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POLICY ANALYSIS

Aligning economic development and water policies in small island developing States

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Introduction

1 INTRODUCTION

Small island developing States (SIDS) are among the most water-scarce countries in the world, with seven in ten SIDS facing risks of water shortage, including nine in ten low-lying SIDS (UNESCO, UNEP, 2016). Water being an element of life, its scarcity undermines fundamental priorities, such as the human right to clean water and sanitation and the conservation of habitat and biodiversity.

By extension, water scarcity constrains economic development in SIDS. A limited availability of freshwater impacts, for example, the feasibility of developing water-intensive industries that might otherwise be suited to SIDS' contexts, such as fish processing, beverages, textiles, or smelting and refining metals. From a different angle, water scarcity impacts the feasibility of more productive production models, in particular irrigated agriculture. Scarcity also imposes zero-sum compromises in the allocation of water between the production of, on one hand, essentials such as food and energy and, on the other hand, commercial goods and services.

In SIDS where water scarcity precludes investments in higher-value industries, or in other productive capacities, such as infrastructure, human capital or institutions, it constrains the structural transformation of the national economy, limiting long-term development and growth prospects.

Climate change is steadily exacerbating the strategic risk posed by water scarcity. SIDS are highly exposed to climate changes such as sea level rise, changing rainfall patterns and more frequent and severe weather events, all of which threaten to reduce the availability of freshwater resources (Nurse, *et al.*, 2014; Oppenheimer, *et al.*, 2019).

Box 1 – Water security and scarcity

UN-Water defines water security as follows. An infographic of the concept is included in Annex 1.

> *"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."*

Meanwhile, "water scarcity" is a general term that covers a spectrum of worsening states of water availability, measured in terms of water supplies per capita. Areas where water supplies fall below 1,700 cubic metres (m^3) per person are under "water stress"; those below 1,000 m^3 per person are "water scarce" and those with less than 500 m^3 of water per person face "absolute scarcity".

Despite the strategic threat posed by mounting scarcity, water security is only sporadically treated in SIDS' economic development plans. By contrast, many of their plans are tempered with policies to build resilience and mitigate other major risks to their sustainable development, such as climate change adaptation, disaster risk reduction and ensuring food security.

A handful of SIDS' economic plans include measures to ensure access to clean water and sanitation, a human right embodied in Sustainable Development Goal (SDG) 6.[1] While access is fundamental, it is only one component of a broader approach to ensuring water security.

Water security considerations in economic planning include governance questions, such as: how to align economic development and water security objectives; and what priority economic uses have, relative to other uses, in the allocation of scarce water resources. At the strategic level, a water-secure approach

[1] Member States recognized the importance of sustainable water management in the 2014 SIDS Accelerated Modalities of Action (SAMOA) Pathway, under "water and sanitation", committing to assist SIDS in building capacity, constructing infrastructure and improving water management practices. See: Resolution adopted by the General Assembly on 14 November 2014, 69/15: Small Island Developing States Accelerated Modalities of Action (Samoa Pathway). Paragraphs 64-65. Available at: https://sustainabledevelopment.un.org/sids2014/samoapathway. Retrieved 5 November 2020.

could inform the selection of water-efficient industries and/or production models and plot how economic users could contribute to conserving scarce water resources. At the regulatory level, economic plans could stipulate standards and targets – such as for water efficiency, productivity and circularity – for evaluating new productive investments or monitoring existing sectors and firms.

Without including explicit water security priorities and mitigation measures in their economic development plans, SIDS risk pursuing unsustainable strategies. This could lead to outcomes such as: firms being unable to secure a cost-effective supply of water needed to operate and compete; overconsumption by economic users, thereby exacerbating water scarcity; and, indeed, an embedded conflict between SIDS' economic development and water security priorities.

In the opposite direction, economic plans can also contribute to integrated water management efforts. For example, in line with the theme of World Water Day 2021 – " Valuing Water"[2] – the planning process can identify and prioritize the multiple values – both qualitative and quantitative – that economic users assign to water. Economic values can be combined with those from other uses, as part of a national multi-value approach to water governance, as recommended by the United Nations (2021), which can inform management, allocation and investment decisions. Water-related data collected in economic sectors can bolster integrated water management efforts. And enshrining water security priorities and standards in economic plans can drive behaviour change, helping overcome a major hurdle for effective water management.

In this paper, we analyse how SIDS can better align their economic development and water management policies to support the productive transformation of their economies, in particular by incorporating water security and water productivity into their economic plans. In Section 2, we elaborate the fundamental and multi-faceted relationship between water and economic development and present short case studies of both success and failure in considering water security in economic plans.

In Section 3, we profile the use of water as an input in productive economic activities in SIDS – including agriculture, industry and electricity generation – using water footprint and virtual water trade data, to identify key considerations for water-secure economic policies.

Section 4 summarises our analysis of how well economic policies in SIDS incorporate water security and productivity, using national development plans as our research object. The section closes with an identification of policy gaps that SIDS must fill to better incorporate water security and productivity in their economic plans.

In Section 5, we present our policy recommendations to address the considerations and gaps identified in the paper, towards more water-secure, sustainable economic plans in SIDS.

For this study, we used the list of 38 United Nations Member States classified as SIDS.[3] The list appears in Annex 2.

This paper seeks to complement efforts, notably the Integrated Water Resource Management (IWRM) approach, to incorporate economic considerations into water governance and management in SIDS. We also seek to identify tools for evaluating and balancing the highest and best economic uses for water, to inform allocation decisions. Alignment of economic and water policies contributes to policy coherence in building the resilience of SIDS to strategic threats and structural vulnerabilities, towards more sustainable development trajectories.

We structured the paper on incorporating water security priorities in economic development policies and the use of water in productive economic activities. Nonetheless, there is a two-way relationship between economic development and water security, so the paper also includes some analysis and recommendations for water management policy.

[2] https://www.worldwaterday.org/

[3] https://www.un.org/ohrlls/content/list-sids

2

Water and economic development

2 WATER AND ECONOMIC DEVELOPMENT

Small island developing states (SIDS) face multiple challenges to their economic development. They typically have small land areas, small populations and limited natural resource endowments at their disposal. Their small economies, with limited productive capacity, are often structured narrowly on fisheries, tourism or a few other services. While SIDS depend heavily on trade, especially for imports of staples and inputs, their geographic isolation and dispersion makes inter-island commerce costly and undermines their export competitiveness.

SIDS' economic vulnerability is compounded by extreme exposure to natural disasters and climate change. SIDS societies have long coped with the threat of extreme weather events. Until recently, devastating category-5 storms occurred only once or twice in a generation, allowing time for families, firms and the economy to endure and recover. But as the pace of climate change has accelerated, so too has the frequency and intensity of extreme weather events, creating compound effects and leaving some SIDS economies unable to recover from one storm before the next one strikes (Nurse, *et al.*, 2014).

In this context, economic planners in SIDS face considerable challenges in formulating development strategies that will deliver sustainable economic growth, employment and structural transformation. In spite of their smallness and isolation, they must identify economic activities in which they can compete and use their limited revenue base to invest in building the productive capacities and infrastructure necessary for their development.

In parallel, planners must also fortify their development strategies against SIDS' unique exposure to external shocks. This should involve the aligning economic policies with those designed to mitigate external risks, such as natural disasters or climate change, as well as those aiming to "decouple" economic growth from negative externalities such as air and water pollution, greenhouse gas emissions, environmental degradation or water scarcity.

In this paper, we analyse the coherence between economic development and water management policies in SIDS and how a better alignment can contribute to productive transformation. From this analysis, we recommend ways to better integrate water management priorities in economic planning, towards improving water security and the sustainability of economic development plans in SIDS.

2.1 CONCEPTUAL FRAMEWORK

Water is a unique resource, at once an element of life, a human right and an input for economic production. Through its multiple uses, water has a broad societal value, including for its importance to economic development. Water is a classic economic input, for example, in growing cash crops or in industrial applications. Its societal value broadens as an input in the production of essential goods and services, such as food and electricity. Many cultural traditions and recreational activities are associated with water. Water is also a municipal utility with wide-ranging applications in businesses and public spaces.

At the apex of its societal value, water is an element of life, essential for the conservation of habitat and biodiversity, and for human needs such as drinking water, household and sanitation uses – recognised by the United Nations as "the human right to water and sanitation".[4]

Depending on the country, water's uses may therefore include:

1. A resource for the conservation of habitat and biodiversity;
2. Drinking water and sanitation applications, i.e., a human right;
3. A public utility;

[4] United Nations General Assembly, 2010. Resolution 64/292: The human right to water and sanitation. Available at: https://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/64/292. Retrieved: 7 May 2021.

4. The basis for recreational and cultural activities;
5. An input in the production of essentials, such as food and electricity; and
6. An input in other economic activities, such as growing cash crops or producing commercial goods and services.

All of these uses are factors in sustainable economic development. A healthy population, culture and habitat (i.e., uses 1-4) are indirect but essential inputs to an economy's long-term viability and growth. Meanwhile, water is an important input in productive economic activities (uses 5-6) that contribute directly to economic growth and development.

Indeed, water is ubiquitous in the Sustainable Development Goals (SDGs). Clean water and sanitation feature as SDG 6 and water is a prerequisite for achieving SDGs 2 (zero hunger) and 3 (ensuring healthy lives). Water is a critical consideration in economic goals, such as SDGs 7 (clean energy), 8 (economic growth) and 9 (industry, innovation and infrastructure), as well as environmental goals, such as SDGs 12 (responsible production and consumption), 13 (climate action) and 15 (life on land).

Nevertheless, quantifying water's overall relationship with economic development is difficult, if not impossible. We may be able to measure water's share, as an input, in the growth or value added generated by productive economic activities (uses 5-6 above) – provided detailed data exists. Nevertheless, even among productive activities, not all benefits can be quantified. For example, in many cases, we can calculate the market value of food and energy (use 5), but it is much more difficult to quantify the additional benefits of food and energy security that they ensure. As for non-productive uses (1-4) of water, few methodologies exist to quantify their indirect contributions to growth and development (Sadoff, *et al.*, 2015). Some methodologies exist to estimate the economic value of different categories or uses of water, such as those compiled by Lowe, Oglethorpe and Choudary (2020) for estimating the value of virtual water, but these methodologies are often distinct to each use or category of water and rely on limited datasets, all of which complicates comparisons of their findings across uses or categories of water.

Water's relationship with economic development also flows in both directions, further complicating its definition. For example, many advanced economies are among the most water-secure countries in the world, while developing economies, particularly LDCs and SIDS, are among the most water-scarce. In parallel, advanced economies have invested far more than developing countries in, for example, conserving existing water resources, developing costly new ones, as well as implementing water-saving infrastructure, management systems and production methods (Sadoff, *et al.*, 2015).

From these facts, do we infer that a country's available water resources predetermine its development potential? That economic development in advanced economies was water-secure, while water-scarce developing countries are following unsustainable strategies? Or that the wealth generated by economic development, coupled with effective policies and investments, determine a country's water security?

Economic literature offers no definitive answers to these questions, emphasising the need for a multi-dimensional approach to understanding the relationship between economic development and water security. This includes studying the relationship in both directions, i.e.: how economic development and water management decisions can help or hinder each other (United Nations, 2015).

Absent quantitative methodologies, water's relationship with economic development can be expressed in qualitative terms, such as the net combined outcomes from its multiple uses. The net outcomes of a single use, for example the provision of drinking water and sanitation, can yield positive benefits, such as improved public health outcomes, with the associated advantage of workers being more productive at work and missing fewer days due to health problems. Similarly, healthier children can spend more time at school and are better able to learn while they are there.

By contrast, a lack of access to drinking water and sanitation can have inverse disbenefits, with decreased health outcomes contributing to lower labour productivity and educational attainment, as well as increased household and government expenditures on the myriad health problems associated with a lack of access to clean water and sanitation. Balancing actual benefits and disbenefits yields the net outcome for each use of water, with a net combined outcome across all uses.

At a strategic level, understanding the net outcomes associated with current water uses can help countries assess whether or not they are realising adequate advantages from their use of water resources and whether these advantages are aligned with long-term development priorities, such as a productive transformation of the economy.

At a planning level, understanding the net outcomes of water uses can inform decisions on, for example, water allocation, regulatory standards, infrastructure investments and improvements to water management.

For each of the six water uses listed above, Table 1 provides examples of potential benefits from sustainable consumption patterns, versus disbenefits associated with unsustainable patterns. For example, if water resources are used sustainably as an input to economic activities (use 6), it can contribute to long-term economic growth and building productive capacity. By contrast, unsustainable use can contribute to increased water stress and act as a disincentive to productive investments.

Table 1 Potential economic outcomes, by water use

Use	Potential benefits of sustainable consumption	Potential disbenefits of unsustainable consumption
1. Conservation of habitat and biodiversity	• Ecosystem services, e.g., drinking water, fisheries, tourism, flood abatement • Food and water security	• Loss of life, displacements and property damage from more frequent floods or droughts • Decreased quality of water from increased saline intrusion, floods and landslides • Decreased economic activity from tourism and fisheries
2. Drinking water and sanitation	• Public health • Labour productivity • Educational attainment	• Decreased health outcomes • Increased household and government expenditures on health • Reduced labour productivity • Increased interruptions to work and study
3. Public utility	• Public services and businesses better able to operate and provide sanitary conditions • Greener, cleaner, more liveable public spaces	• Additional costs and interruptions for public services and businesses • Additional public health costs due to unsanitary conditions • Reduced security, civic engagement and social interaction due to degraded public spaces
4. Recreational and cultural activities	• Increased social cohesion • Increased civic engagement and social interaction • Public health • Cultural tourism opportunities	• Cost recovery mandates lead to less water allocation for non-profit recreational and cultural activities • Unsustainable consumption due to lack of incentives to conserve water

Use	Potential benefits of sustainable consumption	Potential disbenefits of unsustainable consumption
5. Production of food and electricity	• Availability of affordable food and electricity, including for underserved groups • Food and energy security • Livelihood opportunities for small farming families and women • Predictable supply of energy for the development of businesses and industry, as well as the provision of public services	• Effluents from agriculture reduce average water quality • Water losses due to lack of incentives to adopt water-efficient agricultural practices and/or crops • Shortages, supply interruptions and/or high prices for food undermine food security • Shortages, supply interruptions and/or high prices for energy undermine economic activities and the provision of public services • Increased trade deficits for food and energy
6. Production of other commercial goods and services	• Predictable supply of affordable water attracts investment in productive activities • Increased economic growth • Business and employment opportunities • Increased productive capacity	• Water losses due to lack of incentives to develop water-efficient industries and/or production models • Unnecessary water extractions due to lack of incentives to treat and recycle grey water • Rate-paying commercial users favoured in water allocation decisions over users who pay less • Insufficient supply of affordable water dissuades entrepreneurs and investors, with opportunity costs in terms of economic growth, jobs and productive capacity

Source: Authors and (OECD, 2016)

For productive uses of water – such as agriculture, energy and industry – the concept of “net outcome” is particularly important, since it is possible for policies, activities and/or production models to realise both opportunities and risks simultaneously. For example, developing a mining project can deliver economic growth, jobs, revenues, business opportunities for local suppliers and an increase in productive capacity. But if water-efficient policies and practices are not integrated in the project, it can simultaneously consume an unsustainable share of scarce water resources, leading to considerable disbenefits and undermining national objectives.

