Climate Change and Water

UN-Water Policy Brief

Version September 2019

Source of title page photograph: UN Photo by Tobin Jones (2017)

The production of this document was coordinated by the UN-Water Expert Group on Water and Climate Change. Special thanks go to Ingrid Timboe and José Gesti Canuto for preparing the initial draft and for incorporating, and adapting when needed, the numerous comments received by the UN-Water Members and Partners.

Contents

With support from:

SWEDEN

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

Ministry of Foreign Affairs of the Netherlands

UN WATER

Source: UN Photo by Albert González Farran (2014)

Key messages

The global climate change crisis is inextricably linked to water. Climate change is increasing variability in the water cycle, thus inducing extreme weather events, reducing the predictability of water availability, decreasing water quality and threatening sustainable development, biodiversity and enjoyment of the human rights to safe drinking water and sanitation worldwide.

The growing global demand for water increases the need for energy-intensive water pumping, transportation and treatment, and has contributed to the degradation of critical water-dependent carbon sinks such as peatlands. In addition, some climate change mitigation measures, such as expanded use of biofuels, can further exacerbate water scarcity.

National and regional climate policy and planning must take an integrated approach to climate change and water management. Increased water stress and meeting future demand will require increasingly tough decisions about how to allocate water resources among competing water uses, including for climate change mitigation and adaptation activities. If a sustainable future is to be created, continuing along a "business as usual" pathway is no longer an option, and water management needs to be scrutinized through a climate-resilience lens.

Increased investment is needed in improving hydrological data, institutions and governance, education and capacity development, risk assessment and knowledge-sharing. Policies need to ensure the representation, participation, behavioural change and accountability of all stakeholders, including the private sector and civil society. Adaptation plans need to incorporate targeted strategies that assist lower-income populations – those who are disproportionately affected by climate change impacts – to navigate new conditions.

There are significant co-benefits to managing climate and water in a more coordinated and sustainable manner. Solutions for addressing the above integrated challenges are available and are being implemented by an increasing number of countries and international river basin authorities.

Meeting the climate challenge means:

1. Acting now

Uncertainty about the future cannot be an excuse for inaction today; if the world is to limit the global temperature increase to well below 2°C above pre-industrial levels by the end of this century, action must be taken immediately. Securing water for communities, economies and ecosystems is critical for poverty reduction, green energy transformation and creating a buffer from natural disasters. Climate policy must address water across all sectors of the economy and the environment to ensure a climate-resilient and sustainable future for all.

2. Considering water as part of the solution

Improved water management, including sanitation, is an essential component of successful climate mitigation and adaptation strategies, as called for in the 2015 Paris Agreement. Water is also key to attaining the goals and targets of the Transforming our World: the 2030 Agenda for Sustainable Development and the Sendai Framework for Disaster Risk Reduction 2015–2030. Climate-resilient water management can therefore act as a mechanism of coherence among these global frameworks.

3. Improving water management practices

As countries begin to review and implement their national plans in the context of the Paris Agreement, there is a unique opportunity to improve and enhance water management practices in ways that will allow communities, countries and basin authorities to make confident, risk-informed decisions that can help to increase climate resilience, improve ecosystem health and reduce the risk of water-related disasters.

4. Ensuring transboundary cooperation in adaptation

Transboundary cooperation is needed to address climate impacts that cross national boundaries (for example, droughts or flooding of transboundary rivers), to avoid maladaptive consequences from a basin perspective and to harness the potential co-benefits of improved regional cooperation, such as reduced uncertainty due to exchange of data, peace and stability, enlarged planning space, and shared costs and benefits.

5. Rethinking financing

Climate finance for water resource management and sanitation supports community climate resilience and job creation at the local level, and helps to improve sustainable development outcomes. Innovative, blended finance solutions for water and climate, such as green and blue climate bonds, can help to leverage climate investment across the economy. Barriers to increased access to climate finance, such as lack of capacity and lack of institutional coordination, must be urgently addressed.


Source: UN Photo by Phil Behan (2011)

I. Introduction

Water is a precondition to life on Earth and is essential for sustainable development. Safe drinking water and sanitation are human rights.[1] Water – including sanitation – is critical for socioeconomic development, food security and healthy ecosystems, and is vital for reducing the global burden of disease and improving the health, welfare and productivity of populations.

The science is clear: the global climate change crisis is increasing variability in the water cycle, thus reducing the predictability of water availability and demand, affecting water quality, exacerbating water scarcity and threatening sustainable development worldwide. These impacts disproportionately affect poor and vulnerable communities and are compounded by contributing factors, including population increase, unmanaged migration, land-use change, reduced soil health, accelerated groundwater extraction, widespread ecological degradation and biodiversity loss.

While all regions of the globe are affected, the impacts of climate change are highly variable and uneven. Some regions are experiencing extraordinary periods of drought, others increasingly severe and frequent floods and storms, while some face both sets of extremes. Slower-onset impacts derived from accelerated sea-level rise affect coastal areas, posing a particularly direct threat to small, low-lying island nations. At the same time, increased demand for water for energy, agriculture, industry and human consumption is leading to gradually more difficult trade-offs for this limited and precious resource, especially in areas of the world already facing water stress. For these reasons, it is often said that climate change is felt most directly through water.

Climate change represents a profound threat and an unprecedented opportunity to invest in and transform water governance and management systems so humanity can thrive in an increasingly uncertain and variable future. With regard to intergenerational justice, the global climate crisis raises particularly pressing issues, such as which risks society should be allowed to impose on future generations. Young people around the world are using their knowledge and innovation to offer solutions, raise awareness, protest for their rights and advocate for enhanced global action to address and combat the climate crisis and its consequences. As they correctly and urgently insist, the time to act is now.

[1] Resolutions A/RES/64/292 and A/RES/70/169.

Source: UN Photo by Amjad

II. Water and climate in the global sustainable development agenda

Over the last decade, floods, storms, heat-waves, droughts and other weather-related events have caused more than 90 per cent of major natural disasters.[2] These events are expected to increase in frequency and intensity because of climate change.[3]

Against this background and with the aim to end all forms of poverty and hunger, fight inequalities and tackle climate change, countries adopted the Transforming our World: the 2030 Agenda for Sustainable Development in 2015. Its 17 Sustainable Development Goals (SDGs) are interlinked and intended to support one another. For instance, "Ensure availability and sustainable management of water and sanitation for all" (SDG 6) supports the attainment of the other 16 SDGs. Realization of SDG 6 and other water- and ecosystem-related targets are essential for society's health and well-being, improving nutrition, ending hunger, ensuring peace and stability, preserving ecosystems and biodiversity, and achieving energy and food security. Water is also an essential component of national and local economies. Water management fosters gender equality and social inclusion, and supports the creation and maintenance of jobs across all sectors of the economy.

[2] United Nations Office for Disaster Risk Reduction, *The Human Cost of Weather Related Disasters* (Geneva, 2015).

[3] Valérie Masson-Delmotte and others, eds., *Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty* (Geneva, Intergovernmental Panel on Climate Change, 2018).

