent storms, ice-accretion loads, extreme winds and offshore hazards can reduce the supply and potentially the quality of fuel (coal, oil, gas), reduce the input of energy (water, wind, sun, biomass), damage generation and grid infrastructure, reduce output and affect security of supply;

(d) Sea-level rise can affect energy infrastructure in general and limit areas appropriate for the location of power plants and grids.

Detailed local assessments are necessary to provide greater confidence in understanding current climate variability and how the climate might change in the future and, therefore, which measures are warranted at the level of specific projects. There is a need to improve energy-sector (and broader) decision-making by improving local weather and climate knowledge, regardless of whether large climate changes are expected, by improving access to existing meteorological and hydrological data and by developing better mechanisms so that local weather and climate data, as well as specialized analyses, are archived for the public good.

The energy sector will undergo a radical transformation in the coming years, due partly to climate change. On the one hand, decarbonizing energy is central to international climate mitigation targets and a transition towards a larger energy supply from renewables is therefore essential for reducing GHG emissions. On the other hand, the different forms of renewable energy production such as hydropower, biomass, solar and wind energy, draw on resources which are significantly dependent on climate and weather conditions. Adequate provision and use of meteorological information for energy, via so-called climate services, will therefore play a major role in addressing these key societal issues. For example, climate services will play a major role in mapping new sources of energy.

3.5.2 The relationship between climate and SDG 7 targets

The SDG 7 targets are aimed at ensuring access to affordable, reliable, sustainable and modern energy for all.

Weather, water and climate information, tailored specifically for the energy industry and its subsectors, will eventually lead to assessing capacity, improved planning, better policy and practice and an efficient and clean energy system for least developed and developing countries. One of the key areas for the GFCS in the energy sector is to support climate resilience and adaptation, due to its fundamental importance for development.

Climate information and services and through them the implementation of the GFCS will make a significant contribution to the achievement of this target. Given the apparent climate sensitivity of renewable sources, such as wind, solar and hydropower, climate services support increased development and use of renewable energy. As the sector is currently producing the largest share of anthropogenic GHGs, supporting the expansion of the renewable subsector could substantially contribute to mitigation options.

Energy efficiency can be greatly improved through the use of climate information and services. Energy supplied by individual generators needs to be dispatched in a balanced/integrated manner to suitably meet energy demand. Highly detailed weather and climate information (predicted and historical) are required for an efficient use of generated energy via optimal balancing of supply and demand. Moreover, detailed climate information guides optimal infrastructure siting or efficient use of shading on hot days to offset energy use for air-conditioning.

Provision of climate services for energy in many countries falls short of meeting identified needs. At the regional level, the GFCS aims to improve existing and establish new mechanisms for collaboration, cooperation and knowledge exchange on climate services activities, notably focused on enhancing the role of regional coordination mechanisms that will be supported technically through Regional Climate Centres (RCCs). This will include assessing regional capacities and needs to develop, deliver and use climate services and facilitate regular feedback and dialogue mechanisms to continue exchanging views. By engaging at these different levels, a partnership focused on improving climate services for energy could have a significant leveraging impact.

Climate–energy link: irradiance

When planning for solar power as a renewable energy source, climate data and statistics play an essential role in determining the potential for solar power generation at a particular site. Accurate measurements of the incoming irradiance are essential to solar power plant project design, implementation and operations. Because irradiance data are relatively complex and therefore expensive compared to other meteorological measurements, they are available for only a limited number of locations. The collection of data to support this essential source of information will therefore be fundamental in moving towards more renewable energy sources and should be expanded where practical.

Climate–energy link: hydropower

Hydropower provides a significant amount of energy worldwide even if, so far, only 25% of its potential has been developed. In recent years, despite an increase in global installed hydropower capacity, the total electricity produced dropped significantly in many countries, due partly to water shortages, as well as an evolving energy mix and markets, which in turn encourage hydropower to operate in peaking mode rather than baseload, and therefore reducing the overall generation figures.

3.6 Climate change (SDG 13) - Take urgent action to combat climate change and its impacts

3.6.1 The connection between SDG 13 and climate

The connection between climate change and climate is obvious. Living with, and adapting to, climate variability and change is an everyday reality. Society has always had to deal with climate variability, including extreme weather and climate events, but the assumption that past climatic and socioeconomic conditions are indicative of current and future conditions is now not necessarily valid. The combined effects of impacts of climate change on climate variability and of increasing vulnerability and exposure to hazardous conditions due to migration, infrastructural development and changing land use present unprecedented challenges to society.

Near-term (weeks to months), operational decisions are better supported by using historical climate information and information about forecast variations in the climate. Longer-term decisions on adapting to, and mitigating, future climate change can also be strengthened by using projections of the impacts of climate change. In all cases, climate services can be used to ensure that investments are made and used wisely. Services based on high-quality climate information thus have a huge potential for enabling better-informed decisions that are of great value to society.

3.6.2 The relationship between climate and SDG 13 targets

There is a growing need to improve our understanding of climate, climate predictions and our use of climate information to better serve societial needs. Many countries are attempting to address these challenges by developing climate service capabilities.