Agriculture, in particular for food production, consumes the majority of global water withdrawals, which are absorbed in crops. In fossil fuel-based energy production, contaminated water is an important by-product throughout the value chain, from the extraction of primary fuels, through to generating electricity in thermal power plants. Hydropower plants also consume water through the evaporation of water stored behind dams. Meanwhile, agriculture contributes to energy consumption, in the form of fuel and fertilizer derived from fossil fuels, just as the production and treatment of water consumes electricity and fuel.

As global demand for water, food and energy grows, securing a supply of each of these necessities is fundamental to sustainable economic, environmental and social development. Given the interdependencies in the production and consumption of water, food and energy, only an integrated approach can deliver the desired security in the three areas. The “water-food-energy nexus”[5] concept provides such an integrated approach, from analysing production and consumption interdependencies, to formulating policies that balance water, food and energy security.

The water-food-energy nexus concept is useful in analysing water-related problems that straddle the three topic areas. For example, irrigation often contributes to greater agricultural productivity than rainfed

5 https://www.unwater.org/water-facts/water-food-and-energy/

production. Nevertheless, irrigation also requires more withdrawals from surface and groundwater sources and is often integrated within more energy-intensive, mechanised production models. Similarly, biofuels are often hailed as substitutes for fossil fuels, but they may displace food crops and processing them into refined fuel consumes large volumes of water. In this example, considering water, food and energy in an integrated way can minimise trade-offs inherent in a more siloed approach (Smaigl, Ward, & Pluschke, 2016).

2.2 MACROECONOMIC RISKS

The potential outcomes of individual water uses, listed in Table 1, include implications for national objectives, from benefits such as increased economic growth, investment and productive capacity, to disbenefits such as an erosion of food and energy security, or interruptions to production and output.

The net combined outcomes of all water uses can also have aggregate macroeconomic effects. For example, in the Report of the GWP/OECD Task Force on Water Security and Sustainable Growth, Sadoff *et al.* (2015) found that a lack of investment in water-smart infrastructure can lead to a *poverty trap* at the macroeconomic level. Although the poverty trap concept is usually applied at the household level, shocks from water-related hazards can lead to such a self-reinforcing trap in the national economy.

According to this concept, economies that achieve sustained economic growth and development generate wealth that can be invested in water-efficient productive assets, as well as infrastructure that reduces the effects of water-related hazards, such as droughts, floods, or water losses through leakage or pollution. This infrastructure reduces the risk of water-related losses, especially from major events, that could stall economic growth over the short term, or derail it entirely.

By contrast, poorer countries, or those at greater risk of water-related hazards, often lack sufficient wealth to invest in minimum levels of water-secure infrastructure. As a result, when water-related hazards strike, these countries suffer greater shocks to economic growth. When faced with multiple water scarcity shocks, or water scarcity is compounded by other types of shocks, such as climate changes or natural disasters, these countries may not have the time and resources to fully recover their productive output before the next shock. As this cycle recurs, the country's productive potential contracts, provoking a self-reinforcing, vicious circle of lower growth, productivity and wages. Along with lower levels of wealth and a less accessible hydrology, a reliance on agriculture and greater exposure to climate change – common features in many SIDS – are additional risk factors for this type of poverty trap (Sadoff, *et al.*, 2015; Hanjra, Ferede, & Gutta, 2009; Borgomeo, Hall, & Salehin, 2017).

The risk of this water-driven poverty trap underlines the importance of aligning economic development and water management policies, along with investing in water-smart infrastructure.

Chronic water scarcity can lead to a breakdown in *social cohesion* and mounting macroeconomic risks. Without effective management and a consensus among stakeholders on how to conserve scarce water resources, competition among user groups can entrench, or even worsen unsustainable water consumption, raising the risk of many of the disbenefits listed in Table 1.

Where water scarcity reaches extreme levels, communities can no longer sustain their populations. This can lead to migration and humanitarian crises, or inflame existing tensions into security crises, such as unrest, violence, civil conflicts or even war (Ide, Lopez, & Frölich, 2020; Bromwich, 2015; Adler, Claasen, Godfrey, & Turton, 2007). These crises entail major losses, or even breakdown, for the national economy.

Considering these macroeconomic risks, the World Bank (2016) estimated that, without corrective action, water scarcity could erode economic growth by as much six per cent per year by 2050 in some water-scarce regions. By contrast, the same report estimated that water-secure policies and investments could mitigate many of these risks and, in some cases, even contribute to an acceleration in economic growth by as much as six per cent per year.

2.3 WATER SCARCITY

Water scarcity is a strategic challenge at the crux of SIDS' economic and environmental vulnerabilities. Their small land area means they have relatively few aquifers and a short surface water circulation cycle, limiting the availability of groundwater. The degree of scarcity varies among SIDS, for example in relation to their topography, with the higher average altitude of volcanic islands lengthening their water circulation cycle, as compared to low-lying islands or atolls, which are more at risk of water scarcity. Nevertheless, SIDS are among the most water-scarce countries in the world: seven in ten SIDS face risks of water shortage, including nine in ten low-lying SIDS (UNESCO, UNEP, 2016).

In terms of consumption, growing populations, rapid urbanization and competition among uses such as agriculture, households and tourism, have exacerbated freshwater scarcity in many SIDS.

Meanwhile, pollution steadily reduces the average quality of freshwater supplies in many SIDS. In general, a lack of treatment facilities means a significant portion of industrial grey water, domestic sewage and agricultural effluents are insufficiently treated before their disposal, leading to increasing pollution of freshwater sources and marine environments. Due to scarce land area, SIDS also lack viable sites for solid waste disposal facilities, meaning that a portion of solid waste is disposed of in insecure conditions, with the risk of a variety of pollutants leeching into soil and groundwater. As population and urbanisation continue to grow in SIDS, the pollution problem grows as well, reducing the average quality of freshwater resources and effectively reducing the usable supply (Gheuens, Nagabhatla, & Perera, 2019).

These trends leave water-scarce SIDS increasingly vulnerable to acute shocks to freshwater availability, threatening the functioning economic activities, such as agriculture, or environmental services derived from freshwater, such as biodiversity, flood abatement, recreation and a regular supply of drinking water.[6] The risk of chronic water shortages is also growing, threatening social cohesion, food security and the health of their populations (UNESCO & UN-Water, 2020).

Long-term economic development prospects in SIDS are vulnerable to water scarcity, through its effect on the feasibility of productive investments. For example, agriculture and fisheries remain important sectors in many SIDS economies. But they typically have few processing facilities to add value to these raw materials. Agri-food and fish processing being relatively water-intensive, water scarcity is one of the factors dissuading investment in these activities. Water scarcity has a similar impact on investments in other productive industries that are roughly suited to SIDS' contexts, such as beverages for the tourism sector, or smelting ores and refining metals in mineral-rich SIDS.

Water scarcity also has a dampening effect on investments in more productive production models. Agriculture is the compelling example in SIDS, where rainfed production predominates and the sector consumed, on average, 95 per cent of water withdrawals in 2017 in the 38 SIDS.[7] Water scarcity, coupled with low water prices that do not reflect the full value of water resources, render investments in irrigation unfeasible.

Among other benefits, reducing water scarcity can therefore improve the feasibility of public and private investments in more productive activities, production models and infrastructure, contributing to the productive transformation of SIDS' economies.

2.4 CLIMATE CHANGE

The relationship between climate change and water scarcity in SIDS is complex. For example, the impact of changing rainfall patterns on freshwater availability varies by region. This includes regions where rainfall is increasing, but in ways that actually reduce freshwater availability. During extreme weather events, more rain falls than can be absorbed, leading to flooding and contamination of groundwater reserves.

[6] Climate Policy Watcher, 2020. Types of Freshwater Ecosystem Services. Available at: https://www.climate-policy-watcher.org/ecosystem-processes/types-of-freshwater-ecosystem-services.html. Retrieved: 5 November 2020.

[7] Source: FAO AQUASTAT

The Intergovernmental Panel on Climate Change (IPCC) organises its predictions with modelled scenarios called Representative Concentration Pathways (RCPs) – each based on possible future concentrations of greenhouse gas. For example, under its intermediate RCP 4.5 scenario, the IPCC predicts that, by 2100, annual rainfall will increase by nine per cent in the North Indian Ocean and one to two per cent in the Pacific region, while falling by five per cent in the Caribbean (Nurse, *et al.*, 2014).

Rising sea levels also threaten available water resources in SIDS through an increased risk of flooding, erosion and saline intrusion. Under its most optimistic scenario – RCP 2.6, in which emissions are cut dramatically and rapidly before mid-century – the IPCC projects global mean sea level (GMSL) will rise by a total of 0.43 m by 2100, with regional variation of +/- 30 per cent (Oppenheimer, *et al.*, 2019).

Nonetheless, in considering the impact of climate change on water scarcity, there is an important distinction between a region's hydrology – for example, its surface water features, groundwater reserves and circulation cycle – and the societal management and consumption of those resources, which can contribute to water scarcity. From this perspective, climate change can have a varied effect on a region's hydrology, even as it poses a more uniform threat to regions or countries where societal factors drive worsening water scarcity (Jiménez Cisneros, *et al.*, 2014).

In SIDS, societal factors in water scarcity include growing populations, rapid urbanization, and competition among uses such as agriculture, households and tourism, driving unstainable demand growth. This leaves SIDS vulnerable to acute shocks to freshwater availability, threatening the functioning of economic activities, such as agriculture, or environmental services, such as conservation of biodiversity, flood abatement, and a regular supply of drinking water.[8] Increasingly, SIDS are vulnerable to chronic water shortages, threatening social cohesion, food security and the health of their populations (United Nations, 2020).

Climate change therefore exacerbates existing water scarcity risks in SIDS, with knock-on effects on other channels affecting economic development, such as: macroeconomic stability, economic activity, employment, food and energy security, human health and habitat.

2.5 COVID-19

The COVID-19 pandemic created a global health and economic shock and impacted SIDS particularly hard. On the epidemiological front, by June 2021, incidence rates per 100,000 population were decreasing in the most affected SIDS, such as Bahrain, Maldives and Cabo Verde. Other SIDS continued to have relatively low incidence rates since the beginning of the pandemic, especially those in the Pacific region.[9] Nevertheless, on the economic front, the pandemic pushed many SIDS into crisis, with the collapse of key sectors, such as tourism and exports, accompanied by increasing indebtedness.[10]

The United Nations World Tourism Organization (UNWTO) estimates that COVID-19 travel restrictions caused year-on-year international tourist arrivals to fall worldwide by 70 per cent from January to August 2020, putting well over 100 million jobs at risk and representing US$730 billion in lost revenues,[11] eight times more than the losses the tourism sector sustained during the 2008–09 global economic crisis. Tourism accounts for over 30 per cent of total exports in the majority of SIDS, reaching as much as 85 per cent in the Maldives and 84 per cent in Antigua and Barbuda.[12]

8 Climate Policy Watcher, 2020. Types of Freshwater Ecosystem Services. Available at: https://www.climate-policy-watcher.org/ecosystem-processes/types-of-freshwater-ecosystem-services.html. Retrieved: 5 November 2020.

9 Johns Hopkins University, Coronavirus Resource Centre: https://coronavirus.jhu.edu/ (accessed 17 June 2021).

10 UNCTAD (2021). Small island developing states need urgent support to avoid debt defaults. Blog entry. 12 April. Available at: https://unctad.org/fr/node/32611. Retrieved: 7 May 2021.

11 UNWTO (2020). International tourism down 70% as travel restrictions impact all regions. Blog entry, 27 October. https://www.unwto.org/news/international-tourism-down-70-as-travel-restrictions-impact-all-regions

12 Source: UNWTO, Yearbook of Tourism Statistics, International tourism, receipts (% of total exports), 2018.

International tourist arrivals declined by 74 per cent worldwide in 2020, with the rate even higher in many SIDS. Such a major shock translated into a massive loss of jobs, a sharp decline in foreign exchange and tax revenues, which curbed the public spending capacity, and the ability to deploy the measures necessary to support livelihoods through the crisis. Although the tourism industry in many SIDS has relatively few links to the rest of the economy, the demand shock provoked by COVID-19 also had indirect follow-on effects on demand and employment in other subsectors that supply tourism business, in particular agriculture, transport and financial services (Vanzetti & Valensisi, 2021). Women, who account for half of the workforce in almost all SIDS, as well as informal workers, were particularly exposed to these risks.

UNCTAD (2021) estimated that tourist arrivals will not return to pre-COVID-19 levels until 2023 or later. Along with the interruption in arrivals, SIDS will also be impacted by the way the tourism industry will evolve in response to the pandemic, in terms of modes of travel, duration of stay, source markets and visitor segments. For example, prior to 2019, the cruise ship segment was among the fastest growing in the tourism industry, including in SIDS. Cruise ship passengers typically spend only one or two days in a port of call, where they spend more than average visitors, but not on accommodation. Due to passenger densities on cruise ships, relaunching cruise tourism proved challenging amid ongoing COVID-19-related sanitary restrictions. Indeed, modelling by Vanzetti and Valensisi (2021) suggests that a prolonged halt in cruise tourism would hit particularly hard in Caribbean SIDS, where roughly half of international visitors arrive by sea and stay only one day.

The COVID-19 crisis has accentuated water stress in affected SIDS. On the demand side, sanitary measures, such as handwashing, disinfection and sterilization, have increased consumption, mitigated by reduced consumption because of the slowdown in the hospitality and tourism subsectors. Meanwhile, water supply is interrupted by the general disruption in transportation, especially to poorer, more isolated communities and islands. In this way, the COVID-19 crisis has exacerbated existing weaknesses in basic needs provision in contexts already prone to environmental and economic shocks.

2.6 MANAGEMENT CHALLENGES

2.6.1 Competing uses and the value(s) of water

Managing scarce water resources strategically requires policy makers to implement a mix of incentives, standards and other tools to ensure that these resources yield maximum benefits towards the achievement of national objectives. This inevitably involves prioritising some objectives over others and, by extension, some uses of water over others. These decisions are politically risky, often impossible, without some form of consensus among stakeholders on the principles or values that inform allocation decisions. Absent this consensus, therefore, effective water management is elusive (United Nations, 2021).

In this context, we refer to “values” from a broader governance perspective, for example according to the main societal benefits and outcomes derived from water, which can inform policy decisions. This should not be confused with narrower financial measures of value, such as “price” or “cost”.

