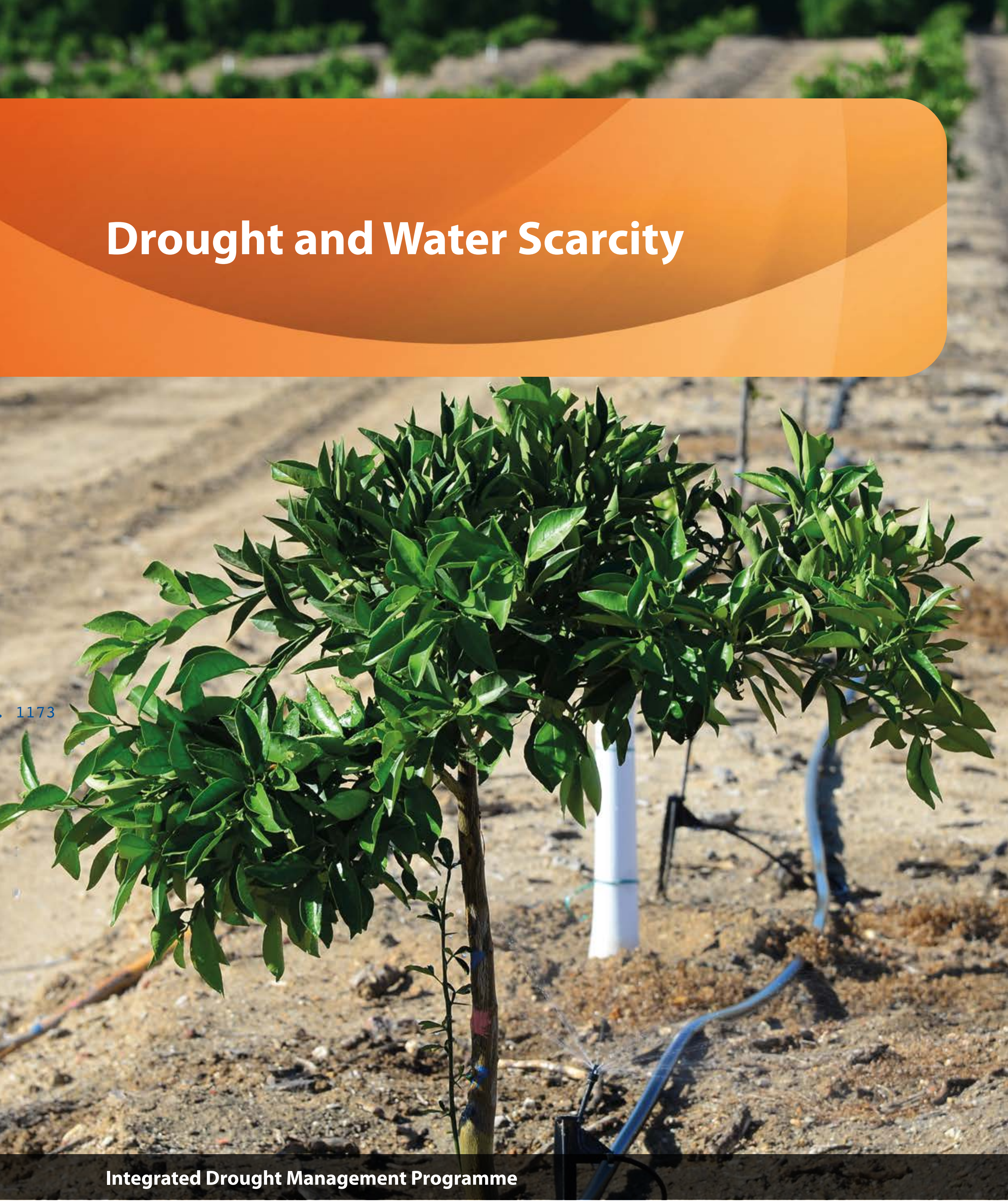
Drought and Water Scarcity



Integrated Drought Management Programme

World Meteorological Organization
Integrated Drought Management Programme
Global Water Partnership
Food and Agriculture Organization of the United Nations
United Nations Convention to Combat Desertification

WMO-No. 1284

WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION

The World Meteorological Organization (WMO) is a specialized agency of the United Nations. It is the United Nations system's authoritative voice on the state and behaviour of the Earth's atmosphere, its interaction with the land and oceans, the weather and climate it produces, and the resulting distribution of water resources. WMO has a membership of 193 Member States and Territories.

www.wmo.int

Global Water Partnership

The Global Water Partnership (GWP) is an international network whose vision is for a water secure world. The GWP mission is to advance governance and management of water resources for sustainable and equitable development. The GWP network is open to all organizations that recognize the principles of integrated water resource management endorsed by the network.

www.gwp.org

Food and Agriculture Organization of the United Nations

The Food and Agriculture Organization (FAO) is a specialized agency of the United Nations that leads international efforts to defeat hunger. The organization's goal is to achieve food security for all and make sure that people have regular access to enough high-quality food to lead active, healthy lives. With over 194 member states, FAO works in over 130 countries worldwide, and believes that everyone can play a part in ending hunger.

www.fao.org

United Nations Convention to Combat Desertification

The United Nations Convention to Combat Desertification (UNCCD) is the only legally binding international agreement on land issues. The Convention promotes good land stewardship. Its 197 Parties aim, through partnerships, to implement the Convention and achieve the Sustainable Development Goals. The end goal is to protect our land from over-use and drought so it can continue to provide us all with food, water, and energy. By sustainably managing land and striving to achieve land degradation neutrality, now and in the future, we will reduce the impact of climate change, avoid conflict over natural resources, and help communities to thrive.

www.unccd.int

INTEGRATED DROUGHT MANAGEMENT PROGRAMME

The Integrated Drought Management Programme (IDMP) was launched by WMO and GWP at the High-level Meeting on National Drought Policies in March 2013. IDMP works with a wide range of partners with the objective of supporting stakeholders at all levels. IDMP provides its partners with policy and management guidance through globally coordinated generation of scientific information, and shares best practices and knowledge for integrated drought management. It contributes to the Global Framework for Climate Services and especially seeks to support regions and countries in developing more proactive drought policies and better predictive mechanisms.

www.droughtmanagement.info

Drought and Water Scarcity

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CONTENTS

EXECUTIVE SUMMARY

Driven by climate change, population growth, economic development, and poor water management, the increasingly limited availability of freshwater resources is a fundamental concern for societies worldwide. Drought and water scarcity – two major phenomena that challenge water security – know no national boundaries and affect all socioeconomic sectors of society, with a greater impact on the more vulnerable, poorer, or marginalized populations. Drought is a natural climatic feature of below-average precipitation, which can last for months or years, while water scarcity results from a long-term imbalance between water demand and supply. Drought and water scarcity are often interrelated, and droughts can trigger or amplify water scarcity, while water scarcity can aggravate droughts.