Climate–climate change link: Intergovernmental Panel on Climate Change (IPCC)

One of the main IPCC activities is the preparation of comprehensive assessment reports about the state of scientific, technical and socioeconomic knowledge on climate change, its causes, potential impacts and response strategies. The Fifth Assessment Report of the IPCC provides a clear and up-to-date view of the current state of scientific knowledge relevant to climate change. It consists of the reports of three working groups (WGs) and a synthesis report (SYR). The WG I report provides the contribution on the physical science basis of climate change; the WG II report the contribution on impacts, adaptation and vulnerability; and the WG III report the contribution on mitigation of climate change.

4. The Global Framework for Climate Services and other climate-related Sustainable Development Goals

4.1 Poverty (SDG 1) - End poverty in all its forms everywhere

4.1.1 The connection between SDG 1 and climate

Climate-related shocks and stresses, already a major obstacle to poverty reduction, will worsen with climate change. Climate change is already preventing people from escaping poverty and, without rapid, inclusive and climate-smart development, together with emission-reduction efforts that protect the poor, there could be more than 100 million additional people in poverty by 2030 (World Bank Open Knowledge Repository, 2016).

Poor people are disproportionately affected – not only because they are often more exposed and invariably more vulnerable to climate-related shocks, but also because they have fewer resources and receive less support from family, the community, the financial system and even social safety nets to prevent, cope and adapt.

Climate is involved in most of the shocks that keep or bring households into poverty – notably, natural disasters (such as floods that cause asset loss and disability); health shocks (such as malaria that results in health expenditure and lost labour income); and crop losses and food price shocks (due to drought or crop disease). Climate change will worsen these shocks and stresses, contributing to a decoupling of economic growth and poverty reduction, thereby making it even harder to eradicate poverty in a sustainable manner.

Climate-related shocks also affect those who are not poor but remain vulnerable and can drag them into poverty – for example, when a flood destroys a micro-enterprise, a drought decimates a herd or contaminated water makes a child sick. Such events can erase decades of hard work and asset accumulation and leave people with irreversible health consequences. Changes in climate conditions caused by increasing concentrations of GHGs in the atmosphere can worsen these shocks and slow down poverty reduction.

4.1.2 The relationship between climate and SDG 1 targets

In a pessimistic development scenario, climate change could drag more than 100 million people into poverty by 2030. This number can be reduced to fewer than 20 million if rapid, inclusive, and climate-informed development is combined with targeted adaptation actions. Between now and 2030, climate policies can do little to alter the amount of global warming that will take place. The only option, therefore, is to reduce vulnerability through both targeted adaptation investments and improved socioeconomic conditions (higher incomes, lower poverty and inequality). Development and adaptation cannot prevent all negative impacts from climate change but, by 2030, they can prevent or offset most of its effects on poverty. Development must be rapid and inclusive, however, to reduce poverty and provide poor people with social safety nets and universal health coverage. It also needs to be climate-informed, meaning that investments and development patterns do not create new vulnerabilities and account for what we know

about future climate conditions. It needs to be accompanied by targeted adaptation (such as upgrades in flood defences, or more heat-tolerant (reference) crops) (World Bank Open Knowledge Repository, 2016).

4.2 Education (SDG 4) - Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

4.2.1 The connection between SDG 4 and climate

With respect to education, the emphasis is more on what education can do to improve our ability to manage the impacts of climate and climate change. Access to education is impacted by poverty and other SDGs and other sections of this paper identify possible impacts on obtaining the targets in this regard. Education and awareness-raising play an essential role in increasing climate-change adaptation and mitigation capacities of communities by enabling individuals to make informed decisions. In order for climate services to be effective, they have to meet specific needs and requirements. These include the need for training and capacity-building. The PAC network has many educational courses and training materials at the disposal of Member States, ranging from shorter awareness-raising sessions to longer face-to-face, online and even blended learning programmes.

Education helps learners understand the causes and consequences of climate change, prepares them to live with its impacts and empowers women and men to adopt more sustainable lifestyles.

Climate–education link: One UN Climate Change Learning Partnership

The One UN Climate Change Learning Partnership (UN CC:Learn) promotes knowledge-sharing with material from more than 30 multilateral organizations. It offers a range of learning materials and supports countries at national level in developing national climate change learning strategies. UN CC:Learn is one alternative for governments, NGOs and other stakeholders with training in climate services.

4.2.3 The relationship between climate and SDG 4 targets

The 2030 Agenda for Sustainable Development recognizes that education is essential for the success of all SDGs. Education is also included in goals on health, growth and employment, sustainable consumption and production and climate change. A community with well-established and functioning education systems will be better placed to meet the challenges of a variable and changing climate.

The targets focus not only on primary and secondary education, but also on tertiary education, training of trainers concentrating on sustainable development, which includes understanding of climate change adaptation, scientific programmes and applications of information technologies. Such a comprehensive approach to education facilitates both crosscutting integration of capacity development for climate services, as well as in-depth technical training when required.

Climate–education link: education for sustainable development

As part of its work on education for sustainable development, the United Nations Educational, Scientific and Cultural Organization (UNESCO) supports countries in integrating climate change into their education systems and facilitates dialogue and exchange of experiences on climate change education by organizing international expert meetings. It mobilizes schools to implement climate change education through a whole-school approach, whereby sustainability principles are also integrated into the management of school facilities and the governance structures of learning institutions. It develops technical guidance material and teaching and learning resources, such as a six-day online course: "Climate Change in the classroom: UNESCO course for secondary teachers on climate change education for sustainable development". UNESCO's clearing house on climate change education provides stakeholders with free access to hundreds of climate change education resources.