Agreed to by countries in 2015, the United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement entered into force in 2016. It addresses the need to limit the rise of global average temperature to well below 2°C above pre-industrial levels by the end of this century, and to adapt to the impacts of climate change. The implementation phase of the Paris Agreement focuses on Parties working to define and enact their national commitments.

The Sendai Framework for Disaster Risk Reduction 2015–2030 (hereafter referred to as the Sendai Framework)[4] was adopted at the Third United Nations World Conference on Disaster Risk Reduction in Sendai, Japan, in 2015. It includes seven targets and four priorities for action to reduce the occurrence and impact of disasters resulting from natural hazards. Among those priorities, the Sendai Framework calls for the strengthening and implementation of global mechanisms on hydrometeorological issues, to raise awareness and improve understanding of water-related disaster risks and their impact on society and to advance strategies for risk reduction.

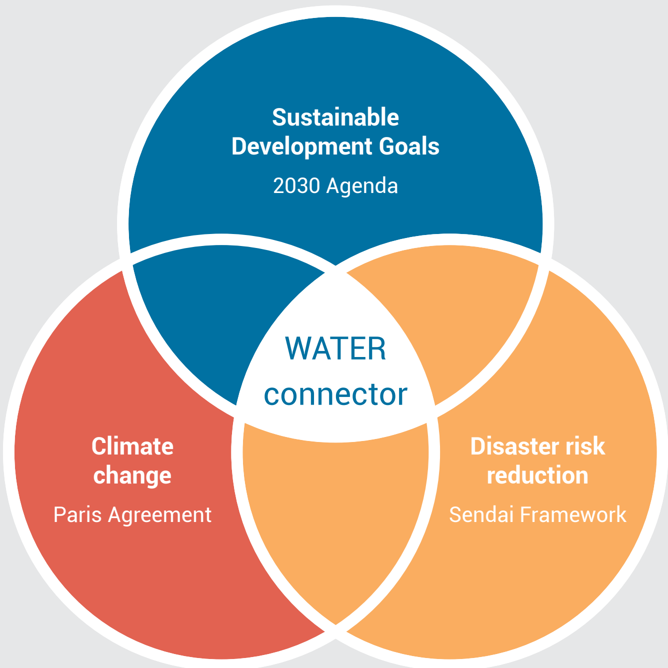
While these global agreements are discrete frameworks with their own sets of targets, mechanisms and reporting requirements, they have an overlapping agenda. With 2030 steadily approaching, there is urgent need to enhance action, coherence and coordination among them (as shown in the figure), to reduce duplication or even triplication of effort, misalignment and competition over funding. Given water's inherent centrality to achieving these goals, it can play a connector role among them, reinforcing and strengthening each country's commitments to mitigating and adapting to climate change, reducing disaster risks, ending poverty and inequality, and "leaving no one behind".

A good example demonstrating this connectivity is SDG 13: "Take urgent action to combat climate change and its impacts". Given that the impacts of climate change are deeply linked to water (for example, floods, storms and droughts), many mitigation and adaptation measures include numerous water-based interventions. This further aligns with the Sendai Framework's targets related to improving the disaster resilience of new and existing water infrastructure to provide life-saving essential services during and after extreme events (Target (d) and Priority 4).[4]

Water is not explicitly mentioned in the Paris Agreement. However, closer analysis reveals the deep extent to which the Paris Agreement is dependent on adequate water resources. Adaptation initiatives related to fresh water, coastal water and groundwater are included as a first priority in many nationally determined contributions (NDCs). Yet governance mechanisms and methods for integrating water and climate remain largely absent.[5] NDCs, together with other key national and multisectoral strategies such as national adaptation plans (NAPs), are a powerful framework for laying out national priorities for national climate action, with the potential to guide priorities such as building water climate resilience and to foster integrated management of resources.[6] They also provide a basis for investment plans that integrate climate vulnerability and resilience in the broader context of the SDGs and the Sendai Framework.

The following chapters of this Brief provide a solid background for why and how countries could consider water mitigation and adaptation interventions for inclusion in NDCs, NAPs, national communications and other planning documents related to climate and water.

Role of water as a connector among the global commitments adopted in 2015



4 Resolution A/RES/9/283.

5 Mélisa Cran and Victor Durand, *Review of the Integration of Water within the Intended Nationally Determined Contributions (INDCS) for COP21* (The French Water Partnership and Coalition Eau, November 2015, updated in March and June 2016).

6 Global Water Partnership, *Preparing to Adapt: The Untold Story of Water in Climate Change Adaptation Processes* (Stockholm, 2018).

III. Observed and projected water-related climate impacts

Water is the medium through which many of the impacts of the climate crisis are felt by society – for example, through diverse risks to the energy, agriculture, health and transport sectors. These are conditioned by interactions with non-climatic drivers of change such as population growth, migration, economic development, urbanization, and environmental and land-use or natural geomorphic changes that challenge the sustainability of resources by decreasing water supply or increasing demand.[7]

Source: UN Photo by Eskinder Debebe (2013)

[7] Bianca E. Jiménez Cisneros and others, eds., “Freshwater resources”, in *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Chris Field and others, eds. (Cambridge, United Kingdom, and New York, Cambridge University Press, 2014).

Such interactions often result in uneven and unforeseen phenomena such as the recent advent of drought in the Netherlands, a low-lying coastal country far more adapted to life with floods. In other cases, it may be easier to identify hotspots for water-related climate impacts. This is the case for glacial meltwater, which is a critical water source, and an increasing threat, at certain times of the year for millions of people – for example those living in the Andean highlands of Bolivia, Chile and Peru.[8]

An estimated 3.6 billion people worldwide now live in areas that are potentially water scarce at least one month per year. According to *The United Nations World Water Development Report*,[9] that will increase to 4.8–5.7 billion people by 2050, thus creating unprecedented competition among water users and across political boundaries. Sudden- and slow-onset disasters linked to the hydrological cycle have long been a major driver of forced migration as people move out of harm's way. Lack of access or availability of water – whether due to drought or the interaction of drought and deficient water governance – has also been considered a factor in the decision to migrate as it affects well-being and livelihood.[10]

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) assesses hydrological impacts due to climate change. The 2018 IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels provides mitigation pathways compatible with 1.5°C in the context of sustainable development.[11,12] Both reports provide the most comprehensive information available on observed and projected hydrological changes due to climate change such as:

- Limiting global warming to 1.5°C above pre-industrial levels, compared to 2°C, can have huge implications on water resources as it may reduce the proportion of the world's population exposed to an increase in water stress induced by climate change by up to 50 per cent.
- Freshwater-related risks of climate change increase significantly with increasing greenhouse gas (GHG) concentrations. The latest modelling studies estimate that for each degree of global warming, approximately 7 per cent of the global population is projected to be exposed to a decrease of renewable water resources of at least 20 per cent.
- Since the mid-twentieth century, socioeconomic losses from flooding have increased mainly due to greater exposure and vulnerability. Projections imply increasing variability in the frequency of floods. Flood hazards are projected to increase in parts of: South Asia, South-East Asia, North-East Asia, tropical Africa and South America.
- Climate change is likely to increase the frequency of meteorological droughts (less rainfall) and agricultural droughts (less soil moisture) in many presently dry regions over the coming decades. This is likely to increase the frequency of short or "flash" hydrological droughts (less surface water and groundwater) in these regions.
- Climate change negatively affects freshwater ecosystems by altering streamflow and water quality, posing risks to drinking water even with conventional treatment. The sources of the risks are increased temperature, increases in sediment, nutrient and pollutant loadings due to heavy rainfall, reduced dilution of pollutants during droughts and disruption of treatment facilities during floods.
- In regions with snowfall, climate change has and will likely continue to alter streamflow seasonality. Except in very cold regions, warming in the last decades has reduced the spring maximum snow depth and brought forward the spring snowmelt, leaving less snow in storage for dry summer months. Smaller snowmelt floods, increased winter flows and reduced summer low flows have all been observed.