The on-ground impacts of drought and water scarcity are often the same, with agriculture and food security often being the most severely affected. Drought and water scarcity exacerbate poverty and adversely affect economic growth, health and well-being, gender equality, and the environment. Integrated drought management emphasizes the need for a framework or structured way of looking at impacts – direct and indirect – by sectors (e.g. agriculture, health, tourism, and environment). Although it can be challenging, this approach includes considering the costs of inaction and benefits of action for all relevant sectors. Yet failure to enact holistic and proactive measures to cope with and prepare for recurring drought hazards, as well as human-induced deterioration of increasingly scarce water supplies, will increase risks for economic sectors and societies.

Strategies for coping with droughts and water scarcity involve proactive approaches to minimize adverse effects. These responses and coping strategies should be part of overall integrated drought and water resource management strategies, including sustainable water resource development. Opportunities for proactive approaches include strengthening early alert systems, risk mitigation measures, and long-term adaptation strategies to build climate, economic, and societal resilience for the well-being of future generations. In countries and regions prone to drought and water scarcity, risk management and resilience are important for sustaining and enhancing future quality of life.

INTRODUCTION

Water is essential to all life on Earth. Its availability – or the lack of it – can be both the driver and inhibitor of economic development, as water nourishes healthy ecosystems for food production, and human and animal health, generates hydropower and supports industry, to mention only a few of its vital functions for human well-being. Water availability depends upon the amount of water physically available as well as how it is stored, managed, and allocated to various users. It includes aspects related to the management of surface water, soil water, and groundwater, as well as water recycling and reuse (UNESCO and UN-Water, 2020). The paramount importance of sound water management for global well-being was recognized in the United Nations' Sustainable Development Goals (SDGs) Targets 6.4 and 6.5 on water use efficiency and integrated water resources management (IWRM). Moreover, the United Nations World Water Development Report 2020 emphasizes that water is the 'climate connector' that allows for greater collaboration and coordination across most targets for sustainable development, climate change, and disaster risk reduction (UNESCO and UN-Water, 2020). For many countries and regions, short- or long-term water shortages are a reality (Vörösmarty et al., 2010), and will very likely be aggravated by the future effects of climate change. These climate change effects can be direct or indirect and are induced by intensification and acceleration of the water cycle. This leads to intensified rainfall and associated floods in some regions, and more frequent and intense droughts in others, or even both in the same region (IPCC, 2021).

High or critical water stress already affects around 10 percent of the global population (FAO and UN-Water, 2021), and the dimension of water stress can stretch from local to national or river basin level. Therefore, collective action and political leadership are necessary at all levels to ensure sustainable and insightful management of limited and vulnerable water resources and to increase societal and ecosystem resilience, particularly for the most vulnerable. There are different drivers of water stress of which the following are the most frequent and can occur in isolation or combination:

- climate variability
- climate change
- population growth and urbanization
- economic development
- mismanagement.

Drought and water scarcity are two separate phenomena, which both lead to the depletion of available water resources but differ in their driving forces and temporal characteristics (Table 1).

Aim of this publication

This publication shows how the three pillars of drought management: (1) monitoring; (2) vulnerability assessment; and (3) risk mitigation and response, help to integrate the management of the two phenomena. With climate change seriously affecting the water cycle in many parts of the world, it is important that stakeholders understand each of these phenomena and undertake appropriate management measures. Understanding which phenomena are being faced by a country or region can enable stakeholders to implement the appropriate monitoring and early warning systems. This publication outlines existing water management approaches and initiatives, and provides guidance on proactive integrated water management decisions in a world facing ever more pressure on water resources. These approaches include the strengthening of early alert systems, the development and implementation of risk mitigation measures, and the long-term adaptation of strategies to build societal and environmental resilience.

WATER SCARCITY AND DROUGHT

The terms 'water scarcity' and 'drought' are often used interchangeably, despite their subtle but important differences with regards to water management. The aim of this publication is to inform stakeholders about the different characteristics of drought and water scarcity and how they can be interdependent (with clear examples of each). This publication also shows that with climate change, increased water use by the various economic sectors, and poor water management, the line between drought and water scarcity can become blurred.

Table 1. Characteristics and impacts of water scarcity and drought

	Water scarcity	Drought
Length	Long-term to permanent	Temporary (weeks to multiyear)
Driving forces	Demand–supply imbalance, human-driven, and/or natural (overexploitation, pollution). Climate change can impact both supply and demand	Natural climate variability which can be modified/amplified by climate change
Potential impacts	Restricted water availability, environmental degradation, desertification, exacerbated inequalities in access to water resources, potential competition	Water shortages, competition, environmental degradation
Measures	Long-term IWRM to bring supply and demand back into sustainable balance	Integrated drought management, including: (1) monitoring and early warning; (2) vulnerability and impact assessment; and (3) risk mitigation, preparedness and response

Source: adapted from Hohenwallner et al. (2011)

DROUGHT AND WATER SCARCITY – DEFINITIONS AND CHARACTERISTICS

Multiple definitions of drought exist; these highlight different aspects of drought and can therefore be understood as complementary. One common definition focuses on the meteorological aspects and defines drought as a prolonged absence or marked deficiency of precipitation that can be characterized as a period of abnormally dry weather with a sufficiently prolonged lack of precipitation as to cause a serious hydrological imbalance (WMO, 1992) (see Figure 1). Other definitions include impacts like hydrological imbalances that adversely affect land resource productions systems (United Nations, 1994; Article 1 of the Convention) or include evaporative demand and other assessment variables (soil moisture, streamflow, groundwater). A more detailed overview of the discussions around the definition of drought is provided in Sims et al. (2021).

