United Nations University
Institute for Water, Environment and Health

Global Water Security 2023 Assessment

UNU INWEH

Acknowledgments

The authors would like to acknowledge the generous input and data-discussions with:

Rick Johnston, Co-lead, WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP)

Sophie Boisson and Joanna Esteves Mills, Technical Officers (WASH), WHO

Paul Glennie, Senior Technical Advisor, UNEP-DHI Centre on Water and Environment

Philip Ward, Professor of Global Water Risk Dynamics, Vrije Universiteit Amsterdam.

Fiona Spooner, Senior Data Analyst, Our World in Data

UNU-INWEH gratefully acknowledges its host, the Government of Canada, and ongoing financial support from Global Affairs Canada.

Global Affairs Canada Affaires mondiales Canada

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Suggested Reference: MacAlister, C, Baggio, G, Perera, D, Qadir, M, Taing, L, Smakhtin, V. 2023. Global Water Security 2023 Assessment. United Nations, University Institute for Water, Environment and Health, Hamilton, Canada.

Front cover image: Rashad MAMMADOV/Shutterstock

Back cover image: Axel Fassio/CIFOR

Design: Art and Words Inc.

Download at: http://inweh.unu.edu/publications/

ISBN: 978-92-808-6115-0

About UNU INWEH

UNU INWEH's mission is to help resolve pressing water challenges that are of concern to the United Nations, its Member States, and their people, through critical analysis and synthesis of existing bodies of scientific discovery; targeted research that identifies emerging policy issues; application of on-the-ground scalable science-based solutions to water issues; and global outreach. UNU INWEH carries out its work in cooperation with the network of other research institutions, international organisations and individual scholars throughout the world.

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Executive Summary

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Sufficient water of adequate quality is an essential precondition of human life, socioeconomic development, and environmental sustainability. However, the security of our finite freshwater resources is threatened by the competing demands of rapidly expanding populations and global economies and made vulnerable by ongoing conflicts and multiple compounding effects of climate change. To accelerate the efforts to meet water security challenges, the United Nations General Assembly declared 2018-2028 the Water Action Decade for Sustainable Development. This coincides with and complements the 2030 Agenda for Sustainable Development (SDGs 2015-2030).

Midway into the Water Action Decade and the SDG era, this report – undertaken by the United Nations University Institute for Water Environment and Health (UNU INWEH), the UN's only think tank on water – provides a preliminary quantitative global assessment that evaluates the state of water security for 7.78 billion people living in 186 countries. While not an easy undertaking, it is essential to track our progress towards realising a more water secure world, and identify where and what more targeted developmental efforts, funding, and policy focus should be to ensure that the most vulnerable and insecure are not left behind. This report is not a definitive assessment of our constantly changing world, which is rarely well measured. It is a necessary first step to establishing a clearer picture of global water security that can and will be updated on a regular basis as additional and more robust data become available.

This report applies the UN-Water definition water security:

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

By European Union

The SDGs, and SDG 6 specifically, reflect these holistic dimensions of water security. The SDG targets and indicators are universally agreed means of monitoring and reporting on progress towards achieving water security. Therefore, it should be possible to quantify national water security for all countries worldwide using this framework. The preliminary assessment presented in this report addresses 10 development outcomes as components of water security that should be quantifiable using SDG indicators. This report aims to:

- Quantify and compare current levels of the primary components of water security, by country, using SDG-defined indicators and available datasets to reveal an explicit picture of global water security in the middle of the Water Action Decade and Agenda 2030.
- Support the 'Improved data and information' acceleration pillar of the UN-Water SDG 6 Global Acceleration Framework, by ensuring that 'high-quality information on SDG 6 indicators is shared and easily accessible by any decision maker' (UN Water, 2020).
- Highlight the overall status of available water data routinely reported by countries within the SDG framework and indicators and identify data gaps that need to be filled to support accurate and confident analyses of water security moving forward.
- Recommend, where gaps are identified, improvements for SDG indicator reporting for the remainder of the SDG era, and key considerations to enhance water security monitoring – for the next phase of SDGs – beyond 2030.

This assessment applies an inclusive approach to ensure a maximum number of countries are represented and compared globally by their assessed national water security levels. All countries with sufficient data to assess the 10 water security components are included, regardless of size, population, or geography.

The 10 components of water security assessed are:

1. *Drinking water*
2. *Sanitation*
3. *Good health*
4. *Water quality*
5. *Water availability*
6. *Water value*
7. *Water governance*
8. *Human safety*
9. *Economic safety*
10. *Water resource stability*

These components are assessed and mapped at a national level using indicators with clear metrics and publicly available data. Where possible, single indicators are quantified using national SDG indicator data, freely available via online platforms maintained by UN SDG custodian data agencies. When this preliminary assessment was completed in early 2023, the most recent SDG indicator data available were for 2020, and unfortunately, over half of the water indicators had major data limitations that required the application of some sub-indicators and proxy values from open-source datasets.

Each water security component is assessed, and each country receives a score out of 10. All national component scores are then mapped for a global comparison. An overall national water security score is calculated from the sum of each 10 components, with a maximum score of 100 (see Figure A).

National scores are classified as water 'secure' (75 and above), 'moderately secure' (65–74), 'insecure' (41-64), or 'critically insecure' (40 or less). National water security status is compared between countries, across global regions (Figure B) and between income groups (Figure C).