8 Kari Synnøve Johansen and others, *The Andean Glacier and Water Atlas: The Impact of Glacier Retreat on Water Resources* (Paris, United Nations Educational, Scientific and Cultural Organization International Hydrological Programme, 2018).

9 *The United Nations World Water Development Report 2018: Nature-based Solutions for Water* (United Nations Educational, Scientific and Cultural Organization, Paris, 2018).

10 Eva Mach and Christopher Richter, "Water and migration: implications for policy makers" (2018). Available at https://sustainabledevelopment.un.org/hlpf/2018/blog#20mar.

11 Gregory Flato and others, "Evaluation of climate models", in *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Thomas Stocker and others, eds. (Cambridge, United Kingdom, and New York, Cambridge University Press, 2013).

12 Valérie Masson-Delmotte and others, eds., *Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty* (Geneva, Intergovernmental Panel on Climate Change, 2018).

- Due to continued warming in glacier-fed rivers, total meltwater yields from stored glacier ice will increase in many regions during the next decades but decrease thereafter.
- Increasing warming amplifies the exposure of small islands, low-lying coastal areas and deltas to the risks associated with sea-level rise and saltwater intrusion into freshwater systems.

While these are relevant observations and projections, in many countries, there is a gap in knowledge in terms of observational data and understanding how climate change will affect the hydrological cycle and water-dependent services at the appropriate temporal and spatial scales relevant to decision-making. Major observational and data gaps include the impacts of climate change on water quality, aquatic ecosystems and groundwater conditions.

In the meantime, climate models continue to be refined and improved. Regional downscaling methods are now used to provide climate information at the smaller spatial scales needed for many climate impact studies, adding value in regions with highly variable topography and for various medium-scale phenomena.[11] However, probabilistic predictions related to precipitation and evapotranspiration remain poor, particularly at scales relevant to decision-making.

Strong interactions among multiple drivers combined with the intrinsic complexity of hydrological processes and systems make it difficult to precisely assess the full cascade of changes and their causalities. Conversely, when hydrological changes are detected, attribution of causes, including climate change, often remains uncertain. This uncertainty does not mean managers cannot make informed decisions. Rather, alternative, risk-based methods and approaches to assess and evaluate management options can be employed for a range of plausible future conditions. Chapter VIII provides further details on these approaches.

Source: UN Photo by John Isaac (1986)

IV. Mitigating climate change

According to IPCC, "the relationship between climate change mitigation measures and water is a reciprocal one".[13] Measures introduced to reduce GHG emissions have direct implications for water resource use and management. Conversely, water extraction and management measures have an impact on carbon emissions due to the energy intensity of water treatment and distribution systems. For example, GHG emissions reduction activities often depend on a stable supply of adequate quality water while an assessment of this demonstrated that over half of companies surveyed reported that better water management was delivering GHG reductions.[14]

The role that governments and other actors, including the private sector, must play in water stewardship to achieve a sustainable, low-carbon future is acknowledged in SDGs and NDCs. However, this awareness is still incomplete. Few institutions and actors responsible for updating and implementing NAPs, NDCs and national climate change strategies have fully taken water-related mitigation issues into account. Most companies are not following the example of forward-looking corporations in their approach to integrating water, energy, biodiversity and climate goals to minimize trade-offs and maximize synergies.[15]

Mitigation strategies

Mitigation strategies in the context of water can be broadly classified as nature based or technology driven. Nature-based solutions (NbSs) offer a vital means of moving beyond business as usual to address many of the world's water challenges while simultaneously delivering additional benefits vital to all aspects of sustainable development. NbSs use or mimic natural processes to enhance water availability (for example, soil moisture retention or groundwater recharge), improve water quality (for example, natural and constructed wetlands), reducing then the risks associated with water-related disasters and climate change.[9]

In NbS mitigation approaches, ecosystems act as carbon sinks, absorbing GHG emissions. Examples include preserving or restoring wetlands, reforestation of coastal mangrove forests and preserving natural flood-plains in watercourses. Peatlands (peat soil and the wetland habitat growing on its surface) cover only about 3 per cent of the world's land surface but store at least twice as much carbon as all of Earth's forests. Mangrove soils hold about 6 billion tonnes of carbon and can sequester up to three or four times more carbon than their terrestrial counterparts.[16,17] These linked hydrological and terrestrial ecosystems represent a major untapped resource for mitigation.

NbSs often have a lower cost and multiple synergistic benefits for a variety of sectors compared with technology-based solutions to climate challenges.[18] However, at present, water management remains heavily dominated by traditional, human-built infrastructure, and the enormous potential for NbSs remains underutilized.

13 Bryson Craig Bates and others, eds., "Climate change and water", Technical Paper (Geneva, Intergovernmental Panel on Climate Change, 2008).

14 Carbon Disclosure Project, "Thirsty business: why water is vital to climate action", 2016 Annual Report of Corporate Water Disclosure (London, United Kingdom, November 2016).