Droughts are often characterized according to their impacts on the environment or on society during the progression of water shortage (i.e. meteorological drought, agricultural drought, hydrological drought, etc.; see Box 1). Usually there is a progression in the severity of adverse impacts with the duration of drought and increasing water shortage. Monitoring parameters of both the hazard (e.g. precipitation, river discharge, and soil moisture) and associated impacts (e.g. water shortages and associated sector-specific impacts) should be formulated in a broader and more flexible way than strictly defining different types of drought according to their impacts (WMO and GWP, 2016).

In other words, drought is a climatic phenomenon that can occur almost anywhere in the world when there is a significant decrease in water availability (atmospheric, surface, soil, or groundwater) over a

Box 1. Drought and sectorial impacts

Drought events are characterized in terms of magnitude, location, duration, and timing. The impacts of droughts are distinguished according to the sector(s) affected. The range of affected sectors is broad, including education (children being withdrawn from school), health, agriculture, energy (hydropower), transport (water levels), and industry. The impacts of drought, generally and in specific sectors, are a function not only of the severity of the event but also of the degree of exposure of people, and socioeconomic and environmental assets and processes, and their vulnerabilities. A common feature is that impacts often persist long after a meteorological drought has ended, i.e. when it starts to rain again. (See section on impacts of drought and water scarcity, below.)

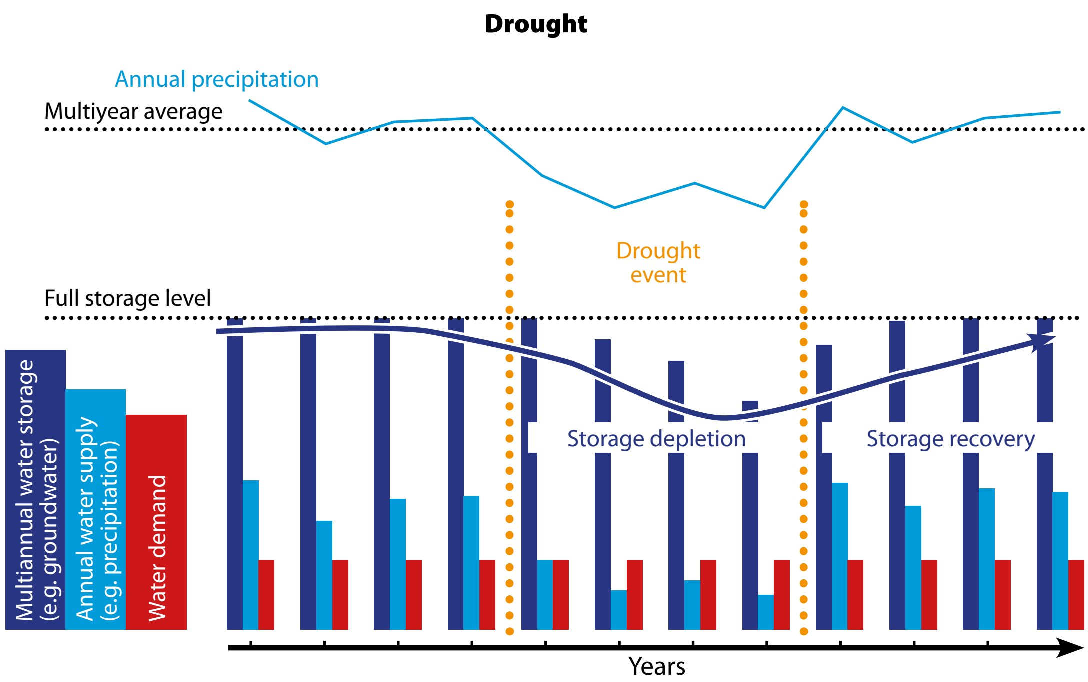

FIGURE 1. Schematic representation of drought with temporary water storage depletion and slow storage recovery. During a drought, the annual water demand (red bars) exceeds the annual water supply (bright blue bars), and therefore, the multiannual water storage (dark blue bars) is used to cover the demand during this period. After the drought conditions stop, the annual supply again exceeds the demand, and the storage recovers.

period of weeks to years. Climate change is increasing the frequencies and/or magnitudes of droughts in many regions of the world (IPCC, 2021). Droughts are generally considered to be slow-onset events; however, high temperatures, strong winds, and low relative humidity (i.e. an increase in atmospheric evaporative demand) aggravate drought conditions and can accelerate the onset, extend the duration, and delay the cessation of drought.

Droughts vary by intensity, duration, timing, and geographical coverage, creating conditions of limited moisture availability to a potentially damaging extent. They are part of the natural climate variability; however, their occurrence is often associated with extreme or protracted climate patterns connected with climate variability and/or climate change. These deviations are caused by abnormal atmospheric circulation patterns and unusual ocean–atmosphere interactions, such as the El Niño Southern Oscillation. Recent advancements in hydrological modelling and observation technologies, including from remote sensing, have allowed countries to develop or strengthen appropriate drought policies (Verbist et al., 2016). In agriculture, for instance, improved monitoring and assessment methodologies would support better estimation of available resources and avoid over-allocation of water rights that may be leading to water shortages during drought periods (FAO, 2012).

Droughts can be monitored using a variety of climate indices, such as the standardized precipitation index (SPI), and standardized precipitation evaporation index (SPEI). These compare current conditions with long-term averages, and can be forecasted to a certain extent (WMO and GWP, 2016).