4.3 Gender equality (SDG 5) - Achieve gender equality and empower all women and girls

4.3.1 The connection between SDG 5 and climate

If they are to serve users adequately, climate services need to be sensitive to gender differences. Men and women throughout our communities may require different types of climate information or may access and use it differently. Due to social roles and constraints, they may have different needs and capacities. A typical example concerns water. In the rural areas of many developing countries, tasks related to household water supply and sanitation are generally divided and organized by gender. Water scarcity, heavy rainfall and more frequent flooding would lead to additional burdens for women.

Climate–gender link: World Meteorological Organization

At international, national and local levels, there is a drive to improve access for women to technology, information, science education and technical training and to strengthen the position of women scientists and technologists. Ensuring that women have equal access to science education and technology is an essential catalyst to ensure that the developers and users of weather, water and climate services provided by WMO and its Members serve the global community – men, women, boys, girls. This commitment strengthens the position of women as scientists, technologists and users of weather, water and climate services and fosters increased participation of women in weather and climate decision- and policymaking.

The same often applies to agriculture since, in some communities, the differentiation of agricultural practices and responsibilities takes place along gender lines. In turn, this may affect the resilience of

agricultural systems to climatic shocks. Gender differences also play a role in disaster risk reduction. Depending on the sociocultural context, differences in the mobility of men and women can affect them in an uneven way in the event of weather and climate extremes. This is often the case with floods and droughts.

The health sector is obviously not free from these issues. Mortality due to heatwaves, for example, shows different patterns according to gender and may therefore require the provision of diversified information services.

4.3.2 The relationship between climate and SDG 5 targets

Providers of climate services should take these gender-related differences into consideration, including women as well as men in developing and delivering user-tailored information and services. Climate services that are sensitive to gender can better help to further sustainable development and build climate resilience.

4.4 Economic growth and employment (SDG 8) - Promote inclusive and sustainable economic growth, employment and decent work for all

4.4.1 The connection between SDG 8 (economic growth and employment) and climate

Climate variability and change impact economic growth and will inevitably lead to the loss of jobs in certain sectors. However, the transition to a greener economy and the emergence of green technologies can generate positive shifts in employment and create opportunities for decent work.

The Intergovernmental Panel on Climate Change has noted that there is a dual relationship between sustainable development and climate change. On the one hand, climate change influences key natural and human living conditions and thereby also the basis for social and economic development while, on the other hand, society's priorities in sustainable development influence both the GHG emissions that are causing climate change and vulnerability.

Climate change impacts on development prospects have also been described in an interagency project on poverty and climate change (African Development Bank et al., 2003). Climate change will compound existing poverty. Its adverse impacts will be most striking in the developing nations because of their dependence on natural resources and their limited capacity to adapt to a changing climate. Within these countries, the poorest, which have the fewest resources and the least capacity to adapt, are the most vulnerable.

The International Labour Organization (ILO) has noted that transforming economies for quality growth and quality jobs has been a main theme in the discussion on the development framework beyond 2015, setting the stage for the proposal of SDG 8 to "promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all". This global goal, strengthened by reference to aspects of decent work such as social protection and development of skills under other proposed goals, is an indispensable response to the concerns of many governments and the demands of people in countries in all regions.

4.4.2 The relationship between climate and SDG 8 targets

Climate policies can be more effective when consistently embedded within broader strategies designed to make national and regional development paths more sustainable. This occurs because the impact of climate variability and change, climate policy responses, and associated socioeconomic development will affect the ability of countries to achieve SDGs. Conversely, the pursuit of those goals will in turn affect the opportunities for, and success of, climate policies.

Innovative learning approaches, as well as pertinent vocational and academic training, are essential for strengthening institutional capacity and improving employment opportunities across water-dependent sectors.

Climate–economic growth and employment link: International Labour Organization

Climate change and environmental degradation pose significant challenges to economic growth and employment today and risks will be greater in the medium to long term. By contrast, if properly managed, climate change action can lead to more and better jobs. Both adaptation to climate change and measures to mitigate GHG emissions offer opportunities to create new jobs, while securing existing ones. A transition to a low-carbon, greener economy will imply the creation of new jobs in environmentally friendly production processes and outputs, whereas other jobs will be at risk, in particular in those sectors with fewer options for a transition towards more sustainable means of production.

4.5 Resilient infrastructure (SDG 9) - Build resilient infrastructure, promote sustainable industrialization and foster innovation

4.5.1 The connection between SDG 9 (resilient infrastructure) and climate

Resilient infrastructure is the central underpinning of economic development and human well-being. Our daily lives depend – in almost all aspects – on reliable transport, energy, water supply, communication systems and those systems specifically designed for the protection of life and property from natural hazards. Resilient infrastructure is dependent, among other factors, on solid planning assumptions and operations scenarios. It is important, however, to recognize that, in many cases, these are not primarily climate-driven.