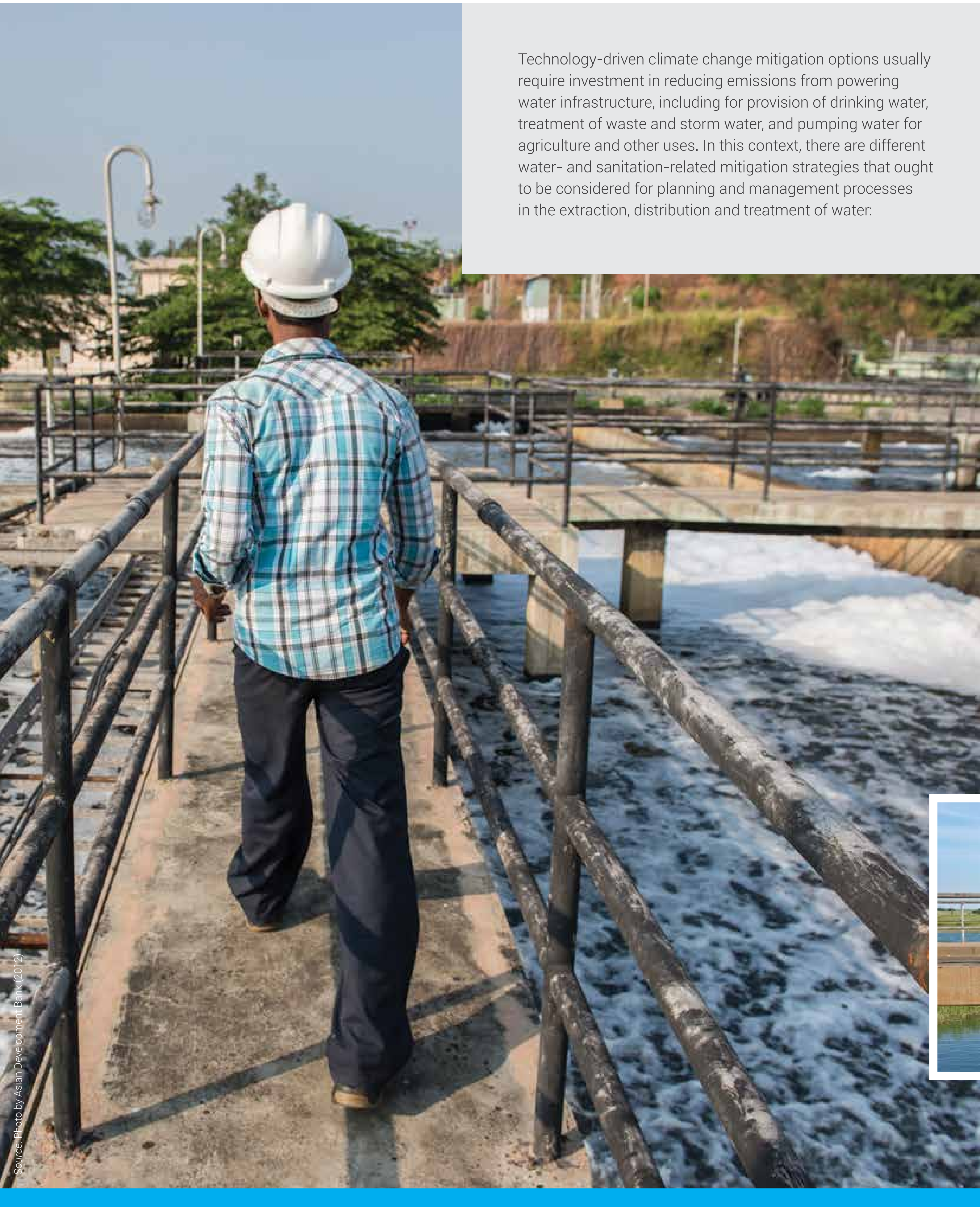
15 Carbon Disclosure Project, "The role of water in the low-carbon transition", Policy Briefing (London, United Kingdom, 2016).

16 Wetlands International, "Countries can strengthen climate plans in 2020 with peatland and mangrove targets" (2018). Available at https://www.wetlands.org/news/countries-can-strengthen-climate-plans-2020-peatland-mangrove-targets/.

17 Jonathan Sanderman and others, "A global map of mangrove forest soil carbon at 30 m spatial resolution", *Environmental Research Letters*, vol. 13, No. 5, 055002 (2018).

18 Sandra Naumann and others, *Nature-based Approaches for Climate Change Mitigation and Adaptation. The Challenges of Climate Change - Partnering with Nature* (German Federal Agency for Nature, 2014).

Technology-driven climate change mitigation options usually require investment in reducing emissions from powering water infrastructure, including for provision of drinking water, treatment of waste and storm water, and pumping water for agriculture and other uses. In this context, there are different water- and sanitation-related mitigation strategies that ought to be considered for planning and management processes in the extraction, distribution and treatment of water:



Source: Photo by Asian Development Bank (2012)

- **Increasing the energy efficiency.** Installing energy-efficient pumps and matching them to system requirements can save 10–30 per cent of the energy demand in water supply and wastewater treatment.[19] Additional efficiency measures include:
  - Reduction of non-revenue water such as leakage, metering errors and water theft.
  - Metering of water consumption to manage demand.
  - Water-saving technologies especially in the agricultural and industrial sectors.
  - System monitoring and regulation, potentially with automation.
  - Utilization of unconventional water resources, such as regulated treated wastewater for irrigation.
- **Production of renewable energy and recovery** (thus reducing demand for fossil fuels) such as:
  - Turbines placed along the water supply and wastewater systems for hydropower generation (in the context of an integrated water resources management system that can identify whether particular developments are feasible and advisable).
  - The use of wastewater, which can be a cost-efficient and sustainable source of energy, nutrients, organic matter and other useful by-products.[20] Biogas from the wastewater treatment process can be captured and contribute to carbon-neutral treatment. Also, given the temperature of wastewater, heat pumps can be installed in sewer pipes to produce energy.


Source: UN Photo by Marco Dormino (2013)

Mitigation measures are often associated with collateral benefits. For example, the strategies mentioned here can provide economic advantages for utilities such as the treatment plant Strass in Austria, which produces an energy surplus of 8 per cent, turning a wastewater treatment plant into a power generator,[21] or the improved adaptive capacity of coastal communities associated with coastal mangroves (for example, storm buffers and aquatic habitat protection). These benefits can drive additional investment in energy-efficient technologies.

However, there are also trade-offs associated with water-related mitigation strategies. Thus, water impacts need to be considered when selecting mitigation measures, especially in water-scarce regions. For example, biofuel production can decrease water availability and increase demand as water resources for agriculture are becoming increasingly scarce in many countries due to increased competition with domestic or industrial uses. On-site sanitation facilities and wastewater treatment plants emit varying amounts of air pollutants (for example, methane); therefore, technology choice when planning service provision and management of systems can exacerbate or alleviate climate change. Hydropower reservoirs are considered to be major sources of low-carbon electricity that can be used to reduce GHG emissions, but some reservoirs, for example those in tropical areas where the concentrations of organic matter are higher, emit GHGs due to the decomposition of organic material in the flooded area (for example, carbon dioxide and methane).[22] In most other conditions, reservoirs act as carbon sinks: absorbing more emissions than they emit.

Failure to consider the role of water in all mitigation (and adaptation) activities can reduce the effectiveness of these activities and increase the risk of maladaptation or outright failure. The goal is therefore to find the most appropriate blend of nature-based and technology-driven investments to maximize benefits and system efficiency while minimizing costs and trade-offs.

[19] Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH, *Climate Change Mitigation in the Water Sector* (Bonn and Eschborn, Germany, 2012).

[20] *The United Nations World Water Development Report 2017: Wastewater: The Untapped Resource* (United Nations Educational, Scientific and Cultural Organization, Paris, 2017).

[21] International Energy Agency, *World Energy Outlook 2018* (Paris, 2018).

[22] Bridget R. Deemer and others, "Greenhouse gas emissions from reservoir water surfaces: a new global synthesis", *BioScience*, vol. 66, No. 11, pp. 949–964 (2016).

V. Adapting to climate change

"Water is to adaptation what energy is to mitigation",[23] meaning that reliable, clean water resources are essential in absorbing and adapting to changes brought on by the climate crisis. Water's centrality to climate adaptation has been increasingly recognized over the past decade. Since the NAP process was instituted under the 2010 UNFCCC Cancun Adaptation Framework, Parties to UNFCCC have been formulating strategies and programmes to identify and address their medium- to long-term adaptation needs. Additionally, while it is not mandatory for Parties to include an adaptation component in their NDCs, most have chosen to do so. Even more encouragingly, over 90 per cent of NDCs with an adaptation component refer to water.

