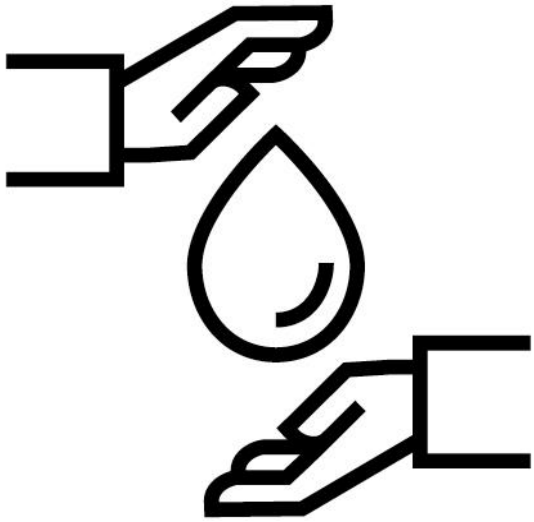

Sectoral Guide Consultation Version 1

Water security

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Abbreviations

5R	Reduce, Reuse, Recycle, Recover, Restore
AE	Accredited Entities
AI	Artificial Intelligence
CDP	The Carbon Disclosure Project
DRR	Disaster Risk Reduction
EbM	Ecosystem-based Management
ESG	Environmental, Social and Corporate Governance
FAO	Food and Agricultural Organization of the United Nations
GCF	Green Climate Fund
GHG	Greenhouse gases
IFI	International financing institutions
IRMF	Integrated Results Management Framework
IWRM	Integrated water resources management
LDC	Least Developed Countries
MAR	Managed Aquifer Recharge
NAP	National Adaptation Plan
NDA	National Designated Authorities
NDC	Nationally determined contributions
NDE	National Designated Entities
NRW PBC	Non-revenue water- performance based contracts
O&M	Operation and maintenance
PPP	Public-Private Partnerships
SDGs	Sustainable Development Goals
SIDS	Small Islands Developing States
SPV	Special Purpose Vehicle
UNFCCC	United Nations Framework Convention on Climate Change
UN-SDG	United Nations - Sustainable Development Goal
WASH	Water, Sanitation and Hygiene
WSSG	Water Security Sectoral Guide

Executive summary

The Green Climate Fund (GCF) is the world's largest dedicated fund helping developing countries respond to climate change. It was established by the United Nations Framework Convention on Climate Change (UNFCCC) in 2010 and has a crucial role in supporting the developing countries in achieving their commitments and ambitions towards meeting the goals of the Paris Agreement. GCF is dedicated to boosting climate finance and has set an ambitious agenda with its Strategic Plan for 2020-2023. Despite the global pandemic, GCF is providing increased support, helping developing countries build a low-emission, climate-resilient recovery. The GCF Sectoral Guide series supports the progressive work programme approved for 2020-2023 providing evidence-based information for impactful projects in priority investment areas and giving further momentum to making GCF operations more efficient and more effective.

There are eight result areas that GCF has targeted because of their potential to deliver a substantial impact on mitigation and adaptation in response to climate change. Result areas provide the reference points that guide GCF and its stakeholders to ensure a strategic approach when developing programmes and projects, while respecting the needs and priorities of individual countries. Water security has synergistic opportunities with the other result areas for greater impact in line with the recently approved integrated results management framework.[1] Cross-sectoral issues are addressed through multiple result areas in a complementary manner as presented in Table ES-1.

Table ES-1: Cross-sectoral issues addressed throughout the series

Sectoral Guide Name	Cross-sectoral issues addressed
Agriculture and food security	• Climate smart agriculture: irrigation and efficient water-use including treated wastewater. • Enhanced food security through nutrients valorisation.
Cities, buildings, and urban systems	• Urban water supply resiliency; urban water treatment; urban sanitation including decentralised wastewater management. • Flood management, including sponge cities using Ecosystem Based Management (EbM) within an integrated urban water approach. • Circular economy to manage the water cycle, including urban farming.
Ecosystems and ecosystem services	• Ecosystem based Management: preserving water resources (forest watersheds; wetlands; Mangroves, riparian zone management) and reducing soil erosion.
Forest and land use	• Forest management to preserve watersheds; potential use of wastewater sludge for both water and nutrient contents.
Energy access and power generation	• Low-carbon energy pathways in water security and efficient pumping: water resources; transmission; water supply; production and distribution; sanitation: collection and treatment. • Biomass from wastewater and sludge. • Solar panels in water channels / hydro-dams, generating power and reducing evaporation. • Large and mini hydro for energy access and energy generation.
Climate information and early warning systems	• Early warning systems for flood and drought management including forecasting. • Climate information for water-related issues. • Glacial Lake Outburst Flood monitoring.
Health and well-being	• Drinking quality water supply. • Sanitation.

[1] The integrated results management framework (IRMF) sets out the approach of GCF to assessing how its investments deliver climate results and how its results contribute to the overall objectives of GCF to promote paradigm shift towards low-emission and climate-resilient development pathways in the context of sustainable development and make a significant and ambitious contribution to the global efforts towards attaining the goals set by the international community to combat climate change. https://www.greenclimate.fund/document/integrated-results-management-framework

Sectoral Guide Name	Cross-sectoral issues addressed
	• Reduction of water borne diseases through water disinfection, WASH programmes, and tertiary wastewater treatment; monitoring and evaluation.
Water security	• Water use efficiency, including demand management; water conservation; circular economy; water efficiency technologies. • Preservation of water resources (quantity and quality), including rainwater harvesting, groundwater protection; and managed aquifer recharge (MAR). • Wastewater management: sewer network; wastewater treatment on-site, off-site, and decentralised wastewater; water re-use; water recycling. • Climate Resilient Water, Sanitation and Hygiene (WASH) programmes. • Integrated EbM in flood management, including permeable pavements, integrated watershed management.
Low emission transport	• None.
Energy efficiency	• Efficient pumping for both municipal water supply as well for irrigation including treated wastewater.

GCF Water Security Sectoral Guide

Climate change affects water security. By 2050, the population under water stress is expected to rise 50% to about 3 billion while those at risk of floods is expected to increase from 1.2 to 1.6 billion (WMO, 2020). In addition to 2 billion people lack access to safely managed drinking water and 3.5 billion lack access to safely managed sanitation (WHO & UNICEF JMP, 2022). Increasing weather and climate extreme events have exposed millions of people to acute food insecurity and reduced water security (IPCC, 2022), with the largest impacts observed in many locations and/or communities in Africa, Asia, Central and South America, Small Islands, and the Arctic (*high confidence*).

Changes to the hydrological cycle are projected under all future climate scenarios: increased frequency and peak intensity of precipitation events and reduced rainfall will lead to more severe flooding and drought, respectively. Planners need to consider the appropriate design of the water infrastructure to cope with floods caused by extreme climate impacts, and simultaneously, utility managers need to deal with water scarcity. Harnessing economically available water resources and developing resilient water infrastructures and services brings opportunities for water conservation and preservation of water resources. Water security is at the intersection of numerous non-climatic challenges that increase demand for scarce water resources while impacting water quality.

Water is a human right (UN, 2010), supported by the United Nations - Sustainable Development Goal 6 (UN-SDG6) *Clean Water and Sanitation* (UN, 2015). Thematically, this Guide focuses primarily on integrated water resources management (IWRM) at the core of UN-SDG6, under pressure from climate change (UN-SDG13 *Climate Action*). Operationally, water security emphasises adaptation projects addressing three key water-related impacts from climate change with an increase in: (i) water-related disasters; (ii) areas suffering from water stress; and (iii) poor water quality-related fatalities (UNESCO, 2020). Renewable surface and groundwater resources are already stressed in some regions facing competition within the water-food-energy nexus.

Water Security

"The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability."

(UN-Water, 2013)

A new paradigm in energy positive water utilities incentivises: (i) resilient distributed water and wastewater infrastructures adapted to the changing climate patterns, capturing mitigation benefits by reducing water transfers and maximising renewable energy production from wastewater; and (ii) climate resilient-smart utilities and agriculture maximising cost-effective sensors combined with the Internet of Things.

In the context of climate adaptation, GCF is exploring non-conventional water sources – including wastewater in general and water re-use and water recycling in particular – as a new asset class through credit enhancement and acceptable revenue in line with ESG, Paris agreement and SDGs. In some regions, water re-use is already a water source, but there are several barriers for broader adoption in other countries.

Paradigm-shifting pathways

The vision for a paradigm shift in water security is to secure water resilience and water services under conditions of increased climate change impacts. This can be achieved through integrated adaptative planning and policies that: (i) compel water demand management by enhancing water efficiency and removing barriers; and (ii) encompass climate proofing of water infrastructures, promoting the preservation of water at each step of the water cycle, by maximising innovation and supporting circular economy principles.

Cross-referencing the targets of UN-SDG6 with UN-SDG13 indicates that water security, induced by water scarcity supports fast-tracking climate investment into transformational water projects as a new asset class and integrated grey-green infrastructure under blue finance in two inter-linked pathways:

- Enhancing water conservation, water efficiency and water re-use – With the supply side under threat or not financially sustainable, water security requires a paradigm shift in demand management through enhanced water conservation, water efficiency, water re-use and water recycling, producing both mitigation and adaptation results. Modelling in the United Kingdom showed that 7 tons of carbon dioxide are emitted for every megalitre of water used (Environment Agency, 2008). Demand management options thus reduce greenhouse gas (GHG) emissions by transporting less water and reducing the quantity of wastewater to be treated. Demand management practices: (i) improve water efficiency alongside supply-side management, as a key component of integrated water resource planning; (ii) address the water-food-energy nexus without depriving any existing water users through efficiency gains and smart water management with climate smart water utilities (IWA, 2020); and (iii) promote alternative water resources, such as water re-use and water recycling as a new water asset class within a circular economy approach.

- Strengthen integrated water resources management – protection from water-related disasters, preserve water resources and enhanced resilient water supply and sanitation services This pathway will focus on three sub-areas to generate mostly adaptation projects:
  - Preservation of existing water resources.
  - Development of new water supply sources.
  - Protection from water and climate related hazards including disaster risk reduction and enhanced resilient water supply and sanitation services.

Barriers and enablers to achieving these paradigm-shifting pathways

Water security requires an enabling environment, water resource conservation, integrated approaches to water management, restorative and regenerative approaches to economic development, and planning for climate change resilience.

There are many barriers to achieving the paradigm shift for water security, most of which apply across the entire water sector. Key barriers and enablers are summarised as:

- Environmental: the water sector often lacks adequate climate information to plan, develop, and manage water sustainably to ensure that environmental limits are not reached. There is often a lack of time and funds for policy and decision-makers to be familiar with the latest environmental technologies.

- **Economic and financial**: water pricing is often insufficient to cover the maintenance cost and investments in new water management technologies and inefficient management of resources at the utility or water services providers. Rising operation and maintenance (O&M) costs and declining revenues resulting from inefficient water management, threaten funding sources for new infrastructures.
- **Cultural and social**: the water sector including sanitation is perceived as less innovative, resulting in less research and development compared to other sectors. Investment decisions and the success of water security initiatives are influenced by social factors including gender, which can inhibit project viability or the sustainability of outcomes.
- **Institutional and regulatory**: institutions may be reluctant to support novel sustainable technologies over traditional hard engineering grey approaches. There may be a lack of political will to implement new technologies and a lack of capacity (financial or technical) and poor governance including stakeholders' participations. In addition, new technologies often face higher regulatory costs as compared to existing technologies (Brears, R.C. 2016; Brears, R.C. 2021).
- **Infrastructure and technical**: a lack of appropriate infrastructure can impede innovation, and current infrastructure may be unable to support alternative practices. For instance, new technologies including water monitoring may require complementary technologies that may not be available or are expensive or difficult to use.

Role of GCF in financing paradigm shifting pathways

The United Nations Framework Convention on Climate Change (UNFCCC) underscores the importance of enhancing linkages between financial and technology mechanisms under the Convention and encourages Technology Needs Assessments and Action Plans. Possible actions for each of the paradigm shifting pathways, across the four drivers of the GCF Strategic Plan 2020-2023, are summarised in Figure ES-1.

(1) **Transformational planning and programming:** integrated climate development policies promoting climate finance coherence.
(2) **Catalysing climate innovation:** technology development and transfer with enabling institutional environments, including conservation, preservation, sanitation and reuse new asset class, integration of the Grey-Green Infrastructure, EbM, and smart utilities.
(3) **Mobilising finance at scale:** scaling-up successful climate investments to de-risk investments through strengthening domestic capital markets and climate financing institutions.
(4) **Coalitions and knowledge to scale up success:** creating and sharing knowledge to harmonise valuation methodologies with climate risks built into financial decisions for sustainable development.

GCF investment criteria

Proposals to GCF are assessed based on six GCF Board approved investment criteria:

(1) **Impact potential**: to what extent does the project or programme contribute to the achievement of GCF objectives and result areas.

(2) **Paradigm shift potential**: degree to which the proposed activity can catalyse impact beyond a one-off project or programme investment.

(3) **Sustainable development potential**: how do the actions align with national SDG priorities? What are expected environmental, social, gender, and economic co-benefits? Wider benefits and priorities.

(4) **Recipient needs**: vulnerability and financing needs of the beneficiary country and population.

(5) **Country ownership**: beneficiary country ownership of, and capacity to implement, a funded project or programme, policies, climate strategies and institutions.

(6) **Efficiency and effectiveness**: economic and, if appropriate, financial soundness of the programme/project.

Figure ES-1: Possible actions for each paradigm shifting pathway following the four pillars of the GCF Strategic Plan

Sector		Actions across the drivers of the GCF Strategic Plan			
Water security		**Transformational planning & programming**	**Catalyzing climate Innovation**	**Mobilization of finance at scale**	**Coalitions & knowledge to scale up success**
Paradigm shifting pathway	**Enhancing water conservation, water efficiency, and water re-use**	• Encourage benchmarking across service sectors and providers • Incentivise circular economy approaches for resources recovery • Design low emission climate resilient investment pathways that maximise long term water benefits • Strengthen water security into NDCs and NAPs	• Mainstream climate smart water and agriculture using digital solutions • Promoting new asset classes in sanitation and water re-use that follow these characteristic in finance, revenue stream, SDGs and Paris agreement • Reduce performance uncertainty through asset management • Advocate decenetralised water supply and wastewater management • Support desalination using renewable energy • Employ data science and initiate "big data" solutions, such as reducing CO_2 emissions	• Allocate grant funding for technical assistance and capacity building • Enable private sector participation by supporting credit enhancements and full cost recovery through direct and indirect charges • Support comprehensive cost-benefit analyses with co-benefit from EbM • Introduce tax initiatives to contain adverse environmental impact of activities • Support carbon credits intiatives for revenue generation	• Improve available information and data acquisition through knowledge platforms • Support peer-to-peer learning and regional exchanges of lessons learned and best practices • Support catchment-based initiatives to promote water stewardship • Empower communities into the decision-making process • Foster cultural-specific communication with stakeholders • Encourage behaviour change in water conservation practices
	Strengthen integrated water resources management – protection from water-related disasters, preserve water resources and enhanced resilient water supply and sanitation services	• Link IWRM with water safety plans for long term adaptive planning to map climate hazards with risks and vulnerability • Encourage transboundary water resource cooperative arrangements • Support resilient planning and design processes dealing with uncertainties • Improve flood modelling into disaster risk resilience assessment and drought rationale through climate vulnerability assessment • Integrate social and gender sensitive dimensions into water security interventions	• Promote and implementing a well-managed mix and integration of the Grey-Green Infrastructure to enhance the adaptability and resilience of coastal and upstream communities • Mainstream rainwater catchment harvesting and storage systems • Promote stromwater harvesting (e.g., sponge cities, agriculture) • Advocate for water re-use and water recycling as alternative water sources • Strengthen resilient WASH programmes preventing maladaptation • Introduce EbM to enhance climate resilience in water infrastructure and build coastal resilience • Contribute to urban climate resilience for flood and land use management • Reduce drought vulnerabilities through water re-use and recycling	• Catalyse public funds to scale-up blended finance • Enhance projects' risk-return profile • Address risks vs. perceived risks • Improve creditworthiness through credit enhancements and de-risking • Defer investment using resilient water solutions within the whole water cycle • Expand micro-finance to support household level resilient water systems • Initiate ecosystem-based insurance and disaster risk insurance and bonds • Participate in specialised water and blue-green funds	• Enhance collaboration with independent institutions for Monitoring, Evaluation and Verification • Promote partnerships and new alliances in water security • Strengthen innovation climate hubs • Develop localised accredited climate education programmes • Invest in research to support evidence-based decision making

1 Introduction

1.1 GCF Sectoral Guides

The Green Climate Fund (GCF) is the world's largest dedicated fund helping developing countries reduce their greenhouse gas emissions and enhance their ability to respond to climate change in line with the Paris Agreement. Water security is part of the health, food, and water security result area emphasises mostly adaptation projects to harness available water resources and develop resilient water infrastructures and services.