4.5.2 The relationship between climate and SDG 9 targets

The SDG 9 targets are aimed at building resilient infrastructure, promoting sustainable industrialization and fostering innovation. The following examples illustrate the relevance of the possible impact of climate on infrastructure resilience:

(a) Hurricane frequency and intensity and infrastructure resilience in coastal communities;

(b) Rainfall intensity and frequency and the relationship to slope stability, suitability of freshwater storage and urban drainage systems;

(c) Permafrost development and sustainability of road and energy links;

(d) Seasonal sea-ice development and the sustainability of shipping routes;

(e) Icing conditions and their impact on the electricity grid;

(f) Urban development: heat-island effects and human health, sustainability of water and electricity supply, as well as the health and care system, to operate under more extreme scenarios.

All these examples require climate information in terms of high-quality data about the past, as well as advice on methods of accounting for the evolution of extreme events in the coming years and decades.

Climate–infrastructure: design of infrastructure

The sizing of road links is driven by factors such as requirements of market access of economic goods and mobility requirements of the population. Climate and weather conditions, however, have an influence on their fitness for purpose and their long-term maintainability and operability. Most of the infrastructure on which we rely, from houses to buildings, from culverts to dams and water and power delivery systems are reliant on climate information and data for their design, construction and operation. Rainfall intensities in particular are used in the design of roads, culverts, bridges and dams.

4.6 Reduced inequality (SDG 10) - Reduce inequality within and among countries

4.6.1 The connection between SDG 10 (reduced inequality) and climate

Every country is vulnerable to climate variability and change, so all countries will benefit from high-quality climate information that is prepared and delivered to meet users' needs. Needless to say, some countries are more vulnerable than others, due to their limited national capacities, their markedly volatile or difficult climate, or both. African countries, less developed countries, SIDS and LLDCs are particularly vulnerable.

Developing countries that experience dramatic climate variability urgently need to improve their capacity to respond to extreme events such as storms and floods, as well as to longer-term trends such as drought and heatwaves. Countries that already struggle with climate variability tend to be particularly vulnerable to climate change. Adaptation strategies and emergency response services required for climate variability will often be essential for climate change. This is equally true for the types of data and information systems that will be required.

4.6.2 The relationship between climate and SDG 10 targets

The GFCS seeks to build on continued improvements in climate forecasts and climate change scenarios to expand access to the best available climate data and information. Policymakers, planners, investors and vulnerable communities need climate information in user-friendly formats so that they can prepare for expected trends and changes. They need good-quality data from national and international databases on temperature, rainfall, wind, soil moisture and ocean conditions. They also need long-term historical averages of these parameters as well as maps, risk and vulnerability analyses, assessments and long-term projections and scenarios.

Depending on user' needs, these data and information products may be combined with non-climate data, such as agricultural production, health trends, population distributions in high-risk areas, road and infrastructure maps for the delivery of goods, and other socioeconomic variables. The aim is to support efforts to prepare for new climate conditions and adapt to their impact on water supplies, health risks, extreme events, farm productivity, infrastructure placement, etc.

The GFCS will facilitate national efforts to address climate variability and climate change simultaneously and to integrate climate adaptation activities into sustainable development strategies.

Climate–reduced inequality link: Global Framework for Climate Services

The Global Framework for Climate Services – Adaptation and Disaster Risk Reduction in Africa project has two main objectives: building capacity for improved weather and climate services and developing weather- and climate-related services for agriculture. As part of the Metagri operational project, some 7 000 farmers and agricultural extension officers have been trained in the use of climate information and nearly 4 000 plastic raingauges have been distributed. This innovative, cost-effective programme provides farmers with the knowledge and means to measure rainfall and plan their planting and harvesting accordingly to maximize yields and adapt to climate variability.

4.7 Sustainable consumption and production patterns (SDG 12) - Ensure sustainable consumption and production patterns

4.7.1 The connection between SDG 12 and climate

Sustainable consumption and production is about promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and a better quality of life for all. Its implementation helps to achieve overall development plans, reduce future economic, environmental and social costs, strengthen economic competitiveness and reduce poverty.

Sustainable consumption and production aims at "doing more and better with less", increasing net welfare gains from economic activities by reducing resource use, degradation and pollution along the whole lifecycle, while increasing the quality of life. It involves different stakeholders, including

business, consumers, policymakers, researchers, scientists, retailers, media and development cooperation agencies.

4.7.2 The relationship between climate and SDG 12 targets

This goal is very closely linked to a number of other goals and the climate link has already been addressed in previous sections of this paper. Climate variability and change are factors, among others, that will influence sustainable consumption and production and thus need to be taken into consideration as appropriate.

Climate–sustainable production and consumption patterns link: household energy consumption

In some developing countries, particularly in Africa and Asia, urban households consume more energy – particularly fossil fuels and electricity – than rural households, which consume mostly biomass and often do not have access to the electricity grid. As biomass fuel is often, although not always, harvested as a renewable resource, the climate impact of energy consumption in rural Africa and Asia is generally small. As those areas develop and modernize, their household energy consumption patterns and carbon-dioxide emissions are expected to evolve gradually towards those in urban areas and in developed countries.

4.8 Oceans, seas and marine resources (SDG 14) - Conserve and sustainably use the oceans, seas and marine resources

4.8.1 The connection between SDG 14 and climate

Covering about 70% of the Earth's surface, the world's oceans have a two-way relationship with weather and climate. The oceans influence the weather on local to global scales, while changes in climate can fundamentally alter many properties of the oceans.