As for drought, several definitions exist for water scarcity, and the characterization often depends on whether the view of water scarcity is qualitative or quantitative. A short overview of the discussion on definitions is provided in FAO (2012). The publication at hand follows the definition used in FAO (2012), understanding water scarcity as a gap between available supply of and expressed demand for freshwater in a specified domain, under prevailing institutional arrangements (including both resource pricing and retail charging arrangements) and infrastructural conditions (see Figure 2). This means that, even if drought is a driver of water scarcity (e.g. reduction in rainfall), there is always a human dimension to the reduction in

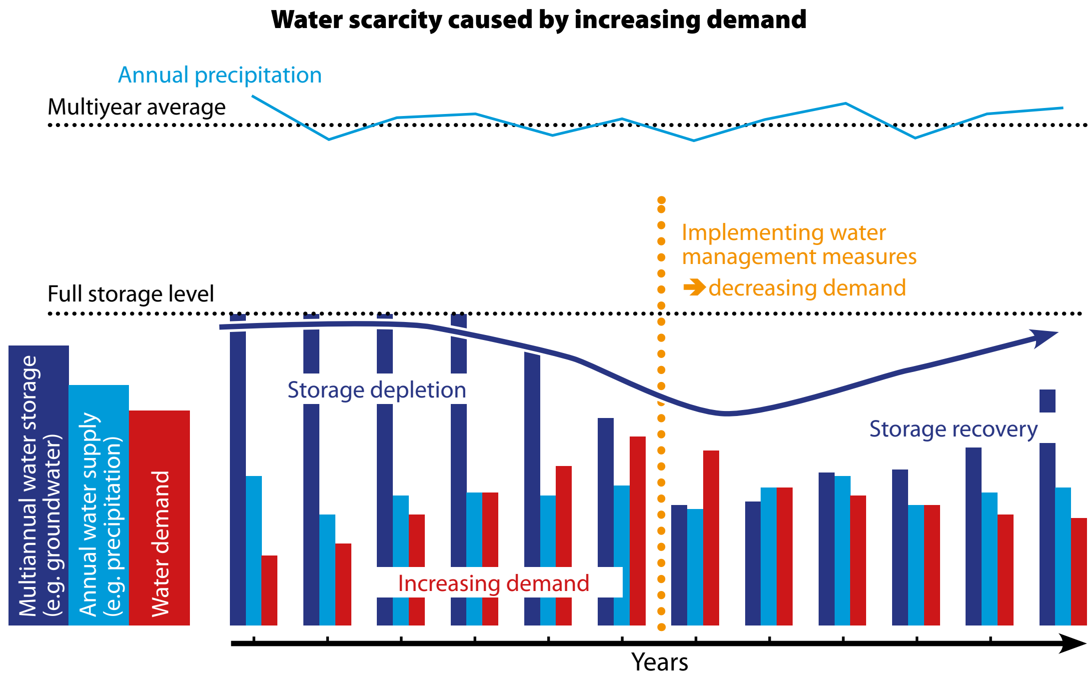

FIGURE 2. Schematic representation of water scarcity caused by increasing water demand (red bars) while annual water supply (bright blue bars) stays stable, leading to a storage (dark blue bars) depletion. After implementing water management measures (e.g. increased water use efficiency), the demand decreases, the annual supply exceeds the demand again, and the storage recovers. Please note that actual water scarcity and related processes are usually a multiyear, long-term process, which may exceed the time scale displayed in this illustration.

the natural water supply (European Commission, 2019). The drivers of water scarcity are either a reduction in water supply, an increase in water demand, or both at the same time. Whereas the reduction in water supply can be human- or nature-induced, the increase in demand is solely human-induced. Therefore, the severity of water scarcity responds to water resources management strategies and practices.

In regions with strong intra-annual climatic variability of precipitation, seasonal shortfalls display the characteristics of drought when available water resources are overexploited. Water scarcity can be caused by long-term overuse and misuse of water resources and by pollution, all of which adversely affect the quality and suitability of water supplies for human consumption and other uses. Water quality issues arising from pollution and saltwater intrusion (SWI) in coastal areas adversely affect clean water availability and contribute to the reduction or unsuitability of water supplies for different uses (FAO, 2016). Water scarcity is usually characterized by a permanent and continued lack of water for ecosystems and socioeconomic functions.

Several different types of water scarcity have been distinguished, including physical and economic water scarcity. Economic water scarcity arises when access to water resources cannot be facilitated, due to a lack of infrastructure for example. FAO (2012) notes that a well-known but simplified indicator of national physical water scarcity is the 'per capita renewable water' (water withdrawal divided by water availability), where a threshold value of 1,000 m^3 per capita per year is the threshold of water scarcity and 500 m^3 per capita per year is used to indicate countries or regions facing absolute water scarcity.

INTERRELATIONSHIPS BETWEEN DROUGHT AND WATER SCARCITY

In many regions, the balance between water supply and demand is fragile, and droughts can trigger, amplify, and/or accelerate the development of an unsustainable water balance, leading to water scarcity (see Figure 3). The interrelationship between drought and water scarcity is complex. A drought leads

Water scarcity amplified and accelerated by drought

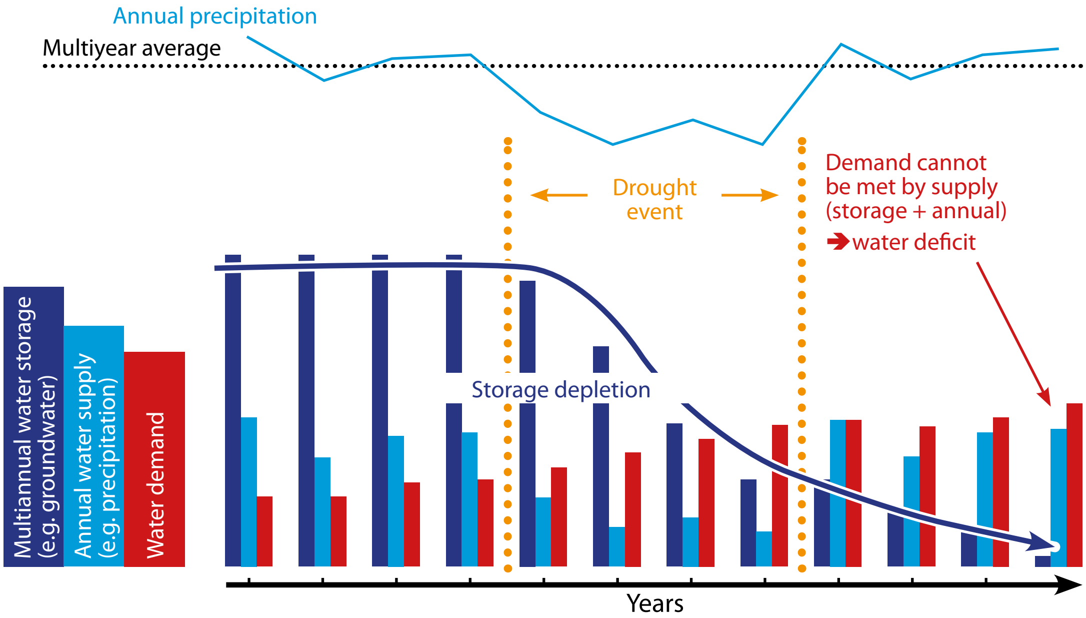

FIGURE 3. Schematic representation of how drought and water scarcity can interrelate. Drought causes an increase in water demand (red bars), such as through increased need for irrigation, which exceeds the annual water supply (bright blue bars). This leads to an accelerated storage (dark blue bars) depletion and a water deficit, where the expected annual demand can no longer be fully met by the annual water supply and the available water storage.