Downstream of governance, price is a fundamental part of market-based mechanisms, such as the spot markets in a handful of countries where farmers and municipalities trade water rights like other commodities,[13] or the first-ever water futures market launched on the Chicago Mercantile Exchange in December 2020.[14] In many developing countries, the pricing of water is a sensitive issue, as it is related to many failed attempts at privatising municipal water systems over recent decades. Privatisation often resulted in insufficient investment, tariff hikes, environmental degradation and, in the worst cases, residents and neighbourhoods losing access to water. Many of these failed privatisations were since “re-municipalised”.[15]

13 See, for example, Australia’s water markets: https://www.agriculture.gov.au/water/markets

14 https://edition.cnn.com/2020/12/07/investing/water-futures-trading/index.html

15 https://www.theguardian.com/global-development/2015/jan/30/water-privatisation-worldwide-failure-lagos-world-bank

Compiling the full cost of water has a wider utility in water management. Computing the direct costs to extract, treat, store and deliver water to users, as well as any capture, treatment and recycling of grey water is a valuable input in calculating delivered costs, tariff rates and subsidies. At an aggregate level, the full cost of water should include indirect costs, such as management, monitoring and capital investments. Full cost accounting can be a useful input in budgeting and cost recovery decisions.

Nevertheless, price and cost fall short as measures of value for water governance, as they are too limited to resolve more complex competition among uses and users. For example, uses such as conservation, drinking water or sanitation have a high societal value that cannot be priced on a market, in the same way as industrial uses. Some residential users can afford to pay more for water, some less, some very little, but all of them have the right to the water they need to live. Meanwhile, farms producing food and factories producing pencils may draw from the same municipal water sources, but society values food over pencils, with implications for allocating public water resources between the two uses.

2.6.2 Minimum infrastructure

Infrastructure is fundamental to managing water resources, including adapting to the impact of climate change on water availability, or redressing water scarcity. This includes the "hard" – or physical – infrastructure used to extract and treat surface or groundwater, or recycle grey water, to then store, transport and deliver it to users. Meanwhile, "soft" infrastructure can include the systems, technologies and techniques used to monitor and manage water resources, policy and regulatory tools, water demand management programmes, as well as overall water governance (UN-Water, 2013).

Faced with scarce water resources and/or water stress, some SIDS have succeeded in building what Grey and Sadoff (2007) refer to as a "minimum platform for water institutions and infrastructure". This concept refers to the minimum economic, governmental and infrastructural requirements for effective water management. Below a minimum level of hard and soft infrastructure, a society is highly vulnerable to water-related shocks. This means that the supply of water cannot be reliably predicted or managed, posing a significant threat to economic prosperity and growth. By contrast, when minimum infrastructure is in place, and basic water security assured, communities are sufficiently resilient to scarcity risks so that water can foster, rather than undermine economic development.

Once a minimum level of water infrastructure been achieved, further investments tend to focus on growth enhancement, rather than on mitigating risks and meeting basic needs. Additional investments can also enhance water security dynamically, anticipating and mitigating geographic, climatic, social, epidemiological, economic and political risks as they shift over time. Water security can be schematized by an "S-curve" which illustrates how a minimum platform of investments in water infrastructure and management can produce a tipping point beyond which water makes an increasingly positive contribution to growth (Grey & Sadoff, 2007).

Improving hard and soft infrastructure is therefore part of overcoming water management challenges, whether adapting to the impacts of climate change, achieving a minimum infrastructure or redressing water scarcity.

2.6.3 Outdated mindsets

In many countries, improving water management is constrained by a complex of outdated mindsets. These can include: a belief among users that water is a virtually limitless resource; that water is a social service, rather than a finite resource or an economic good; or that a user's right to abundant, cheap water supersedes any obligation to limit their own consumption. These mindsets are often embodied and reinforced by the management system itself, with, for example:

- Pricing and cost recovery policies that provide no incentives for users to reduce consumption or conserve water resources;
- Fragmented policies, management systems and/or infrastructure among water's different uses; or
- Governance approaches that fail to foster durable compromise among competing user groups.

Effective management of these competing uses is necessary to avoid a vicious cycle of intensifying aggregate demand for increasingly scarce water resources.

2.6.4 Case studies

In this subsection, we provide three case studies demonstrating the importance of considering water security in economic plans: one success story from Singapore and two examples of sector-level strategies in Kiribati and Kenya that generated economic benefits, but faced sustainability challenges due to a lack of attention given to water security.

There exist more SIDS-specific examples that demonstrate the importance of sustainable water resource management. Nevertheless, we chose the following case studies because they illustrate the interdependence between long-term economic development and water security and, thus, the importance of considering water security in economic plans.

Case study 1: Water policy as a lever of development in Singapore

Singapore is an acknowledged leader in water management. The country receives plentiful rainfall, but with a surface area of approximately 730 square kilometres, it has little room to store water and no aquifers. Beginning before its independence in 1965, Singapore sought to overcome its hydrological limitations by developing multiple new sources of water. At first, this involved signing an agreement with neighbouring Malaysia to import a guaranteed supply of raw water. The arrangement met Singapore's needs, but introduced a security concern that remains a central strategic consideration for Singapore to the present day.

With its 1972 Water Master Plan, the Government of Singapore anticipated future demand growth from its population, as well as the need for a supply of water to sustain economic development. The Plan was ambitious in that it sought to fully satisfy demand growth from the different user groups, i.e., rather than just apportioning existing water resources among user groups, it envisioned expanding the water supply, specifically with new domestic sources, to satisfy demand growth and reduce reliance on imported water. The Plan laid the foundations for the so-called "Four National Taps" that remain the main sources of Singapore's water.

Along with imported water from Malaysia (1), Singapore has developed a rainwater catchment system (2) that currently covers 67 per cent of the island, as well as non-conventional water sources, such as facilities for recycling sewage and grey water (3) and desalination plants (4).

In 2020, Singapore's total domestic water demand was approximately 430 million gallons per day. At present capacity, recycled water can supply 40 per cent of the country's demand, mainly for non-residential uses, while desalination plants can supply up to 30 per cent of demand, mainly for residential uses.[16] Singapore aims for these non-conventional water sources to replace imported water entirely in the coming decades.

Singapore's water policy also includes comprehensive demand control measures, including water prices, conservation measures and public education. The Government uses full, marginal costs to set prices, meaning they include not only delivery, but also production, management and quality costs, with residential prices pegged to the cost of desalination (Tortajada, Joshi, & Biswas, 2013).

Singapore's water management achievements include:

- A relative decoupling of water consumption from economic and population growth, for example: GDP per capita grew by a factor of 40 from 1965 to 2019,[17] while total water consumption grew by a factor of six[18] over the same period;

[16] https://www.pub.gov.sg/watersupply/singaporewaterstory

[17] Source: UNCTADStat

[18] https://www.pub.gov.sg/watersupply/singaporewaterstory

- Per capita household water consumption has contracted steadily, from 165 litres per person per day in 2000 to 141 litres in 2018;[19]
- With per capita residential consumption falling, Singapore devotes most of its expanding water supplies to non-residential sectors, contributing to further economic development;[20] and
- Singapore reduced its total water distribution losses to only 8.2 per cent in 2019,[21] one of the lowest rates in the world.

Economic development

A key objective of Singapore's water policy is to sustain economic development. As well as fully meeting their water needs, the policy imposes water efficiency standards on non-residential users. In 2015, Singapore introduced Mandatory Water Efficiency Management Practices (MWEMP), requiring large water users to submit annual reports on water consumption and efficiency plans. This allows the government to set water efficiency benchmarks for a variety of business sectors.[22]

For example, the 2020 Water Efficiency Index,[23] based on 2018 consumption figures, included the following sectoral targets:

- 4-star hotels: 0.36 m^3 of water per guest night;
- 5-star hotels: 0.57 m^3 per guest night;
- Retail: 1.3 m^3 per square meter of area, per year; and
- Data centres: 2.6 m^3 per megawatt hour of electricity consumed.

Singapore also aims to leverage the knowledge and innovations developed through its water security strategy into new economic opportunities. To oversee the development of Singapore's water technology industry into a "Global Hydrohub", the government formed the Environment and Water Industry Development Council, led by the water authority (the Public Utility Board) and the Economic Development Board. Among other responsibilities, the Council implements research, development and training programmes to develop human capital and new technologies.

As a result of these efforts, by 2020, Singapore hosted approximately 180 companies and 25 research institutes devoted to water technology. The government estimates that, since 2016, Singapore's water technology industry has created 400 jobs and contributed 300 million Singapore dollars (SGD) annually to the economy.[24]

Singapore's water security strategy would be difficult for SIDS to replicate. Unlike Singapore, most SIDS do not have access to plentiful, inexpensive imports of water, as the basis for a long-term plan. The population in most SIDS is much more widely dispersed than in Singapore. And the domestic sources that Singapore developed – rainwater catchment, desalination and wastewater recycling – are extremely costly.

Nevertheless, SIDS can adapt to their context the core principles underlying Singapore's strategy, namely that:

- With long-term, coherent policies and investments, a small, water-scarce country can simultaneously achieve economic development and water security;

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19 Ibid

20 Ibid

21 Ministry of Sustainability and the Environment, 2020. Key environmental statistics 2020. Available at: https://www.mse.gov.sg/. Retrieved: 10 June 2021.

22 https://www.pub.gov.sg/savewater/atwork/WaterEfficiencyBenchmarks

23 https://www.pub.gov.sg/Documents/WaterEfficiencyBenchmarkTable.pdf

24 The Straits Times, 2016. "Singapore's water industry to receive $200 million boost". The Straits Times, 11 July. Available at: https://www.straitstimes.com/singapore/environment/singapores-water-industry-to-receive-200-million-boost. Retrieved: 5 May 2022.

- Investments in water-smart infrastructure should be evaluated on the future value of the economic development they enable, rather than simply on their present-day costs; and
- Investments in water-smart infrastructure are often repaid – even many times over – by the wealth generated by economic development.

Case study 2: Unsustainable phosphate mining in Kiribati

Phosphate mining on the coral island of Banaba in Kiribati is a classic water-related example of an environmentally unsustainable economic development strategy. Water being inherently scarce on coral islands, Banaba islanders traditionally captured rainwater and, in drought conditions, relied on water that accumulated in underground caves. From the early 20th century until 1979, foreign investors mined phosphate on Banaba, with the governments of Australia, New Zealand United Kingdom jointly administering the Pacific Phosphate Company's operations there as of 1919. Phosphate mining eventually stripped 90 per cent of Banaba's surface area and contaminated the caves that had acted as the islanders' emergency aquifers. The resulting stress on living conditions led the British government to relocate most of the population to Rabi Island in Fiji in 1945 and, after mining stopped in 1979, left the remaining islanders dependent on a desalination plant for their water supply (Teaiwa, 2015). In late November 2020, the plant broke down and the 300 islanders endured four desperate months, without clean water to drink, raise livestock or grow crops, before relief arrived in March 2021.[25]

Although phosphate mining contributed benefits such as economic activity, revenues and some jobs to the Kiribati economy, disbenefits related to the environmental devastation on Banaba crippled islanders' water and food security and left them with a precarious existence on the island.

Case study 3: Victim of its own success: Water and cut flowers in Kenya

On a larger scale in a non-SIDS country, Kenya's cut flowers industry achieved considerable economic success since its inception three decades ago. By 2019, cut flowers were Kenya's second most valuable export, generating US$ 584 million in earnings. The industry employed an estimated 100,000 workers, offered opportunities for smallholder farmers and prompted the construction of essential public infrastructure. Nevertheless, the early development plans for the industry neglected environmental protections, with severe consequences for the environment and communities in the main production zone around Lake Naivasha. Water withdrawals rose beyond sustainable levels, pollution flowed directly into the lake and construction eroded hillsides and watersheds. As a result, water levels fell and pollution levels rose in Lake Naivasha, threatening the very source of the industry's prosperity (Mekonnen, Hoesktra, & Becht, 2012).

The Kenyan government has since tried to improve sustainability, for example through the 2016 update of the Water Act, which, among other changes: enshrined access to clean and safe water as a human right, with priority over other uses; enacted programmes to ensure water access to marginalized groups; and devolved the management of water supply and sanitation to the county level. The cut flowers industry also implemented the Flower and Ornamental Sustainability Standard (FOSS). Despite these efforts, water use continues to grow around Lake Naivasha due to a continued lack, for example, of full-cost pricing of water and awareness-building campaigns on sustainable water use (Ndege, 2020). Lake Naivasha therefore remains an example of the importance of aligning economic, environmental and water policies to decouple economic growth from negative externalities.

[25] McDonald, J., 2021. The island with no water: how foreign mining destroyed Banaba. The Guardian, 8 June. Available at: https://www.theguardian.com/world/2021/jun/09/the-island-with-no-water-how-foreign-mining-destroyed-banaba, Retrieved: 9 June 2021.

3

Water use in productive economic activities in SIDS

3 WATER USE IN PRODUCTIVE ECONOMIC ACTIVITIES IN SIDS

Water's multiple societal values are realised through its uses, from conservation, to drinking water, to productive economic activities. By extension, water-secure economic policy should be based on past and present water uses and map the changes to water use necessary to support development objectives. In this section, we profile water use in SIDS, focussing on its use as an input in productive economic activities: agriculture, industry and energy generation.

3.1 DATA CONSIDERATIONS

Data limitations prevent a comprehensive comparison of countries' water consumption for the full list of uses given in subsection 2.1. These include complexities, such as:

- Conserved resources (use 1) are a stock, rather than a flow (or withdrawal) and are often not recorded;
- Measuring and managing water uses must consider the different sources of water, from available ones, such as surface, groundwater or precipitation, to potential ones, such as treated wastewater;
- Measurement is easier for withdrawals of water from metered municipal systems, but less so for water that falls as rain or is contained in plants;
- Meanwhile, wastewater does not disappear from the system – its lower quality precludes it from some uses, such as drinking water, but it can be treated for reuse, thus reinjecting it into the system; and
- Households, agriculture and industry each withdraw water from different sources and produce different types and volumes of wastewater, complicating cross-sectoral comparisons.

As a result of these complexities, the coverage and timeliness of existing data sources is limited. The Food and Agriculture Organization of the United Nations (FAO) publishes water use data by sector – agriculture, industry and municipal – in its AQUASTAT database. This is the most comprehensive database for comparisons of water use across countries. Nevertheless, these data cover only withdrawals from surface and groundwater sources. Reporting and compiling the data is also slow, with 2017 the most recent available year of data at the time of writing in 2021. Thankfully, there is less year-on-year variability in water use than in macroeconomic statistics, for example, so we judged that the 2017 data from FAO AQUASTAT's would still allow for useful comparisons among countries.