While this is a positive development, there remains a concerning gap regarding how NAPs and NDCs envision water governance for adaptation, in particular the incorporation and regulation of groundwater, as well as climate-resilient sanitation. Institutional reforms must be crafted accordingly, bearing in mind that local-level leadership is crucial for successful adaptation. In addition, the creation of local-level management groups, such as water user associations, is an important instrument for cross-sectoral, horizontal and vertical coordination for the management of water resources and related adaptation strategies.

Climate adaptation is, at its core, an iterative, context-specific and cross-sectoral process for managing and transforming the risk of society and ecosystem collapse in the face of rapid and uneven change. Risks transcend boundaries, yet water is still largely perceived and managed as a stand-alone sector. Consequently, the cross-sectoral water demands of climate adaptation activities are poorly accounted for in nearly all NAPs and NDCs, as well as other climate strategies and plans.

Meanwhile, private- and public-sector mechanisms for tracking water use (national water accounting or corporate data on water use and discharge) across sectors remain rare. For example, the increased adoption of ecosystem-based adaptation such as reforestation or coastal restoration, while positive, has not included systematic accounting for the water needs of these measures, leaving them vulnerable to changes in water availability or demand.

Additional adaptation measures

- **Climate-proof infrastructure.** New and retrofitted water infrastructure is listed as a priority for adaptation action in over 68 per cent of all NDCs.[23] As climate change implies more variability and uncertainty in local and regional water cycles, water infrastructure must be robust (meaning it can withstand a range of future conditions) and flexible (meaning it can be modified or successfully adapted to change). Conventional, so-called grey infrastructure, with its high maintenance costs, relative immobility and operational lifetimes in the 50–100+ year range is often neither robust nor flexible on its own.[24] This does not imply the need to abandon traditional infrastructure, but rather the wider adoption of blended grey–green–blue[25] infrastructure, which can be more cost effective, less vulnerable to climate change, offer mitigation co-benefits, and provide better service and protection over its lifetime.[26] The need for increased flexibility also extends to institutions, for example, flexible operating rules for dam/reservoir systems to manage electricity generation, irrigation and flood storage requirements across the system under a changing climate. Bottom-up approaches focusing on local engagement in climate-resilient infrastructure planning and development can also support the local economy and create jobs. However, it is important to note that these considerations are site specific and require local input and expertise.

[23] World Bank, *High and Dry: Climate Change, Water, and the Economy* (Washington, D.C., 2016).

[24] Keke Li and Zhifang Xu, "Overview of Dujiangyan Irrigation Scheme of ancient China with current theory", *Irrigation and Drainage*, vol 55, No. 3, pp. 291–298 (2006).

[25] Grey infrastructure refers to entirely human-built "hard" systems such as pipes, levies and concrete dams. Green and blue infrastructure includes natural elements such as a flood-plain or coastal forest but can also be engineered by humans.

[26] United Nations Environment Programme, *Green Infrastructure Guide for Water Management: Ecosystem-based Management Approaches for Water-related Infrastructure Projects* (Nairobi, 2014).

- **Preserve and protect aquifers.** Aquifers comprise the world's largest source of fresh water available for human use and can be less vulnerable than surface water to the direct impacts of climate change. Thus, aquifers represent a key component in reducing the risk of short-term water shortage and increasing water security through climate adaptation measures such as managed aquifer recharge (MAR).[27] However, storage capacity and recharge rates vary considerably, meaning that measures must be adapted locally.
- **Joint management of surface water and groundwater.** Co-management can boost resilience to droughts and address water scarcity, making it possible to expand a region's overall water storage capacity. Conjunctive water management interventions such as MAR and underground taming of floods for irrigation are sustainable, cost-effective and scalable solutions, and may be especially relevant in the developing-country context.[28,29,30] MAR (through rainwater capture) is particularly pertinent in regions with uneven rainfall distribution to reduce the risks of extreme rainfall run-off and to store fresh water in the soil for the dry season. MAR is an important adaptation measure for small island developing States, which are among the most vulnerable communities to climate change and sea-level rise.

Source: UN Photo by Irwandi M. Gade (2012)

[27] United Nations Educational, Scientific and Cultural Organisation International Hydrological Programme, *Groundwater and Climate Change: Mitigating the Global Groundwater Crisis and Adapting to Climate Change* (Paris, 2015).

[28] *The United Nations World Water Development Report 2018: Nature-based Solutions for Water* (United Nations Educational, Scientific and Cultural Organization, Paris, 2018).

[29] Paul Pavelic and others, "Controlling floods and droughts through underground storage: from concept to pilot implementation in the Ganges River Basin", Research Report No. 165 (Colombo, International Water Management Institute, 2015).

[30] Paul Pavelic and others, "Balancing-out floods and droughts: opportunities to utilize floodwater harvesting and groundwater storage for agricultural development in Thailand", *Journal of Hydrology*, vol. 470–471, pp. 55–64 (2012).

- **Conserve, maintain or rehabilitate wetland ecosystems.** Wetlands play a crucial role in adaptation– for example as a buffer against flooding and other extreme weather events or for filtering water. Wetland loss further compromises the future health and productivity of ecosystems and threatens biodiversity, altering the suitability of vast regions for food production and human habitation, and contributes to global GHG emissions.[31] Thus, their preservation and restoration is an essential component in an overall climate adaptation strategy.
- **Understand water dependency and related climate risks.** Cross-sectoral mechanisms that can account for the implicit and explicit water commitments across all parts and levels of society within and among countries – particularly in the context of understanding key hydroclimatic risks – are important to ensure that activities are viable and do not undermine local water security, especially for vulnerable populations.
- **Reduce urban and rural exposure to risk and improve resilience.** Policy interventions including integrated urban planning, risk management, expanded use of early warning systems and community engagement can reduce the exposure of cities to flood and drought risk. A special challenge is finding enough space to handle peak flows during extreme storm events and saving enough clean water for use during dryer periods. This challenge calls for solutions at different scales from the household level up to the city level. In rural areas, diversifying livelihood options, providing access to credit, securing land tenure, improving access to electricity and agricultural extension, as well as hydroclimate services, and expanding crop insurance programmes can help rural communities to be more resilient to rainfall shocks and stressors.

Source: UN Photo by Marco Dormino (2013)

[31] Ramsar Convention on Wetlands, *Global Wetland Outlook: State of the World's Wetlands and their Services to People* (Gland, Switzerland, 2018).

VI. Integrating approaches to managing water and climate change

Taking advantage of water's potential to address climate change mitigation and adaptation requires contending with new insights into two fundamental challenges: (i) that the past can no longer effectively predict the future, thereby introducing the challenge of confidence and uncertainty, and (ii) that most of the tools, infrastructure and institutions currently used to interact with water assume largely fixed and stable conditions, thereby locking in decisions for decades or longer and thus presenting the challenge of infrastructure inflexibility over relevant timescales.[32] These are surmountable, but will require a significant transformation of the ways in which water is managed, in terms of approach and scale. Integrated water resources management must be coordinated across traditional sectoral, political and spatial boundaries.[33,34]

The following sections outline particular challenges and opportunities related to integrated water management.