There are eight result areas that GCF has targeted because of their potential to deliver a substantial impact on mitigation and adaptation in response to climate change. Result areas provide the reference points that guide GCF and its stakeholders to ensure a strategic approach when developing programmes and projects, while respecting the needs and priorities of individual countries.

This Sectoral Guide focuses on integrated water resources management including conservation, preservation and basic services and addresses climate impacts in water-related disasters, areas suffering from water stress, and poor water quality-related fatalities. GCF investment in water security in August 2022 totalled USD 489 million, contributing to an investment volume of USD 934 million. Water Security has synergistic opportunities with the other result areas for greater impact in line with the recently approved integrated results management framework (IRMF). Cross-sectoral issues are addressed through multiple result areas and presented in Table 1.

Table 1: Cross-sectoral issues addressed throughout the series

Sectoral Guide Name	Cross-sectoral issues addressed
Agriculture and food security	• Climate smart agriculture: irrigation and efficient water-use including treated wastewater. • Enhanced food security through nutrients valorisation.
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Forest and land use	• Forest management to preserve watersheds; potential use of wastewater sludge for both water and nutrient contents.
Energy access and power generation	• Low-carbon energy pathways in water security and efficient pumping: water resources; transmission; water supply; production and distribution; sanitation: collection and treatment. • Biomass from wastewater and sludge. • Solar panels in water channels / hydro-dams, generating power and reducing evaporation. • Large and mini hydro for energy access and energy generation.
Climate information and early warning systems	• Early warning systems for flood and drought management including forecasting. • Climate information for water-related issues. • Glacial Lake Outburst Flood monitoring.
Health and well-being	• Drinking quality water supply. • Sanitation. • Reduction of water borne diseases through water disinfection, WASH programmes, and tertiary wastewater treatment; monitoring and evaluation.

Sectoral Guide Name	Cross-sectoral issues addressed
Water security	• Water use efficiency, including demand management; water conservation; circular economy; water efficiency technologies. • Preservation of water resources (quantity and quality), including rainwater harvesting, groundwater protection; and managed aquifer recharge (MAR). • Wastewater management: sewer network; wastewater treatment on-site, off-site, and decentralised wastewater; water re-use; water recycling. • Climate Resilient Water, Sanitation and Hygiene (WASH) programmes. • Integrated EbM in flood management, including permeable pavements, integrated watershed management.
Low emission transport	• None.
Energy efficiency	• Efficient pumping for both municipal water supply as well for irrigation including treated wastewater.

1.2 Water security context

Water stress affects every continent with heightened pressure from climate change on available freshwater resources. At least 45 countries, mainly in Africa or the Middle East, have severe water stress: they cannot provide enough water to meet their citizens' basic needs. Business as usual indicates that water demand will outstrip supply by 40% by 2030, with an estimated 700 million people potentially displaced because of water scarcity (World Bank, 2009; UN Water, 2022).

Climate change is expected to increase the intensity and frequency of storms and cyclones, inundation from wave overtopping because of sea-level rise and storm surges, and temperatures and heatwaves leading to glacial retreat and permafrost thawing. Floods and extreme rainfall events have surged by more than 50% this decade and are now occurring at a rate four times higher than in 1980. By 2100, under a business-as-usual scenario, hundreds of millions of people, mostly in Asia, would be affected by coastal flooding and displaced due to land loss (Wong, P.P et al, 2014).

Nationally determined contributions (NDCs) identify water security risks as a high priority in over 90% of developing countries. At the same time, as climate impacts the global water cycle, the water sector is contributing to increased GHG emissions. Those emissions resulting from the water sector are typically under-accounted and are embedded in energy production, industrial and agricultural production, and more explicitly in freshwater supply and wastewater treatment.

Water infrastructure potentially increases the carbon footprint of the water cycle. For example, seawater desalination, advanced wastewater treatment and water transfer climate adaptation responses all contain embedded carbon emissions. Therefore, it is important that these projects are not stand-alone strategies but developed in an integrated way with low-carbon development pathways.

Economic losses associated with lack of water security are in the billions of dollars, including damages from floods and drought as well as health and productivity impacts of water-borne diseases. The estimated annual capital costs of extending services to the unserved to achieve universal basic WASH access are USD 28.4 billion (range: USD 13.8 to 46.7 billion) per year from 2015 to 2030, or an average of 0.10 % (range: 0.05 to 0.15 %) of the gross product of the 140 countries included (GP 140) over the period 2015-2030.[2] Recent OECD estimates indicate that around USD 6.3 trillion of infrastructure investment is needed each year to 2030 to meet development goals, increasing to USD 6.9 trillion a year to make this investment compatible with the goals of the Paris Agreement (OECD, 2017). Projections of global financing needs for climate resilient water infrastructure are estimated to reach USD 6.7 trillion by 2030 and USD 22.6 trillion by 2050, with large variation

[2] These baseline results of cost as a percentage of the gross product are presented under a realistic assumption of economic growth in low- and middle-income countries of 5 percent. According to the World Bank, in low- and middle-income regions the gross domestic product (GDP) growth rates averaged 5.8 percent from 2000 to 2013. All future costs and GDP are discounted at 5 percent per year.

per region (Winpenny, J, 2015). Investment in safe drinking water and sanitation contributes to economic growth. For each USD 1 invested, the World Health Organization (WHO) estimates returns of USD 3-34, depending on the region and technology. The net benefit on average of investing in more resilient infrastructure in low- and middle-income countries would be USD 4.2 trillion with USD 4 in benefit for each USD 1 invested, according to a new report from the World Bank (Hallegatte, S. et al., 2019).

1.3 Organisation of the document

This Guide has seven sections. Following this introduction, Section 2 provides an overview of water security within the global context of its potential for climate change adaptation and mitigation; Section 3 highlights the paradigm shifting pathways, including barriers and opportunities; Section 4 provides guidance on the most appropriate public and private finance mechanisms for water security and their transformative potential; Section 5 explores case studies that demonstrate paradigm shift potential; Section 6 provides specific guidance for the development of impactful projects and programmes in relation to the GCF investment criteria; finally, Section 7 is the conclusion.

2 Global context

2.1 Scientific basis: why is the water sector relevant to climate action?

Water security is simultaneously impacted by and contributes to climate change. Extreme precipitation events are increasing as the climate warms and the atmosphere's capacity to hold water increases. At the same time, warmer temperatures are increasing the frequency and magnitude of heat waves and droughts (IPCC, 2021). Globally, it is estimated that the number of people at risk of floods will increase from 1.2 to 1.6 billion from 2010 to 2050 (WMO, 2020). The immediate impacts of flooding include loss of human life, damage to property, destruction of crops, loss of livestock, soil/land degradation, dam sedimentation and deterioration of health conditions due to waterborne diseases. Floods impact socio-economic activities by damaging and disrupting communication links and infrastructure, including power plants, roads, and bridges. Furthermore, disruption to industry can lead to loss of livelihood.

Meanwhile, it is estimated that for each degree of global warming, 7% of the world's population is exposed to a decrease in renewable water resources of at least 20%. Already, more than 2 billion people live in countries experiencing high water stress. Droughts can cause a range of impacts, including economic (for example, increased costs to water utilities due to the need for new or additional water supplies), environmental (for example, losses or destruction of fish and wildlife habitats), and social (for example, health problems related to low water flows and poor water quality).

GHG emissions from the water sector are mainly associated with grid electricity use, which is consumed by a several key processes: treating water to a potable standard, pumping water for distribution, and treating wastewater to a standard appropriate for discharge to receiving waters. With increased environmental regulation and higher water quality standards, treatment processes are becoming more high-tech and complex, often resulting in rising energy consumption and associated GHG emissions (Zhang Q. et al., 2017). Overall, there are three categories of GHG emissions from the water sector: direct (resulting from the operations of the water utility and production of GHG from wastewater treatment); indirect (resulting from grid electricity used for transferring, treating, collecting and disposing of water); and supply-chain-centric (resulting from contractors, suppliers and manufacturers, including transport of raw material and finished goods to site) (CIWEM, 2013). The wastewater industry accounts for 9% of the estimated global methane emissions. The World Energy Outlook report found that the amount of energy used in the water sector will more than double over the next 25 years due to large-scale water transfer projects, increased use of desalination and increased demand for sanitation (and higher levels of wastewater treatment), contributing to rising GHG emissions (IEA, 2017).

2.2 Global baseline: where is the sector today?

The water sector faces multiple climatic and non-climatic challenges including conflict that has direct and indirect impacts on water supply and services to achieving water security for both humans and the environment. Reflecting on its relevance across sectors and themes these are identified as:

- Climate change: climate change is resulting in more frequent and extreme floods and droughts. There will be fewer freshwater sources available due to higher evaporation rates, increased demand for various uses, salinisation of coastal groundwater supplies, and increased contamination due to poor water quality (Brears, R.C., 2018).
- Population growth: the world's population is expected to increase from 7.7 billion in 2019 to 9.7 billion in 2050 (UNDESA, 2019b). By mid-century, between 4.8 billion and 5.7 billion people will live in areas that are water-scarce for at least one month each year, up from 3.6 billion in 2018 (UN-Water, 2018).
- Rapid urbanisation: in 2018, 55% of the world's population resided in urban areas. By 2050, it is estimated that this will increase to 68% (UNDESA, 2019a). Already, one in four cities is water stressed. Meanwhile, urbanisation is impacting water quality in urban source watersheds (McDonald et al., 2014).
- Rapid economic growth: between 2018 and 2050, global water demand is expected to increase for all major economic sectors including various users. The most significant proportion of this growth is expected to occur in countries with emerging economies (OECD, 2018; Alberto and Lorenzo, 2019). Overall, 78% of all jobs globally are dependent on water to some extent (UN-Water, 2016).
- Water-energy nexus: by 2040, the amount of energy used in the water sector is projected to more than double. The most substantial increase will come from desalination, large-scale water transfers, and increased demand for wastewater treatment and higher levels of treatment. At the same time, energy-related water consumption is likely to increase by nearly 60%, with a low-carbon pathway potentially exacerbating water stress or be limited by it if it is not properly managed (IEA, 2017).
- Water-food nexus: agriculture already accounts for 70% of global freshwater withdrawals. Increased demand for food could result in irrigated food production increasing by more than 50% by 2050. Agricultural production already impacts water quality through non-point source pollution (HLPE, 2015; FAO, 2017a; FAO, 2017b).
- Aging infrastructure: in many cities, water infrastructures are operating beyond their service life. Ageing infrastructure translates into higher O&M costs and reduced efficiency and performance with high water loss and cross-contamination from the sewer to drinking water pipes (World Bank, 2006).
- Biodiversity loss: around one million species face extinction due to loss of habit within decades unless action is taken to reduce the intensity of drivers of biodiversity loss and improve ecosystem services and functions. The main driver of freshwater ecosystem degradation is changes in land use (Chotpantarat, S. and Satika B., 2018; IPBES, 2019; Kumar P. et al., 2019).

2.3 Global adaptation and mitigation potential: where does the sector need to be?

The water sector can achieve a paradigm shift in water security for both humans and the environment by simultaneously mitigating and adapting to climate change through demand management and smart digital water management, preserving and developing alternative water supplies, EbM, circular economy resource recovery, and IWRM.

2.3.1 Demand management

Demand management involves making better use of existing water supplies before attempting to increase water production further; the ensuing delay in investment in water infrastructure for rural and urban areas also alleviates financial stress on capital expenditures and any subsequent tariff and fee increases. Specifically, it promotes water conservation at all times through managed changes in practices, culture, and people's attitudes toward water resources. Demand management can be applied anywhere with strong gains in urban and rural areas, buildings, agriculture, and industry through water conservation (GWP, 2012; Brears, R.C., 2020; Brears, R.C., 2021).

2.3.2 Smart digital water management

Smart digital water management is the use of Information and Communication Technology to provide real-time, automated large volume of data (big data) for use in resolving water challenges in different contexts. There are many such applications for smart digital water management brought by the cost-effectiveness of sensors and computing power and the wide availability of the Internet of Things: (i) smart water and irrigation grids aim to ensure water is efficiently delivered only when and where it is needed to improve resilience: well managed peak demand for agricultural, industrial or domestic usage reduces both water and carbon footprints. In addition, water quality data can be monitored and accessed securely and transparently through smart contracts using blockchains; and (ii) Artificial Intelligence (AI) can be used for residential water use monitoring and management, optimisation of industrial and agricultural water use; predictive maintenance of water and wastewater infrastructure; and an early-warning system for any water infrastructures. AI uses machine learning to detect trends from big data generated by people, devices, and smart systems: for example, AI learns the most efficient pump configuration for any time of the day or week, or uses a combination of data on pipe material, age, location, flow, and pressure for the prognosis of non-revenue water by analysing past historical events on the network (Huber J. et al., 2020), reducing energy consumption and carbon emissions (Brears, R.C., 2021).

2.3.3 Alternative water supplies

Even with successful demand management measures, some locations still require alternative water sources, namely water re-use and water recycling initiatives for agricultural use. Regarding water conservation hierarchy terminology, re-use is defined as the re-use of water within a single process or the use of harvested water for another purpose without treatment, while recycling is defined as the use of harvested water for another purpose, after treatment such as treated wastewater for irrigation. Various water re-use and water recycling systems are available to meet needs from greywater, blackwater, rainwater harvesting, stormwater harvesting, and desalination.

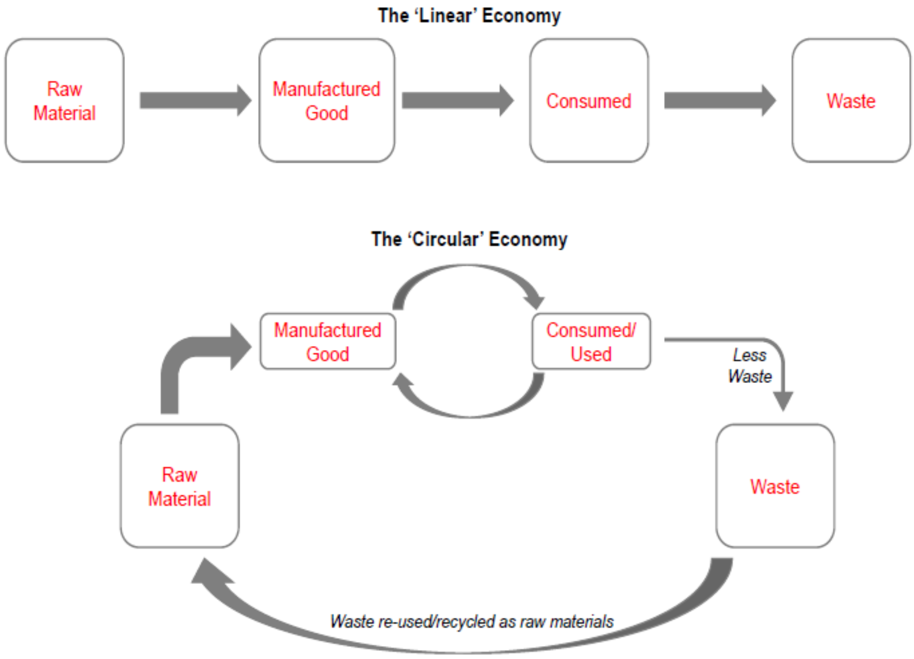
2.3.4 Ecosystem-based Management

EbM uses ecosystem services for IWRM while generating multiple co-benefits, including reducing flooding impacts, mitigating droughts, and improving water quality. In water security, EbM is implemented in a wide variety of contexts: green roofs, rain gardens, bioswales, green parks, urban forests, constructed wetlands, agricultural best management practices, protection of water resources, and floodplain restoration (Brears, 2018; Brears, 2020; Brears, 2021).

2.3.5 Circular economy and resource recovery

In contrast to the linear “take-make-consume-dispose” economy, the circular economy (Figure 1) aims to decouple economic growth from resource use and associated environmental impacts.