The scarcity of granular water use data also limits micro-level analysis, with consequences for policy recommendations, which are typically at the level of subsectors – tourism, fisheries, mining, etc. – in rigorous economic plans. For example, sector-level water use data can show that agriculture consumes most of a water-scarce country's withdrawals, underlining that water-saving measures in this sector offer the greatest potential for efficiency. Nevertheless, actionable economic policy recommendations would require more granular data on, for example, water use by the main crops, whether those crops are rainfed or irrigated and whether they are subsequently transformed into value-added products. With these data, planners can decide on policies to support the crops, irrigation investments and value chain strategies that deliver a "highest and best use" for water in a national development plan.

There exist no regularly updated panel databases for product-level water use, which would allow for micro-level analysis across SIDS and other countries over time. Nor were we able to find any recent product-level datasets compiled by individual SIDS.

3.2 WATER FOOTPRINT METHOD

The water footprint methodology can help overcome some of the data limitations related to the use of water in production and consumption. According to the Water Footprint Network, the water footprint methodology "measures the amount of water used to produce each of the goods and services we use".[26] It can be applied at the product, firm, industry and country level, or for a specific river basin or aquifer.

The water footprint comprises three subcategories, based on the different sources of water. Figure 1 shows the definitions of "green", "blue" and "grey" water footprints, according to the Water Footprint Network.

Figure 1 Definitions of green, blue and grey water footprints

Green water footprint is water from precipitation that is stored in the root zone of the soil and evaporated, transpired or incorporated by plants. It is particularly relevant for agricultural, horticultural and forestry products.

Blue water footprint is water that has been sourced from surface or groundwater resources and is either evaporated, incorporated into a product or taken from one body of water and returned to another, or returned at a different time. Irrigated agriculture, industry and domestic water use can each have a blue water footprint.

Grey water footprint is the amount of fresh water required to assimilate pollutants to meet specific water quality standards. The grey water footprint considers point-source pollution discharged to a freshwater resource directly through a pipe or indirectly through runoff or leaching from the soil, impervious surfaces, or other diffuse sources.

Source: Water Footprint Network, https://waterfootprint.org/en/water-footprint/what-is-water-footprint/.

As concepts, green and blue water are relatively intuitive: they represent withdrawals of fresh water from different sources, reducing the available stock.

Grey water is a more nuanced concept. Households, municipalities, businesses, farms or industry withdraw fresh water for their uses from the same surface and groundwater sources. After being used, any water that has not evaporated or been incorporated, but contains some degree of contamination, is called wastewater, which includes two distinct types.

Wastewater from toilets, called sewage or "black" water, requires heavy treatment before it can be reused. From a policy perspective, black water and its treatment falls under the water and waste management portfolios, typically overseen by municipal or regional governments and public utilities. Given that black water is not directly relevant to productive economic activities, we considered that it was beyond the scope of this paper.

By contrast, lightly contaminated wastewater, for example from sinks, agricultural runoff or the washing and cooling of machines in a factory, is called "grey" water and requires less treatment to be reused. Grey water is a by-product of most productive economic activities, meaning that its management, treatment and reuse can yield a combination of economic, environmental and water security benefits.

Within the larger water footprint concept, grey water therefore differs from green and blue water, representing both a withdrawal of fresh water and, if it is treated to meet water quality standards, a potential source for reuse, i.e., increasing the available stock of water.

In this paper, we use the general term "wastewater" to encompass both black and grey water. Nevertheless, we focus our policy analysis on the grey water component, given its relevance to economic planning.

[26] See: https://waterfootprint.org/en/water-footprint/what-is-water-footprint/

In this context, the national water footprint accounts compiled by Hoekstra and Mekonnen (2011) are an invaluable resource, despite their age – they are based on data from 1996-2005. The water footprint data complements the FAO AQUASTAT database in two key dimensions, capturing:

- Product-level water use for dozens of agricultural products, for 204 countries, including 35 of the 38 SIDS in our sample; and
- A sector- and product-level breakdown of water withdrawals, broken down by green, blue and grey water.

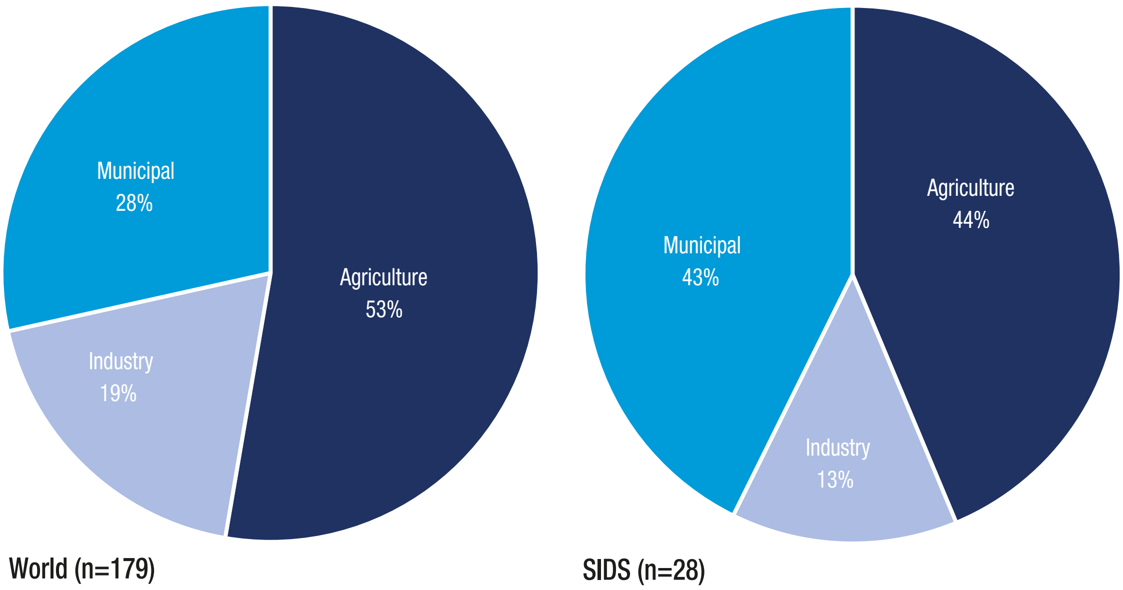
Water footprint data therefore allows for more granular analysis of opportunities to, for example:

- Increase the water efficiency of agriculture through rainfed and/or irrigation techniques;
- Increase the circularity of industry and agriculture through the recycling of grey water; and
- Identify water-efficient crops and value-added agricultural products.

3.3 WATER FOOTPRINT BY SECTOR

As shown in Figure 2, agriculture represented over half of world blue water withdrawals in 2017, followed by municipal uses (28 per cent) and industry (19 per cent). In SIDS, withdrawals were relatively equally distributed among agriculture (44 per cent) and municipal uses (43 per cent), with a smaller share for industry (13 per cent).

Figure 2 Share of water withdrawals by sector, world and SIDS, 2017

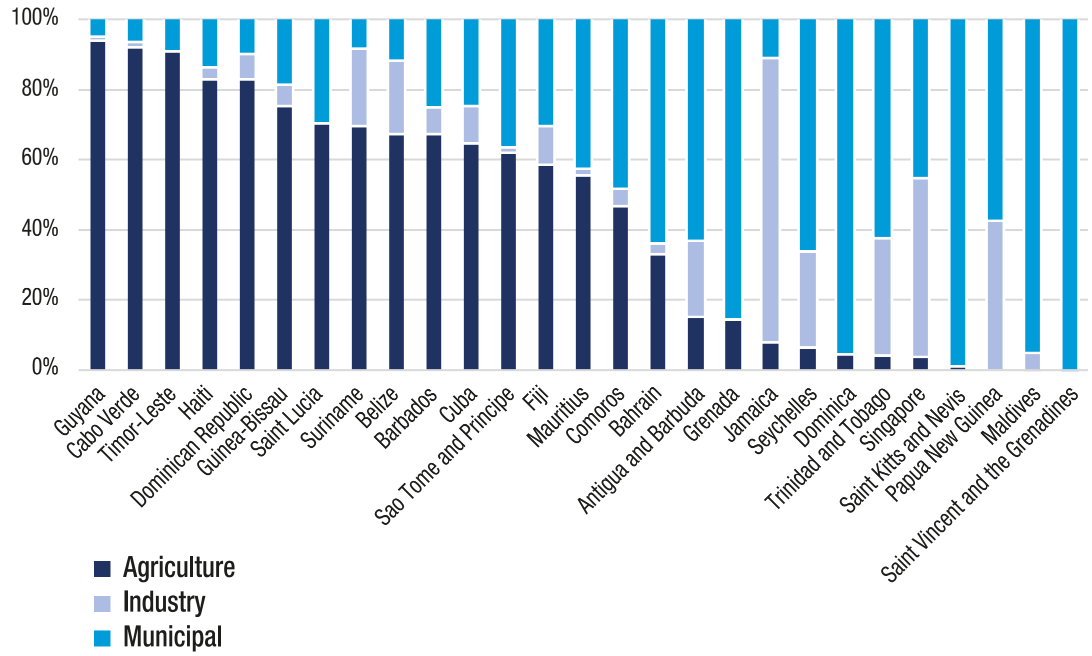


Notes: "Agriculture" includes all crops, livestock and grazing
"Industry" includes industry, mining and power generation
"Municipal" includes drinking water, fire protection, street cleaning and uses in households, businesses and public buildings

Source: FAO AQUASTAT

Figure 3 shows the sectoral breakdown of water withdrawals in 2017 for the 28 SIDS with complete values, illustrating the heterogeneous distribution among the countries. For example, agriculture was the main use for withdrawals in 14 of the countries, while municipal uses consumed most of the water withdrawals in another 10 SIDS. Jamaica and Singapore were exceptions among the 38 SIDS, with industry consuming 81 per cent and 51 per cent, respectively, of their water withdrawals.

Figure 3 Water withdrawals by productive use in selected SIDS, 2017



Notes: "Agriculture" includes all crops, livestock and grazing
"Industry" includes industry, mining and power generation
Source: FAO AQUASTAT

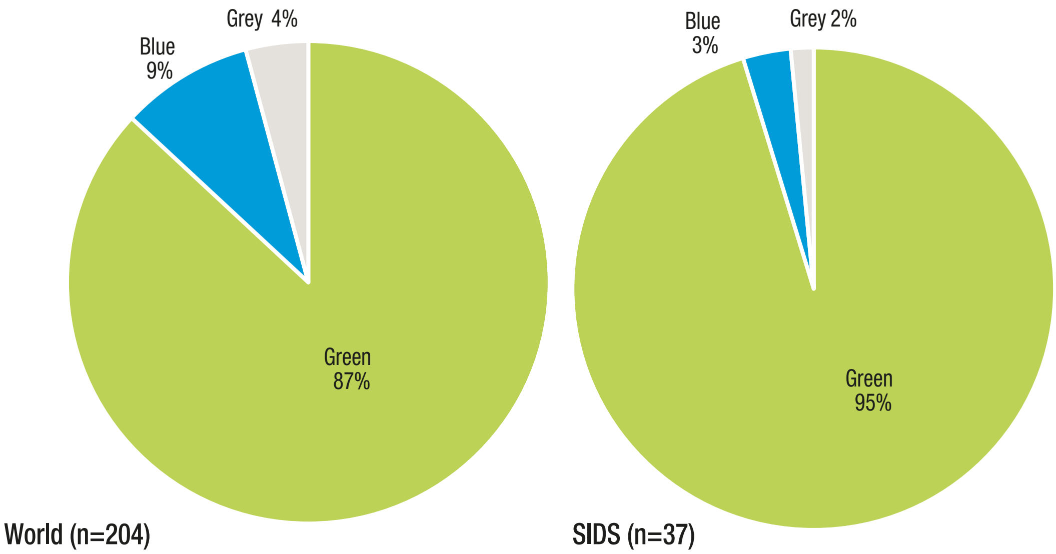
In the following subsections, we briefly review how water is employed in agriculture and industry. For this paper, we also devoted a subsection to electricity generation, data for which is usually grouped under "industry".

3.3.1 Agriculture, food and diets

Farmers use water to nourish their crops and livestock. In many parts of the world, rainfed agriculture predominates. In some areas, farmers can afford to install more capital-intensive irrigation systems, which withdraw surface or groundwater sources, to supplement what falls from the sky. Irrigated agriculture is typically more productive for a given surface area and, due to the capital investments required, is more commonly used on large and/or commercial farms in more developed regions.

As shown in Figure 4, rainfed agriculture (green water) represented an estimated 87 per cent of the global water footprint of agriculture over the 1996-2005 period, with blue and grey water representing a total of 13 per cent. In SIDS, rainfed agriculture predominated, at 95 per cent of the agricultural water footprint. Blue water irrigation represented just three per cent of the footprint, due to small farm sizes and low capital intensity of agriculture in SIDS.

Figure 4 Average water footprint of agriculture, by water source, world and SIDS, 1996-2005



Notes: "Agriculture" includes all crops, livestock and grazing
"Green" water refers to water consumed from precipitation and soil
"Blue" water refers to water consumed from surface and groundwater sources
"Grey" water refers to water withdrawals that are lightly contaminated after use
Source: (Mekonnen & Hoekstra, 2011)

Choices of what livestock or crops to grow is determinant in the water footprint of agriculture. To illustrate the impact of product choice on water consumption, Table 2 shows the global average water footprint for selected raw or primary agricultural products. Coffee, edible nuts and bovine meat were among the thirstiest products. Among food crops, cereals were generally thirstier than roots, tubers and vegetables.

Please note that these averages represent water consumption per metric tonne (MT) of production, not total water consumption. For example, the global production of cereals far outstripped that of spices, meaning its total water consumption was much higher, even if the two types of crops consumed a similar volume of water per MT.

Table 2 Global average water footprint of selected animal products and crops, 1996-2005

Raw or primary agricultural product	Global average water footprint (m^3/MT)
Animal products	
Bovine meat, fresh (carcasses)	10,942
Swine meat, fresh (carcasses)	4,361
Poultry, live, over 185g	3,364
Cereals – group	3,441
Rice	1,673
Maize	1,222
Roots and tubers – group	385
Manioc / cassava	564
Sweet potatoes	383

Raw or primary agricultural product	Global average water footprint (m³/MT)
Sugar cane	**210**
Pulses – group	**3,118**
Nuts, edible – group	**10,425**
Oleaginous fruits and seeds – group	**3,421**
Coconuts	**2,687**
Oil palm fruit	**1,098**
Vegetables – group	**338**
Peppers (capsicum)	**379**
Onions and shallots	**272**
Tomatoes	**214**
Fruits – group	**1,512**
Guavas, mangoes, mangosteens	**1,800**
Bananas	**790**
Lemons, limes	**642**
Pineapples	**255**
Beverages	
Coffee, green	**15,897**
Spices – group	**3,367**

Notes: MT – metric tonne
HS – Harmonized Commodity Description and Coding System
Source: Adapted from (Mekonnen & Hoekstra, 2010a; Mekonnen & Hoekstra, 2010b)

Table 3 shows the average water footprint for the crops commonly grown among the 38 SIDS in our sample. For each crop, the table also compares the unweighted average water footprint in SIDS with the global average. Relatively water-efficient roots and tubers, such as manioc, sweet potatoes, yams and taro figured prominently in the list. Water-efficient vegetables, such as tomatoes and the pumpkin-squash-gourd group, figured further down the list, while coconut, a relatively thirsty crop, topped the list, grown in 31 SIDS. Green coffee, consuming an average of 49,598 m³ of water per MT, was the thirstiest crop in the list.