The world's oceans are crucial to heating the planet. While land areas and the atmosphere absorb some sunlight, the majority of the Sun's radiation is absorbed by the ocean. Particularly in the tropical waters around the Equator, the ocean acts as a massive, heat-retaining solar panel. Earth's atmosphere also plays a part in this process, helping to retain heat that would otherwise quickly radiate into space after sunset.

Ocean currents act much like a conveyer belt, transporting warm water and precipitation from the Equator toward the poles and cold water from the poles back to the tropics. Thus, currents regulate global climate, helping to counteract the uneven distribution of solar radiation reaching the Earth's surface. Without currents, regional temperatures would be more extreme – excessively hot at the Equator and cold toward the poles – and much less of Earth's land would be habitable.

4.8.2 The relationship between climate and SDG 14 targets

Climate change is affecting ocean temperatures, the supply of nutrients, ocean chemistry, food chains, wind systems, ocean currents and extreme events such as cyclones. All these, in turn, affect the distribution, abundance, reproductive cycles and migrations of animals and marine plants on which millions of people rely for food and income.

Climate—oceans, seas and marine resources link: marine organisms

Evidence is emerging that marine organisms may be responding faster to climate change than land-based plants and animals. As the climate warms, marine plants and animals are shifting towards the poles, changing marine food webs and impacting the plants and animals (including people) that depend on them. Slower ocean dynamics also mean that some changes, such as ocean acidification, will be irreversible this century.

4.9 Terrestrial ecosystems (SDG 15) - Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss

4.9.1 The connection between SDG 15 and climate

The terrestrial biosphere interacts strongly with the climate, providing both positive and negative feedbacks due to biogeophysical and biogeochemical processes. Some of these feedbacks, at least on a regional basis, can be large. Surface climate is determined by the balance of fluxes, which can be changed by radiative (albedo) or non-radiative (water-cycle-related processes) terms. Both radiative and non-radiative terms are controlled by details of vegetation. High-latitude climate is strongly influenced by snow albedo feedback, which is drastically reduced by the darkening effect of vegetation. In semi-arid tropical systems, such as the Sahel or north-eastern Brazil, vegetation exerts both radiative and hydrological feedbacks.

Surface climate interacts with vegetation cover, biomes, productivity, respiration of vegetation and soil and fires, all of which are important for the carbon cycle. Various processes in terrestrial ecosystems influence the flux of carbon between land and the atmosphere. Terrestrial ecosystem photosynthetic productivity changes in response to changes in temperature, precipitation, carbon dioxide and nutrients. If climate becomes more favourable for growth (e.g. increased rainfall in a semi-arid system), productivity increases, and carbon uptake from the atmosphere is enhanced. Organic carbon compounds in soils, originally derived from plant material, are respired (oxidized by microbial communities) at different rates, depending on the nature of the compound and on the microbial communities; the aggregate rate of respiration depends on soil temperature and moisture.

Shifts in ecosystem structure in response to a changing climate can alter the partitioning of carbon between the atmosphere and the land surface. Migration of boreal forest northward into tundra would initially lead to an increase in carbon storage in the ecosystem due to the larger biomass of trees than of herbs and shrubs, but over a longer time (centuries), changes in soil carbon would need to be considered to determine

the net effect. A shift from tropical rainforest to savannah, on the other hand, would result in a net flux of carbon from the land surface to the atmosphere.

4.9.2 The relationship between climate and SDG 15 targets

SDG 15 is closely related to other goals, such as SDG 6 (Water) and SDG 2 (Agriculture and food security), hence the relationship to some targets has already been covered in earlier sections of this paper. Climate change may exacerbate desertification through alteration of spatial and temporal patterns in temperature, rainfall, solar radiation and winds.

Climate–terrestrial ecosystems link: biodiversity

Biodiversity provides ecosystem services, including the regulation and mitigation of the adverse impacts of climate change. Biodiversity conservation and terrestrial ecosystem management are therefore critical to address climate change. Robust climate-oriented models with the use of geographic information systems and remote-sensing technology are needed to make effective predictions about the spatial and temporal effects of climate change.

4.10 Peaceful and inclusive societies (SDG 16) - Promote just, peaceful and inclusive societies

4.10.1 The connection between SDG 16 and climate

SDG 16 is dedicated to the promotion of peaceful and inclusive societies for sustainable development, the provision of access to justice for all and building effective, accountable institutions at all levels. Although many other factors impact peaceful and inclusive societies, the impacts of climate variability and change on water availability and access, food security and disasters have the potential to lead to conflicts between peoples and nations.

4.10.2 The relationship between climate and SDG 16 targets

Although there are no strong linkages between the SDG 16 targets and climate, impacts of climate variability and change may influence the ability to achieve some goals and it should be considered a background linkage.

5. Means of implementation (SDG 17) - Revitalize the global partnership for sustainable development

Transforming our World: the 2030 Agenda for Sustainable Development recognizes that a successful sustainable development agenda requires partnerships between governments, the private sector and civil society. These inclusive partnerships, built upon principles and values, a shared vision and shared goals that place people and the planet at the centre, are needed at the global, regional, national and local levels.