Figure 1: Comparison of linear and circular economy approaches



Source: HSBC, "Waste less Grow more", 2019

In the context of water, the circular economy aims to design out externalities and keep resources in use while regenerating natural capital. Specifically, the circular economy:

- Designs out externalities: the circular economy optimises the amount of resources used in water systems in concert with other systems, optimises consumptive use of water, and uses measures or solutions that deliver the same outcome without using water.
- Keeps resources in use: the circular economy aims to optimise resource yields (water use and reuse, energy, minerals, and chemicals) within water systems, optimise energy or resource extraction from the water system and maximise their reuse, and optimise value generated in the interfaces of water systems with other systems.
- Regenerates natural capital: the circular economy aims to maximise environmental flows by reducing consumptive and non-consumptive uses of water, preserve, and enhance natural capital (e.g., pollution prevention, quality of effluent), and ensure minimum disruption to natural water systems from human interaction and use (Ellen Macarthur Foundation, 2018).

To action the circular economy to achieve water security that mitigates GHG emissions and enhances resilience to climatic extremes, water resources managers can follow the circular economy 5R approach of Reduce, Reuse, Recycle, Recover, and Restore summarised in Table 2 (Gandiglio, M. et al., 2017; Brears, R.C., 2021).

Table 2: Circular economy and water security

5R Approach	Description	Climate Action
Reduce	• Water conservation and water-use efficiency best management practices can reduce demand for scarce water resources, such as drip irrigation, smart water metering, water pricing, leak detection, and proactive maintenance.	• Mitigation: reduces energy and emissions in pumping and treating water and wastewater. • Adaptation: reduces demand for water resources by doing more with less (more crop per drop).
Reuse	• Water users can implement reuse systems (without treatment) for non-potable uses, such as cooling buildings, irrigating landscapes, and flushing toilets/urinals. Reuse systems can utilise greywater, blackwater, rainwater harvesting, and stormwater harvesting.	• Mitigation: reduces need for energy-intensive water transfers and reduces the volume of wastewater requiring treatment.

5R Approach	Description	Climate Action
Recycle	• Water recycling systems developed for non-potable projects that treat wastewater for specific purposes other than drinking, including agricultural irrigation. • Water recycling systems can be used for potable use directly: injection of recycled water directly into the potable water supply distribution downstream of the water treatment plant or into the raw water supply immediately upstream of the water treatment plant. • Water recycling systems used for potable use indirectly: reclamation and treatment of water from wastewater and its return into the current/natural water cycle well upstream of the drinking water treatment plant.	• Adaptation: provides climate-independent supply of water for potable and non-potable uses and reduces pressure on groundwater resources.
Recover	• Water resources managers can generate renewable energy from wastewater, including biogas from anaerobic digestion and thermal conversion of biosolids into various forms. • Wastewater treatment plants can recovery various resources from wastewater, including biosolids, nitrogen, phosphorous, struvite, caustic soda, cellulose, bioplastic, green bricks and tiles, and metals.	• Mitigation: reduces emissions from treating wastewater and provides low-carbon fertilisers for agriculture. • Adaptation: biosolids help improve soil moisture retention enhancing resilience to drought.
Restore	• Water resource managers can maximise environmental flows by reducing consumptive and non-consumptive uses of water. • EbM solutions can preserve and enhance natural capital (e.g., pollution prevention, quality of effluent, etc.). • Water conservation/efficiency/re-use/recycling can ensure minimum disruption to natural water systems from human interaction and use.	• Mitigation: lowers demand for energy-intensive grey infrastructure. EbM has carbon sequestration benefits. • Adaptation: EbM and DRR protect communities from extreme weather events.

2.3.6 Integrated Water Resources Management

IWRM is a cross-sectoral approach at the core of UN-SDG6, designed to promote the coordinated development and management of water, land, and related resources to maximise economic and social welfare equitably, without compromising the sustainability of ecosystems and the environment (GWP, 2011). The development of holistic governance arrangements required by the IWRM approach fosters the type of innovative decision-making that builds adaptive capacity. Specifically, the community, structural and ecosystem-based measures implemented through the IWRM approach often addresses one or more climate adaptation or mitigation outcomes, such as reforestation, protected land or marine areas, agriculture, or equitable water use design.

2.4 Financing adaptation and mitigation: how much will it cost to meet these targets?

Recent analysis provides a partial estimate of the scale of global economic losses related to water security: USD 260 billion per year from inadequate water supply and sanitation, USD 120 billion per year from urban property flood damages, and USD 94 billion per year to existing irrigators (OECD, 2022). Already 25% of cities – representing over USD 4 trillion in economic activity – are water stressed (McDonald et al., 2014). To date, this strong economic case for water-related investment has failed to translate into a compelling financial case for investment at scale. Future investment needs are estimated to be significantly higher than current financial flows. The World Bank estimates in excess of USD 114 billion is required globally per year to reach the UN-SDG6.1 and 6.2 with 724 climate activities identified (NDC-SDG Connections, 2022). Global financing needs for water infrastructure range from USD 6.7 trillion by 2030 to USD 22.6 trillion by 2050. There are barriers creating a gap between current financing and future needs, including those listed in Table 3 (Kauffmann, 2011; OECD, 2018; Stanford Water in the West, 2018; Brears, R.C., 2019).

Table 3: Barriers to financing water security

Barrier	Description
Under-pricing of water	Water is a public good and generally an under-valued resource, not properly accounted for by the government and the investors that depend on or affect its availability in other sectors such as urban development, agriculture, and energy.
Water services under-priced	Water services are often under-priced, resulting in low cost-recovery for water investments.
Capital-intensive	Water resources, irrigation, water supply, and wastewater infrastructures are generally capital intensive, with high sunk costs and long pay-back periods.
Difficulty of monetising benefits	Water management provides both public and private co-benefits, many of which cannot be easily monetised. This reduces potential revenue flows and availability of credit worthiness.
Context-specific projects	Water projects are often too small or too context-specific, raising transaction costs and making innovative financing models difficult to scale-up.
Poor business models	Business models often fail to support O&M efficiency, hampering the ability to sustain service at least cost over time in addition to integrity and transparency context.

To overcome these barriers, the *High-Level Panel on Water* has defined a range of principles to help finance investments, enhance water services, mitigate water-related risks, and contribute to sustainable growth:

- **Maximise the value of existing assets for water-related investments**: service providers can reduce overall investment needs and improve capital efficiency through operational improvement. Efficiency often results from better O&M with the objective to improve the service delivery to the users.
- **Design investment pathways that maximise water-related benefits over the long term**: the multiple benefits that water-related investments generate depend on how investments are designed and sequenced to meet strategic goals, including climate change adaptation. This means projects should be designed to be scalable and adjustable to changing conditions.
- **Ensure synergies with investments in other sectors**: policies outside of the water sector should be encouraged to factor in water risks, which in turn stimulates water-wise investments.
- **Attract more financing by improving the risk-return profile of water investments**: governments can employ a range of fiscal policy instruments to recover the costs of investment from users, improve financial sustainability, and secure revenue stream to improve the risk-return profile of water investment with more effective and efficient financial and operational management, better accountable and participative governance.

3 Paradigm shifting pathways: water security

3.1 Drivers of change across paradigm shifting pathways

The concept of paradigm shift in the GCF context is the degree to which a funded activity can catalyse impact beyond a one-off project investment: the GCF Updated Strategic Plan 2020-2023 seeks to promote paradigm shifts across high-impact areas encompassing mitigation potential and countries' adaptation and resilience needs (GCF, 2020). The GCF Theory of Change is based on four pillars: transformational planning and programming, catalysing climate innovation, mobilising finance at scale, and expansion and replication of knowledge. Key actions supporting a paradigm shift in water security across the four pillars are outlined in Table 4.

Table 4: Theory of change for water security

<table>
<tr><td colspan="5">Goal statement: GCF promotes a paradigm shift in water security that is low-carbon, resilient to climate change, and meets the goals of the UNFCCC and Paris Agreement:

IF the GCF creates an enabling investment environment to identify, design, and implement public and private funded transformational water security interventions as a new asset class,

THEN GCF's recipient countries can simultaneously mitigate and adapt to climate change through two low carbon climate-resilient development pathways in: (i) water conservation; and (ii) preservation of water,

BECAUSE an increasing share of investment in water security will be catalysed to deliver systemic change and maximise impact across the four drivers of change in water security.</td></tr>
<tr><th></th><th>Transformational planning and programming</th><th>Catalysing climate innovation</th><th>Mobilising finance at scale</th><th>Coalition and knowledge to scale up success</th></tr>
<tr><td>Outcomes</td><td>IF GCF's recipient countries identify long-term low-carbon and climate resilient water security public and private investments,
THEN AEs will prepare transformational interventions to meet the paradigm shift in water security,
BECAUSE public and private sectors will develop a strategic vision and know-how to design and execute water security interventions that maximise climate benefits and generate additional co-benefits.</td><td>IF GCF's recipient countries enable an environment where technological and financial innovation in water security is allowed to thrive,
THEN pilot innovative water security investments will create a new asset class that enhances water security and fosters the circular economy,
BECAUSE climate smart water security interventions will be scaled-up and replicated.</td><td>IF finance is deployed to reduce risks and barriers of water security interventions and increasing returns on investing with acceptable revenue streams in line with ESG impacts, Paris Agreement and UN-SDGs,
THEN financial resources will catalyse private and commercial finance at scale to support the paradigm shifting pathways of water conservation and preservation of water
BECAUSE the financial viability of new asset classes in water security will be demonstrated.</td><td>IF the knowledge of best practices and lessons learned from GCF funded water security projects are disseminated,
THEN countries development pathways and global finance flows will transform and align with the paradigm shift in water security,
BECAUSE the concept of water security will be mainstreamed into the operation of governments, businesses, and financial markets.</td></tr>
<tr><td>Output</td><td>• Incorporate water security into NDCs and NAPs.
• Strengthen transboundary operations and cooperation.
• Integrate social and gender sensitive dimensions into water security interventions.</td><td>• Adopt climate smart water management practices.
• Enhance water infrastructure technologies and approaches.
• Mainstream EbM into GCF funded water security interventions.</td><td>• De-risk water security investments.
• Scale-up blended finance into water security interventions.
• Increase collaboration with financial partners.</td><td>• Encourage behaviour change in water conservation practices.
• Promote partnerships and new alliances in water security.
• Improve access to public data in water security.</td></tr>
</table>

To achieve a paradigm shift in water security to "Build Back Better World", high quality climate resilient water infrastructure with an efficient service delivery to the users, pilot transformational projects and programmes are required to demonstrate high impact before scaling up and replicating the lessons learned at each step of the project cycle. NDCs identify water security risks as a high priority in over 90% of developing countries supported by the GCF, international financing institutions (IFI) and civil society organisations.

3.2 Two paradigm shifting pathways in the water sector

Cross-referencing the targets of UN-SDG6 with UN-SDG13 indicates that water security induced by water scarcity supports fast-tracking climate finance in transformational water projects in two inter-linked pathways on water conservation and preservation of water resources.

3.2.1 Pathway 1: enhance water conservation, water efficiency and water re-use

Current status of water use and demand gaps

Climate change, rapid urbanisation, population growth, and pollution are all contributing to increased water scarcity. Economic growth in a climate constrained world, business as usual supply-side options of large-scale capital expenditures on dams, and energy-intensive desalination plants are no longer adequate and are more expensive than demand-side measures. Most often, water supplies are expanded only to see water consumed inefficiently or lost, eventually worsening water stress. The World Business Council for Sustainable Development stated that "*in too many places water is a triple paradox: scarce, cheap, and wasted*" (WBCSD, 2005). Therefore, the path towards responsible and sustainable water management lies not only in more 'hard' infrastructure but through a combination of (i) saving water through water conservation, water efficiency, non-revenue water reduction, and water re-use and water recycling; (ii) educating the public and policy-makers; (iii) allocating scarce water resources through proper regulation; and (iv) a *well-managed mix and integration of the Grey-Green Infrastructure* to enhance the *adaptability* and *resilience of coastal and upstream communities* to climate change (drought and flooding) and mitigate energy-intensive grey infrastructure including increasing storage of carbon.

Demand management

Demand management is one of the most cost-effective approaches to managing existing water supplies. In the new paradigm of demand management, the climate smart water utility and climate smart agricultural producer need to become water service providers going beyond their traditional role of water supplier and user, respectively. They need to obtain new skills and work across new technologies and practices, such as water efficiency alongside supply-side management to create "new" water through efficiency gains without depriving any existing users. Demand reduction lowers GHG emissions by transporting less water and treating less wastewater, whereas all new supply-side measures result in an increase in GHG emissions. Desalination is one of the greatest potential contributors to increased GHG emissions followed by water re-use and reservoir options. Demand management benefits include:

- Deferring capital expenditure on water supply systems allows for capital to be preserved.
- Retrofitting water-saving fixtures reduces water use by 20% as well as GHG emissions.[3]
- Re-using and recycling water helps reduce water abstraction and withdrawal.
- Reducing non-revenue water by 5% in the United States would save 1 million m^3/day, reduce energy demand by 313 million kWh annually, and avoid GHG emissions of 225,000 tons. In developing countries, roughly 45 million cubic meters of water are lost daily with an economic value of over USD 3 billion per year (Bill, K. et al., 2016). World Bank (2016b) puts the global estimate of physical water losses at 32 billion cubic meters each year, half of which occurs in developing countries. A World Bank financed project in Ho Chi Minh City used a non-revenue water performance-based contracts (NRW PBC) approach in a part of the city and saved half of the water that was previously being lost to leakage – 100,000m3/day (enough water to serve 500,000 people). It also provided the same opportunity in African countries where NRW ranged from 25-60% against a global best practice of about 15%.
- Reducing wastewater treatment costs to the community and businesses.
- Allocating more water for environmental flows.

[3] The UK Environment Agency found that 89% of carbon emissions in the water supply - use - disposal system is attributed to "water in the home" and includes the energy for heating water (excludes space heating), which compares with public water supply and treatment emissions of 11%.

Water conservation

There are many definitions of "*water conservation*", which is used synonymously with demand management. For example, the U.S. Water Resources Council defines water conservation as "activities designed to (i) reduce the demand for water; (ii) improve efficiency in use and reduce losses and waste of water; or (iii) improve land management practices to conserve water". The above definition allows for the application of technologies and associated management strategies to a broad range of issues involving water usage among all user groups. It also allows for education and awareness programmes on the need to conserve scarce water resources. Another definition takes the perspective of a cost-benefit approach: the socially beneficial reduction of water use or water loss. In this context, water conservation involves trade-offs between the benefits and costs of water management options. The advantage of this definition is that it focuses on comprehensive demand-management strategies with a goal of increasing overall well-being, not curtailing water use.

Developing water conservation programmes requires accurate demand management forecasts, inclusive of sector analysis. End-use modelling and demand-side least-cost planning decision support systems are among the planning models used by climate smart utilities and climate smart agriculture. When developing demand management models, it is important to assess the needs of the energy sector as well, given their interdependencies. Economic analysis can include cost-benefit analysis, cost-effectiveness, and unit cost analysis. However, according to White S. (Institute for Sustainable Futures, 2006) it is widely accepted that unit cost is the best method to enable a fair comparison between supply and demand options. Levelised cost of which is a measure of the present value unit cost of water saved or supplied. These need to be viewed from the perspective of the users and the utility.

Sydney Water Conservation (1995 – 2010)

Sydney Water, Australia implemented one of the largest urban water conservation programmes from 1999 – 2010 globally using Integrated Resource Planning methodology. It set targets to reduce demand by 35% by 2011 based on 1991 consumption levels. Using levelised cost planning methodology, over 40 options to reduce demand across residential, business, and institutional sectors were identified. As a result, from 1995 to 2010, Sydney Water saved 116,703 ML of water despite an increase in population of over 1.3 million people compared to the 1970s

Water re-use

Regarding water conservation hierarchy terminology, re-use is defined as the re-use of water within a single process or the use of harvested water for another purpose without treatment and recycle is defined as the use of harvested water after treatment for another purpose; treatment can be tailored to meet the water quality requirements of a planned use. Water recycling, in general, involves the reclamation of water from wastewater for non-potable or potable use, which can be supplied back to the water system either directly or indirectly. Water for recycling can come from centralised schemes or small on-site systems involving, for example, treated sewage or greywater. Recycled water can be used for various purposes, including agricultural and landscape irrigation, industrial processes, toilet flushing, and replenishing groundwater basins. In businesses, industrial water can be reused (wastewater is reused directly) or recycled (treated before reuse) within a business itself or between several businesses, for instance:

- A business can directly re-use wastewater that is clean enough for the purpose for which it is being re-used. Process water is produced by industrial processes such as cooling and heating and usually contains few contaminants after use. Cooling towers are one of the most common water technologies used by industry and are frequently used for washing processes.
- Direct wastewater re-use can be practiced between businesses, with the exchange of waste product for the mutual benefit of two or more businesses known as "industrial symbiosis". Examples of direct re-use of wastewater in industrial symbiosis include the exchange of process water from one business to another and subsequent re-use: re-use of organic waste or wastewater for biogas production, or the re-use of wastewater for aquaculture of plants or animals.