Table 3 Average water footprint of common crops grown in SIDS, 1996-2005

Raw or primary agricultural product	SIDS (n)	SIDS average water footprint (m³/MT)	Global average water footprint (m³/MT)	Ratio, SIDS:global
Coconuts	31	3,537	2,687	1.3
Bananas	29	1,867	790	2.4
Manioc / cassava	28	821	564	1.5
Sweet potatoes	26	1,347	383	3.5
Maize	24	3,105	1,222	2.5

Raw or primary agricultural product	SIDS (n)	SIDS average water footprint (m^3/MT)	Global average water footprint (m^3/MT)	Ratio, SIDS:global
Tomatoes	21	580	214	2.7
Yams	20	687	343	2.0
Arrowroot / sago	20	557	385	1.4
Sugar cane	19	345	210	1.6
Guavas, mangoes, mangosteens	18	1,625	1,800	0.9
Coffee, green	17	49,598	15,897	3.1

Notes: MT – metric tonne
HS – Harmonized Commodity Description and Coding System

Source: Adapted from (Mekonnen & Hoekstra, 2010a; Mekonnen & Hoekstra, 2010b)

As well as illustrating the water footprint of crop choices, Table 3 shows that, for all products save one – the guavas-mangoes-mangosteens group – SIDS had a higher average water footprint than the global average. Indeed, relative to the global average, SIDS used double the volume of water, or more, to produce six of the 11 crops listed. For example, 26 SIDS grew sweet potatoes during the 1996-2005 period, which consumed an average of 1,347 m^3/MT of water, or 3.5 times the relatively water-efficient global average of 383 m^3/MT.

On the supply side, crop choices are limited by climatic, water and soil conditions, as well as the availability of technology, agronomic knowledge, inputs and suitable seed varieties. On the demand side, they are limited by dietary preferences, both locally and in export markets, as well as opportunities to add value in the local value chain.

Many SIDS already incorporate these considerations into their choices of priority crops under their development plans – water footprint data suggests that water efficiency should be included as an additional criterion in agricultural policy, with respect to crop choices.

The relative water inefficiency of agricultural production suggest SIDS should also adopt more water-efficient production models and techniques for their priority crops. Investing in irrigation infrastructure may be feasible in isolated cases, but is likely too expensive and draws too heavily on surface and groundwater sources to be a general solution, especially on low-lying islands.

Indeed, policy makers need to carefully study the trade-offs involved in shifting from rainfed to irrigated production, as gains in productivity can be undermined by environmental risks, including unsustainable water consumption. For example, in their analysis of the water footprints of agriculture and diets, Mekonnen and Gerbens-Leenes (2020) found that 57 per cent of the global water footprint of irrigated agriculture, concentrated in the production of cereal crops and livestock in a handful of large producing countries, was unsustainable.

In most cases, SIDS should therefore look to adopt water-saving techniques for rainfed agriculture, such as: water harvesting, conservation tillage, planting on ridges and furrows and using bio-mulches.

Although rarely addressed in development plans, SIDS can also improve the water efficiency of food consumption by using public awareness and education campaigns to promote diets based on water-efficient crops, such as roots, tubers, vegetables and some fruits, while de-emphasising thirstier agricultural products, such as meats, oils, nuts and cereals.

Research suggests that shifting to healthier, more plant-based diets can significantly reduce the water footprint of consumption. For example, in their global meta-analysis of research on the water footprint of diets, Harris et al (2020) found, in general, that a relatively minor shift from current "average" diets to "healthier" ones based on consuming fewer processed and fatty foods and more plant-based foods, would yield a six per cent reduction in dietary water footprint. More significant water savings come from reducing the consumption of animal-based foods, especially meat. Simply prioritising more water-efficient animal-based foods, for example removing meat but continuing to consume dairy products, can yield up to an 18 per cent reduction in dietary water footprint, while a full vegetarian diet can yield a 25 per cent reduction.

3.3.2 Industry

Industry uses water mainly to wash and cool machines, with a smaller proportion incorporated or evaporated in the production process itself (i.e., blue water). When used on machines, water absorbs pollutants, such as solids, chemicals, microorganisms or heavy metals. The resulting grey water is one of the main by-products of industrial processes. Grey water represented 84 per cent of the industrial water footprint in SIDS from 1996-2005, a slightly lower rate than the world average of 88 per cent over the same period. The United Nations (2017) reports that, as of 2017, high-income countries treated up to 70 per cent of grey water for reuse. By contrast, low-income countries treated only eight per cent of their wastewater, contributing to more than 80 per cent of wastewater worldwide being discharged into the environment without treatment.

As well as posing risks to the environment and public health, the discharge of untreated wastewater represents an untapped resource. Treating grey water for reuse as drinking water can be cost-prohibitive, but more affordable methods exist to treat water to the standards necessary for reuse in agriculture or industrial applications. Water treatment techniques also allow for the recovery of valuable resources, such as biogas or nutrients, each with potential productive applications.

At the firm level, the advantages of treating and reusing grey water include: reducing purchases of municipal water; lowering disposal costs; adding new income streams from recovered resources; and reducing the overall environmental footprint with an increasingly closed (or circular) production cycle.

For the national economy, treating and reusing grey water reduces stress on groundwater resources, while increasing the available water supply. Additional supply can be reallocated to other existing uses, or to new, more productive economic activities, thereby contributing to building productive capacity and long-term economic growth.

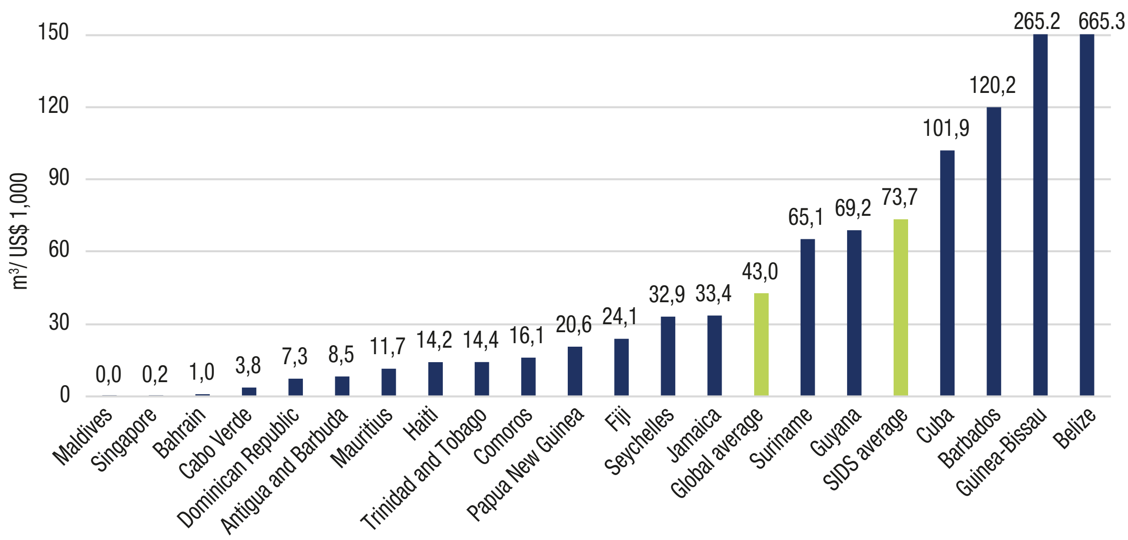
Despite these advantages, the cost-effectiveness of investing in grey water treatment facilities is often undermined by low water prices that do not reflect the full, marginal cost of water production.

Where centralised grey water treatment plants are unfeasible, for example due to high capital and operating costs or lack of scale – as is likely the case in many SIDS – small-scale, on-site treatment facilities may be feasible in a handful of industries.

Turning to water efficiency of industrial activities, a useful indicator is the volume of water consumed per unit of value added. Figure 5 shows the water footprint per US$ 1,000 of value added for the 20 SIDS with complete data. The SIDS average water footprint of 73.7 m^3 per $1,000 of value added was considerably greater than the global average of 43 m^3.

Due to their age (1996-2005), these data should only be used as a general illustration, rather than for country-by-country analysis, since they may not reflect recent improvements made in water efficiency in some SIDS.

Figure 5 Water footprint per unit of industrial value added, 1996-2005



Source: (Mekonnen & Hoekstra, 2011)

Water footprint data is also available for processed agricultural – mostly food – products, which further illustrate the water efficiency of industrial activities in SIDS. Table 4 shows water footprint of SIDS' most common processed agricultural products, compared with the global average for each product. As for raw and primary agricultural products, SIDS consumed significantly more water than the global average to produce processed foods.

Table 4 Water footprint of selected processed agricultural products, 1996-2005

Agri-food product	SIDS (n)	SIDS average water footprint (m³/MT)	Global average water footprint (m³/MT)	Ratio, SIDS:global
Coconut oil, crude	31	5,793	4,401	1.3
Coconut fibre, processed	31	4,299	3,266	1.3
Manioc / cassava starch	28	3,284	2,254	1.5
Maize starch	24	4,245	1,671	2.5
Maize oil, crude	24	6,411	2,524	2.5
Tomato juice, concentrated	21	724	267	2.7
Refined sugar	19	2,933	1,782	1.6
Cane molasses	19	867	527	1.6

Source: (Mekonnen & Hoekstra, 2010b)

Given these data, interventions to improve water efficiency in the industrial sector should therefore focus on:

- Improving and expanding grey water treatment infrastructure;
- Working with industry to implement new applications for grey water;
- Creating incentives for small-scale, firm-level investments in grey water treatment facilities; towards
- A more circular industrial water cycle, with fewer blue water withdrawals.

3.3.3 Electricity generation

Various technologies exist to generate electricity, each based on a different feedstock fuel or energy source. Each type of plant also has a different water consumption profile. For example, thermal power plants drive their turbines with steam generated by burning fossil fuels, such as coal, fuel oil, diesel or natural gas, or biomass fuels derived from organic residues. In general, thermal plants have a large water footprint due to their withdrawals of water to cool machines and condense steam back into (grey) water for reuse. Meanwhile, hydroelectric plants have a large footprint for the surface water flow they require to drive their turbines. Renewable technologies such as wind and solar have relatively low water footprints (Vaca-Jiménez, Gerbens-Leenes, & Nonhebel, 2019).

In recent years, many SIDS have adopted ambitious plans to transition their energy mix from fossil fuels to renewable technologies, in line with their climate change adaptation strategies and a desire to reduce consumption of water and imported fossil fuels. Nonetheless, implementation of renewable technologies has been slow, due to a lack of financing and identification of cost-competitive sources of renewable energy. As a result, at the time of writing, many SIDS relied almost exclusively on diesel-fired generators and thermal power plants to generate electricity. These plants are expensive to operate, due to a reliance on imported diesel, and have a large water footprint (IRENA, 2018).

Energy transition is therefore a cross-cutting priority for climate change adaptation, water security and sustainable economic development in SIDS. Possibilities for water-saving policy interventions include:

- Research and incentives for the development of wind and solar energy;
- Development of biomass energy;
- Upgrading and improving cooling systems in thermal plants; and
- As for the industrial sector, continued improvement of grey water recycling in thermal plants.

3.3.4 Virtual water trade

According to Mekonnen and Hoekstra (2010b), producing one metric tonne (MT) of sesame oil consumed a global average of approximately 21,800 m^3 of water over the 1996-2005 period. This makes it a relatively water-intensive product, when compared with other edible oils, such as soya-bean oil (4,100 m^3/MT), or palm oil (4,900 m^3/MT).

Of sesame oil's total water footprint, growing sesame seeds consumes approximately 9,400 m^3 of water, while milling oil from the seeds consumes an additional 12,400 m^3. These two production steps – or nodes of the value chain – can occur in the same country, or in several, with implications for the water footprint of each country's production. Moreover, trade patterns often mean that the sesame oil is consumed in countries other than those where it was produced.

The water footprint methodology therefore includes the concept of "virtual water trade", which estimates the invisible flows of so-called "embedded" water contained in traded goods. This concept allows for the reconciliation of the water footprints of production – comprising its different value chain nodes – with final consumption.

In principle, policy makers in water-scarce countries can also use virtual water trade data as an input in trade policy, to try and shift local production to water-efficient goods – such as roots, tubers and vegetables, which typically consume under 1,000 m^3/MT of water – and import water-intensive ones, such as sesame oil. This would reduce the volume of embedded water contained in exports and improve the country's virtual water trade balance.

Globally, Mekonnen and Hoekstra (2011) estimated total virtual water trade flows were approximately 2.32 trillion m^3 per year over the 1996-2005 period, equivalent to one quarter of the global water footprint of production. These flows were concentrated mainly in primary agricultural and animal products. Table

5 shows the products that embodied the largest share of virtual water trade for the 1996-2005 period, computed as the water footprint of production per unit of quantity (m^3/MT), multiplied by total trade volumes, led by seed cotton (24.5 per cent) and industrial products (12.2 per cent). Cereals, bovine meat, cocoa and coffee occupy the remainder of the list. The table also illustrates that most virtual water trade derives from green water, or rainfall, embodied in agricultural goods produced under rainfed conditions.

Table 5 Global virtual water trade volumes, by product, 1996-2005

	Virtual water trade (millions m³ / year)				
Product	Green	Blue	Grey	Total	Share of total (%)
Seed Cotton	327,310	166,997	74,523	568,830	24.5
Industrial products	0	22,123	260,031	282,154	12.2
Soya beans	194,634	5,606	2,659	202,899	8.7
Wheat	174,869	7,849	17,901	200,619	8.6
Bovine meat	141,413	9,799	5,377	156,589	6.7
Cocoa Beans	86,132	12	751	86,895	3.7
Coffee, Green	80,807	514	3,590	84,911	3.7
Oil Palm Fruit	67,629	2	3,314	70,945	3.1
Maize	51,501	4,623	12,661	68,785	3.0
Rice, Paddy	38,058	25,398	5,129	68,585	3.0

Source: (Mekonnen & Hoekstra, 2011)

Among SIDS' common products – shown earlier in Table 4 – green coffee (3.7 per cent of the total), maize (3 per cent), sugar cane (2.9 per cent) and coconuts (1.1 per cent) figure most prominently in global virtual water trade.

Annex 3 shows the average virtual water trade balance for the 38 SIDS in our sample, over the 1996-2005 period. The group average was a positive virtual water trade balance of 827 million m^3 per year. Twelve (12) of the 38 SIDS had negative virtual water trade balances.