In the area of climate, the GFCS represents one such partnership, providing a worldwide mechanism for coordinated actions to enhance the quality, quantity and application of climate services. The GFCS vision is to enable better management of the risks of climate variability and change and adaptation to climate change through the development and incorporation of science-based climate information and prediction into planning, policy and practice on global, regional and national scales.

The GFCS is a UN-wide initiative in which WMO Members and inter- and nongovernmental, regional, national and local stakeholders work in partnership to develop targeted climate services. The initiative has received strong support from governments of developed and developing countries. In its implementation phase, it is critical that the GFCS, its UN partners and other stakeholders with mandates in the initial priority areas of the GFCS build the necessary cross-sector, multi-disciplinary framework for such services.

The World Health Organization (WHO), World Bank, United Nations Development Programme (UNDP), UNISDR, World Food Programme, UNESCO and FAO are directly involved in the planning and implementation of GFCS-related activities in alignment with their mandates and priorities to advance the application of climate services in the initial five priority areas, namely: Agriculture and food security; Disaster risk reduction; Health; Water; and Energy.

There are many other examples of global partnerships related to climate and the SDGs, that have been and are being established. Some of these are described in the following text boxes.

Box 1. Climate–water goal – means of implementation link: the SDG Water Preparedness Facility

Achieving the post-2015 Development Agenda will require a sophisticated approach that takes into account the relationships between water and a wide range of decisions and developments proposed by other sectoral interests. The increased complexity requires smarter decision-making based on the best knowledge available, including the availability of, and access to, a wide range of climate information and services. This means raising awareness and commitment to action with other sector actors through working partnerships and shared responsibilities.

Based on this realization and the need to move immediately into implementation, an alliance of the Global Water Partnership, its regional and country water partnerships and thematic partners has launched the SDG Water Preparedness Facility to provide practical support for a rapid start to implementing SDG 6 on water and other water-related SDGs in 20–25 countries. The main expected results are:

(a) A rapid start to implementation of SDG 6 on water and interrelated goals, in which selected countries make a commitment and take action to implement SDG 6 and related targets;

(b) Better policy, access to finance, improved monitoring working collaboratively to ensure that national policy and planning frameworks are geared towards the SDGs; help countries understand and access finance for SDG implementation from multiple sources; collaboratively develop and put in place a robust global and national monitoring framework for water-related targets, in particular 6.5, together with UN-Water;

(c) Improved knowledge and capacity to help countries develop the skills to enable implementation of the water targets and develop knowledge on issues related to the implementation of SDG 6;

(d) Stronger partnerships to bring in actors from non-water sectors that substantially interact with water; share experiences across partnerships to expand SDG implementation.

Box 2. Climate–water goal – means of Implementation link: the Integrated Monitoring initiative (GEMI)

The whole SDG 6 on water and sanitation requires a coherent monitoring framework with improved data collection and analysis. While the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP) and Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS) are already tracking progress in regard to drinking water, sanitation and hygiene (SDG targets 6.1 and 6.2, and 6.a and 6.b), the many initiatives that monitor different aspects of the management of water, wastewater and ecosystem resources (SDG targets 6.3 to 6.6) lacked a coherent global mechanism.

To meet this need, GEMI was established in 2014 as an interagency initiative composed of UNEP, the United Nations Human Settlements Programme (UN-Habitat), UNICEF, FAO, UNESCO, WHO and WMO, operating under the UN-Water umbrella and complementing JMP and GLAAS.

The focus of GEMI is to integrate and expand existing monitoring efforts on wastewater treatment and water quality, water use and water-use efficiency, integrated water resources management and water-related ecosystems, to establish and manage, by 2030, a coherent monitoring framework for water and sanitation to inform the post-2015 period and contribute to country progress through well-informed decision-making on water, based on harmonized, comprehensive, timely and accurate information.

The first phase of GEMI implementation (2015–2018) focuses on the development of monitoring methodologies, to be integrated into a monitoring guide for use by countries, and the establishment of a global reference data baseline. During 2016, methodologies were pilot-tested in a few countries and revised as necessary, based on lessons learned. In 2017, the methodologies will be implemented on a global scale, to enable the establishment of a global baseline in 2018.

6. Relevant climate services

Climate information, climate data, climate products and/or climate knowledge and a climate service provide climate information in a way that assists decision-making by individuals and organizations. A service requires appropriate engagement, along with an effective access mechanism and must respond to user needs. The full range of climate information and services are of direct relevance to meeting the SDGs. This includes historical information for the full range of climate variables, including rainfall, temperature, evaporation, wind, etc. Information that should also be derived from these historical sequences for design and planning purposes, includes statistical data such as rainfall intensity-frequency-duration curves, probable maximum precipitation, temperature extremes, hot- and cold-spell statistics, windroses, etc.

The use of seasonal and sub-seasonal outlooks and other related products and services will also be highly important to the maintenance and operation of agricultural, health, water-related supply, delivery and water-quality and other management systems.

7. How climate services will contribute to the achievement of the Sustainable Development Goals

There is a risk-based element to the achievement of all these goals and access to high-quality, fit-for-purpose climate information and services will greatly reduce the risks associated with achieving the SDGs and their related targets. For example, the determination of yield or availability of water from ecosystems or a water-supply scheme will greatly depend on the quality of the data and information used to determine the expected availability of water. Also, the development of any strategy or plan, as well as the construction of any water-related structure will be impacted by the quality of the design information available for the structural and non-structural measures taken.