to decreased water supply but, on the other hand, can affect water consumption and increase water demand. In a system that has been in balance before, a drought can, for example, trigger an increase in groundwater storage exploitation that exceeds the recharge rate, such as by increasing the demand for irrigation. Combined with a temporarily reduced precipitation recharge, such a situation can cause storage depletion and lead to long-term water scarcity, even if precipitation returns to long-term average conditions after the drought event. This process is more likely to accelerate or amplify water scarcity in a region with a long-term increasing water demand. Likewise, existing water scarcity can aggravate drought effects due to a decreased coping capacity from water resources being overexploited over the long term.

As a prime example, the Mediterranean region consists of multiple countries with a semi-arid climate that causes scarce and unpredictable water resources from year to year. The water management challenges in the region are immense and growing, with rising demands due to population growth and improving standards of living. Thus, even without drought events, the imbalance between availability and demand is tremendous. However, droughts occur regularly in the region, and when combined with water scarcity, dramatically impact national economies, environments, and population well-being (European Commission, 2007).

IMPACTS OF DROUGHT AND WATER SCARCITY

Droughts are among the costliest natural hazards on an annual basis, affecting many economic sectors and people at any one time, with adverse impacts often lingering long after the cessation of a drought event (UNESCO and UN-Water, 2020). Droughts adversely affect agriculture and food security, natural ecosystems, nuclear and hydropower generation, inland navigation, industry, human and animal health, livelihoods and personal security, and access to education. Such impacts depend on the socioeconomic contexts in which droughts occur, in terms of who or what is exposed to the drought, and the specific vulnerabilities of the exposed entities (WMO and GWP, 2016). Prolonged drought increases competition for scarce water supplies among all economic sectors and for human consumption, and it also adversely affects natural and ecological systems by reducing both water storage in soils and the water supply and quality of aquifers (Vicente-Serrano et al., 2020). The latter can be affected by a number of processes connected with low stream levels, including increased salinity and stratification, oxygen depletion, and algal blooms. Drought can reduce agricultural and industrial productivity, with losses often passed on to consumers in the form of food shortages and higher prices. In less developed countries, these consequences may lead to famine and potential conflict relating to shortages in commodities and water resources. Humans are altering both drought intensity and impacts through human-induced climate change, land use, and water infrastructure (e.g. reservoirs or river diversion). In the Anthropocene – the current period in which humans are the dominant influence on climate and the environment – droughts are closely entwined with human actions, cultures, and responses (Gjerdi et al., 2019).

Water scarcity, as a supply/demand-driven and natural and/or human-made phenomenon, is one of the greatest challenges of the twenty-first century. Agriculture, including crops, livestock, fisheries, aquaculture, and forestry, is both a cause and a victim of water scarcity. It accounts for an estimated 70 percent of global water withdrawals, while competition for water with other sectors is increasing (FAO, 2016). Globally, water use has been growing at more than twice the rate of population increase over the last century, and water scarcity has been exacerbated by poor water management, urbanization, and water pollution. Rapidly growing populations, increased demand for irrigation and industrial use, and greater quality of life requirements increase the competition for limited water supplies and thus aggravate water scarcity.

Severe drought and water scarcity also increase the potential for health risks due to poverty and hygiene issues. The environmental impacts of prolonged drought include loss of species biodiversity, migration changes, reduced air quality, and desertification. Drought restricts water availability, and water mismanagement during times of water shortage can lead to a situation of water scarcity. Drought and water scarcity stand as major threats to future advances in poverty alleviation, as poor communities face the greatest health burden from inadequate water supplies and suffer from the cycle of poverty and disease.

CASE STUDIES OF DROUGHT AND WATER SCARCITY

The following case studies examine drought and water scarcity situations in different contexts and regions. They showcase how the two phenomena can be overlaid under certain circumstances and give examples on responses to drought and water scarcity, and the mitigation of their impacts. Additional case studies can be found in *Droughts in the Anthropocene* (Gjerdi et al. 2019).

Case study I: Ethiopia drought

Rainfed agriculture is predominant in the Horn of Africa. A failed 2016 rainy season led to extreme drought in the region. This event was linked to La Niña (an ocean–atmosphere interaction in the Pacific Ocean) and exceptionally warm sea surface temperatures in the eastern Indian Ocean. The La Niña conditions aggravated drought conditions in the region, which had been triggered by a preceding strong El Niño event (ACAPS, 2016; WMO, 2017). The region experienced frequent and severe droughts, which exacerbated food insecurity for millions of people. The Kenyan government declared a national disaster, and the governments of both Kenya and Ethiopia stated that several million people in each country required food, nutrition, and livelihood support following the drought event (Grünewald et al., 2019).

In Ethiopia, agriculture is the primary source of livelihoods for 85 percent of the population (Jirata et al., 2016). The dry lowlands often experience erratic rainfall and very severe droughts, which place great stress on the socioeconomic well-being of a society that is affected by land degradation, population growth, and climate change. Agricultural production remains low, primarily due to unreliable rainfall as well as inefficient agricultural management techniques (Jirata et al., 2016). The Government of Ethiopia, the World Food Programme, and development partners have worked together to increase families' long-term resilience to food shortages during the frequent and persistent droughts. Specific cases of improved drought management have been recorded based on experiences in the watersheds of Abreha we-Atsebeha, Lake Hamaraya, and Lake Ziway, all of which are susceptible to drought (GWP EA, 2016). The concerned areas are characterized by rural communities that face the challenge of poverty as well as food and water insecurity. Soil erosion, deforestation, overgrazing, and a resulting loss of biodiversity are factors that lead to severe land degradation.