Source: UN Photo by Fredy Noy (2006)

A. Transboundary water management

Worldwide, 153 countries share rivers, lakes and aquifers, and 286 river basins and 592 aquifers cross sovereign borders.[35] Transboundary basins account for an estimated 60 per cent of global freshwater flow, and are home to more than 40 per cent of the world's population.[36] Transboundary cooperation in mitigation and adaptation is thus crucial to prevent possible negative impacts of unilateral measures, to prevent maladaptation and to make mitigation and adaptation more effective (for example, by reducing uncertainty through the exchange of data, enlarging the range and location of available measures, and sharing the costs and benefits). It also helps to prevent conflict, reduces existing knowledge gaps, and promotes peace and regional integration, as well as wider economic development.[37,38] River basin organizations play a crucial role in this.

32 Mark Smith and John Matthews, "Freshwater resources: the medium for change", Background Paper for the Global Commission on Adaptation (forthcoming).

33 Global Water Partnership, "Integrated water resources management", Technical Advisory Committee Background Paper, No. 4 (Stockholm, 2000).

34 Clauda Sadoff and Mike Muller, "Water management, water security and climate change adaptation: early impacts and essential responses", Technical Committee Background Paper, No. 14 (Stockholm, 2009).

35 United Nations Economic Commission for Europe and United Nations Educational, Scientific and Cultural Organization, *Progress on Transboundary Water Cooperation: Global Baseline for SDG Indicator 6.5.2* (United Nations and United Nations Educational, Scientific and Cultural Organization, Geneva and Paris, 2018).

36 UN-Water, *Transboundary Waters: Sharing Benefits, Sharing Responsibilities* (Geneva, 2008).

37 United Nations Economic Commission for Europe, *Guidance on Water and Adaptation to Climate Change* (Geneva and New York, United Nations, 2009).

38 United Nations Economic Commission for Europe and United Nations Office for Disaster Risk Reduction, *Words into Action Guidelines. Implementation Guide for Addressing Water-related Disasters and Transboundary Cooperation* (New York and Geneva, 2018).

Most existing transboundary water-sharing agreements are relatively inflexible and do not account for climate variability or the need for adaptive institutions. Climate adaptation requires extensive cooperation among neighbouring States to manage rivers and aquifers affected by climate change. Thus, the added adaptation benefits of transboundary cooperation and the risks of inaction need to be laid out in a way that drives demand for cooperation at the highest political levels.

Appropriate transboundary cooperation should be emphasized in all steps of the climate change adaptation process: from collecting and sharing information (which form the basis of robust decision-support systems), developing joint vulnerability assessment, managing water with flexible and adaptive institutions, and developing basin-wide adaptation strategies, to planning and operation of different adaptation measures such as infrastructure on shared waters.[37] Basin organizations can sometimes even raise funds for adaptation measures across the basin. Joint data and knowledge-sharing arrangements, as well as joint monitoring of basin conditions, are prerequisites for successful transboundary cooperation in an era of climate change.

Source: UN Photo by Kibae Park (2010)

B. Nexus considerations

There are inextricable interlinkages or nexuses among water and economic sectors such as energy and food (including agriculture), urban systems, landscapes and ecosystems. For example, as urbanization continues around the world, resulting in higher population density and more intense land and water use, reserving urban land for flood alleviation (above or below ground) will likely lead to conflict with other potential uses (such as housing or agriculture), which must be anticipated and addressed. For this reason, it is important to improve overall water resilience, due to the cascading effects it can have on people, economies and natural systems.

Addressing climate change offers the opportunity to transform governance systems, management approaches, infrastructure and financing mechanisms to acknowledge and account for the inherently cross-sectoral nature of water. Part of this transformation includes a need to merge top-down governance approaches with inclusive bottom-up, community-based decision-making that is responsive to local climate risks. An emerging global community of practice around resilient water management is working to implement a growing suite of these risk-based approaches.[39] While the nexus concept continues to evolve, the following sections reinforce why an integrated approach to water is needed to maximize synergies and help mitigate and adapt to climate change in all sectors.

1. Water, sanitation and hygiene

Climate change negatively affects drinking water availability and quality, and the performance of sanitation, wastewater and hygiene services. For example, more-frequent combined sewer overflows can flood and pollute low-lying and/or densely populated areas and receiving waters, while drought can increase the use of poorly treated wastewater for peri-urban agriculture. Therefore, it is essential that water, sanitation and hygiene (WASH) infrastructure and services are adapted to make them sustainable, safe and resilient to climate-related risks. At the same time, it is important to ensure investments in resilient WASH systems in areas

[39] See, for example, www.agwaguide.org.

identified as being at highest risk contribute to building community resilience to the impacts of climate change,[40] for example, by enabling access to water during times of scarcity, or reducing the risk of disease from faecal contamination of water during floods.

Local implementation approaches are necessary to adapt WASH services to climate change, and decisions should be based on the best available local information for the relevant time period. For example, there may be limited value in scrutinizing climate projections to the end of the century for rural WASH programmes that prioritize household or community-based systems with a design life of a few years (for example, pit latrines) or decades (for example, wells or boreholes). In these cases, it is advisable to understand risk and base decision-making on observed impacts of climate change at local levels. Major investments in storm drains, wastewater plants and other big infrastructure projects – investments that are long lived and inflexible – will require different analysis (including climate projections) and interventions.

2. Water and health

The influence of climate change on the human right to health is significant and varied. A primary impact is the spread of infectious diseases, many of which are waterborne and already present a major burden to vulnerable populations worldwide. Waterborne diseases such as cholera are highly sensitive to changes in temperature, precipitation and humidity.[41] Indirectly, climate change can reduce agricultural productivity, negatively influence nutrition and increase the spread of food-borne illness.

Increased incidences of extreme weather can intensify human exposure to water contaminated by agricultural run-off, flooded water and sewage treatment systems, and standing water (a habitat for toxic algal blooms and a breeding ground for disease vectors that increase malaria risk), while drought can decrease water quantity and quality.[42] Drought also increases the entrainment of dust and fine particulate matter in the air, causing a variety of human health impacts, particularly for children and the elderly. These impacts are felt over a range of timescales, requiring advanced planning and adaptation measures that can respond to short-term emergencies and longer-term stressors. Climate-resilient water and sanitation safety planning[43] are relevant risk-based management approaches for managing health risks associated with climate variability and change.

[40] UNICEF and Global Water Partnership, *WASH Climate Resilient Development* (New York and Stockholm, 2014, updated 2017).

[41] World Health Organization and World Meteorological Organization, *Atlas on Health and Climate* (Geneva, 2012).

[42] Christopher Portier and others, *A Human Health Perspective on Climate Change: A Report Outlining the Research Needs on the Human Health Effects of Climate Change* (Research Triangle Park, N.C., Environmental Health Perspectives/National Institute of Environmental Health Sciences, 2010).