The maintenance and operation of systems established to attain these goals and targets will be more efficient and effective when there is ready access to climate information and services, such as current climate trends, seasonal outlooks, or other short-term climate information.

Climate services enable society to better manage the risks and opportunities arising from climate variability and change, especially for those which are most vulnerable to climate-related hazards. This will be done through developing and incorporating science-based climate information and prediction into planning, policy and practice.

The GFCS will assist the meeting of the SDGs by:

(a) Reducing the vulnerability of society to climate-related hazards through better provision of climate information;
(b) Advancing the key global development goals through better provision of climate information;
(c) Mainstreaming the use of climate information in decision-making;
(d) Strengthening the engagement of providers and users of climate services;
(e) Maximizing the utility of existing climate-service infrastructure.

Improved climate services, in support of the SDGs, will ensure that user communities make climate-smart decisions and that climate information is disseminated effectively and in a manner that lends itself more easily to practical action. Effective development and use of climate services will be of great value for decision-making in many economic and social sectors.

Box 3. Climate services needed: example – energy sector

Interventions, related tools and methods focus on five areas of energy system operations:

1. Identification and resource assessment. Climate information (historical and projected) for an initial assessment of the energy resource and the required infrastructure and for management of weather/climate hazards and risks.

2. Impact assessments (including infrastructure and environment). Detailed and tailored weather and climate information (historical and projected) for codes, standards, site-specific designs and policy, to assist with the construction and maintenance of the energy system infrastructure (e.g. hydropower plants or solar collectors), including connecting infrastructure for energy transmission, distribution and transfer, as well as detailed site-specific and regional climate information (mainly historical) for assessments and mitigation of impact of energy systems on the surrounding environment (air-quality modifications), human health (air particles), ecosystems (solar plants, marine turbines) and wildlife, as well as potential contributions to GHG reduction.

3. Site selection and financing. Detailed, site-specific climate information (mainly historical) for rigorous resource assessment, risk management and financial closure.

4. Operations and maintenance. Detailed, site-specific weather and climate information (predicted, historical and projected) for efficient running of the energy system, as well as for site maintenance (on-/offshore wind turbines or solar farms).

5. Energy integration. Technical inputs required such that energy supplied by individual generators is dispatched in a balanced/integrated manner to suitably meet energy demand:

    - Market trading (including supply and demand forecasts) and insurance. Requires highly detailed weather and climate information (predicted and historical) for efficient use of generated energy via optimal balancing of supply and demand, as well as for pricing of insurance structures used to hedge against market volatility and/or risks to assets, such as windfarms, and transmission infrastructure.

Energy efficiency requires highly detailed climate information (predicted, historical and projected) for an efficient use of generated energy via measures such as optimal infrastructure siting or use of shading on hot days to offset energy use for air conditioning.

8. How climate services contribute to monitoring the achievement of the Goals

Climate information will be essential background information in monitoring the achievement of Transforming our World: the 2030 Agenda for Sustainable Development Goals. When the information on the achievement of the targets is compiled, the prevailing climate information will provide context in terms of many of the relevant targets. For example, has the period being monitored been wet or dry? Have the systems put in place achieved their expected levels of reliability? What climate factors may have impacted the achievement of the targets and thus Goals?

9. Conclusion

The GFCS has an essential role to play in the application of the SDGs and should strongly promote the role it can play in their achievement. The GFCS is a fundamental component of, and contributor to, a significant number of the SDGs. The GFCS and the climate information and services it will enable are essential to the delivery of the majority of the SDGs and the GFCS should ensure that the benefits of climate and information services to their achievement is understood and recognized by all stakeholders. In particular, the GFCS should use its partner agencies and contacts at the national and local levels to promote the use of climate information and services in meeting the SDGs and their relevant targets.

Climate service providers at local, national, regional and global levels should use this paper in discussions with those agencies implementing and monitoring the SDGs to ensure that the roles and responsibilities of the providers are recognized and taken into consideration as the processes to reach the SDGs are planned and implemented.

World Climate Conference-3 recognized that many countries lacked policies and institutions or human resources with the right skills or practices to enable them to take advantage of new or existing climate data and products or create national user interface groups to establish national dialogue on these issues. The GFCS aims to develop the capacity of countries to apply and generate climate information and products relevant to their particular concerns, thus all aspects of GFCS include capacity development. The capacity-development component of the GFCS Implementation Plan tackles two separate but related activity areas: (a) the particular capacity development requirements identified in the other four pillars; and (b) more broadly, the basic requirements (national policies/legislation, institutions, infrastructure and personnel) to enable any GFCS-related activities to occur. Further activities associated with the provision of climate products and services to support the implementation of the SDGs should include capacity-development initiatives.

This document is essential in providing Member States, international and development partners and key stakeholders with the basic elements on the role and importance of climate services to attaining the SDGs, in particular, those impacted by weather and climatic conditions. Support to the SDGs is just one aspect of the role and importance of climate services, but it is an essential one if we are to live sustainably in this world. The GFCS should provide Member States with the necessary supporting guidance and direction to enable them to establish and maintain the climate services needed by them to fulfil the requirements of the national users of climate information and services.