Overall, in addition to providing a dependable, locally controlled, climate resilient water supply, water re-use and water recycling provide a range of benefits, including decreasing diversion of freshwater from sensitive ecosystems, decreasing discharge to sensitive water bodies, creating, or enhancing wetlands and riparian habitats, reducing, and preventing pollution, and saving energy.

Managed aquifer recharge

MAR consists of water management methods that recharge an aquifer using either surface or underground recharge techniques. The stored water is available for use in dry years when surface water supplies may be low. MAR can be used as a drinking water supply, as process water for industry, for irrigation, and for sustaining groundwater-dependent ecosystems. There are two approaches used to recharge aquifers: surface infiltration and deep injection. Surface infiltration can involve creating artificial streams and ponds (spreading grounds) in fast-draining soil, creating local catchment systems for rainwater and stormwater, or diverting water to naturally infiltrating river channels during low-flow seasons. Meanwhile, deep injection methods put excess water directly into the aquifer using wells (Katja, 2017). Overall, MAR can be used to address a wide range of water management issues, including smoothing out supply and demand fluctuations, increasing resilience to droughts, and managing saline intrusion or land subsidence (Brears, 2021).

Water efficiency

Water efficiency is when new hardware or management techniques are used to get the same benefits from using water, with water users needing less water to receive those benefits. In agricultural sector, there is great potential taking the agricultural is the largest water user with efficiency on average around 50-60%. In the business and industrial sectors, there are a number of options for improving water efficiency, including production planning and sequencing and re-adjusting production plans to minimise water consumption; introducing more sensible and more resource-conscious routines in operations; making modifications in processes or equipment, with relevant retrofits, if required; designing entirely new products that lead to reduced water demand and less effluent generation; and replacing equipment or technology with more effective and efficient ones (Brears, 2018). Overall, for business sector uptake of water efficiency measures, the true cost of water must be considered rather than the water supplied by the utility.

> **Example of Hidden-Cost**
>
> *A Chinese textile dyeing and processing facility bought water at RMB0.65/m^3. Once other hidden costs were added such as cooling, wastewater treatment and steam generation the true cost of water increased to RMB18.03/m^3: almost 28 times the original supply cost.*

Figure 2: Identifying the hidden cost of water

Source: Mohan Seneviratne, 2021

The final cost should include the costs of pumping, treating, disposing of and other hidden costs (Figure 2).

3.2.2 Pathway 2: Strengthen integrated water resources management – protection from water-related disasters, preserve water resources and enhanced resilient water supply and sanitation services

In a climate strained environment, increased water risks and growing uncertainty about future conditions both exacerbate existing water security challenges and complicate any planning, management, and water infrastructure-related investment decisions. Although climate change is a significant driver of water risks, there are a number of reasons why adaptation to climate change should be considered in the broader context of water security from increased population growth, urbanisation and demand for water from agriculture and industry. Climate change adaptation needs to be mainstreamed into existing IWRM, using adaptive management techniques. Adaptive water management techniques are flexible to the changing risks, uncertainty from limitations of data and predictions and challenges whilst striving to meet the needs of all stakeholders from household water supply, industry, irrigation, energy production and flood mitigation despite the high sunk costs in long-lived infrastructure. This paradigm shifting pathway will focus on three sub-areas to generate mostly adaptation projects:

Preservation of existing water resources

- Developing policies and incentives for underground water conservation and preservation including the transboundary context.
- Improving comprehension of the complex hydrology of basin and inter-basin water flows to better understand the potential for supply and avoiding maladaptation including water quality.
- Enabling private sector engagement in supply and demand issues via financial incentives.
- Working with local associations at the scale including regional and national to promote knowledge sharing on the costs and benefits of various options to manage water resources including the transboundary context.

New water supply sources

- Promoting integrated water resource plans and systems.
- Encouraging rainwater harvesting, water re-use, and water recycling.
- Understanding trade-offs between water technologies (e.g., desalination vs. rainwater harvesting).
- Linking specific water supply activities to sanitation to avoid maladaptation, including planned and ongoing initiatives at project design, construction, policy and institutional level.
- Strengthening community engagement for potential water projects that may cause displacement.
- Promoting regional sharing of climate adaptation experiences with Small Islands Developing States and Least Developed Countries (e.g., regional dialogues).

Protection from water related hazards and enhanced resilient water supply and sanitation services

- Progressing understanding of relevant water hazards and risks into national adaptation plans.
- Enhancing knowledge of ecosystem-based management and its suitability to manage water related hazards mostly in urban areas (e.g., sponge cities and constructed wetlands vs. grey infrastructure).
- Piloting and implementing a *well-managed mix and integration of the Grey-Green Infrastructure* to enhance the *adaptability and resilience of coastal and upstream communities* to climate change (Drought and Flooding) and mitigate energy-intensive grey infrastructure including increasing storage of carbon through *promoting, designing, and financing resilient grey-natural water infrastructure projects* that demonstrated improvements to water and climate risk resilience.
- Piloting adaptation projects on flood protection and coastal protection.
- Expanding blended finance for infrastructure adaptation projects on water hazard protection and enhanced resilient water supply and sanitation services.
- Engaging community groups where knowledge on climate change adaptation technology and financing options can be shared, including costs and co-benefits.

There are three critical areas for transformation under the pathway of preservation of water:

Water governance and management structures

The water governance and management approach provide a framework under which water initiatives are developed, including their boundaries to determine failure and sustainability conditions over time. Systemic change in the sector is unlikely to occur on a project basis because of its limited sphere of influence: "*as a result, many projects produce only minor and often temporary changes in the status quo, at best* (Government of the Netherlands, 2020)." Governance is one of the key limitations to implementing IWRM, including coordination issues among institutions at the scale, weak institutional capacity, and insufficient funding. As such, large-scale adoption of sustainable and resilient water management practices requires both transformative policy and governance approaches.

The vision for a paradigm shift in water security for water governance and management structures supports an inclusive and accountable stakeholder process and transparency that values the multi-faceted dynamics of IWRM including community-based water management to reinforce climate proofing of water systems and increase climate resilience. The key success factors lie in empowering communities into decision making, building global alliances for knowledge sharing, and deploying digital solutions to collect, process and publish data in a transparent manner to support evidence-based decision-making. To achieve a paradigm shift in water security, governance and management policies must be considered in the local and social context and enabled to build the capacity of all the stakeholders.

Water infrastructure systems

Water infrastructure systems include the entire water resources, water supply and sanitation chains, including water extraction and transmission, water treatment and supply, and wastewater collection, treatment, and disposal. Those systems are most likely compromised under climate change scenarios due to variable water availability from changes in rainfall patterns and glacial melting and increases in extreme weather events causing drought and flooding. The vision for a paradigm shift in water security for water infrastructure systems needs to demonstrate how water resources are managed in an integrated manner, water supply is treated and distributed, and wastewater is collected, treated, and disposed of. To achieve the vision, appropriate tariffs and fees support an equitable water distribution and provide adequate financing for O&M and future investment. In addition, climate proofing of water infrastructure systems enhances access to safe and adequate irrigation and water supply; expands sanitation and hygiene outcomes; limits eutrophication of surface waters and associated ecosystem; improves livelihoods; and increases resilience of communities.

Mitigating water-related hazards

Water-related hazards are present as floods, droughts, glacial melt, storm events and sea-level rise. Climate projections indicate that most regions will experience changes to rainfall such that either drought or flooding, or cycling between the two, will increase. Rural and urban areas already experience flooding impacts from increased rainfall intensity. In other regions, prolonged droughts reduce water resources, cause severe food shortages, and contribute to extreme forest fires.

The vision for a paradigm shift in water security for mitigating water-related hazards differs depending on the location and the type of hazard including area with water-borne diseases. In general, it requires sustained participation in planning and management; improved coverage and application of digital solutions; increased acceptance and use of non-traditional financing mechanisms; and environmentally sound use of structural measures to increase resilience. EbM and smart systems provide opportunities to mitigate water-related hazards with a climate cross-cutting impact potential combined with sustainable development co-benefits.

3.3 Barriers to achieving paradigm shifting pathways and key actions

Barriers and risks are identified in the theory of change (Table 4). Water security requires an enabling environment, water resource conservation, integrated approaches to water management, restorative and regenerative approaches to economic development, and planning for climate change resilience. There are many barriers to achieving the paradigm shift for water security, most of which apply across the entire water sector. Key actions to overcome these barriers include:

- Cultural change: achieving water security involves creating a culture and environment that allows changes to take hold and work in practice. It can also apply to the application of existing methods or technologies, in new ways or to new fields.
- Collaboration: collaboration is essential for inspiring new ideas and applications, allowing for insights to develop, spurring innovation. As well as collaborating with external stakeholders, water sector actors can collaborate within their organisations, with other organisations, and with partners outside of the water sector at the scale (water sector is the connector between many sectors i.e., food, energy, ecosystems, etc).

- **Technology**: technology, when paired with the right culture, processes, and people, is a powerful enabler of innovation. In addition to technology, such as smart meters and water-efficient appliances giving more control to water users over their consumption levels, technology can be applied to help water managers understand their systems and networks, helping them prevent interruptions to services and respond to and recover from service delivery challenges.
- **Innovative regulatory frameworks**: regulatory frameworks can be adequately designed to challenge various actors in the water sector to improve innovation for the benefit of customers, the environment, and broader society including inclusive governance arrangements. Regulatory frameworks can encourage innovation by:
  - Reconciling inconsistent regulations between government agencies and levels of government.
  - Coordinating regulations across sectors, for example, water and wastewater and water and energy, to ensure consistent treatment of new technologies and to reduce obstacles to the development and adoption of new technologies.
  - Shaping regulations to encourage utilities and various regulated water sector actors to meet performance standards, rather than force them to adopt fixed technology mandates.
  - Creating markets and competition in the water sector that encourages innovation through virtual water and/or water trading, greater third-party involvement in large projects, and markets for ecosystem services.
  - Developing market-based instruments to recover the full cost of providing water and related services and encourage research and development in innovative projects in areas including water efficiency, resource recovery, and protection of ecosystems (Brears, 2016).
  - Developing regulatory framework and policy for integration of EbM in the water sector as integral to IWRM that can serve the adequately mix and integration of the grey-green resilient infrastructure.

3.4 Enablers to achieving paradigm shifting pathways

When associated with the theory of change (Table 4), the actions required to overcome and enable those barriers provide a roadmap to pursuing paradigm shifting pathways in water security generally. These actions must address the underlying conditions that create or hinder transformation and the fundamental systems that support that transformation. It is also crucial to understand that, while the barriers are often assigned to separate systems, they are interconnected. As such, actions proposed must address the interconnected nature of the barriers and identify those actions that, when pursued together, create the pathway with the highest impact and transformative potential. Key actions include:

(1) **Apply scientific evidence to support decision-making and develop response to future needs**: countries will benefit from strategic planning that identifies and prioritises water security risks and potential opportunities in response to climate change. This creates a tailored pathway for their own shift toward water security in an evolving climate system. Equally, this can be done at regional levels, particularly as transboundary challenges exist or access to resources is scarce. Preparing water security projects based on an understanding of the future trends of the water cycle and the changing needs of the society will provide a level of security to project investments both financial and social.

(2) **Investment programmes need to build long term capacity of local actors, rather than short-term delivery efficiency:** the past and current application and allocation of development assistance programmes and concessional financing for water infrastructure has long reinforced the dependence on outside technical and financial support. Investing in the local commercial and private sector and building the local social capital, will favourably advantage paradigm shift for improving water security in response to climate change effects. This may be achieved through financing that lowers the cost of capital and guarantees in blended finance models for water infrastructure projects that support the operations phase, which provides opportunities for small- and medium- enterprises that provide operations and maintenance support services. In addition, the technical assistance grants need to be used to build the capacity of water service delivery providers to better meet the changing demands associated with climate change.

(3) **Change how success is measured and make it culturally and locally specific:** quantitative and quantifiable forms of data have a place as performance indicators and methods of measurement. To provide a fuller

picture of the interlinked nature of water and climate, and the very human aspects of their changes, consideration should be given to including the nuance of cultural and local success measures, participatory evaluation and communication methods, and non-traditional methods such as narrative and storytelling. These active processes can connect diverse stakeholders and foster imaginative forms of collaboration and collective action of the type required to move society toward a water-secure world.

(4) **Embrace the central role of an IWRM approach to addressing water security challenges yet recognise that water is not the only actor**: though many climate change impacts will be felt through the water cycle, it is the decisions made outside of the water sector that most impact the water sector. For example, projects framed as disaster risk reduction (DRR), ecosystem services, or public health are likely to experience climate change impacts through water and may have greater opportunity to bring about systemic change than one framed purely as 'water'.

(5) **Innovative technical and social approaches may not have access to the scale required for great impact potential**: there is an opportunity to bundle these into programmes that may collectively create impact at a system scale. Much of the private and commercial sector experience is hampered by limited access to financing to expand to a scale needed to create an impact that will shift social and political thinking toward inclusive and climate resilient water-secure futures. Caution must be taken however that in programme design, the nuance of each group is not lost as these details determine sustained success. Additionally, the capability and sensitivity of the managing entity will be critical for driving collaboration and the collective understanding of the dynamic links between water systems and economies.

(6) **There is no "silver bullet" for technological adaptation to climate-related water security challenges:** innovations continue to be developed, primarily in treating wastewater and re-using and applying data science to supplying water services. However, the local context and access to markets and finance will continue to define what is technically available in a given locale, and no one size fits all. Nevertheless, a suite of innovations (technical, financial, business, institutional and social) targeted to hazards and domestically accepted for addressing water security in a changing climate would be worth pursuing.

3.5 Role of GCF in financing the paradigm shifting pathways in water security

Based on its mandate and comparative advantages and the theory of change for water security (Table 4), the GCF offers its four-pronged approach to address the barriers highlighted above and to support developing countries drive the implementation of the paradigm-shifting pathways at scale (Figure 3): **transformational planning and programming** to support preparation and readiness; **catalysing climate innovation** to identify and promote new business models, technologies, and financing mechanisms; **mobilising finance at scale** to shift finance flows and ensure financial and operational sustainability; and **coalition of knowledge to scale up success** to replicate successful projects and programmes and benefit from lessons learned.

To support the paradigm shift in water security, the paradigm shifting pathway in water conservation and increased efficiency and performance contributes to GHG emission reduction and increases the resilience of people benefitting from water services. The paradigm shifting pathway in preservation of water focuses on climate proofing of water infrastructures, including new water sources to strengthen people's resilience. The role of GCF in financing the paradigm shift in water security with two inter-linked paradigm shifting pathways across the GCF four drivers of change is summarised hereafter and detailed in Figure 3.

- **Transformational planning and programming:** GCF supports developing countries to create and strengthen integrated climate development policies. Water security is mainstreamed into policies framework through (i) preserving water resources; (ii) developing water supply, including from new sources; (iii) protecting from water-related hazards; and (iv) promoting water re-use, recycling, and water conservation.
- **Catalysing climate innovation:** GCF encourages innovation in policy, business, technology, and finance through enabling institutional and invest environments. Key climate innovations include (i) addressing water scarcity by conserving water and preserving water resources; (ii) piloting new asset classes in sanitation and water re-use that follow these characteristic in finance, revenue stream, SDGs and Paris agreement (Figure 4); (iii) mainstreaming EbM; (iv) piloting and implementing a *well-managed mix and integration of the Grey-Green Infrastructure* to enhance the *adaptability and resilience of coastal and upstream communities*; and (v) developing climate smart water utilities and climate smart agriculture.

- **Mobilising finance at scale:** GCF fosters scaling-up successful climate investments to de-risk investments through strengthening domestic capital markets and climate financing institutions.
- **Coalitions and knowledge to scale up success:** GCF creates and shares knowledge to harmonise valuation methodologies. It incorporates climate risks into every single financial decision to align climate finance with sustainable development.