Country-level flows are not broken down by individual products, but rather by product groups: crops, animal and industrial products. For the 38 SIDS, the positive average virtual trade balance derives mainly from imported crops, which represented 83 per cent of all imported virtual water. Crops represented roughly the same proportion of the smaller virtual water export flows. Alongside the data on water sources – presented in Table 5 – this underlines that SIDS: a) depend on rainfed agriculture as a major engine of economic output; b) have relatively few water-intensive products in their export baskets; and c) rely on imports of water embedded in agricultural products, mainly staple foods.

In a forthcoming paper, UNCTAD (forthcoming) used virtual water trade data to elaborate a "water import dependency rate" for a country's consumption of agricultural products. According to this measure, populations in the Middle East and North Africa (MENA) region is the most import dependent, relying on imports for 61 per cent of embedded water in the agricultural products they consume. Although not a region, SIDS rank second to MENA countries, with a water import dependence rate of 47 per cent for agricultural products.

In the case of SIDS, water import dependency shows no particular relationship to food security/insecurity or water security/scarcity. Rather, it underlines SIDS' dependence on imports of essentials, such as staple foods. This import dependency is expected to grow. For example, Chouchane et al (2018) estimate demand from water-scarce countries – including many SIDS – will drive an increase in the international trade in staple crops by a factor of 1.4 to 1.8 by 2050, from the 2001-2010 average. This has implications on where SIDS will source additional imports of staple crops, as well as whether it will remain viable for exporting countries to continue to devote more resources – including water – to produce and export those crops.

3.4 POLICY IMPLICATIONS

The water footprint and virtual water trade concepts are useful analytical tools to understand, for example, the water embedded in traded goods and, thereby, to reconcile the water footprints of production and consumption in a globalised world. Nevertheless, the direct policy utility of the two concepts remains limited.

On one hand, the water footprint and virtual water trade methodologies break down the use of water in production, consumption and trade by the type of water – green, blue or grey – whereas other methodologies focus mainly on blue water withdrawals. The breakdown by "colour" of water is invaluable for analyses of key policy questions in developing countries, for example: how water efficiency fits into cost-benefit analyses of irrigation (blue water) versus rainfed (green water) production in agriculture, or the performance of industry in "closing the loop" in their water consumption by recycling grey water. The water footprint methodology can also be applied down to the level of an individual firm, river basin, aquifer or product – which can inform and enrich policy analysis.

On the other hand, while the methodology's breakdown of water "colours" may be informative, by itself, it may oversimplify the fungibility among water sources. For example, financial considerations – not the type of water source – often dictate decisions on investments in rainwater harvesting, irrigation or grey water treatment infrastructure.

Moreover, resource management policies are framed around outcomes, not on bare estimates of stocks and flows. The water footprint methodology studies water as an input to productive economic activities, and is not easily extended to other, non-economic uses – such as habitat conservation or for drinking water and sanitation applications – and the benefits (or values) that these other uses contribute towards national development objectives. Even for water-scarce countries, this means that targeting reductions in the use of domestic water resources in goods and services consumed, alone, would be an arbitrary exercise that, on balance, may or may not ease water stress, but would risk undermining other national development objectives.

The useful map of water use drawn by the water footprint methodology should therefore be one of several inputs into a policy-making process that frames the outcomes of water security, alongside other national objectives, such as sustainable economic development, food and energy security and resilience to shocks (Liu, *et al.*, 2019; Lee, Choi, Yoo, & Mohtar, 2018; Wilchens, 2018).

For the virtual water trade concept, empirical results show that its implied policy utility – that water-scarce countries could use trade to import water-intense goods from more water-abundant countries, while producing water-efficient ones locally – is not reflected in real-world trade patterns. Some corroborating examples exist, such as water-scarce economies in the Middle East and North Africa (MENA) being net importers of virtual water, while water-abundant Canada is a net exporter. Nevertheless, many conflicting examples exist, including water-secure, advanced economies, such as Japan, The Republic of Korea and several European countries, being among the main net virtual water importers, while water-scarce Pakistan and Uzbekistan are net exporters (Mekonnen & Hoekstra, 2011).

Rather than influencing trade policy and patterns, virtual water trade may actually be a symptom of the classic economic factors that structure international trade. Recent empirical studies show strong correlation between virtual water trade patterns and land and water productivity (i.e., $/m^3), for example, emphasising that more advanced economies are able to devote their land and water resources to more productive activities, importing goods and services from less productive activities. This fits with classic dynamics of production and trade between advanced and developing economies, which reinforce economic inequality and shift negative externalities, such as water scarcity, pollution and environmental degradation onto poorer countries (Chen, Kang, & Han, 2021; Duarte, Pinilla, & Serrano, 2019; Liu, *et al.*, 2018; Afkhami, Bassetti, Ghoddusi, & Pavesi, 2020).

The importance of water and land productivity in trade patterns implies that water-scarce SIDS should go beyond policies to adapt production and consumption to water scarcity, or to alleviate it through virtual water trade. In addition, they should seek to improve land and water productivity, especially in agriculture, upgrading to higher-value activities and products, as these strategies are associated with greater long-term water security.

In this context, it is important to frame the policy considerations identified in the previous subsections in the terms of policy outcomes in SIDS, with a focus, where possible, on linking improved water security with increased productivity . For example:

Agriculture, food and diets

- How can water-saving techniques for rainfed agriculture, such as rainwater harvesting, conservation tillage, planting on ridges and furrows and using bio-mulches, make agriculture more productive and environmentally sustainable?
- Where are investments in irrigation a feasible solution to improve water security and agricultural productivity?
- What opportunities exist to promote diets based on water-efficient crops, such as roots, tubers, vegetables and some fruits, while respecting cultural and dietary traditions?

Industry

- What small-scale, on-site grey water treatment technologies are feasible investments for firms to reduce their pollution, reduce water-related risks, save on water costs and recover valuable resources such as biogas or nutrients, thereby contributing to their bottom line, as well as water security and environmental conservation?
- How can governments support a more circular water cycle in industry and agriculture, through incentives and turnkey infrastructure investments, including grey water treatment facilities?

Electricity generation

- How can the implementation of wind, solar and other renewable energy technologies, as well as biomass energy, contribute to water and energy security, as well as reduce SIDS' fossil fuel trade deficits?
- What are feasible funding models for investments in:
  - Upgrading to more water-efficient cooling systems; and
  - Grey water treatment facilities in thermal power plants?

Trade

- How can SIDS use trade to complement efforts to improve agricultural productivity, thereby improving food and water security, in the context of growing demand for staple foods?

General

- How can governments use water use data in a participatory process towards an agreed list of the multiple societal values of water, which can inform water allocation decisions, manage competing uses and, when applied to national objectives, point to the "highest and best uses" of water resources?

4

Policy analysis

4 POLICY ANALYSIS

In this section, we present an evaluation of how well water and economic development policies are aligned in the 38 SIDS in our sample. Our objective was to identify policy gaps, for which we recommend remedies in the following section.

4.1 METHODOLOGY

As we outlined in Section 2, the relationship between water and economic policy is multi-faceted and flows in both directions. For the purposes of this paper, we focussed our analysis on how well economic policies incorporate water security as a strategic objective. Nonetheless, our analysis inevitably led to some recommendations that pointed in the opposite direction, that is: how water management policies can better incorporate economic principles and objectives.

To examine these questions, we evaluated national economic development plans as our research object. Of the 38 SIDS in our sample, 29 had publicly available plans that met our basic criteria, namely that they:

- Expressed the country's medium- to long-term economic objectives and strategies;
- Were relatively recent, with a time horizon of no earlier than 2018; and
- Were available in English or French.

According to these criteria, the following nine SIDS were omitted from our analysis: Cabo Verde, Cuba, Dominican Republic and São Tomé and Príncipe (plans not in English or French), Palau (plan not recent enough), Comoros, Guinea-Bissau, Saint Kitts and Nevis and Suriname (no plans available). The full list of the 29 national development plans appears in Annex 4.

We used a comparative approach to evaluate how well the economic plans incorporated water security, as defined by UN-Water (see Annex 1). As a threshold, we considered that a plan incorporated water security if it included a range of policy actions and/or standards related to both water supply and demand, for example conserving and expanding blue water resources, while raising public awareness of water conservation and expanding access to clean water and sanitation. According to this threshold, we did not require a plan refer specifically to "water security", provided it treated a broad enough range of the factors underlying water security.

To begin, we assessed whether economic plans included a substantive treatment of the following five strategic priorities common to SIDS, including water security:

1. Climate change adaptation
2. Disaster risk reduction
3. Energy security
4. Food security
5. Water security

Given SIDS' vulnerabilities in these areas, these priorities feature prominently in the 2014 SIDS Accelerated Modalities of Action (SAMOA) Pathway, which is part of the United Nations 2030 Agenda for Sustainable Development, alongside agreements such as the Addis Ababa Action Agenda on financing for development and the Paris Agreement on greenhouse gas-emissions mitigation, adaptation and finance.

In evaluating the inclusion of these five strategic priorities in the 29 economic plans, we considered "substantive treatment" to include:

- A clear statement of objectives, actions and desired outcomes that embodied the spirit of water security, if not the term itself; backed up by

- Specific and measurable targets for the policy actions, whether framed around programmes, investments or outcomes.

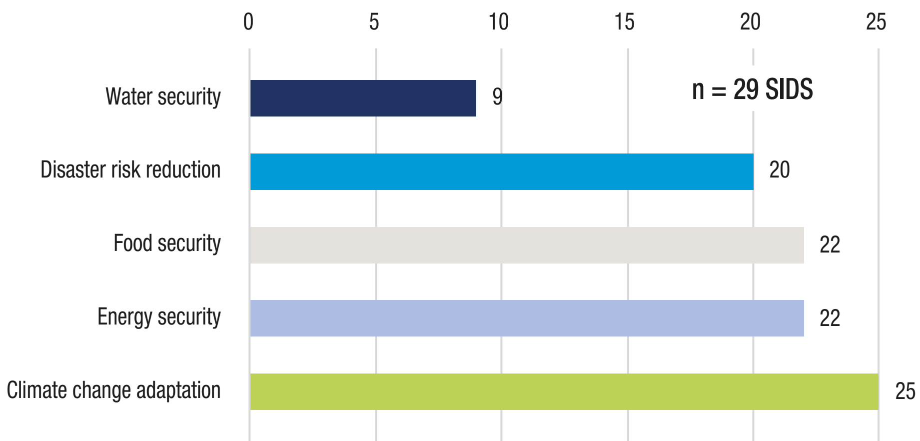
Following this comparative analysis of the treatment of water security as a strategic objective in economic plans, the remainder of the section summarises our analysis of the types of policy interventions on water and/or water security contained in the 29 economic plans, according to questions such as:

- Are *objectives* framed around, for example: a comprehensive vision of water security; more specific objectives, such as conservation of water resources; or specific outcomes, such as access to drinking water and sanitation (i.e., SDG 6)?
- What *types of interventions* are envisioned, for example: fiscal incentives, management actions or systems, investments in infrastructure, adoption of new technologies or the enforcement of standards?
- What water-related *standards* are envisioned for economic activities, such as efficiency (water consumed per unit of output) or productivity (output per unit of water consumed)?

4.2 WATER SECURITY IN ECONOMIC PLANS

Among the 29 SIDS economic plans we analysed, only nine included "substantive treatment" of water security. As shown in Figure 6, the four other strategic priorities were treated more widely.

Figure 6 Selected strategic priorities treated in SIDS' national development plans



Note: Among the 38 SIDS studied in this paper, 29 had recent national development plans available in English / French
Source: Authors' analysis of national development plans

The nine SIDS with water security featured in their economic plans were not evenly distributed by region, with four Caribbean SIDS (Dominica, Grenada, Jamaica and Trinidad and Tobago), two from the Indian Ocean (Maldives and Mauritius) and one each from Southeast Asia (Singapore), the Middle East (Bahrain) and the Pacific (Vanuatu).

Table 6 lists the classification, in terms of renewable water resources per capita in 2017, of the nine SIDS that featured water security in their economic plans. Three SIDS are classified as having either "very low" (Maldives and Bahrain) or "low" (Singapore) renewable water resources per capita. The remaining six SIDS are classified as having either "medium" or "very high" volumes of renewable water resources. This underlines that the countries that feature water security in their economic plans are not necessarily driven by the scarcity of their naturally occurring water resources.

Table 6 Available renewable water resources of selected SIDS, 2017

Country	Total renewable water resources per capita (m^3/person/year)	Classification
Maldives	60.4	Very low
Bahrain	77.6	Very low
Singapore	105.1	Low
Grenada	1,803.8	Medium
Mauritius	2,175.6	Medium
Trinidad and Tobago	2,774.4	Medium
Dominica	2,798.8	Medium
Jamaica	3,705.4	Medium
Vanuatu	35,025.0	Very high

Note: Water stress classifications by renewable water resources per capita (m^3/person/year):
Very low: - <100
Low: 101-1,000
Medium: 1,001-5,000
High: 5,001-10,000
Very high: >10,000

Source: FAO AQUASTAT

Although we qualified these nine SIDS as having incorporated water security in their national development plans, five of them did not use the specific term “water security”. Rather, they embodied water security by including substantive policy actions and targets for both water supply and demand. We can therefore paraphrase the water-security language used in these five plans as “sustainably manage water resources to respond to the needs of different user groups”.

Only Bahrain, the Maldives, Mauritius and Singapore used the term “water security” in their plans. These countries also had among the most comprehensive range of interventions. On the supply side, these included projects to develop new sources of fresh water in Bahrain, Mauritius and Singapore and, in all four countries, to increase the treatment and reuse of grey water and to improve overall water quality. On the demand side, interventions included a broad public awareness campaign on water management issues in the Maldives and Singapore and, along with Mauritius, integrated water pricing strategies.

With respect to an integrated treatment of water, food and energy, only Trinidad and Tobago framed its water security policies around the water-food-energy nexus. Meanwhile, the Maldives, Mauritius and Singapore linked water and energy in interventions aimed at developing water-efficient renewable energy sources.

In general, water security in the nine SIDS plans included a broad treatment of supply issues, from conservation of watersheds and aquifers, to treatment and water quality. The framing of demand issues was narrower, at least in terms of the different uses and values of water. All plans devoted their primary water-related focus to access to clean water and sanitation, with a secondary focus, in some plans, on the production of food and energy. Only a small handful of plans included water-related interventions devoted to cultural and recreational activities.