With the support of donors and public–private partnerships, integrated and participatory watershed management practices have been adopted, and this has restored hope to local communities. Management practices include enacting natural resource management bylaws, controlling soil erosion, and adopting water harvesting and drip irrigation. In addition to improving water security, these interventions have increased food production and regenerated the biodiversity of the areas. The cases also highlight the crucial role of political will, stakeholder engagement, and capacity and ownership building in improving drought preparedness. Significant improvements in monitoring and early warning of drought and food shortages were implemented using both satellite and in situ measurements (Deltares, 2018).

Case study II: Egypt water scarcity

Egypt relies on the Nile, the longest river in the world, for 97 percent of its water needs. The Nile draws its water from three long tributaries: the White Nile, the Blue Nile, and the Atbara. These tributaries pass through 11 countries in eastern Africa. Egypt faces severe future water scarcity due to a generally low water supply through precipitation. This is exacerbated by climate change and growing demand associated with population growth, and other factors including the possible redistribution of the Nile's resources to other riparian nations. The United Nations reported that Egypt could run out of water by 2025 (Srour, 2018). However, Egypt already meets part of the demand from alternative sources, e.g. reuse, desalination plants, and deep aquifers. These have the potential to balance supply and demand.

Currently, Egypt is the world's largest grain importer (Di Nunzio, 2013). Water shortages and limited arable land mean that Egypt must rely increasingly on food imports to feed its growing population. Meanwhile, Egypt's agriculture sector uses more than 80 percent of the nation's water supplies to irrigate crops (World Bank Group, 2016). In addition to flood irrigation, border and furrow irrigation and localized techniques are being applied increasingly in many parts of the country. Therefore, improving irrigation at system level and applying modern techniques at farm level would improve water use efficiency and productivity in the country. Changing planting dates and optimizing irrigation management to coincide better with natural climate patterns, such as planting cotton during the cooler season, could also help to reduce the total irrigation usage.

After the construction and filling of the Aswan High Dam in 1976 (Abdel-Meguid, 2016), a suite of irrigation flagship projects has been implemented (El Gamal and Zaki, 2017). The first irrigation improvement programme was followed by the Integrated Irrigation Improvement and Management Project in the Nile Delta. It was implemented to improve water distribution, quantity, quality, equity, and timeliness, with the goal to increase agricultural production and alleviate poverty. The project was implemented on the two main canal and branch networks in the Nile Delta (the Mahmoudia and the

Mit Yazid). It required extensive relining of irrigation canals to substantially reduce leakage. The project focused on biophysical interventions to improve water management and helped to promote institutional reform to decentralize operational decision-making and accountability. It also provided on-farm water management training and education to increase productivity. Both projects improved irrigation on around 500,000 hectares of land and the following project increased the area to over 1 million hectares (Khalifa and Moussa, 2017). Another suite of irrigation flagship projects implemented in Egypt focused on on-farm irrigation development. Funded by Agence Française de Développement (AFD), the International Fund for Agricultural Development (IFAD), the Organization of Petroleum Exporting Countries (OPEC) Fund, and the World Bank, these projects aimed to improve water use efficiency and water productivity at farm level, thus improving livelihoods among the rural poor. Other key outcomes of these projects included an increase in local, participatory, and accountable decision-making, an increase in field irrigation efficiency and on-farm productivity, and improvements in water quality (World Bank Group, 2016).

Case study III: Viet Nam drought and water scarcity

Viet Nam has a dense river network, including many rivers that originate in catchments in other countries. About two thirds of Viet Nam's water resources originate outside the country. This makes Viet Nam susceptible to the water resources decisions of upstream countries. Viet Nam has a monsoonal rainy season, but the uneven distribution of average monsoon rainfall and a prolonged dry season of six to seven months often leads to serious water shortages in many areas. The heavily populated delta areas of the Red and Mekong rivers are especially at risk. Each year, typhoons, floods, or droughts have significant impacts on agriculture, infrastructure, and livelihoods. In fact, Viet Nam is one of the most hazard-prone countries in the East Asia and Pacific region, with both droughts and floods contributing to substantial economic and human losses (World Bank, 2017). Climate change is projected to exacerbate these hazards, especially the timing, frequency, severity, and intensity of hydro-meteorological events (Grosjean et al., 2016). While groundwater resources are abundant, overexploitation in the Mekong River Delta has resulted in falling water tables, causing land subsidence and salinity intrusion (WEPA and IGES, 2015). Viet Nam's 2015–2016 drought and associated SWI event offers a preview of what could become the new normal (IFRC, 2016).

Recognizing these serious issues, Viet Nam has begun to implement policies focusing on land-use planning, integrated water resource management, disaster risk management, and community engagement efforts to sustain economic growth and build climate resilience for societal well-being. To effectively address drought and SWI, an integrated approach directed at national and local policies, capacity building, information and technology systems, infrastructure, and application services is being developed (Grosjean et al., 2016). Through the SERVIR-Mekong project, remote-sensing-based geo-spatial decision support tools have been developed to address drought monitoring and early warning as well as the provision of crop yield information (ADPC, 2020).

Case study IV: Cape Town, South Africa drought and induced water scarcity

Cape Town is a world-class tourist destination, rivalling the Kruger National Park as a key South African attraction. It has a Mediterranean climate characterized by winter rainfall and a high level of endemic biodiversity. A prolonged drought with three years of low rainfall that started in 2015 contributed to the major water supply reservoirs becoming so depleted that the mayor was forced to announce 'day zero' for the first quarter of 2018 as the last day on which water could be drawn from the sources (Pijoos, 2017; Gjerdi et al., 2019). The response by local government was complicated by the deep rivalry between two political parties: the one controlling revenues for infrastructure and the other being responsible for the reticulation of water and the treatment of return flow (Enqvist and Ziervogel, 2019). Cape Town faced a very real possibility of becoming the first major city in the world to completely run dry. A tight water use restriction of 50 litres per capita per day for Cape Town residents was enforced; farmers abandoned roughly a quarter of their crop lands and employed new irrigation methods; leaky infrastructure was reduced; and water efficiency was promoted by the city (Chutel, 2018). These efforts reduced demand on the rapidly receding municipal reservoirs, which began to see some increase to around 30 percent of capacity following rain in early June 2018. 'Day zero' has since been pushed to a future date several times thanks to a combination of rainfall and the success of some water conservation schemes. Cape Town's water resources still face much uncertainty, however, as future rains are not guaranteed (Welch, 2018). At the real heart of the matter is the inability of policy, legal, and institutional arrangements to respond adequately in the lead up to an unprecedented drought event, giving this case a unique place in the literature (Enqvist and Ziervogel, 2019).