Figure 3: Possible actions for each paradigm shifting pathway following the four pillars of the GCF Strategic Plan

Sector		Actions across the drivers of the GCF Strategic Plan			
Water security		**Transformational planning & programming**	**Catalyzing climate Innovation**	**Mobilization of finance at scale**	**Coalitions & knowledge to scale up success**
Paradigm shifting pathway	**Enhancing water conservation, water efficiency, and water re-use**	• Encourage benchmarking across service sectors and providers • Incentivise circular economy approaches for resources recovery • Design low emission climate resilient investment pathways that maximise long term water benefits • Strengthen water security into NDCs and NAPs	• Mainstream climate smart water and agriculture using digital solutions • Promoting new asset classes in sanitation and water re-use that follow these characteristic in finance, revenue stream, SDGs and Paris agreement • Reduce performance uncertainty through asset management • Advocate decenetralised water supply and wastewater management • Support desalination using renewable energy • Employ data science and initiate "big data" solutions, such as reducing CO2 emissions	• Allocate grant funding for technical assistance and capacity building • Enable private sector participation by supporting credit enhancements and full cost recovery through direct and indirect charges • Support comprehensive cost-benefit analyses with co-benefit from EbM • Introduce tax initiatives to contain adverse environmental impact of activities • Support carbon credits intiatives for revenue generation	• Improve available information and data acquisition through knowledge platforms • Support peer-to-peer learning and regional exchanges of lessons learned and best practices • Support catchment-based initiatives to promote water stewardship • Empower communities into the decision-making process • Foster cultural-specific communication with stakeholders • Encourage behaviour change in water conservation practices
Paradigm shifting pathway	**Strengthen integrated water resources management – protection from water-related disasters, preserve water resources and enhanced resilient water supply and sanitation services**	• Link IWRM with water safety plans for long term adaptive planning to map climate hazards with risks and vulnerability • Encourage transboundary water resource cooperative arrangements • Support resilient planning and design processes dealing with uncertainties • Improve flood modelling into disaster risk resilience assessment and drought rationale through climate vulnerability assessment • Integrate social and gender sensitive dimensions into water security interventions	• Promote and implementing a well-managed mix and integration of the Grey-Green Infrastructure to enhance the adaptability and resilience of coastal and upstream communities • Mainstream rainwater catchment harvesting and storage systems • Promote stromwater harvesting (e.g., sponge cities, agriculture) • Advocate for water re-use and water recycling as alternative water sources • Strengthen resilient WASH programmes preventing maladaptation • Introduce EbM to enhance climate resilience in water infrastructure and build coastal resilience • Contribute to urban climate resilience for flood and land use management • Reduce drought vulnerabilities through water re-use and recycling	• Catalyse public funds to scale-up blended finance • Enhance projects' risk-return profile • Address risks vs. perceived risks • Improve creditworthiness through credit enhancements and de-risking • Defer investment using resilient water solutions within the whole water cycle • Expand micro-finance to support household level resilient water systems • Initiate ecosystem-based insurance and disaster risk insurance and bonds • Participate in specialised water and blue-green funds	• Enhance collaboration with independent institutions for Monitoring, Evaluation and Verification • Promote partnerships and new alliances in water security • Strengthen innovation climate hubs • Develop localised accredited climate education programmes • Invest in research to support evidence-based decision making

Figure 4: **Water Innovative Approach: New Asset Class**

4 Financing paradigm shifting pathways

4.1 The business case for financing water security interventions

There is a compelling economic argument to invest in water infrastructure (refer to Section *Global Context*). The benefits from strategic investment in water security could exceed hundreds of billions of dollars annually. However, in most low income and low middle-income countries, the water sector is perceived as high risk with heavy reliance on limited public sector funding without much interest from private investors. Only 1.36 % (USD 2.14 billion) of total private and commercial finance mobilised from 2012-2017 (USD 157.2 billion) was allocated to the water sector (OECD, 2019). Therefore, the water sector is not able to meet these financing challenges without a new paradigm. The new paradigm shift in water security must include four broad themes:

1. Improve creditworthiness of utilities, including irrigation companies, through improved sector governance and efficiency (refer to Section on *water governance and management*)
2. Leverage public funds by crowding in private capital and blended finance
3. Target capital more effectively to get a higher return for every dollar invested to address the higher risks (perceived or not)
4. Minimise capital requirements by better planning and maximising blue-green infrastructure with EbM and smart digital solutions to improve operational efficiency and monitoring performance

GCF participation through the AE with the support of the NDA and proper safeguard due diligence is a direct benefit for investors, which can earn risk-adjusted returns to manage climate risks and water security while avoiding fiscal shocks due to mispriced pricing and stranded assets.

Risk allocation: risks need to be mitigated as much as possible and residual risks need to be allocated based on the following principles: (i) Risks should be allocated to the party which can minimise and manage the risk most effectively; and (ii) Where no party has a clear comparative advantage in managing the risks, they should be shared. To attract private and commercial capital, the undermentioned risks (Table 5) need to be recognised and mitigated.

Table 5: Water security-related financing risks

Risk	Description	Comments
Commercial risks	*Tariff affordability*	• Water tariff affordability; willingness to pay for service from the users; and willingness to charge from the local government.
	Cash flow profile, demand and markets, information gaps *Deal flow*	• Feasibility study with cost-benefit analysis of technical options; water demand; cost estimates; financial modelling with assumptions and sensitivity analyses are robust and completed by independent consultants. • Projects have safe and stable returns, reliable offtake agreement and the ability to ring-fence debt to pay from revenues. • Sufficient deal flow available to recoup development costs and exit.
	Credit risk	• Credit risk of the borrower is assessed and deemed acceptable: international Financial Institutions (IFIs) can provide financing as "unsecured" debt and rely on the creditworthiness of the counterparty rather than relying on other credit enhancements.
	Performance risk	• A reputable contractor undertakes construction.
	Technical risk	• Technical solutions are based on the most appropriate and economically feasible technology for the selected water security intervention. • Suppliers of goods and services have a good track record. • The energy intensity of the selected technology is an entire part of the investment decision (life-cycle cost).

Risk	Description	Comments
Political risks	*Country stability* *Expropriation*	• Political stability: how stable is the country? • Expropriation: is there a risk of the government nationalising the project? What is the track record of the country?
	Political interference,	• How robust is the water pricing process? • What is the political influence over the water security project? • Are procurement processes transparent and fair?
	Currency risk and risk of devaluation[4]	• How stable is the local currency? • Does the country have enough reserves?
Regulatory, legal and contractual	*Regulatory, counterparty, legal and contractual, local banks capital tiers*	• Is the off-taker credible and has a good track record in timely payments? • Is there a regulation framework in place or regulation by contract applies? • How is the legal framework for legal protection of investors and enforcement of contracts? • What are the licensing and permitting requirements? • Can land value capture enhance the commercial viability of projects? • Are local banks capitalised in line with adequacy ratios as per Basel III capital requirements?
Financing risks	*Availability of Development capital to offset project risks*	• Is there interest from IFIs to have a multiplier effect on private capital because of good project preparation and transaction advisory services? • Participation of IFIs demonstrates the project is bankable, and risk mitigation instruments are in place.
	Financing risks pertaining to local government borrowings	• Can the local government borrow without sovereign guarantees? • What assets and ring-fenced revenues can the local government propose as securities? • Can the land be provided free and clear by the local government?
ESG related risks	*Climate change and safeguards*	• Was an assessment of the water situation, climate change impacts, pollution, environmental liability, and costs considered? Are they acceptable? What are the residual risks? • What is the project impact on livelihood? • Does the project promote gender sensitive approaches?
Reputational risks	*Promoter and investor reputational risks*	• What are the compliance and disclosure procedures? • Are there community sensitivities about the project? • Is there any corruption and business ethics issues about the project? Has Integrity due diligence and Know Your Clients of key officials carried out? • Project sponsor experience in dealing with IFIs, the sector and the country?

Source: Mohan Seneviratne

4.2 Financial instruments

Water and sanitation utilities have distinct needs when it comes to accessing finance. Water infrastructure investments can be capital intensive, especially for water resources and wastewater management: Such projects require long tenors to repay debt while maintaining affordability for users. Too often, water projects do not have enough operational and financial efficiency for attractive risk-adjusted returns to private and commercial investors. Given the pressure on public sector finance to meet the climate actions targets under UN-SDG6, it is critical to attract private, institutional, and commercial financiers together with IFIs, including

[4] Currency fluctuations hamper project development if funds are sourced in foreign currency but offtake revenue from water tariff are always priced in local currency. High currency risk and borrower premiums inhibit the use of international finance for water projects. Some IFIs can offer local currency financing to mitigate the need for foreign currencies.

the GCF in climate finance in general and water security in particular. The GCF accesses a wide range of financial products to mitigate the projects' financing risk by structuring, securitising, and aggregating to reduce those risks and make the projects more palatable to investors. Instruments for credit enhancements, such as blended finance and guarantees that complement and mitigate projects' risk, are particularly well suited in water security. Key features of financing instruments commonly used in water infrastructure are summarised in Table 6:

Table 6: GCF financial instruments

Financing Instrument	Definition	Advantage/disadvantage
Grant	Funding resources without the expectation that funds will be repaid.	Advantage: • Technical assistance for project development and capacity building to supplement loans. • Grant can be approved on a reimbursable basis. Disadvantage: no inflow.
Corporate loan	Loan provided against the borrower's financial audited statement and not based on a specific project.	Advantage: unsophisticated borrowers can finance multiple projects within the frame of the approved loan. Disadvantage: difficult to avail for deserving small and medium enterprises.
Project loan and syndicated loan	Loan provided against a specific project by one or multiple International Financial Institutions (IFIs).	Advantage: • Debt repayments rely on the project's cash flows. • IFIs can lend at concessional terms against a sovereign or a sub-sovereign guarantee. Disadvantage: • No recourse from the lender. • Lender most often requires collateral in the form of assets and guarantees from a corporate entity. Disadvantage: transaction costs can be high.
Private equity	Investors share part of the borrower's profit & loss.	Advantage: no interest paid by the borrower on the investment. Disadvantage: highest form risk for the investor with the lowest priority for repayment in case of default No secured returns (profit & loss).
Guarantees	Form of credit enhancement and insurance against sovereign, political, credit and other types of risks.	Advantage: Comfort to private and commercial investors. Disadvantage: • Cost of the guarantee. • Selection of triggers for the guarantee to kick-in.

Financing vehicles for private sector participation

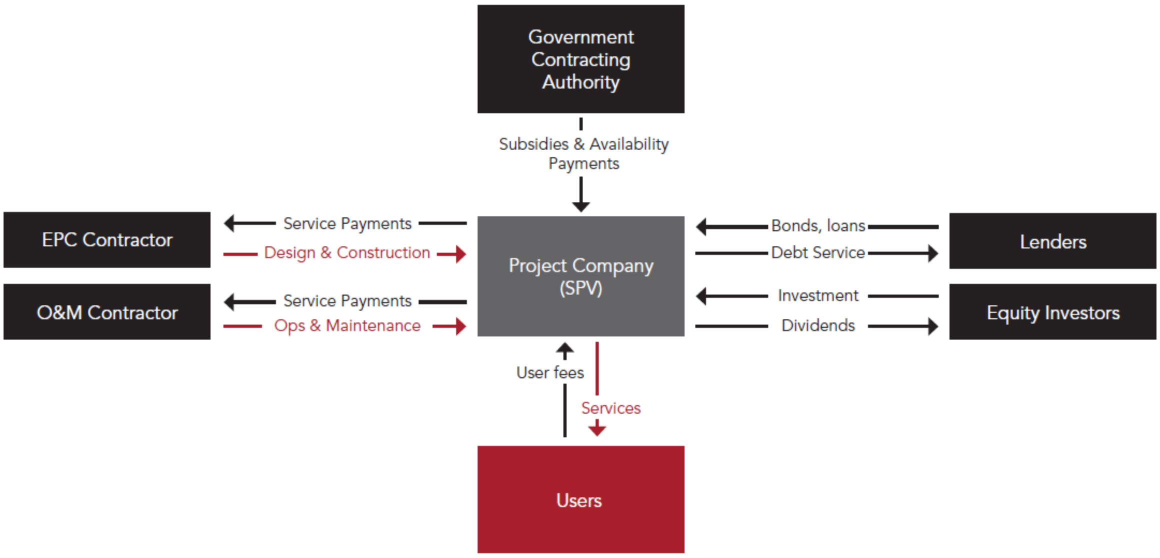
In addition to the various financial instruments which the GCF can develop, there are preferred financing vehicles for water security interventions to attract private, institutional, and commercial funding:

PPP: Long-term contract between a private party and a government entity to provide a public asset or service. The private party bears a significant risk and management responsibility with its remuneration linked to performance. Therefore, PPPs are well suited for water security interventions: The legal and institutional frameworks in the country need to support this new model of service delivery and provide effective governance and monitoring mechanisms for PPPs; pilot PPP can use regulation by contract in case of weak legal framework. PPPs are usually structured under a Special Purpose Vehicle (SPV)

Example of Corporate Loan through Syndication: in 2020, Asian Development Bank led a USD 300 million package for the *Climate Resilient and Smart Urban Infrastructure Water Project* supporting Shenzhen Water Group investment programme and knowledge transfer in smart water management and sponge cities to 3rd and 4th tier cities in China.

as a form of equity investment where a separate company is incorporated to prepare and implement the project (including O&M) and secure financing for the project. The typical financial structure of PPP projects and project flows are shown in Figure 5, where the private party will form a SPV to manage and implement the contract. The SPV raises funds to finance the project. The engineering-procurement-construction and the O&M contractors may be affiliated within the SPV or through a contractual arrangement.

Figure 5: Financial structure of PPP within a SPV



Source: World Bank, "Public Private Partnerships Reference Guide", 2017

Blended Finance: Blended finance refers to the strategic use of concessional public or philanthropic capital to mobilise additional private and commercial finance to meet the targets of UN-SDG. Blended finance seeks to demonstrate proof of concept and viability of innovative business models to crowd-in private and commercial finance for water security intervention. Within blended finance, guarantees account for 58 % (USD 1.24 billion) of the private and commercial finance mobilised in the water sector and syndicated loans for 29 % (USD 0.6 billion).

First-loss risk sharing facility is a specific type of blended finance. Risk sharing facility is a form of credit enhancement in which a third party agrees to cover a certain amount (about 10 – 20 % of loss for an investor). By decreasing the financial risk, RSF loans encourage private and commercial investors to co-finance transformational projects. If the project fails, the RSF lender would be last to be repaid, allowing other investors to recoup some of their capital.

The GCF offers blended finance when private and commercial financing cannot mitigate the financial risk, specifically, blended finance:

- Can only finance bankable projects that can generate investment returns.
- Can support targeted and time-bound subsidies; However, blended finance is not a substitute to long term structural issues and to address policies and institutional bottlenecks.
- Is justified when the climate benefits and the socio-economic co-benefits of a project exceed the financial return to investors. In addition, blended finance-funded projects need to demonstrate strong externalities and evidence of market failures and affordability constraints as key barriers to private sector participation.
- Cannot be used to crowd out private and commercial investors to prevent market distortion.

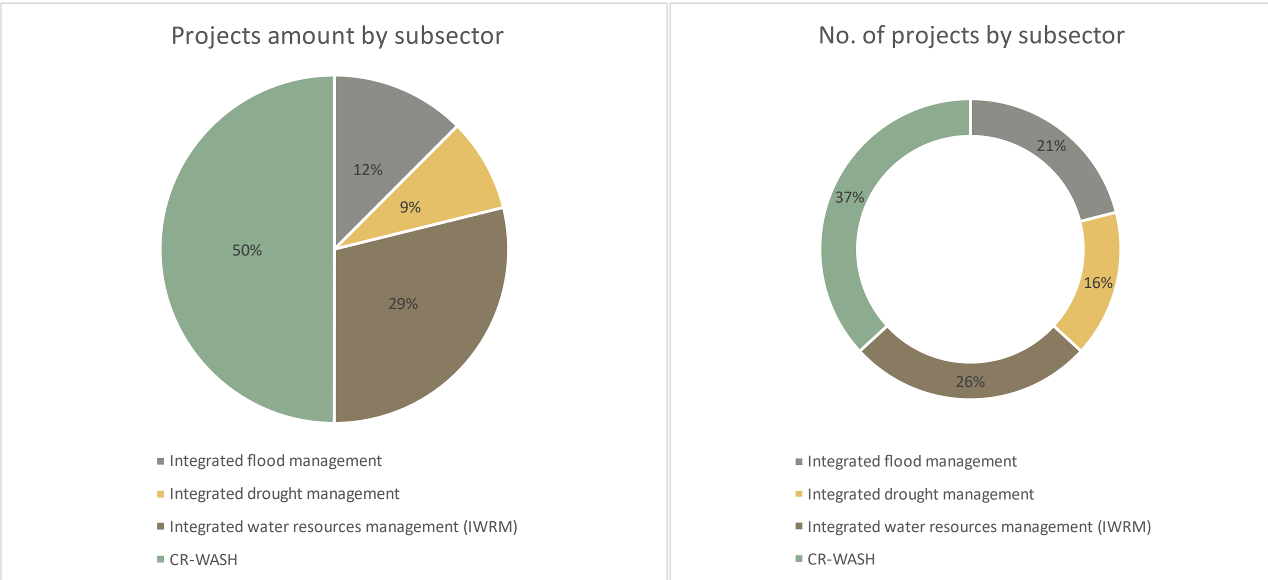
Green, Water (or Blue) and Climate Bonds: Other more recent type of investments vehicles to finance water security programmes are Green, Water (Blue) and Climate bonds. Bonds are a form of debt security offering a fixed interest payment (coupon) over a maturity period. The bonds' sale proceeds can then finance projects with a specific green, water, or climate focus. ***Green Bonds*** are defined as any type of bond instrument where the proceeds will be exclusively applied to finance or re-finance projects with clear environmental benefits, and which are aligned with the four core components of the Green Bonds Principles (ICMA, 2021). ***Water Bonds*** are a growing subset of the green bonds market that encourages investments for a low-emission and climate-resilient economy. As a result, the Climate Bonds Initiative, and its consortium partners (Alliance for Global Water Adaptation, Ceres, World Resources Institute and CDP) released the world's first standard for low-carbon and climate-resilient water bonds. For investors, water bonds can achieve attractive risk-adjusted returns along with climate benefits and environmental co-benefits, in addition to satisfying green investment mandates, without the need for time-consuming due diligence.