Only Jamaica's plan included policy actions aimed at water as an input in non-food, non-energy economic activities, such as growing cash crops, or in industrial or service sectors. Indeed, Jamaica's plan contained the clearest language on the importance of water in economic development:

> *"… improvement in physical economic infrastructure (such as roads, energy and water supplies, air and sea ports, and telecommunications networks) usually has higher payoffs in the form of higher rates of economic growth than equivalent investment in health and education… because such improvements have a faster impact on total factor productivity."*[27]

None of the 29 SIDS plans reviewed referred to qualitative or quantitative statements on the value(s) of water and/or an ordered list of priorities that might guide, for example, the allocation and pricing of water for priority economic sectors.

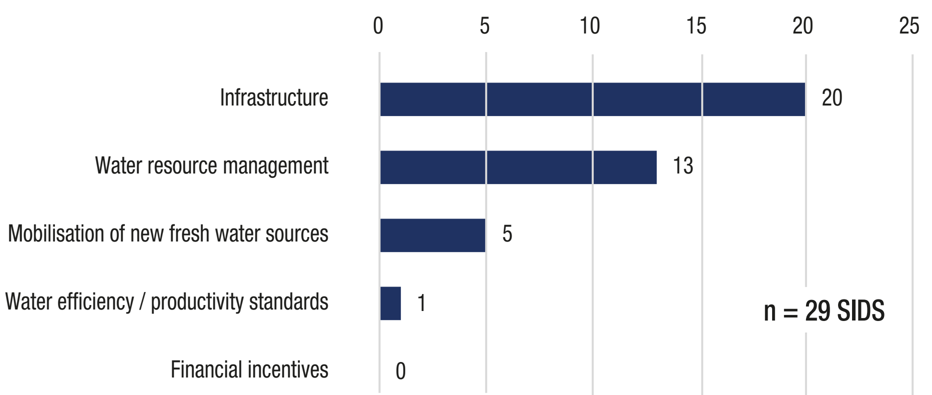
4.3 ACCESS TO CLEAN WATER AND SANITATION

In addition to the nine SIDS economic plans that incorporated water security, a further nine SIDS (for a total of 18) included specific policy actions to ensure access to clean water and sanitation (i.e., SDG 6). This is a fundamental objective and prerequisite to sustainable economic development. Nevertheless, we deemed that access to clean water was just one outcome in the broader concept of water security and, indeed, that it depends on supply-side policies to conserve water resources and develop new sources of fresh water. From this perspective, we concluded that SIDS plans with policy actions only for access to clean water and sanitation were not fully aligned with the concept of water security.

4.4 TYPES OF INTERVENTIONS

As shown in Figure 7, water-related policy interventions in 20 of the 29 SIDS national development plans focussed mainly on improving and expanding infrastructure to process, store and deliver fresh water to residents. Meanwhile, 13 SIDS included policy interventions on water resource management. Only the plans in five SIDS (Bahrain, Maldives, Mauritius, Singapore and Trinidad and Tobago) included strategies and targets to develop new sources of fresh water to meet growing demand. Only Singapore's plans included actions or targets to improve the water efficiency or productivity of productive activities, in this case in several key economic sectors. None of the 29 SIDS' plans included water-related financial incentives, such as tax breaks, preferential pricing, grants or subsidies.

Figure 7 Selected types of water-related policy interventions in SIDS



Source: Authors' analysis of national development plans

[27] Vision 2030 Jamaica, National Development Plan, p. 155.

Figure 7 demonstrates that most SIDS limit themselves to more traditional policy actions, based on improving water resource management and infrastructure to produce, store and deliver existing sources of fresh water. Singapore's policies were the only ones to operationalise the economic payback of investments in new water sources, as well as continual improvements in water efficiency in households and industry.

4.5 GAPS

In general, SIDS need to better incorporate water security as a strategic priority in their economic plans, alongside other priorities, such as climate change adaptation, disaster risk reduction and food and energy security. Even in the nine SIDS whose plans already address water security to some degree, the incorporation of a water security strategy could be more complete, with, in particular, a wider consideration of the different uses and values for water. Access to clean water and sanitation (SDG 6) has its rightful place as a priority in these plans, although water as an input to productive economic activities requires more attention.

By extension, most SIDS economic plans lack a coherent logic on how sustainable water management is fundamental to economic development. Conserving water resources is important, as is alleviating water scarcity. Ensuring access to clean water and sanitation is crucial. Nevertheless, treated in isolation, these priorities/outcomes/values stop short of providing coherent, water-smart economic policies, which would allow for decisions on the "highest and best uses of water", towards long-term sustainable development.

Alignment of economic and water policies flows in both directions, so economic plans can only go so far in incorporating water security as a strategic priority. Water policies in SIDS typically do not contain clear statements or ordered priorities for the multiple societal values of water, which economic planners could apply to the policies, investments and standards contained in national development plans.

SIDS' national development plans largely limit their water-related policy actions to water management and infrastructure, based on the traditional mindset of delivering low-cost water to users. Actions to change the status quo – for example, to develop new sources of fresh water, to capture its full value as a lever of sustainable development, to build public awareness around the scarcity and value of water resources and to set and measure water-smart targets for economic activities – are rare in SIDS' national development plans.

Indeed, only Singapore set economic targets for water use, such as water efficiency and productivity. Without such targets and standards, policy makers in SIDS will struggle to create incentives, raise public awareness, change behaviours and foster water-secure development in key areas, such as: improving agricultural productivity, transitioning to water-efficient renewable energy technologies and increasing the treatment and reuse of wastewater in non-residential sectors.

5

Policy recommendations

5 POLICY RECOMMENDATIONS

In this paper, we argued that water security needs more attention from SIDS as a strategic priority in their national development plans (Section 2). To identify how SIDS can align economic plans with water security priorities, we drew policy implications from the water footprint of production, consumption and trade in SIDS (Section 3) and identified policy gaps in the national development plans themselves (Section 4). In this section, we take up the considerations identified in earlier sections and provide actionable policy recommendations for SIDS to better incorporate water security and productivity in their national development plans.

5.1 MAINSTREAM WATER SECURITY IN ECONOMIC PLANNING

SIDS need to incorporate water security as a strategic priority in economic planning, alongside other priorities, such as climate change adaptation, disaster risk reduction, food and energy security. Water-smart economic policies should be based on a coherent logic of: a) water's multiple uses or values; and b) how water's multiple uses represent opportunities or risks to the country's sustainable development. From this logic, economic plans should incorporate desired water-related outcomes, guiding policy actions and relevant targets. Given the interdependence of water, food and energy outcomes, plans can even treat these policies in an integrated way, according to the water-food-energy nexus.

For those SIDS that already treat water in a limited way in their national development plans – for example with a focus on access to clean water and sanitation (SDG 6) – we recommend adopting a more holistic vision of water security, involving, for example: conserving existing water resources and developing new sources of fresh water, towards meeting demand growth from different user groups and proactively using water as a lever for sustainable development.

With respect to economic development models, the literature on water scarcity and virtual water trade suggests that policies designed to simply adapt production to water scarcity, or alleviate scarcity by importing water-intensive goods, are unlikely to achieve the desired result. Instead, land and water productivity remain more influential on production and trade patterns, including for virtual water trade. SIDS should therefore incorporate water efficiency and productivity into their economic plans.

5.2 IMPLEMENT INTEGRATED WATER RESOURCE MANAGEMENT (IWRM)

Water-secure economic planning relies on coherent water policy. SIDS should therefore redouble their efforts to implement Integrated Water Resource Management (IWRM), the accepted international framework for the holistic management of water resources. IWRM is a process organised on three principles: social equity, economic efficiency and ecological sustainability. The IWRM approach allows countries to consider their specific water management context and priorities, apply good management practices and arrive at an IWRM approach that can guide sustainable water management.[28]

In general, SIDS score poorly on implementation of IWRM policies. According to SDG Indicator 6.5.1 on "degree of implementation of IWRM" on a scale of 0-100, the 2017 baseline showed that most SIDS scored below the world average of 49, in the "low" (10-30) or "medium-low" (30-50) categories. Only a handful of SIDS outperformed the world average, namely Cabo Verde (64), Mauritius (64), Samoa (70), Cuba (82) and Singapore (100).[29]

28 Global Water Partnership. What is IWRM? Available at: https://www.gwp.org/en/GWP-CEE/about/why/what-is-iwrm/. Retrieved: 7 May 2021.

29 Source: IWRM Data Portal. UNEP-DHI Centre on Water and Environment. Available at: http://iwrmdataportal.unepdhi.org. Retrieved: 9 November 2020.

Although the IWRM approach varies among the handful of good performers, they offer general lessons for other SIDS on the importance of ensuring the building blocks of a strong management systems, such as: platforms for broad-based participation across user groups, an enabling policy environment, robust institutions and management tools, all underpinned by sufficient financing.

On the supply side, an integrated approach to water management in SIDS could consider the upstream effect of waste management, with limited land area on many islands leading to insufficient protections from effluents polluting the water supply (Periathamby & Herat, 2014). With climate change increasing the frequency and severity of natural disasters in many SIDS, an IWRM approach must also integrate disaster risk reduction, for example according to the Sendai Framework for Disaster Risk Reduction (Gheuens, Nagabhatla, & Perera, 2019).[30]

On the demand side, SIDS should use the IWRM process to foster behaviour change, through public awareness campaigns about the values of water, its scarcity and the need for responsible consumption. These efforts can be reinforced with coherent and transparent pricing and cost recovery policies.

5.3 COLLECT MORE DETAILED DATA ON WATER SUPPLY AND CONSUMPTION

SIDS should also use the IWRM process to improve data collection and management, in support of evidence-based water governance and regulation. At the time of writing, only data on blue water withdrawals from municipal systems was reported on a widespread basis. This excludes, for example, data on the supply of green water (i.e., from rainfall and plants) and on the production of grey water. In many cases, these data gaps represent blind spots for policy analysis on key questions, such as how to improve the water productivity of rainfed agriculture, or how to incentivise the treatment and reuse of grey water in agriculture and industry.

In addition, widely available data on water consumption is typically limited to the generic "agriculture", "municipal" and "industry" groupings, limiting their utility in policy analysis with respect to, for example: identifying the "highest and best" uses for water as an economic input; establishing targets for water efficiency, productivity or circularity for specific subsectors, such as food processing, accommodation or manufacturing; evaluating water-related incentives or investments to develop infrastructure, more productive production models, or priority sectors.

Countries therefore need to collect more granular data on water supply and consumption, to enable evidence-based policy analysis at the national and international levels. In this paper, we relied on the excellent database of water footprint accounts compiled by Mekonnen and Hoekstra (2011), which provides much of the required granularity, but is limited by the age of the underlying data, from 1996-2005. Whether based on the water footprint or another conceptual framework, countries need regular collection and reporting of data on: the full range of water sources (i.e., green, blue and grey); the consumption by use, user group and/or product; water efficiency and productivity in the main productive sectors; as well as on the full cost of water, comprising the marginal production cost, plus management, infrastructure and ancillary costs.

5.4 ENGAGE WATER STAKEHOLDERS IN A PARTICIPATORY PROCESS

In the 2021 World Water Development Report on "Valuing Water", the United Nations (2021) recommends a multi-value approach to governance. This involves engaging water stakeholders in a participatory process to agree on an ordered list of qualitative values that policy makers will use to govern water

[30] See: "Sendai Framework for Disaster Risk Reduction 2015-2030". United Nations Office for Disaster Risk Reduction. Available at: https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030. Retrieved: 6 November 2020.

resources. This participatory approach is built into the IWRM process, or it can be organised as a parallel governance process.

Ordered values can be structured on, for example:

- National outcomes or objectives, e.g.: "1. Human health; 2. Environmental conservation; 3. Poverty reduction";
- Elements in the value of water, e.g.: "1. Water resources; 2. Water infrastructure; 3. Water services; 4. As an input in socioeconomic activities"; or
- Uses of water, e.g.: "1. Conservation of habitat and biodiversity, 2. Drinking water and sanitation, 3. Food production", etc.

As part of the process, stakeholders can also agree on the indicators to be used in monitoring and evaluating water use and management.

5.5 PRIORITIZE THE "HIGHEST AND BEST USES OF WATER"

At a governance level, economic planners can use an ordered list of the multiple values of water as a criterion in selecting industries for development. Adding water-related criteria may change decisions related to selecting, planning and evaluating the development of priority industries, away from water-intensive ones that might otherwise be suited to SIDS' contexts, such as fish processing, beverages, textiles, or mining, in favour of more water-efficient ones, such as renewable energy or services. An agreed list of values can also help structure compromises among competing uses, although these tensions will always exist, to some extent.

Agreed values of water can also be applied at the management level in economic plans in, for example in:

- Setting water-related financial incentives, such as tax breaks, preferential pricing, grants or subsidies;
- Assessing investments in water-saving improvements to public infrastructure, as well as new investments in, for example, desalination plants and renewable energy technologies; and
- Funding water-related programmes, such as: awareness-building and behaviour change in economic sectors, extension services and credit for farmers, and capacity-building.

With these governance and management actions, SIDS can orient their plans on the "highest and best uses for water", towards the achievement of national objectives.

5.6 SET AND MONITOR WATER EFFICIENCY AND PRODUCTIVITY TARGETS

In support of a strategic focus on water security and productivity, SIDS must include relevant new targets and indicators in their plans, to monitor and evaluate progress. These indicators need not be complicated, simply relating desired economic outcomes with water indicators, such as consumption volume or costs.

For example, at the macroeconomic level, relevant indicators could include:

- Growth in per capita water consumption vs growth in GDP per capita;
- Volume of water consumption vs GDP, value added or agricultural production; and
- Change in water use efficiency over time (SDG Indicator 6.4.1).

At the sector and firm level, the relevant indicators are similar, such as:

- Water productivity: output or value added per volume of water consumed ($\$/m^3$); or
- Water efficiency: volume of water consumed per unit of output ($m^3/\$$).

SIDS governments can use these targets and indicators to work with their main industries on sector- and firm-level plans to improve water-related performance, including supporting them with capacity-building, incentives and subsidies for water-saving investments.

5.7 INCORPORATE WATER SECURITY AND PRODUCTIVITY IN SECTOR-SPECIFIC STRATEGIES

In addition to national development plans, many SIDS have dedicated policies and strategies for their key economic sectors, such as agriculture, fisheries and tourism. After incorporating water security into their national plans, the next step is to align the sectoral plans.

Although it was beyond the scope of this paper to analyse sectoral strategies in SIDS, our findings suggest that greater emphasis on water security requires revisiting a few key sectoral policies. In particular, applying the multiple values of water, as well as water productivity targets, is likely to change the policy rationale in the following areas:

- **Agriculture:** Invest in more productive models, such as more capital-intensive ones based on irrigation, or rainfed ones involving water harvesting, conservation tillage, planting on ridges and furrows and using bio-mulches.
- **Energy:**
    - Pursue energy transition by developing water-efficient renewable energy sources, such as geothermal, wind and solar over more water-intensive ones, such as hydropower and biomass;
    - For existing fossil fuel-fired plants, create incentives for installing water-efficient cooling systems; and
    - Although biomass is converted to electricity in water-intensive thermal plants, it may be an attractive substitute for fossil fuels in some contexts, since it utilises agricultural residues and could provide other synergies in the water-food-energy nexus.
- **Industry:** Create incentives for industrial users, including power plants and mines, to invest in on-site water treatment and by-product recovery technologies, and to reuse grey water.