Drawing from lessons learned during the severe 2015–2017 drought period, and with the aim to support a water-secure future, the city of Cape Town developed and adopted its new water strategy in 2019 (City of Cape Town, 2019) and developed a water resilience profile through stakeholder engagement (City of Cape Town, 2020). The strategy evolves around five commitments that underpin water security in the city by facilitating access to water and ensuring its wise use. Cape Town commits to diversifying water sources at the local and regional levels, and to transforming the city through incentives, investments, and regulatory mechanisms to create a 'water-sensitive city' that is resilient to water-related stress. In addition, a water resilience profile was elaborated in a stakeholder engagement process based on the Cape Town Water Strategy. As an assessment of the current state of water management in the city, it highlights gaps and opportunities on which to build with tangible action to achieve water resilience (City of Cape Town, 2020).

COPING WITH DROUGHT AND WATER SCARCITY

Along with increasing population and consumption, the world faces climate change, ecosystem degradation, and pollution of air, water, and soil. Building resilience to drought and water scarcity requires greater collaboration across sectors, stakeholders, and countries. Proactive measures to address drought and water scarcity are often the same for both phenomena and are essential across the range of economic sectors and from a multinational perspective. Water scarcity is a critical issue for economic development worldwide, from the parched farmlands of eastern Africa to growing cities across India and Southeast Asia, and to water-limited areas of the United States. Driven by climate change, the impacts of water scarcity are projected to cost some regions up to 6 percent of their gross domestic product in the future. However, proactive measures and decisions have the potential to minimize or even neutralize adverse effects, drawing the focus onto water management strategies (World Bank, 2016).

The potential for intensifying droughts and increasing water scarcity demands a new paradigm for water management that builds on proactivity and preparedness, and prioritizes holistic and integrated solutions. Underlying water scarcity issues are likely to influence the health of freshwater ecosystems and the sensitivity of society and freshwater ecosystems to climate variability. Likewise, water management approaches that focus only on drought when it occurs will have missed significant opportunities to reduce drought risk. Furthermore, reactive and response-led strategies often represent less economically valuable approaches, given the estimated benefit–cost ratios of adaptation strategies, ranging from 2:1 to 10:1 (FAO and UN-Water, 2021). The interactions between drought and water scarcity demand integrated action to address both chronic and acute water issues (Sayers et al., 2016).

In many regions, drought or water scarcity have unpredictable impacts due to a lack of preparedness by decision-makers and resource-allocation policies. Handling drought requires the prioritization of policy for water usages to mitigate the effects on society in general, such as involving water accounting and budgeting. Involving stakeholders from across the board, such as across domestic (rural, urban, and livestock), industrial, and agricultural sectors, can generate awareness about shared responsibilities and inform counterstrategies in different areas of operations, which can lead to survival during drought periods. Interannual droughts have good predictability, especially in the monsoon-influenced countries where this approach (water accounting and budgeting combined with seasonal forecasting) can predict the scenario under various types of usage. The tools to be used for drought impact mitigation include alternative cropping strategies, upgrading of infrastructure for better efficiency, resilience through intraregional water transfer mechanisms, and real-time yield predictions and assessments (Batchelor et al., 2016).

Many countries (such as Brazil, China, India, and Mexico) have both water-scarce and water-abundant areas, but there are limited opportunities for inter-basin water transfer. While seemingly a sound practice, transfer of water between basins may cause territorial conflicts during periods of drought, as experienced in central Spain (Lorenzo-Lacruz et al., 2010). For multi-basin countries like India, resolving water allocation issues across political and administrative boundaries can have a positive impact on resilience to drought by interconnecting all stakeholders in the basin. Other countries (e.g. Egypt, Niger, Mauritania, and Turkmenistan) are naturally very arid within their own territories, but their annual renewable freshwater resources are boosted by large perennial rivers that draw supplies from higher precipitation areas upstream.

Addressing water scarcity in transboundary basins is a complex challenge. As stated clearly in the Dublin Statement: "the most appropriate geographical entity for the planning and management of water resources is the river basin, including surface and groundwater" (ICWE, 1992). At the same time, climate change and human influences put pressure on freshwater supplies, while lakes and rivers that cross international borders require coordinated interventions that consider the basin as a whole (Gjerdi et al., 2019). Some countries experience strong seasonality or interannual climatic variability. Such conditions may enable water storage strategies that mitigate the impacts of interannual water stress or drought periods. Implementation of storage with carry-over capacities and appropriate operating policies to cater to downstream uses can provide resilience against droughts spanning consecutive years.

Addressing water scarcity requires decisions and actions at local, national, and river basin levels. Human interventions that do not take account of river basin levels have been shown to alleviate water scarcity upstream while aggravating it downstream (Veldkamp et al., 2017). Climate change and its effects on the ocean–atmosphere–land continuum are likely to exacerbate both drought potential and persistence, as well as impacting scarce water supplies in regions around the world (IPCC, 2019).

Many countries and densely populated areas cope with water scarcity and drought by overexploiting groundwater reserves. Overexploitation of renewable and non-renewable groundwater will make future generations more vulnerable to droughts and cause greater drought impacts from similar hazard levels. Further, several studies have already shown that groundwater reserves in aquifers in many regions around the globe are diminishing due to overexploitation and changing climate, implying that groundwater may become unavailable as an alternative water source (Gleeson et al., 2012; Lingvoet and Hildering, 2014), or showing that the depletion of groundwater resources is connected with land subsidence and increased risk of flooding (Erban et al., 2014). As a result, future drought events may have an even bigger impact than current droughts of the same intensity on agriculture and, consequently, land degradation, urban water supply, and the overall economy.