[43] World Health Organization, *Climate-resilient Water Safety Plans: Managing Health Risks Associated with Climate Variability and Change* (Geneva, 2017).

3. Water and agriculture

Climate change alters the frequency and intensity of rainfall, floods and droughts, causing significant impacts on agriculture and food production. While food shocks and stressors affect all people, women, indigenous populations, subsistence farmers, pastoralists and fishers are disproportionately affected.[44] In regions where basic food production and hunger are significant concerns, addressing climate adaptation – especially through water-related impacts – is essential to reduce long- and short-term threats to food security.

Climate-resilient water resource management is a potentially powerful mechanism to achieve local, and possibly global, food security (encompassing food production, preparation distribution, consumption and waste). On the mitigation side, interventions related to the increased utilization of solar pumps, practising conservation agriculture to improve soil organic matter (needed for the soil to retain water), reducing post-harvest losses and food waste, and transforming waste into a source of nutrients or biofuels/biogas can address food security and climate change. The food systems will also need to produce more food with increased nutritional value, while becoming more efficient in the use of resources including land, soil, water, energy and chemicals.

4. Water and energy

Most energy generation processes require significant water resources, while the abstraction, transportation and treatment of water requires energy (for example, electricity). Population and economic growth are simultaneously increasing energy and water demand, with global energy demand projected to increase by approximately 27 per cent between 2017 and 2040,[45] and water demand is expected to increase roughly 55 per cent over the same time period (primarily from manufacturing, electricity generation and domestic use).[46,47] In addition, climate change and increasing hydrological variability will likely result in a heightened reliance on energy-intensive water supply options, such as transporting water over long distances or desalination.[48]

Renewable sources of energy account for a growing portion of the overall energy supply mix and generally have a smaller water footprint than their carbon-based alternatives. Thus, increased investment in renewables such as solar photovoltaics, wind and small hydropower are needed to ensure future energy and water demand can be met.[49] Integrated planning, regulation and management of the energy and water sectors at the national and basin levels can help to ensure trade-offs are accounted for, synergies are maximized and future demand can be met. As mentioned in chapter IV, efforts to reduce energy demand for water and water demand for energy should be considered, including the provision of alternative cooling systems or combined heat and power plants, as well as revised operations for new and existing hydropower plants.

[44] Food and Agriculture Organization of the United Nations, *Climate Change and Food Security: Risks and Responses* (Rome, 2016).

[45] International Energy Agency, *World Energy Outlook 2018* (Paris, 2018).

[46] Organisation for Economic Co-operation and Development, *OECD Environmental Outlook to 2050: The Consequences of Inaction* (Paris, 2012).

[47] *The United Nations World Water Development Report 2018: Nature-based Solutions for Water* (United Nations Educational, Scientific and Cultural Organization, Paris, 2018).

[48] Diego J. Rodriguez and others, "Thirsty energy", Water Papers (Washington, D.C., World Bank, 2013).

[49] Paul Faeth and Benjamin K. Sovacool, *Capturing Synergies Between Water Conservation and Carbon Dioxide Emissions in the Power Sector* (Arlington, V.A., CNA Corporation, 2014).

5. Water and ecosystems

The services that ecosystems provide for climate change mitigation and adaptation, disaster risk reduction and sustainable development are well recognized. They include: sequestering carbon in forests and peatlands; providing source water, nutrition, livelihoods and medicine; and safeguarding communities from storms, floods, droughts and sea-level rise through coastal forests and wetlands. However, these natural systems remain chronically underutilized and underfunded.

At the same time, freshwater systems remain under serious threat worldwide due to a complex set of drivers such as urbanization, agriculture intensification and soil loss, overextraction of groundwater and increased energy demand.[50] Climate change further complicates these interactions.[51] For example, in some areas, insufficient water can turn carbon sinks into carbon sources,[52] while in others, climate-induced changes to the natural flow regime of rivers can result in cascading impacts throughout entire ecosystems.

Scaling up community-based natural resource management programmes, green job creation and adopting governance mechanisms for protecting freshwater ecosystems need to be expanded. Ecosystem protection must be fully integrated into climate plans and policies and enforced at all levels. The expanded application of such approaches for transboundary basins is especially relevant, as a basin constitutes a holistic ecosystem.

Source: UN Photo by Logan Abassi (2011)

[50] Laura S. Craig and others, "Meeting the challenge of interacting threats in freshwater ecosystems: a call to scientists and managers", *Elementa – Science of the Anthropocene*, vol. 5, p. 72 (2017).

[51] Intergovernmental Plenary on Biodiversity and Ecosystem Services, *Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services* (Bonn, Germany, 2019).

[52] Birol Kayranli and others, "Carbon storage and fluxes within freshwater wetlands: a critical review", *Wetlands*, vol. 30, No. 1, pp. 111–124 (2010).

VII. Climate finance for water

Under the Paris Agreement, developed countries committed to deliver at least $100 billion from public and private sources annually between 2020 and 2025 for mitigation and adaptation projects. However, countries are now lagging far behind these commitments, and there is no common formula as to how much of this sum individual countries should provide, or indeed what the contribution of public and private finance should be.[53]

Development banks, aid agencies, foundations, and a few commercial and private sector sources have tended to make up the bulk of what is generally considered climate finance. In addition, multilateral institutions such as the Global Environment Facility, the Green Climate Fund and the UNFCCC Adaptation Fund have been used to directly fund climate change adaptation and mitigation activities. National and bilateral climate finance initiatives represent an emerging source of funding in developed and developing countries, although they remain focused predominantly on mitigation.[54]

In recent years, the expanded use of verified green and blue[55] bonds such as the climate water bonds of the Climate Bonds Initiative has signalled an increasing global appetite for municipal and private sector investment in debt capital markets for climate change. As of June 2019, approximately $8 billion in grey and nature-based water investments has been certified.[56]

Elsewhere, the World Bank's Global Water Practice has developed an innovative methodology for its water portfolio. This resulted in the launch of a new programme called the Decision Tree Framework in 2015.[57] This framework is a stepwise guide to assessing the climate risk level for all water-intensive investments and to gauging the level of effort necessary to reduce risks. It has now been applied to local-scale facilities such as water utilities and basin-scale planning processes. In addition, the *Hydropower Sector Climate Resilience Guide*[58] offers a methodology for identifying, assessing and managing climate risks to enhance the resilience of hydropower projects.

Discussions around funding for climate change activities are largely centred on how much money is or ought to be available. The quantity of funding is certainly important, especially in countries and regions that are particularly vulnerable to climate change. However, the quality of projects funded is at least as important. Well-defined, targeted finance processes can help mobilize new pools of resources and signal to public and private sector audiences why and how to ensure water and climate resilience.[54]

The financial sector plays a larger role in climate resilience and water security beyond providing resources and measuring and managing climate risks in water-related investments. Insurance provision is one key role, helping to improve societal resilience to the impacts of climate change, especially those related to extreme water-related risks.[59] Insurance can help reduce risk and incentivize disaster prevention through signalling (price setting). However, some water risks will exceed society's risk reduction measures. For these residual risks, insurance plays a role in adaptation and recovery at multiple scales, from smallholder farmer crop insurance to multinational re-insurance.