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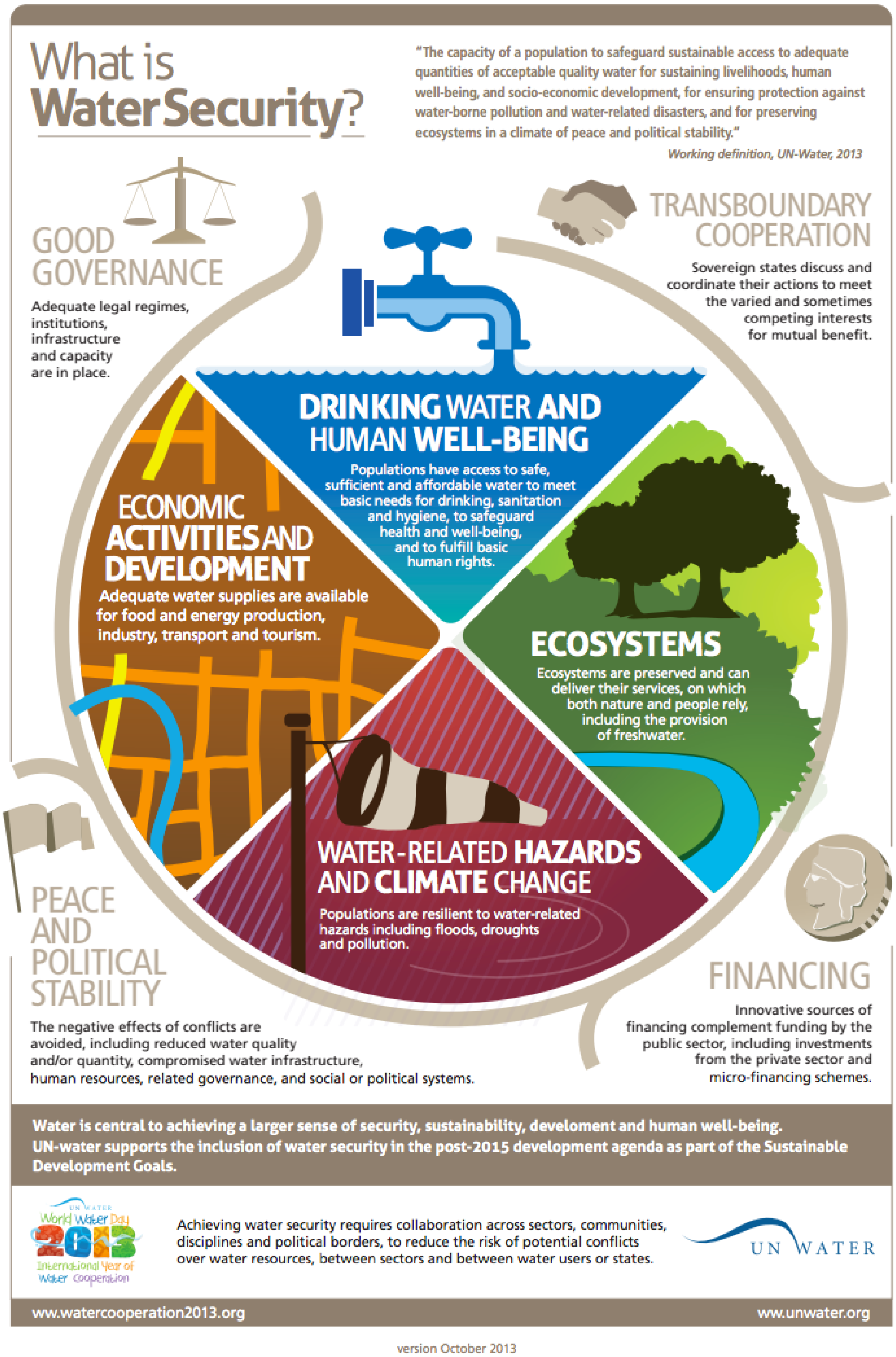
ANNEX 1

Infographic: "What is water security?"



Source: "What is water security?" UN-Water. Available at: https://www.unwater.org/publications/water-security-infographic/. Retrieved: 6 November 2020

ANNEX 2

United Nations list of SIDS

United Nations member States (38)		Non-UN members/associate members of the regional commissions (20)	
1.	Antigua and Barbuda	1.	American Samoa
2.	Bahamas	2.	Anguilla
3.	Bahrain	3.	Aruba
4.	Barbados	4.	Bermuda
5.	Belize	5.	British Virgin Islands
6.	Cabo Verde	6.	Cayman Islands
7.	Comoros	7.	Commonwealth of Northern Marianas
8.	Cuba	8.	Cook Islands
9.	Dominica	9.	Curacao
10.	Dominican Republic	10.	French Polynesia
11.	Fiji	11.	Guadeloupe
12.	Grenada	12.	Guam
13.	Guinea-Bissau	13.	Martinique
14.	Guyana	14.	Montserrat
15.	Haiti	15.	New Caledonia
16.	Jamaica	16.	Niue
17.	Kiribati	17.	Puerto Rico
18.	Maldives	18.	Sint Maarten
19.	Marshall Islands	19.	Turks and Caicos Islands
20.	Federated States of Micronesia	20.	US Virgin Islands
21.	Mauritius		
22.	Nauru		
23.	Palau		
24.	Papua New Guinea		
25.	Samoa		
26.	São Tomé and Príncipe		
27.	Singapore		
28.	Saint Kitts and Nevis		
29.	Saint Lucia		
30.	Saint Vincent and the Grenadines		
31.	Seychelles		
32.	Solomon Islands		
33.	Suriname		
34.	Timor-Leste		
35.	Tonga		
36.	Trinidad and Tobago		
37.	Tuvalu		
38.	Vanuatu		

ANNEX 3

Average annual virtual water trade balances, SIDS, 1996-2005

		Virtual water trade (millions of m³ / year)								
		Imports (IM)				Exports (EX)				Balance (IM-EX)
Code	Country	Crops	Animal products	Industrial products	Total	Crops	Animal products	Industrial products	Total	
ATG	Antigua and Barbuda	41.1	16.5	14.2	71.7	44.3	5.6	3.8	53.7	18.0
BHR	Bahrain	1,359.0	268.4	141.7	1,769.1	577.5	9.6	58.5	645.7	1,123.4
BRB	Barbados	234.7	69.7	28.0	332.5	104.0	1.9	11.9	117.8	214.6
BLZ	Belize	67.4	23.5	14.3	105.2	511.2	5.9	13.1	530.1	-424.9
CPV	Cabo Verde	165.4	17.0	5.8	188.1	5.3	0.4	0.3	6.0	182.1
COM	Comoros	113.6	27.5	2.5	143.6	104.3	0.3	0.3	104.8	38.8
CUB	Cuba	3,129.4	298.6	133.4	3,561.4	7,839.9	20.2	55.4	7,915.5	-4,354.1
DMA	Dominica	35.0	10.4	3.7	49.1	52.6	6.6	1.3	60.5	-11.4
DOM	Dominican Republic	2,810.5	755.1	193.0	3,758.5	5,066.1	83.7	72.6	5,222.5	-1,464.0
FJI	Fiji	593.0	109.6	25.9	728.5	1,014.0	24.7	4.8	1,043.6	-315.1
GRD	Grenada	61.0	23.6	4.7	89.3	97.8	0.6	0.3	98.7	-9.4
GNB	Guinea-Bissau	116.6	4.7	3.1	124.4	33.4	0.2	3.1	36.7	87.8
GUY	Guyana	312.0	30.1	15.1	357.1	880.4	0.3	6.9	887.6	-530.5
HTI	Haiti	1,596.6	78.2	20.8	1,695.7	764.2	8.0	6.9	779.1	916.6
JAM	Jamaica	1,415.8	240.1	87.4	1,743.3	991.0	14.7	42.4	1,048.1	695.2
KIR	Kiribati	38.7	9.0	0.6	48.4	7.2	0.0	0.0	7.3	41.1
MDV	Maldives	239.2	93.9	18.2	351.3	112.9	0.2	3.1	116.3	235.1
MHL	Marshall Islands	26.9	6.2	28.5	61.5	55.6	0.0	2.0	57.6	3.9
MUS	Mauritius	3,322.4	275.1	103.2	3,700.7	1,818.5	24.3	49.0	1,891.9	1,808.8

		Virtual water trade (millions of m³ / year)								
		Imports (IM)				Exports (EX)				Balance (IM-EX)
Code	Country	Crops	Animal products	Industrial products	Total	Crops	Animal products	Industrial products	Total	
FSM	Micronesia (Federated States of)	29.9	16.0	1.4	47.4	21.7	0.1	0.3	22.1	25.3
NRU	Nauru	1.9	5.0	1.5	8.5	2.0	0.9	0.7	3.5	5.0
PLW	Palau	6.1	3.6	1.3	11.0	18.1	0.0	0.6	18.8	-7.7
PNG	Papua New Guinea	9,658.5	799.5	31.7	10,489.7	4,120.1	4.6	18.7	4,143.3	6,346.4
KNA	Saint Kitts and Nevis	67.7	9.2	9.2	86.1	36.0	0.0	3.3	39.3	46.8
LCA	Saint Lucia	67.6	31.2	7.8	106.7	12.4	0.0	0.8	13.2	93.5
VCT	Saint Vincent and the Grenadines	98.9	13.4	5.5	117.7	91.0	0.7	2.3	94.0	23.7
WSM	Samoa	18.9	31.6	2.8	53.3	50.3	0.6	0.3	51.1	2.3
STP	Sao Tome and Principe	29.0	1.9	0.7	31.6	78.9	0.1	0.1	79.0	-47.4
SYC	Seychelles	103.3	24.0	9.4	136.8	41.6	0.9	1.0	43.4	93.4
SGP	Singapore	11,608.4	1,841.4	5,772.5	19,222.3	12,375.2	360.4	3,938.0	16,673.5	2,548.8
SLB	Solomon Islands	170.6	3.8	2.6	177.0	169.5	0.4	0.0	169.9	7.1
SUR	Suriname	92.1	24.4	15.3	131.8	130.6	1.4	18.7	150.7	-18.9
BHS	The Bahamas	284.2	152.4	112.6	549.1	57.5	0.3	18.7	76.5	472.7
TLS	Timor-Leste	31.1	2.9	0.5	34.6	27.5	0.1	0.3	27.9	6.7
TON	Tonga	17.5	26.1	1.1	44.7	28.0	0.0	0.0	28.1	16.6
TTO	Trinidad and Tobago	23,898.8	171.2	111.7	24,181.7	272.9	8.9	105.5	387.4	23,794.4
TUV	Tuvalu	2.0	1.5	1.6	5.2	25.4	0.0	0.4	25.8	-20.7
VUT	Vanuatu	30.4	4.1	3.3	37.8	228.8	24.9	0.6	254.3	-216.4
Average		**1,628.8**	**145.3**	**182.5**	**1,956.6**	**996.5**	**16.1**	**117.0**	**1,129.6**	**827.0**

Source: (Mekonnen & Hoekstra, 2011)

ANNEX 4

SIDS national development plans

Country	Full plan in Eng/Fr?	Name	Year Published	Horizon
Antigua and Barbuda	y	Medium-Term Development Strategy 2016 to 2020	2015	2020
Bahamas	y	Vision 2040, National Development Plan of the Bahamas (2nd working draft)	2017	2040
Bahrain	y	National Development Strategy 2015-2018	2015	2018
Barbados	y	Barbados Growth and Development Strategy 2013-2020	2013	2020
Belize	y	Growth and Sustainable Development Strategy of Belize (2016-2019)	2016	2019
Cape Verde	n	Strategic Plan for Sustainable Development (PEDS) 2017-2021	2018	2021
Comoros	n			
Cuba	n			
Dominica	y	National Resilience Development Strategy: Dominica 2030	2006	2030
Dominican Republic	n			
Federated States of Micronesia	y	Strategic Development Plan 2004-2023	2004	2023
Fiji	y	5-Year and 20-Year National Development Plan: Transforming Fiji	2017	2036
Grenada	y	National Sustainable Development Plan 2020-2035	2019	2035
Guinea-Bissau	n			
Guyana	y	Green State Development Strategy: Vision 2040	2017	2040
Haiti	y	Plan stratégique de développement d'Haïti: Pays émergent en 2030	2012	2030
Jamaica	y	Vision 2030 Jamaica: National Development Plan	2009	2030
Kiribati	y	Kiribati Development Plan 2016 to 2019	2016	2019
Maldives	y	Strategic Action Plan 2019-2023	2019	2023

Country	Full plan in Eng/Fr?	Name	Year Published	Horizon
Marshall Islands	y	National Strategic Plan 2020-2030	2020	2030
Mauritius	y	Mauritius Vision 2030: Strategic Plan 2020-2022	2019	2022
Nauru	y	Nauru National Sustainable Development Strategy 2005-2025	2005	2025
Palau	n	Actions for Palau's Future The Medium-Term Development Strategy 2009-2014	2009	2014
Papua New Guinea	y	Papua New Guinea Development Strategic Plan 2010-2030	2010	2030
Saint Kitts and Nevis	n			
Saint Lucia	y	Medium Term Development Strategy 2020-2023	2020	2023
Saint Vincent and the Grenadines	y	National Economic and Social Development Plan 2013-2025	2013	2025
Samoa	y	Strategy for the Development of Samoa 2017-2020	2016	2020
São Tomé and Príncipe	n			
Seychelles	y	Seychelles National Development Strategy 2019-2023	2019	2023
Singapore	y	(various: Long-Term Low-Emissions Development Strategy 2020-2050, Singapore Green Plan 2030, Singapore's Climate Action Plan 2016)	various	various
Solomon Islands	y	National Development Strategy 2016 to 2035	2016	2035
Suriname	n	Policy Development Plan 2017-2021	2017	2021
Timor-Leste	y	Timor-Leste Strategic Development Plan 2011-2030	2011	2030
Tonga	y	Tonga Strategic Development Framework 2015-2025	2015	2025
Trinidad and Tobago	y	Vision 2030: National Development Strategy of Trinidad and Tobago		2030
Tuvalu	y	Tuvalu National Strategy for Sustainable Development 2021-2030	2021	2030
Vanuatu	y	Vanuatu 2030: The People's Plan	2016	2030

Notes

Palau 2020: National Master Plan for Development was adopted in 1996. Its most recent five-year strategy dates from 2009-2014. As a result, we considered that this was not a full plan on the same level as other countries, so indicated "n"

Suriname: The Policy Development Plan 2017-2021 sets out priorities for new policies, but contains few clear policies or actions. As a result, we did not consider it a full economic development plan.

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