Adequate and reliable weather, water, and climate data and applications are needed to monitor available water resources and provide actionable early warning for water scarcity and drought conditions. A recent report synthesized information obtained from 101 national meteorological and hydrological services worldwide to analyse the current status of information and monitoring they provide with respect to

water (WMO, 2021). The recommendations formulated in the report address the major gaps that were identified; specifically that investment in IWRM and end-to-end drought (and flood) early warning systems in least developed countries is needed, as well as improved capacities in collecting hydrological data. Improved interaction with stakeholders is crucial to promote better tailored information products. The report also highlights the role of international initiatives like the Water and Climate Coalition and the Integrated Drought Management Programme in providing guidance in policy development and adaptation action.

The globally agreed SDGs address the need for sustainable management of finite resources, with two targets in Goal 6: Target 6.4, which calls for an increase in water use efficiency, and Target 6.5, which requests the implementation of IWRM. The Global Water Partnership (GWP) fosters the adoption of IWRM approaches to ensure coordinated development and shared management of water resources (rivers, lakes, and aquifers). The aim of IWRM is to protect economic and social welfare without compromising the sustainability of vital environmental systems (GWP, 2002). Drought management is an integral component of water resource management systems.

Several international initiatives are working on drought and water scarcity issues and can provide guidance on drought and water scarcity management (see Boxes 2–10).

Box 2. Integrated Drought Management Programme (IDMP)

GWP and the World Meteorological Organization (WMO) established IDMP in 2013 as a result of the High-level Meeting on National Drought Policy, to promote effective drought preparedness measures through three pillars for use by countries and communities: (1) drought monitoring and early warning systems; (2) drought vulnerability and impact assessments; and (3) mitigation, preparedness, and response strategies. IDMP has over 35 partner organizations and a HelpDesk.

See www.droughtmanagement.info

Box 3. Food and Agriculture Organization of the United Nations – Global Framework on Water Scarcity in Agriculture (WASAG)

WASAG was established in 2016 with the goal to address the increasing pressure of global change impacts on water scarcity in agriculture. WASAG consists of more than 65 partners.

See http://www.fao.org/land-water/overview/wasag/en/

Box 4. United Nations Convention to Combat Desertification (UNCCD) – Drought Initiative

The 13th Meeting of the Conference of the Parties of the UNCCD requested the UNCCD Secretariat and appropriate UNCCD institutions and bodies, including the Science-Policy Interface, to implement the Drought Initiative during the next few years. The initiative focuses on: (1) drought preparedness systems; (2) regional efforts to reduce drought vulnerability and risk; and (3) a toolbox to boost the resilience of people and ecosystems to drought.

See https://www.unccd.int/actions/drought-initiative

Box 5. United Nations Convention to Combat Desertification (UNCCD) – Intergovernmental Working Group on Drought (IWG)

IWG is a working group set up to develop effective policy and implementation measures for addressing drought impacts in the context of UNCCD. It will present its findings and recommendations for consideration at the 15th session of the UNCCD Conference of the Parties in the spring of 2022.

See https://www.unccd.int/issuesland-drought/intergovernmental-working-group-drought

Box 6. United Nations Educational, Scientific and Cultural Organization (UNESCO) – Global Network on Water and Development Information for Arid Lands (G-WADI)

The UNESCO Intergovernmental Hydrological Programme, through its G-WADI initiative, supports countries to identify and address drought management gaps and needs by strengthening global, regional, and local capacities. The initiative also strengthens cooperation around managing water resources and provides access to data and policy recommendations for a more integrated drought management approach.

See www.gwadi.org

Box 7. United Nations Educational, Scientific and Cultural Organization (UNESCO) – International Drought Initiative (IDI)

Proposed by Iran, IDI was approved at the 19th session of the Intergovernmental Council of the International Hydrological Programme of UNESCO in Paris in July 2010. IDI provides a platform for networking and dissemination of knowledge and information between international entities that are actively working on droughts.

See https://en.unesco.org/themes/water-security/hydrology/programmes/droughts

Box 8. United Nations Children's Fund (UNICEF) – Water Scarcity Programme

This programme addresses the growing lack of available water to meet children's needs. As the factors driving water scarcity are complex and vary widely across countries and regions, UNICEF works at multiple levels to introduce context-specific technologies that increase access to safe water and address the impacts of water scarcity. Several coping strategies using IWRM and water use efficiency approaches, as well as innovative technologies, are implemented in different national contexts.

See https://www.unicef.org/wash/water-scarcity

Box 9. World Bank – Water Scarce Cities Initiative

The objective of the World Bank's Water Scarce Cities Initiative is to bolster awareness of integrated approaches to managing water resources and service delivery in water-scarce cities as the basis for water security and climate resilience.

See www.worldbank.org/en/events/2017/06/11/water-scarce-cities-initiative

Box 10. International Commission on Irrigation and Drainage (ICID) – Working Group on Managing Water Scarcity Under Conflicting Demands (WG-MWSCD)

In 2016, ICID established WG-MWSCD to collect information, knowledge, and, where available, case histories on actions taken to manage water systems to accommodate a change in priority of water use or conflicting demands. The initiative focuses on information collection and analysis on three levels of water management: national, area or basin, and local. It also develops preparedness strategies based on actual case studies. The working group is an extension of the ICID Working Group on Drought (2008–2016), which focused on implementation of drought risk management strategies, equitable water allocation, and redefining the concept of irrigation efficiency.

See https://www.icid.org/wg_mwscd.html

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The Integrated Drought Management Programme (IDMP) was launched by the World Meteorological Organization and the Global Water Partnership at the High Level Meeting on National Drought Policy in March 2013. IDMP works with a wide range of partners with the objective of supporting stakeholders at all levels. IDMP provides its partners with policy and management guidance through globally coordinated generation of scientific information and sharing best practices and knowledge for integrated drought management. It contributes to the Global Framework for Climate Services (GFCS), especially regarding the GFCS priority areas of disaster risk reduction, water, agriculture and food security, energy and health. It especially seeks to support regions and countries in developing more proactive drought policies and better predictive mechanisms. This handbook contributes to that objective.

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