Disaster Risk Financing: Disaster risk finance operates through sovereign bonds and disaster risk insurance (agriculture insurance, property/assets catastrophe risk insurance) to financially assist countries in case of natural disasters. Disaster risk finance is highly customised to the disaster risks identified for the country and the level of financial protection required for the population and it can be public finance for disaster funds, contingent lines of credit, and other mechanisms. Thus, disaster risk finance contributes to building resilience to water-related hazards, especially for the vulnerable groups of the population.

4.3 GCF portfolio and financing structures

GCF portfolio in the water sector within the Food, Health and Water Security result area consists of 19 projects approved for about USD 1.5 billion. 90% of the funding proposals in the water sector proposed for GCF financing comes from international AEs and 5% each by regional and national AEs. The GCF water sector portfolio is distributed between IWRM, WASH and Integrated Flood and Drought Management, with WASH alone representing 50% of the GCF funding allocation to the water sector, as shown in Figure 6.

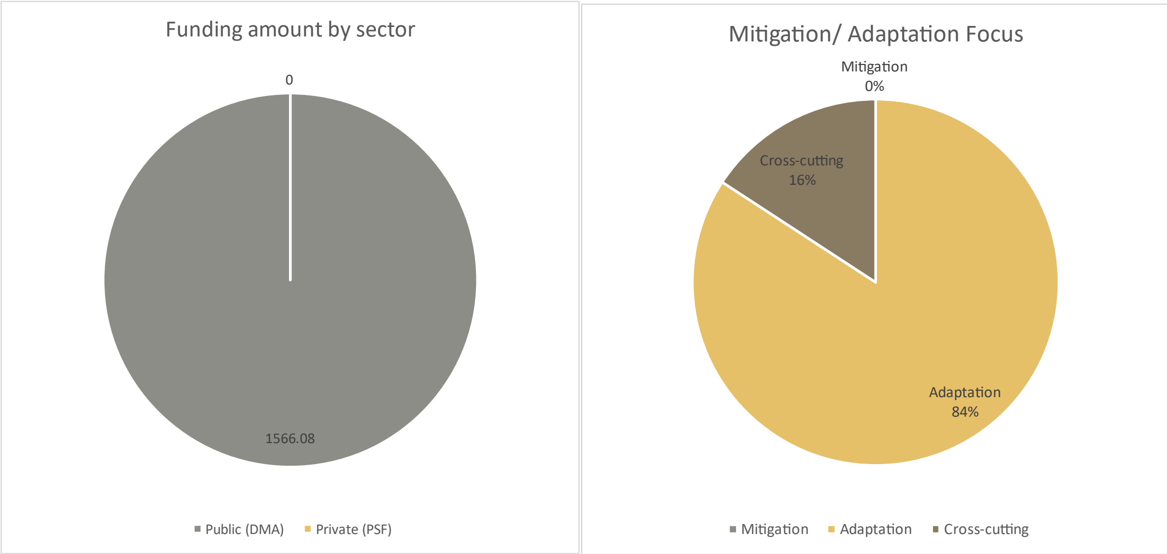
Figure 6: GCF water sub-sectors distribution



Source: Green Climate Fund

To date, grants investment is the only form of GCF financing in the water sector coming from the public sector window of the GCF. The majority (84%) of water projects focuses on climate adaptation and the balance on cross-cutting. There are no pure mitigation projects, as indicated in Figure 7.

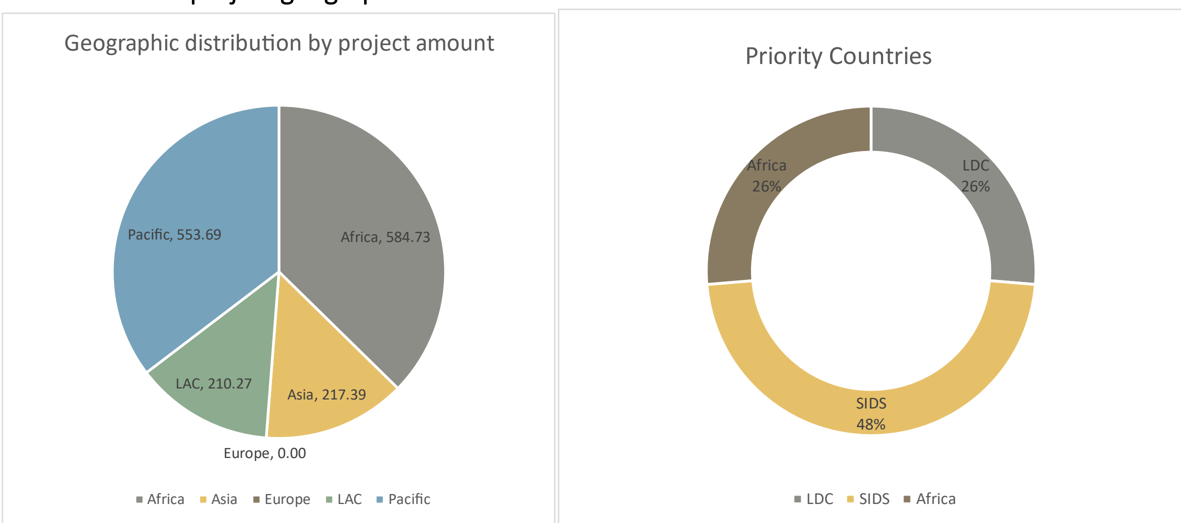
Figure 7: GCF water project funding amount and climate focus



Source: Green Climate Fund

Most water projects financed by the GCF in the water sector are micro and small for 42%, medium for 42%, and 16% for large projects.[5] The water projects are well distributed geographically, with 74% of the projects located in the GCF priority countries in Africa; SIDS and LDC (refer to Figure 8).

Figure 8: GCF water project geographic distribution



Source: Green Climate Fund

GCF funded projects in the water sector directly benefit 6.6 million people with a gender-sensitive approach and a total population of over 39 million indirectly.

The renewed interest from NDAs on water security from the NDCs should generate a new category of water infrastructure projects funded by concessional loans for public-funded projects and programmes and commercial loans for the private sector. The overall approach to finance in water security is to focus on high to extreme water stressed countries or project areas where water availability is threatened when water withdrawal is over 40% of renewable water resources.

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5 The scale of supported projects uses GCF project size categories: Micro: <USD 10m; Small: USD 10-50m; Medium: USD 50-250m; Large: >USD 250m. See Annex I to decision B.08/02

Scaling up solutions for climate change mitigation and adaptation in water security supporting the two inter-linked paradigm shifting pathways of water conservation and preservation of water requires the mobilisation of private and commercial capital to support countries facing with limited public funding available. Funding for climate-friendly water projects (USD 10 billion per year, plus funding from cross-cutting sectors, primarily through adaptation finance, which totals USD 30 billion annually) lags significantly behind the demand for water infrastructure funding and resilient water security management. As part of overall finance structuring strategies for water security, all the financial instruments described can be used for financing water security initiatives. Grant financing is often required to structure new investment opportunities at their earliest stages and reach last mile water infrastructure and services to increase the resilience of the most vulnerable population. In contrast, high concession finance, including blended finance or risk guarantees, are required to advance larger pilot projects.

New Water Asset Class: in 2020, the GCF approved a concept note for the *South Africa Water Re-Use Programme* with a grant for the project preparation to the Development Bank of South Africa (direct access entity): the proposed project will create a new water asset class in water re-use by using credit enhancement to crowd in private sector funding targeted towards developing debt capital market in line with ESG impacts and help to meet the targets set in the Paris Agreement and contribute to UN SDGs (Goal 6 –clean water and sanitation; Goal 13 climate action; Goal 14 – sustainable oceans and Goal 17– Partnerships with the involvement of the private sector).

Tracking existing financial flows reveals significant regional divergences (limited green and water bonds and private equity investment in Latin America and Africa for various reasons). Thus, the GCF can play an important role in developing new markets. Still, in situations where existing institutional capacity is low and investor risk perception is high, this would initially be in the form of technical assistance and policy development in collaboration with selected AEs and recipient countries to create an enabling environment, rather than directly scaling up financial flows. While there is undoubtably a need to leverage public domestic flows and private finance, to help address the financing gap, considering the broader political issues around the international commitments to adaptation finance. Furthermore, previous studies on the Private Sector Initiative of the UNFCCC Nairobi work programme have documented the disconnect between the ten 'adaptation finance criteria' and the private sector reality. Therefore, GCF can ensure projects and programmes' activities align with the UNFCCC goals, and finance flows to the poorest and most vulnerable.

The GCF 2020-23 Strategic Plan recognises that the GCF is designed to take more risks than other major public and private investors and accept some failures in the interest of demonstrating innovative solutions and delivering climate impact. Risk financing unlocks projects that would not have happened without GCF financing. Mobilising conventional sources of finance further multiplies that impact. The GCF private sector strategy aims to become more risk-inclined to catalyse private sector projects, initiatives and programmes with high climate impact and paradigm shift potential; support climate-oriented local financial and insurance systems, green banks, markets, and institutions; and act as a market maker for climate transformation in key sectors and regions per national priorities and objectives.

GCF will develop complementary programming with other funders to deliver large-scale transformative changes, strategically leveraging its competitive advantage (country ownership, open collaboration, flexibility of financing instruments and risk appetite). Consistent with the GCF operational framework for complementarity and coherence, the GCF aims to enhance synergy with projects/programmes/initiatives financed by the other key delivery channels of the climate finance, mainly the Global Environment Facility, the Adaptation Fund, and the Climate Investment Funds. There is significant knowledge base and institutional arrangement established already in relation to enhancing complementarity and coherence with these climate funds. As such, GCF aims to enhance synergy with these climate funds by combining resources, upscaling and sequencing interventions, mobilising different financial instruments, building on synergies identified in a previously funded project to complement each other, provided that such an endeavour is strongly anchored on the national priorities.[6] In return, such an endeavour helps maximise the impact of the proposed interventions while ensuring valuable institutional memories are preserved and leveraged

Improving complementarity and coherence requires NDAs, AEs and other stakeholders to identify barriers, norms and processes for design and implementation, resources to invest in and legitimacy: For instance, major actors in international public finance (e.g., foundations, donor institutions) major donor countries and multilateral agencies can be identified and prioritised using the latest Common Reporting Standard data on development assistance. Table 7 shows examples of how NDAs and AEs can work with GCF to align objectives with other international climate finance vehicles to support countries in identifying existing domestic financial mechanisms that can be leveraged for climate and aligning them to climate change goals.

Table 7: Summary of goals and examples of financing instruments

Main Goal of the structure	Financing Instruments Used	Example
Improving the risk/reward profile	**Concessional lending:** The GCF offers a concessional lending window for publicly funded capital-intensive water resources and wastewater management projects for transformational projects in water security. The GCF offers high and low concessional terms and conditions for public sector projects and programmes and commercial loans for private sector-driven water security interventions.	• Increase focus on adaptation supporting a new asset class in sanitation and water re-use. • Initiate projects and programmes with climate smart utilities and climate smart irrigation systems. • Implement pilot IWRM plans to address trans-basin management, water stress, drought, flood conditions, over-abstraction and pollution, and cross-sector impacts to maximise co-benefits. • Maximise the use of digital systems to catalyse climate innovation in water security projects.
Increase the likelihood of social impact	**Result-based financing, performance-based contracts or development bonds:** Payments are made when selected climate resilience objectives are met. Conditional added payments encourage private and commercial investors to meet climate goals and targets.	• Address financial barriers through de-risking to mobilise GCF concessional finance and crowd-in private and commercial funding in water security. • Promote EbM, ecosystems services restoration and regeneration projects including reforestation of watershed with community benefits and natural capital funding for flood resilience and carbon sequestration. • Design water projects around circular economy approaches in water re-use and water recycling, decentralised wastewater and resources recovery, including biogas and nutrients. • Develop transformational projects and programmes across sectors, such as sponge cities for flood resilient design and construction within integrated urban water management.
Technical Assistance – Blended Finance in developing countries often comes with grant support for: (i) Upstream work to improve country readiness to meet the targets set in their NDCs and NAPs, including updating those key documents. Countries identify potential interventions within the eight results areas of the GCF, including water security, to be prepared and implemented by AEs.[7] (ii) Project development to assist AEs with the project preparation and strengthen the climate rationale, the theory of change, and address the six investment criteria of the GCF investment framework to better prepare climate-related projects supporting the country's NDC and NAP.[8] (iii) Technical assistance as part of the project funding for capacity development and institutional strengthening. (iii) Grant investment projects for community-based water security projects; increased resilience of the vulnerable people; and additional co-benefits for gender and Indigenous people.		

[6] Noteworthy is the ongoing programmatic approach between the Global Environment Facility and the GCF on the global e-mobility programmes
[7] The GCF supports countries and NDAs through its Readiness Programme: https://www.greenclimate.fund/readiness
[8] Support for project development can be accessed through the GCF Project Preparation Fund https://www.greenclimate.fund/projects/ppf

In addition, the GCF will strengthen support of GCF priority countries in Africa, SIDS and LDC through DAEs; and enhance recipient countries’ capacity to finance and implement NDCs and NAPs in water security.

5 Case studies

This section provides GCF funded projects for each of the GCF drivers of change. Many of the examples below span pathways and drivers. Still, efforts have been made to identify the most relevant pathways in each example. In addition, the case studies highlight how barriers to climate solutions can be addressed for successful transformations in water security.

5.1 Jordan: Building climate change resilience through water use efficiency in agriculture

Transformational planning and programming

Theme	Integrating into the project design gender responsiveness and recognising women as change agent for climate adaptation		
Country	Jordan	Project size	Small
Adaptation	212,416 beneficiaries	GCF financing	USD 25 million (Grant)
EES category	B	Co-finance	USD 8.25 million
Accredited entity	Food and Agriculture Organization	Co-finance ratio	75%
Approved	March 2021 (B28)	Completion	7 years
Information	FP155: Building resilience to cope with climate change in Jordan through improving water use efficiency in the agriculture sector (BRCCJ)		

Country ambition. To adapt to the country's climate risks, the project aims to increase new supplies of water from wastewater recycling and rainwater harvesting, and to reduce demand on groundwater sources through more efficient cropping and water use practices among vulnerable farmers, and through household adoption of water efficiency devices. Innovative training and mobilisation of "climate wise women" will be introduced to promote sustainable cropping and household water-saving devices

Barriers addressed. Jordan is one of the most water scarce countries in the world with climate change further exacerbating aridity due to increasing temperatures and reduced and more erratic rainfalls. Water security is addressed through a combination of demand management and adoption of new water sources such as water re-use and recycling and rainwater harvesting.

The key barriers in adapting to climate change in the country stem from constraints at the institutional, household and policy level. Government resources and capacity to invest in the water sector are limited with little strategic thinking on how best to address climate induced adverse impacts.

The NAP also identified general weaknesses in public policy and public finance management and weakly defined institutional roles and remits that affect governance and limit the implementation of identified priorities and ensure compliance of existing regulation. At the household level, key barriers include the limited capacity to invest in addressing climate induced water scarcity in the water and agriculture sectors as well as the lack of knowledge on climate change issues and dynamics.