Any water-related climate project must demonstrate a clear climate rationale. For potential recipients such as water managers and river basin organizations, developing bankable projects necessitates working with national climate change and climate finance colleagues. Additional intersectoral cooperation and specific capacity-building for water managers and basin authorities is thus necessary.

53 Merlyn Hedger, "Climate change and water: finance needs to flood not drip", Briefing Note (London, United Kingdom, Overseas Development Institute, 2018).

54 Mark Smith and John Matthews, "Freshwater resources: the medium for change", Background Paper for the Global Commission on Adaptation (forthcoming).

55 Green and blue bonds are debt instrument issued by governments, development banks or others to raise capital from impact investors to finance terrestrial and/or marine ecosystem-based projects that have positive environmental, economic and climate benefits.

56 Climate Bonds Initiative, *Green Bonds Market Summary: Q1 2019* (2019).

57 Patrick A. Ray and Casey M. Brown, *Confronting Climate Uncertainty in Water Resources Planning and Project Design: The Decision Tree Framework* (Washington, D.C., World Bank, 2015).

58 International Hydropower Association, *Hydropower Sector Climate Resilience Guide* (London, United Kingdom, 2019).

59 Global Water Partnership, "Climate insurance and water-related disaster risk management – unlikely partners in promoting development?", Perspective Paper (Stockholm, 2018).

VIII. Actionable recommendations

This Brief has presented some recommended policies and actions for water-smart climate mitigation and adaptation measures, within and across sectors. Broad recommendations for climate policymakers and decision makers to better integrate water into plans and programmes are given below.

A. Global and regional climate and water negotiations and processes

- Using existing forums such as the UNFCCC regional climate weeks or the NDC Partnership, facilitate participation of a broader set of national and local government agencies and ministries, including those from the water, health, energy and agriculture sectors in global and regional climate events and workshops.
- Using agreed-upon scientific climate impact observations and projections, establish criteria and develop a set of global priorities for climate-resilient water and sanitation interventions in specific hotspots, considering first the most poorly served, exposed and vulnerable rural and urban populations across the globe, as well as areas facing large-scale human displacement pressures.
- While continuing to support the refinement of climate change projections and downscaling of relevant climate information, support overcoming the "observation gap" among countries at different levels of development by financing the expansion of hydrological and meteorological observation networks so that climate information is available and exchanged within and among countries for better water management decisions.
- Develop regional and basin-wide adaptation strategies to maximize the effectiveness of adaptation and prevent the negative effects of unilateral measures, empowering basin organizations to address climate change.
- Ensure the role of water for mitigation is well represented in climate discussions and agreements as a means to achieving GHG emissions reductions. This includes the restoration and preservation of degraded ecohydrological systems. Water protection must feature as part of all climate change plans and activities, including national and regional development plans. Given the great potential for climate mitigation and adaptation, sanitation interventions also need to be considered. Documentation of best practices and exchange of lessons learned around these areas should be promoted.
- Stimulate innovation and foster capacity-building and better awareness of adaptive water management, including the importance and benefits of transboundary cooperation, assuring effective agreements and monitoring mechanisms, and service delivery options for climate change mitigation and adaptation.
- Enhance funding modalities within existing and new climate funds that are conducive to financing integrated approaches to building climate

resilience through improved water governance and management, lowering administrative barriers to capacity-constrained countries and reducing transaction costs to facilitate coordination.

- Engage and empower youth and young water professionals – including indigenous youth – as leaders and knowledge holders who provide solutions for water security and climate action that respect, protect and promote the fundamental human rights to water and sanitation, and facilitate intergenerational global governance processes as entry points for engaging youth as leaders in decision-making.

B. National and subnational capacity-building, planning, implementation and monitoring

- Update existing NDCs, NAPs and other national, subnational and local climate strategies to incorporate risk-based approaches to water provision and management practices that align with climate mitigation and adaptation targets, where appropriate.
- Establish or strengthen national-level mechanisms to foster closer dialogue among ministries of environment/climate, water, energy, agriculture, planning, emergency response and finance in the development, implementation and update of NDCs, NAPs and disaster risk reduction plans.
- In coordination with line ministries such as finance, support the integration of priorities highlighted in NAPs, national communications, and other national and subnational climate strategies into water and sanitation (including wastewater) sectoral strategies and plans, with dedicated agreed budgets and water monitoring systems, and vice versa.
- Facilitate and expand cross-sectoral peer-to-peer knowledge and data-sharing practices, so that new information and lessons learned can be assessed, considered and incorporated into management practice at all levels. The use of citizen science for collecting data and implementing projects "on the ground" should also be expanded.
- Facilitate institutional capacity-building for the use of existing risk-based approaches to climate change mitigation and adaptation at the decision-making and project levels to ensure that decisions made now do not exacerbate future water stress for vulnerable and marginalized populations.
- Support academia to conduct research and collaborate with public and private institutions that invest in low-regret, climate-resilient and context-specific water and sanitation infrastructure and technology.
- When targeting multilateral, bilateral and other sources of climate financing, ensure that proposals bring together cross-sectoral water considerations including sanitation (including wastewater) and hygiene, health, agriculture, energy and industry, and ecosystems. In-country capacity-building to design and package compelling and fit-for-purpose climate-resilient water investment proposals is also urgently needed.

It should be noted that while the above recommendations are directed primarily at climate policymakers, water policymakers and practitioners will be needed to support these efforts with their experience and expertise, and will need to better coordinate their own plans and activities with ongoing climate change planning and implementation.

IX. Conclusions

Freshwater is one of Earth's most precious resources, sustaining ecosystems, economies, biodiversity and society as a whole. The global climate crisis is not the sole threat to freshwater. However, the crisis further exacerbates existing conditions, making the management and management projection of future water availability and quality increasingly difficult, and demanding new strategies for managing this scarce and precious resource within and among riparian countries. Water is thus an enabling factor and a limiting factor in humanity's ability to mitigate and adapt to climate change.

Risk- and ecosystem-based management approaches that ensure the meaningful and effective participations of affected persons allow for no- or low-regret solutions that can be adapted over time as underlying conditions change. Improving the resilience of freshwater ecosystems is essential to adaptation now; it is also a moral imperative for the sake of future generations who did nothing to cause the climate crisis they will inherit. A unique opportunity exists to transform existing governance and management systems, and to increase coherence of the global frameworks society has instituted to bring about a sustainable future for all.

Uncertainty is no excuse for inaction: tools, methods and finance mechanisms are available now. We cannot afford to wait.

Source: UN Photo by Nektarios Markogiannis (2018)

UN-Water Policy Briefs provide short and informative analyses on the most pressing freshwater-related issues that draw upon the combined expertise of the United Nations system. These Briefs can be used for substantive discussions and provide policy recommendations for sustainable management of water and sanitation.

UN WATER
unwater@un.org | www.unwater.org

UN-Water Technical Advisory Unit
7 bis Avenue de la Paix
Case postale 2300
CH-1211 Genève 2 - Switzerland