References and further reading

African Development Bank, Asian Development Bank, Department for International Development (United Kingdom), Directorate-General for Development (European Commission), Federal Ministry for Economic Cooperation and Development (Germany), Ministry of Foreign Affairs - Development Cooperation (Netherlands), Organization for Economic Cooperation and Development, UNDP, UNEP and the World Bank, 2003: *Poverty and Climate Change. Reducing the Vulnerability of the Poor through Adaptation.*
http://www.oecd.org/env/cc/2502872.pdf

Australian Bureau of Meteorology
http://www.bom.gov.au/

eWater Cooperative Research Centre
http://ewater.org.au/uploads/files/eWater-Guidelines-RRM-(v1_0-Interim-Dec-2011).pdf

United Nations Food and Agriculture Organization (FAO)
http://www.fao.org/home/en/

FAO, 2009: *How to Feed the World in 2050* www.fao.org/fileadmin/templates/wsfs/.../How_to_Feed_the_World_in_**2050**.pdf

Global Framework for Climate Services
http://gfcs-climate.org/

Global Water Partnership SDG Water Preparedness Facility
http://www.gwp.org/en/gwp-in-action/SDG-Preparedness-Facility/

Intergovernmental Authority on Development Climate Prediction and Applications Centre
http://www.icpac.net/

International Labour Organization
http://www.ilo.org/global/about-the-ilo/lang--en/index.htm

Intergovernmental Panel on Climate Change (IPCC)
http://www.ipcc.ch/activities/activities.shtml

IPCC, 2012: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. Special Report of the Intergovernmental Panel on Climate Change
https://www.ipcc.ch/pdf/special-reports/srex/SREX_Full_Report.pdf

International Renewable Energy Agency
http://www.irena.org/home/index.aspx?PriMenuID=12&mnu=Pri

Seasonal climate outlooks
http://iri.columbia.edu/~caseyb/Misc/obeyspaper.pdf

One UN Learning Partnership
http://www.uncclearn.org/

United Nations Office for Disaster Risk Reduction (UNISDR)
http://www.unisdr.org/

UNISDR, 2015: *Disaster Risk Reduction and Resilience in the 2030 Agenda for Sustainable Development*
http://www.unisdr.org/files/46052_disasterriskreductioninthe2030agend.pdf

United Nations Educational, Scientific and Cultural Organization
http://en.unesco.org/

United Nations Sustainable Development Knowledge Platform
https://sustainabledevelopment.un.org/sdgs

UN-Water, 2015: *Monitoring Water and Sanitation in the 2030 Agenda for Sustainable Development*
http://www.unwater.org/gemi/en/

Western Australia Department of Agriculture and Food
https://www.agric.wa.gov.au/newsletters/sco

World Bank Open Knowledge Repository
https://openknowledge.worldbank.org/handle/10986/22787

World Health Organization
http://www.who.int/en/

World Meteorological Organization (WMO)
http://www.wmo.int/pages/index_en.html

WMO, 2011: *Climate Knowledge for Action: A Global Framework for Climate Services – Empowering the most Vulnerable*. Report of the High-level Taskforce. WMO-No. 1065.
http://library.wmo.int/pmb_ged/wmo_1065_en.pdf.

WMO, 2014: *Implementation Plan of the Global Framework for Climate Services*
http://www.wmo.int/gfcs/sites/default/files/implementation-plan//GFCS-IMPLEMENTATION-PLAN-FINAL-14211_en.pdf

WMO, 2015: Seventeenth World Meteorological Congress, Abridged final report with resolutions
https://www.wmo.int/aemp/sites/default/files/wmo_1157_en.pdf

Acronyms

COP	Conference of the Parties (UNFCCC)
ENSO	El Niño-Southern Oscillation
FAO	United Nations Food and Agricultural Organization
GEMI	Integrated Monitoring Initiative
GFCS	Global Framework for Climate Services
GHG	greenhouse gas
GIS	geographical information system
ICPAC	IGAD Climate Prediction and Applications Centre
IFRC	International Federation of the Red Cross and Red Crescent Societies
IGAD	Intergovernmental Authority on Development
ILO	International Labour Organization
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resources Management
LDC	Least Developed Country
LLDC	Land-locked Developing Country
NGO	Non-governmental Organization
PAC	Partners Advisory Committee (GFCS)
RCC	Regional Climate Centre
SAMOA	SIDS Accelerated Modalities of Action
SCO	seasonal climate outlook
SDG	Sustainable Development Goal (United Nations)
SIDS	Small Island Developing State(s)
SSF	statistical seasonal forecast
SYR	synthesis report
JMP	WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation
UN CC: Learn	One UN Climate Change Learning Partnership
UN-Habitat	United Nations Human Settlements Programme
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNISDR	United Nations Office for Disaster Risk Reduction
UNITAR	United National Institute for Training and Research
UNOSAT	UNITAR Operational Satellite Applications Programme
WB	World Bank
WCC-3	World Climate Conference-3
WFP	World Food Programme
WG	Working Group (IPCC)
WHO	World Health Organization
WMO	World Meteorological Organization

For more information, please contact:

Global Framework for Climate Services Office

7 bis, avenue de la Paix – P.O. Box 2300 – CH-1211 Geneva 2 – Switzerland

Filipe Lúcio – Tel.: +41 (0) 22 730 85 79 – E-mail: flucio@wmo.int

http://gfcs.wmo.int

JN 17118