Approach to paradigm shift. The project will shift the paradigm in the agriculture sector from looking at crop productivity per unit of land to crop productivity per unit of water. At the farm level, there is significant potential to promote a paradigm shift through the adoption of climate-resilient practices. As water users become accustomed to the use of recycled wastewater, there is potential for regional recognition of wastewater recycling facilities as an asset class for private investment in arid countries.

Expected impact. The goal of the seven-year project is increased climate resilient sustainable development in the country. In line with the objectives of the climate change policy (2013-2020) and the NAP (2020) the project is designed to increase the resilience to climate change of water management systems and of the farming community.

The project will have three interrelated components which will work synergistically to address key barriers and enhance the impact of project investments. The components are designed to deal with the lack of *infrastructure*, limited capacity of *rural farming households* and weak *institutional* capacity: (i) climate resilient water systems for enhanced water security; (ii) climate change resilience for enhanced livelihoods and food security; and (iii) scaling-up climate adaptation into policy and across actors (institutions, private sector, civil society). In line with lessons learned in Jordan as well as with the GCF Gender guidelines, the project builds on the idea of inclusion of women as change agents for climate adaptation.

5.2 Palestine: Water banking and adaptation of agriculture to climate change in Northern Gaza

Catalysing climate innovation

Theme	Define low carbon water management pathway by increasing water efficiency to increase water availability for sustainable agriculture		
Country	Palestine	Project size	Medium
Adaptation	223,553 beneficiaries	GCF financing	USD 27.9 million (Grant)
EES category	A	Co-finance	USD 24.6 million
Accredited entity	Agence Française de Developpement	Co-finance ratio	53%
Approved	November 2019 (B24)	Completion	5 years
Information	FP119: Water Banking and Adaptation of Agriculture to Climate Change in Northern Gaza		

Country ambition. The State of Palestine is characterised by high climate variability that impacts upon its already depleted water resources. It is estimated that they will experience a water deficit of 271 million cubic meters per year from 2020 due to climate change and population growth. Furthermore, the coastal aquifer is the only freshwater resource in the area, serving the needs of the population and agricultural activities, and its water level is declining at a rapid rate, resulting in a significant intrusion of seawater. Against this backdrop, agricultural inefficiencies in the area lead to the overuse of water and high evaporation, putting additional pressure on the aquifer under the increasing effects of climate change.

Barriers addressed. Water security through adoption of new water sources from water re-use and recycling.

The 13 million cubic meters of water per year recovered from the wastewater treatment plant and infiltrated into the aquifer will reduce the exposure of around 23,553 farmers to climate risks by alleviating the pressure on the aquifer from agricultural activity. In the context of extreme water scarcity, it is expected that this additional resource will free up additional quantities of water to cover the domestic needs of a growing population that otherwise would be used for agriculture (in the baseline scenario).

Approach to paradigm shift. Re-use of treated domestic wastewater within the water cycle creates a multiplier effect, as a key adaptive response to water scarcity. The setup and strengthening of a water quality monitoring and control mechanism, which is paramount to the success of any re-use project, will ensure that water is suitable for agricultural.

Expected impact. The project's goal is to develop an integrated low carbon water management scheme to reduce the impact of climate change and deliver additional amounts of water usable for sustaining agriculture and increasing the resilience of local populations in Gaza. It will achieve this through the following three outcomes: (i) reducing the vulnerability of Gaza's coastal aquifer and securing sustainability of access to domestic and agricultural water; (ii) promoting climate-resilient and water-efficient agriculture; and (iii) enhancing the institutional and operational capabilities for integrated and resilient water management.

5.3 Kiribati: South Tarawa Water Supply Project

Mobilising finance at scale

Theme	Address affordability and willingness to pay for water services to increase the climate resilience of the water services to the users including the vulnerable groups.		
Country	Kiribati	Project size	Medium
Adaptation	62,298 beneficiaries	GCF financing	USD 28.63 million (Grant)
EES category	B	Co-finance	USD 29.45 million
Accredited entity	Asian Development Bank	Co-finance ratio	49%
Approved	October 2018 (B21)	Completion	6 years
Information	FP091: South Tarawa Water Supply Project		

Country ambition. Kiribati is one of the most remote and least developed countries in the world. It faces significant challenges due to its vulnerability to climate change. South Tarawa's water supply is entirely dependent on underground freshwater lenses, the quality and quantity of which are seriously threatened by climate change-induced inundations and prolonged drought. Should such events occur in quick succession, they may reduce the lenses' yield to zero for periods of up to five years. Taking a precautionary approach, the lenses cannot be relied upon as the main water source in a future with climate change.

Barriers addressed. Building a water secure future for the residents of Kiribati's capital, South Tarawa: Water security through adoption of new water sources: Water re-use and recycling.

The project expects to tackle willingness to pay through the awareness campaign, which would aim to strengthen trust in the service and provider and create acceptance and demand for the supply of safe piped water. On the one hand, if the tariffs are set higher than the willingness to pay to achieve financial sustainability, the rate of households connected to the network could result in smaller coverage than expected. Consumers may still choose to use contaminated groundwater over charged piped water. On the other hand, if tariffs are set too low following a low willingness to pay, the excessive financial burden on the government could render the system financially unsustainable.

Approach to paradigm shift. The project can have a useful contribution to testing the viability and cost-effectiveness of desalination in SIDS in the Pacific, many of which are low-lying territories highly vulnerable to even modest sea level rises. The technology is not innovative; however, the use of solar power is an innovative option in the context of the Pacific water sector and well suited to their circumstances, in particular their dependence on very expensive fossil fuel imports.

Asian Development Bank is an active partner in the region and a key player in the eventual replication of desalination in the Pacific SIDS. There are several good opportunities and avenues for knowledge-sharing, including the annual conferences of the Asian Development Bank-supported Pacific Water and Wastewater Association and possible regional desalination events.

Expected impact. The project will provide the entire population of South Tarawa with a reliable, safe, and climate-resilient water supply. To achieve this, the project will (i) construct a new 4,000 cubic meter/day seawater reverse osmosis desalination plant powered by a new solar photovoltaic plant; (ii) rehabilitate and extend the water supply network infrastructure to reduce leakages and ensure that all residents can access the new clean water source; (iii) strengthen relevant institutions, provide capacity-building and establish long-term performance-based contracts for the operation of the new infrastructure; and (iv) deliver an intensive five-year climate change, water, sanitation and hygiene awareness-raising programme with the strong involvement of local civil society organisations.

5.4 Ethiopia: Building gender-responsive resilience of the most vulnerable communities

Coalition and knowledge to scale up success

Theme	Responding to the increasing risk of drought: Building gender-responsive resilience of the most vulnerable communities		
Country	Ethiopia	Project size	Small
Adaptation	1.3 million beneficiaries	GCF financing	USD 45 million (Grant)
EES category	B	Co-finance	USD 4.96 million
Accredited entity	Ministry of Finance and Economic Cooperation	Co-finance ratio	90%
Approved	October 2017 (B18)	Completion	5 years
Information	FP058: Responding to the increasing risk of drought: building gender-responsive resilience of the most vulnerable communities		

Country ambition. Climate projections show high uncertainty with rainfall projections ranging from -25% to +30% by 2050. It has been estimated that droughts alone can reduce total Gross Domestic Product by 1-4% while soil erosion reduces agricultural Gross Domestic Product by 2-3%. If no adaptation measures are taken currently, climate change-induced impacts are projected to result in a 2-10% loss of Gross Domestic Product by 2045 relative to baseline growth. Given Ethiopia's general low level of economic development, it is particularly vulnerable to the adverse impacts of climate change. Climate change is further increasing this uncertainty in three main ways: (i) continued temperature increases of 0.8 to 2.7°C; (ii) continued rainfall variability with more frequent extremes; (iii) parts of the country could see changes in key seasonal rainfall.

Barriers addressed. Providing rural communities with critical water supplies for year-round drinking water and small-scale irrigation to address risks of drought and other climate impacts: Water security through IWRM in general and integrated drought management in particular.

The project will generate a discernible climate change adaptation structurally through mainstreaming gender equality and of climate change adaptation into development plans and operations through: (i) increased resilience of most vulnerable (~10-12% of those most severely impacted by drought crisis); (ii) increased resilience of health and well-being, and food and water security; and (iii) rehabilitation of degraded lands through building physical and biological moisture and soil conservation structures.

Approach to paradigm shift. The project is scaling up nationally and uses a design adapted from a project in India through: (i) advances and experiences to be documented and shared through institutional partnership research; (ii) targeted approach to water supply, natural resource management and enabling environment; (iii) partnership implementation model, strengthening institutional linkages and collective understanding of and practical solutions to the water security risks; and (iv) Supporting national strategy.

Expected impact. The project uses an IWRM approach that can respond to the adaptation needs of 330,000 individuals residing in drought-vulnerable areas with three components: (i) delivering water systems (for example, wells, irrigation schemes) and supporting immediate and medium-term adaptation needs with co-benefits in livelihood improvement, food, health and water security and increased agricultural production; (ii) undertaking activities related to land use, ecosystems and forestry by bringing cross-cutting benefits in mitigation and adaptation while supporting ecosystem-based disaster risk reduction for drought management purposes; and (iii) supporting the creation of an enabling environment through capacity building of the beneficiaries and local governments.

6 GCF Investment criteria for impactful proposals

Proposals to GCF need to align with GCF result areas and are assessed based on six GCF investment criteria, summarised in Table 8 followed by examples of how these criteria could pertain to water security programmes.

Table 8: Examples of questions, indicators, and investment criteria examples for the two-water security paradigm shifting pathways

Example of translation of the investment criteria for water security project	Enhance water conservation, water efficiency and water re-use	Strengthen IWRM and water management
Impact: High-impact areas in water security are those with high to extreme water stress, where paradigm shifting pathways support: (i) low carbon development with demand management for water conservation, water efficiency, and water re-use, maximising smart systems for climate smart utilities and climate smart irrigation systems. (ii) climate resilience with preservation of water for IWRM through climate proofing of water infrastructure, developing new asset class in sanitation and water re-use and recycling maximising EbM.	• Reduced tons of carbon dioxide equivalent and increased carbon sequestration measured through carbon sinks. • Reduction of waterborne diseases. • Reduction of water pollution: area of healthy wetlands and rivers. • Number of income generating activities that address the complete water cycle; volume of water re-use to recharge aquifers and environmental flows. • Volume biogas and biomass used as renewable energy sources. • Volume of water supplied for example to the agricultural and/or industrial sector and water quality improved. • Volume of water saved.	• Number of people and communities more resilient to climate change risks in water security: temperature and precipitation increase/ decrease; flood; landslide; water availability; sea level rise; solar radiation change; wind speed increase/decrease. • Number of people and communities with access to safely managed water supply and sanitation (as per UN-SDG6). • Number and level of stakeholder engagement in water management especially in key decision-making processes. • Number of policies supporting increased water access.
Paradigm Shift: For a paradigm shift in water security to occur, there is a strong need to move climate finance from grant funding to concessional finance and then enable private and commercial finance for significant scale-up and replication to meet the financing need of the water sector.	• Additional climate finance mobilised in water security. • What technologies and methodologies can reduce GHG emission through water efficiency (reduced energy consumption) and demand management? • How to maximise volume of biogas and biomass recovered from wastewater and used as renewable energy source, area of reduced deforestation? • Number of low-carbon development solutions implemented in water security. • Number of solutions to improve financial viability and/or operational performance implemented by private entities in water security.	• Would mainstreaming IWRM in NDCs and NAPs ensure that water security is prioritised in policies and investments? • What innovative climate-resilient approaches can be implemented including EbM? • How to apply proper governance mechanisms to improve water security impacted by extreme events and hazards? • Number of measures supported in implementation to improve capacity of public organisations to promote the private sector and finance sector. • Number of measures to improve shared capacity of DMCs to mitigate or adapt to climate change supported in implementation.
Sustainable Development: Proposals to the GCF need to establish their sustainable development potential based on UN-SDG6 which identifies 724 climate	Environmental benefits: • Reduced pollution resulting in environmental improvement in water quality; water resources; watershed resilience through EbM	Environmental benefits: • Quantify land improved through climate-resilient irrigation infrastructure.

Example of translation of the investment criteria for water security project	Enhance water conservation, water efficiency and water re-use	Strengthen IWRM and water management
actions across water security (NDC-SDG Connections, 2022), as well as gender and minority sensitive development impact. Placing gender equality and women's empowerment at the core of projects is critical to achieve sustainable development. Proposals must demonstrate how synergies are enhanced and trade-offs between carbon and other social and environmental goals and targets are reconciled. Projects should take a pathway approach, by supporting enabling environment (e.g., laws, plans, capacity development). Such approaches can be designed using the Water Security Theory of Change. Environmental, social, and other co-benefits are vital to build legitimacy and enable the depth of change required to ensure sustainability.	within a circular economy approach. • Number of sustainable water-food-energy security nexus solutions implemented. Social benefits: • Water security reduces waterborne or water-related diseases through clean water for drinking, cooking, bathing, and washing clothes. Economic benefits: • Address water as a limiting factor for growth and local economic development. • Quantify how the pathway activities help achieve or contribute to UN-SDG6, noting that there are many cross-cutting linkages to a variety of UN-SDGs. Gender-sensitive development impact: • Number of women with increased capacity in implementing mitigation and low-carbon development actions in water security. • Number of gender-inclusive climate and disaster resilience capacity development initiatives implemented.	• Quantify area with reduced flood risk. • Number of solutions to conserve, restore, and/or enhance terrestrial, coastal, and marine areas implemented. Social benefits: • Valuing local and traditional knowledge including indigenous peoples, in decision-making and recognising the need for widespread community support contributes to cultural preservation. Economic benefits: • Economic value of property and business protected from climate change hazards. • Number of measures to improve shared capacity of recipient countries to mitigate or adapt to climate change for water security supported in implementation. Gender-sensitive development impact: • Number of climate- and disaster-resilient infrastructure assets and/or services for women and girls established or improved. • Number of community-based initiatives in water security to build resilience of women and girls to external shocks implemented.
Recipient Needs: a strong proposal describes limitations in institutional support at the national level and includes specific plants for developing capacity through education on regulations and mechanisms for implementing and monitoring compliance. Local organisations can be involved in creating inclusive community level associations, knowledge hubs and co-management bodies to build legitimacy and share lessons (traditional and scientific) to contribute to understanding of methodologies and standards. Proposals can indicate the vulnerability in water security and how it is addressed by the recipient. Monitoring systems should include	Vulnerability of the country: Population faced with livelihood and non-economic losses (cultural heritage, Indigenous knowledge, societal/cultural identity). Socio-economic development in affected populations. Strengthening institutional capacity. Vulnerable groups and gender aspects: High vulnerability of certain groups due to: lack of access to affordable financing; high level of dependence on water heavily affected by external pressures; low-income livelihoods exposed to climate change impact; lack of legal protection and tenure uncertainty; particularly vulnerable groups in national climate or development strategies, with gender disaggregation.	Vulnerability of the country: • What policy interventions in the water sector can be prioritised in national adaptation planning? • How to establish community of learning on climate-responsive WASH planning, project design and financing? Vulnerable groups and gender aspects: • Are vulnerable groups (women, girls, and youth) targeted in the climate policies? • Are the vulnerable groups involved in the implementation of the EbM to derive both economic and environmental benefits?

Example of translation of the investment criteria for water security project	Enhance water conservation, water efficiency and water re-use	Strengthen IWRM and water management
tools available as well as training and integration with stakeholders. Developing participatory monitoring creates stakeholder ownership, especially full and continuous participation of relevant under-represented stakeholders, such as Indigenous peoples and community leaders throughout the process.		
Country Ownership: Beyond alignment with national climate strategies and policies, country ownership requires extra effort to bring together ministries, NDAs and constituents from different government areas, – such as finance, planning and development as well as line ministries such as environment, construction/public works, water, energy, agriculture – and from different levels of governance (national, sub-national, and local). IWRM at the core of UN-SDG6 using digital innovation and EbM approaches can bridge sectoral divides, enhance synergies and maximise benefits and co-benefits.	• What strategic engagement can support the development of country programmes and policies that deliver resilient and low carbon water services to the most vulnerable? • Does the proposal show coherence with other national and sub-national actions to conserve, restore or value water availability; new institutional, governance, or coordinating mechanisms; stakeholder engagement, including showing that project has been developed in consultation with civil society organisations and other relevant stakeholders, with particular attention to gender equality; has sought the free, prior and informed consent of potentially affected Indigenous Peoples (where relevant) and includes mechanisms for the ongoing stakeholder engagement?	• Does the proposal demonstrate consistency with national climate strategy or plan, including priorities identified in NDCs and NAPs, related to water security? • How are the country leadership and institutions promoting the inclusion of WASH in the upstream of the planning process (i.e. from the onset in the IWRM, NAP and NDC planning process to ensure that sustainable WASH is prioritised in sectoral policies and investments). • Can the planning for management of water-related risks be embedded in river basin or coastal zone planning processes?
Efficiency and Effectiveness: To demonstrating efficiency and effectiveness, successful proposals show that a proposed project builds on best practices and lessons learned. Private sector participation should go beyond corporate social responsibility, including for example, alignment with the Equator Principles. The project design should also include economic and financial analysis to illustrate the high impacts and capture all the co-benefits, as well as maximise financial sustainability through a combination of direct and indirect charges to	• Cost-effectiveness and efficiency regarding financial and non-financial aspects: appropriateness of concessionality, for example does the project identify a market failure that justifies the need for public financing, or do the outputs have characteristics of public goods? • Are industry best practices, lessons learned, and a degree of innovation employed, including those of Indigenous Peoples and local communities and best available technologies including EbM and digital solutions?	• Can BF and PPPs scale up investments in solving specific local or national water security challenges? • Who else is financing similar interventions in the same geographies? • Will promoting water security create demand and new markets? • Does the water project have the potential to catalyse other investment (co-financing)? Is there long run financial viability (after GCF)? • Opening opportunities to the income-generating capacity of water supply projects and thereby encouraging private sector participation in this sub-sector.

Example of translation of the investment criteria for water security project	Enhance water conservation, water efficiency and water re-use	Strengthen IWRM and water management
prevent gaps in O&M and ageing water infrastructure.		

7 Conclusion

Water security influences and is intertwined with all aspects of societal prosperity. Most developing countries are facing hydrological challenges of varying types and severity compounded by climate change. Reducing the water security sector to categories helps identify key recommendations for driving a sectoral paradigm shift; however, it is critical not to lose sight of the holistic nature of water: Thematically, water is a human right, supported by integrated water resources management at the core of UN-SDG (Goal 6 *Clean Water and Sanitation)* under pressure from climate change. Cross-referencing the targets of UN-SDG6 and UN-SDG (Goal 13 *Climate Action)* indicates that water security supports fast tracking climate investment into transformational water projects in two inter-linked paradigm shifting pathways presented in this Guide.

The first pathway "**Enhancing water conservation, water efficiency and water re-use"** compels water demand management and competitive water use within the water-food energy nexus, by enhancing water efficiency and distributed water management, removing barriers for water re-use as an alternative water source. This includes a focus on demand management, specifically on water re-use and water efficiency.

The second pathway "**Strengthening integrated water resources management and water management"** encompasses climate proofing of the water infrastructures promoting preservation of water at each step of the water cycle, by maximising technological, institutional, and financial innovation and supporting principles of a circular economy. Specifically, this includes the preservation of water resources, water supply including from new sources, and protection from water related hazards.

Key recommendations needed to drive a paradigm shift in water security are described in connection to the four key drivers of transformational change:

Transformational planning and programming:

- Maximise design measures using a portfolio approach to combine low-emission and resilient water security interventions designed for long-term capacity building instead of short-term project delivery.
- Support technical assistance to develop strategic national and regional road maps that could include adaptive plans for water and wastewater infrastructure, national water security frameworks or prioritisation programmes of watersheds for integrated flood and drought management.
- Foster transboundary dialogue on water security and enable frameworks for dispute resolution.

Catalysing climate innovation:

- Target the many ways that digital solutions and technologies can de-risk and support real-time solutions to water security; improve drought and flood management; integrate social participation in decision making and improve the accuracy of site selection.
- Intensify investment in existing and new technologies to de-risk the water sector: In particular, promoting ecosystem-based management and circular economy approaches, increasing coverage of digital solutions and decentralised water management offer climate resilient and low-emission pathways.
- Strengthen social enterprise, impact models, and community-based financing models that couple sustainable financing with evidence-based actions to improve water security objectives.

Mobilising finance at scale:

- Foster innovation in bringing capital to markets by leveraging public resources to catalytically invest in water security interventions that address climate-related risks and greenhouse gas emissions reductions.
- Promote private investment at the project and portfolio levels by leveraging guarantees in blended finance mechanisms, such as PPP, for risk mitigation.

- Collaborate with development finance institutions, international finance institutions, and “patient capital” private investors to mobilise investment at the portfolio level and support the expansion of domestic financial investment throughout the water sector.

Coalition and knowledge to scale up success:

- Elevate participatory evaluation in the design of water security interventions to encourage behaviour change and adaptive learning models across stakeholders for increased impact coverage in water security;
- Boost effective knowledge exchange; strengthen national, regional, and global alliances; and build platforms for knowledge sharing and mentorship within the broad water security space;
- Advocate for the development of transparent, safe, and secure public data repositories in water security and sponsor cross-sectoral applications and capacity building for analysis of water security data.

The Water Security Sectoral Guide will be supplemented by future technical annexes for example flood management, sponge cities, smart water management, and circular economy supports stakeholders in developing robust funding proposals based on the two inter-linked paradigm shifting pathways within the GCF Theory of Change.

References

Alberto Boretti and Lorenzo Rosa. "Reassessing the Projections of the World Water Development Report." *Npj Clean Water* 2, no. 1 (2019).

American Geosciences Institute. "Managed Aquifer Recharge." https://www.americangeosciences.org/geoscience-currents/managed-aquifer-recharge.

Baumann D.D., J.J Boland, J. H. Sims. "Water Conservation : The Struggle over Definition." Water Resources Res, 1984.

Bill Kingdom, Gerard Soppe and Jemima Sy. "What is non-revenue water? How can we reduce it for better water service?" World Bank Blogs. (2016). https://blogs.worldbank.org/water/what-non-revenue-water-how-can-we-reduce-it-better-water-service.

Boretti, Alberto, and Lorenzo Rosa. "Reassessing the Projections of the World Water Development Report." *Npj Clean Water* 2, no. 1 (2019/07/31 2019): 15.

Brears, R.C. *Blue and Green Cities: The Role of Blue-Green Infrastructure in Managing Urban Water Resources.* Palgrave Macmillan UK, 2018.

———. *Climate Resilient Water Resources Management.* Cham, Switzerland: Palgrave Macmillan, 2018.

———. *Developing the Circular Water Economy.* Cham, Switzerland: Palgrave Macmillan, 2020.

———. "Financing Water Security." Mark and Focus, https://medium.com/mark-and-focus/financing-water-security-a7cf7caf8881.

———. *Nature-Based Solutions to 21st Century Challenges.* Oxfordshire, UK: Routledge, 2020.

———. *Regional Water Security.* Wiley, 2021.

———. *Urban Water Security.* Chichester, UK; Hoboken, NJ: John Wiley & Sons, 2016.

———. *Water Resources Management: Innovative and Green Solutions.* De Gruyter, 2021.

Chotpantarat, Srilert, and Satika Boonkaewwan. "Impacts of Land-Use Changes on Watershed Discharge and Water Quality in a Large Intensive Agricultural Area in Thailand." *Hydrological Sciences Journal* 63, no. 9 (2018/07/04 2018): 1386-407.

"Circular Cities: A Circular Water Economy for Cleaner, Greener, Helathier and More Prosperous Cities." World Economic Forum, 2021.

CIWEM. "A Blueprint for Carbon Emissions Reductions in the Uk Water Industry." (2013). https://www.ciwem.org/assets/pdf/Policy/Reports/A-Blueprint-for-carbon-emissions-reductions-in-the-water-industry.pdf.

Ellen Macarthur Foundation. "Water and Circular Economy." (2018). https://www.arup.com/-/media/arup/files/publications/w/water_and_circular_economy_whitepaper.pdf.

Environment Agency. "Greenhouse gas emissions of water supply and demand management options." Science Report SC070010. London. (2008)

FAO. "Water for Sustainable Food and Agriculture." (2017a). http://www.fao.org/3/i7959e/i7959e.pdf.

———. "Water for Sustainable Food and Agriculture: A Report Produced for the G20 Presidency of Germany." (2017b). http://www.fao.org/3/a-i7959e.pdf.

Gandiglio, Marta, Andrea Lanzini, Alicia Soto, Pierluigi Leone, and Massimo Santarelli. "Enhancing the Energy Efficiency of Wastewater Treatment Plants through Co-Digestion and Fuel Cell Systems." [In English]. *Frontiers in Environmental Science* 5, no. 70 (2017-October-30 2017).

GCF. "Updated Strategic Plan for the Green Climate Fund 2020-2023." (2020). https://www.greenclimate.fund/document/updated-strategic-plan-green-climate-fund-2020-2023.

Government of the Netherlands. "Valuing Water: A Conceptual Framework for Making Better Decisions Impacting Water." (2020). https://www.government.nl/documents/reports/2020/01/31/valuing-water-a-conceptual-framework-for-making-better-decisions-impacting-water.

Griffiths-Sattanspiel Bevan, Wilson Wendy. "The Carbon Footprint of Water." Portland: River Network, 2009.

"Guidelines for State Water Management Planning.". US Water Resource Council, 1980.

GWP. "Water Demand Management: The Mediterranean Experience." (2012). http://www.gwp.org/Global/ToolBox/Publications/Technical%20Focus%20Papers/01%20Water%20Demand%20Management%20-%20The%20Mediterranean%20Experience%20(2012)%20English.pdf.

———. "What Is Iwrm?" https://www.gwp.org/en/GWP-CEE/about/why/what-is-iwrm/. (2011)

Hallegatte, Stephane, Jun Rentschler, and Julie Rozenberg. "Lifelines: The Resilient Infrastructure Opporunity." (2019). Sustainable Infrastructure Series. Washington, DC: World Bank. Doi: 10.1596/978-1-4648-1430-3. https://documents1.worldbank.org/curated/en/775891600098079887/pdf/Lifelines-The-Resilient-Infrastructure-Opportunity.pdf.

HLPE. "Water for Food Security and Nutrition. A Report by the High Level Panel of Experts on Food Security and Nutrition." (2015). http://www.fao.org/3/av045e/av045e.pdf.

Hubert Jenny, Yihong Wang, Eduardo Garcia Alonso, Roberto Minquez. "Using Artificial Intelligence for Smart Water Management Systems." Asian Development Bank. (2020). http://dx.doi.org/10.22617/BRF200191-2.

ICMA. “Green Bond Principles (GBP).” (2021). https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/green-bond-principles-gbp/.
IEA. “Water-Energy Nexus: World Energy Outlook Special Report.” (2017). https://www.iea.org/reports/water-energy-nexus.
“International Demand Management Framework.” Sydney UTS, 2006.
IPBES. “Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.” (2019). https://ipbes.net/sites/default/files/inline/files/ipbes_global_assessment_report_summary_for_policymakers.pdf.
IPCC. “Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.” (2021). https://www.ipcc.ch/report/ar6/wg1/.
———. “Climate Change 2022: Impacts, Adaptation and Vulnerability I Summary for policymakers.” (2022). https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_SummaryForPolicymakers.pdf.
IWA. *Source Magazine “*Climate Smart Utilities*”* p.18. London. (2020).
Katja Luxem. “Managed Aquifer Recharge: A tool to replenish aquifers and increase underground water storage.” (2017). AGI. https://www.americangeosciences.org/geoscience-currents/managed-aquifer-recharge.
Kauffmann, Céline. “Financing Water Quality Management.” *International Journal of Water Resources Development* 27, no. 1 (2011/03/01 2011): 83-99.
Kumar, Pankaj, Rajarshi Dasgupta, A. Brian Johnson, Chitresh Saraswat, Mrittika Basu, Mohamed Kefi, and K. Binaya Mishra. “Effect of Land Use Changes on Water Quality in an Ephemeral Coastal Plain: Khambhat City, Gujarat, India.” *Water* 11, no. 4 (2019).
“Making Blended Finance Work for Water and Sanitation.” 2019.
NDC-SDG Connections. “SDG 6: Clean water and sanitation.” 2022. Retrieved from https://klimalog.die-gdi.de/ndc-sdg/sdg/6/Average.
McDonald, Robert I., Katherine Weber, Julie Padowski, Martina Flörke, Christof Schneider, Pamela A. Green, Thomas Gleeson*, et al.* “Water on an Urban Planet: Urbanization and the Reach of Urban Water Infrastructure.” *Global Environmental Change* 27 (2014): 96-105.
OECD. “Investing in Climate, Investing in Growth,” OECD Publishing, Paris, (2017). http://dx.doi.org/10.1787/9789264273528-en
———. “Financing Water: Investing in Sustainable Growth.” https://www.oecd.org/water/Policy-Paper-Financing-Water-Investing-in-Sustainable-Growth.pdf. (2018)
———. “Global Material Resources Outlook to 2060. Economic Drivers and Environmental Consequences: Highlights.” (2018). https://www.oecd.org/environment/waste/highlights-global-material-resources-outlook-to-2060.pdf.
———. “Financing a Water Secure Future.” (2022). https://www.oecd-ilibrary.org/environment/financing-a-water-secure-future_a2ecb261-en.
———. “Making Blended Finance Work for Water and Sanitation: Unlocking Commercial Finance for SDG 6.” (2019). https://www.oecd.org/environment/resources/making-blended-finance-work-for-sdg-6-5efc8950-en.htm.
“Public Private Partnerships Reference Guide Version 3.” Washington DC: World Bank, 2017.
Sadoff C.W, D. Grey, J. Hall. “Securing Water, Sustaining Growth : Report of the Gwp/Oecd Task Force on Water Security and Sustainable Growth.” OECD, 2015.
Sierra-Escalante K., M. L. Laurisden. “Blended Finace – a Stepping Stone to Creating Markets.” International Finance Corporation, 2018.
Stanford Water in the West. “Water Finance: The Imperative for Water Security and Economic Growth “ (2018). https://waterinthewest.stanford.edu/sites/default/files/Water_Finance_Water_Security_Economic_Growth.pdf.
UN. “United Nations General Assembly Resolution 64/292.” New York. (2010).
———. “The 2030 Agenda for Sustainable Development.” New York. (2015).
UN-Water. “The United Nations World Water Development Report 2018: Nature-Based Solutions for Water.” (2018). https://unesdoc.unesco.org/ark:/48223/pf0000261424.
———. “Water and Jobs.” (2016). https://unesdoc.unesco.org/ark:/48223/pf0000244040/PDF/244040eng.pdf.multi.
———. “Water Scarcity.” (2022). https://www.unwater.org/water-facts/scarcity/.
UNDESA. "World Urbanization Prospects. The 2018 Revision." (2019a).
———. "World Population Prospects 2019: Highlights." (2019b). https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf.
UNESCO. “The United Nations World Water Development Report.” Paris. (2020)
"Waste Not Want Not." 2003.
WBCSD. "Water and Sustainable Development: A Business Perspective." (2005). http://docs.wbcsd.org/2005/10/Water_SusDev_BusinessPerspective.pdf.
Winpenny, J. "Water Fit to Finance?": World Water Council, OECD, 2015.
WHO & UNICEF. https://washdata.org (2022).

WMO. “*United in Science.”* Geneva. (2020).
Wong, P. P., I. J., Gattuso, J.-P., Hinkel, J., Khattabi, A., McInnes, K. L., . . . Sallenger, A. “Coastal Systems and Low-Lying Areas.” Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. (2014)
World Bank. "The Challenge of Reducing Non-Revenue Water in Developing Countries--How the Private Sector Can Help : A Look at Performance-Based Service Contracting." (2006). https://openknowledge.worldbank.org/handle/10986/17238.
———. “Charting Our Water Future: Economic Frameworks To Inform Decision-Making.*”* McKinsey & Company. (2009). Retrieved from www.2030wrg.org.
———. "The Costs of Meeting the 2030 Sustainable Development Goal Targets on Drinking Water, Sanitation, and Hygiene " (2016a). https://openknowledge.worldbank.org/bitstream/handle/10986/23681/K8543.pdf?sequence=1&isAllowed=y.
———. “Enabling Infrastructure Investment: Using performance-based contracts to reduce non-revenue water.” (2016b). https://ppiaf.org/documents/3531/download.
Zhang, Qian, Jun Nakatani, Tao Wang, Chunyan Chai, and Yuichi Moriguchi. "Hidden Greenhouse Gas Emissions for Water Utilities in China's Cities." *Journal of Cleaner Production* 162 (2017/09/20/ 2017): 665-77.

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