Key Findings

Alarmingly, most of the world's population live in water-insecure countries today. Out of 7.78 billion people living in 186 countries, over 0.61 billion people (8%) are critically water-insecure and 5.52 billion (72%) are water-insecure, including 4.31 billion people in the Asia-Pacific region, 1.34 billion in Africa, 415 million in the Americas, and almost 66 million in Europe. 0.65 billion people (8%) live in moderately water-secure countries and over 1 billion (12%) live in water-secure countries, primarily in Europe (0.7 billion) and the Americas (0.6 billion).

Mapped globally, there is a sharp disparity in water security across global regions and sub-regions. The least water-secure regions are Africa, including the Sahel, the Horn of Africa and parts of West Africa, in addition to South Asia, and Small Island Developing States (SIDS) across the world. Europe and the Americas are significantly more water-secure than other global regions. At the sub-region level, Eastern Europe are markedly less secure than Northern Europe, and South and Central America less secure than North America.

Least Developed Countries and SIDS face critical levels of water security. The 23 countries assessed as critically insecure include 16 Least Developed Countries (LDCs) and 7 SIDS: the Solomon Islands, Eritrea, Sudan, Ethiopia, Vanuatu, Afghanistan, Djibouti, Haiti, Papua New Guinea, Somalia, Liberia, St Kitts & Nevis, Libya, Madagascar, Pakistan, South Sudan, Micronesia, Niger, Sierra Leone, Yemen, Chad, Comoros and Sri Lanka. These countries are severely impeded from achieving water security in seven of the ten components: low levels of access to safely managed drinking water and sanitation services (Components 1 and 2), health, measured by high WASH-attributed mortality (Component 3), water quality (Component 4), water value (Component 6), water governance (Component 7) and water resource stability with high interannual variability and low storage capacity (Component 10).

Globally, all regions face a trajectory of low levels of water security due to a range of compounding factors. However, these levels vary in each global region. In Africa, water security scores range from 29 (critically insecure) to 58 (insecure), followed by Asia ranging from 32 (critically insecure) to 81 (secure), the Americas from 52 (insecure) to 80 (secure), Europe from 51 (insecure) to 90 (secure), and SIDS from 23 (critically insecure) to 67 (moderately secure).

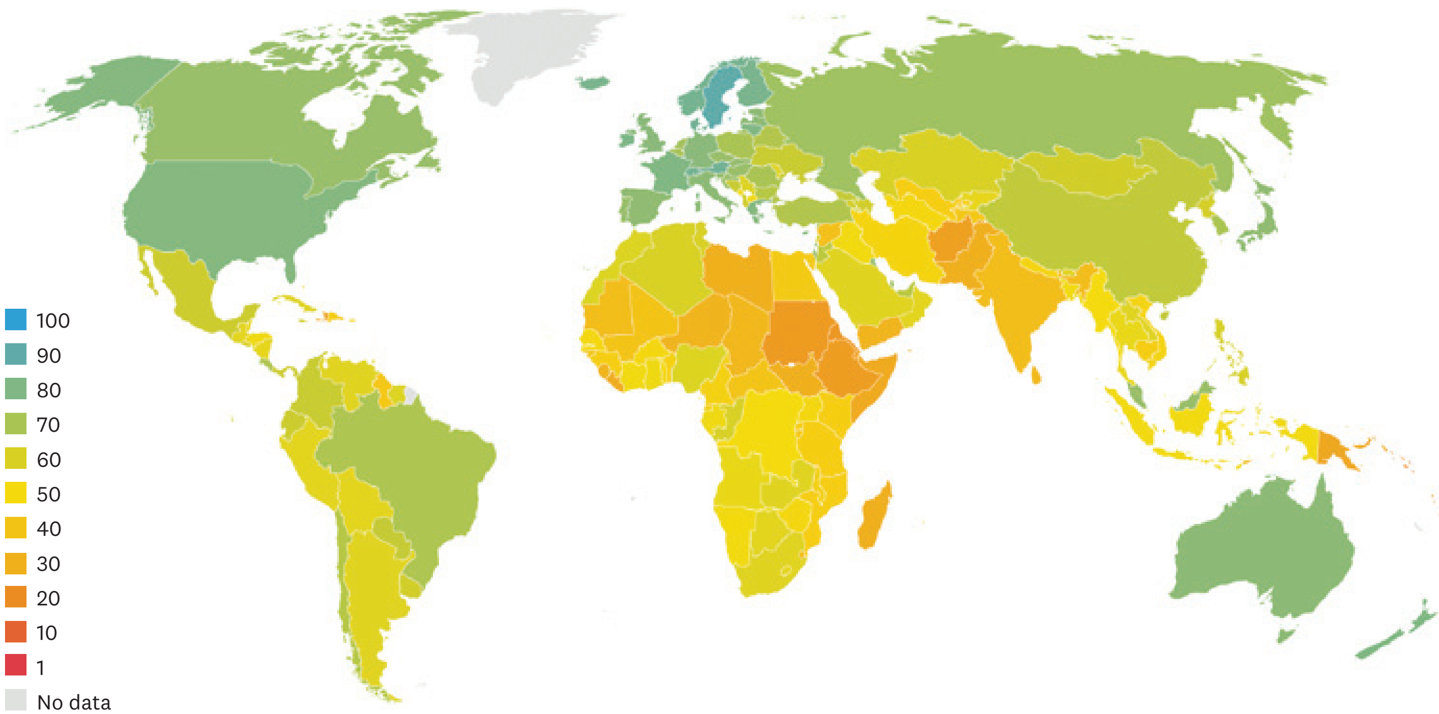


Figure A. National water security mapped globally, based on a score of 1-100.

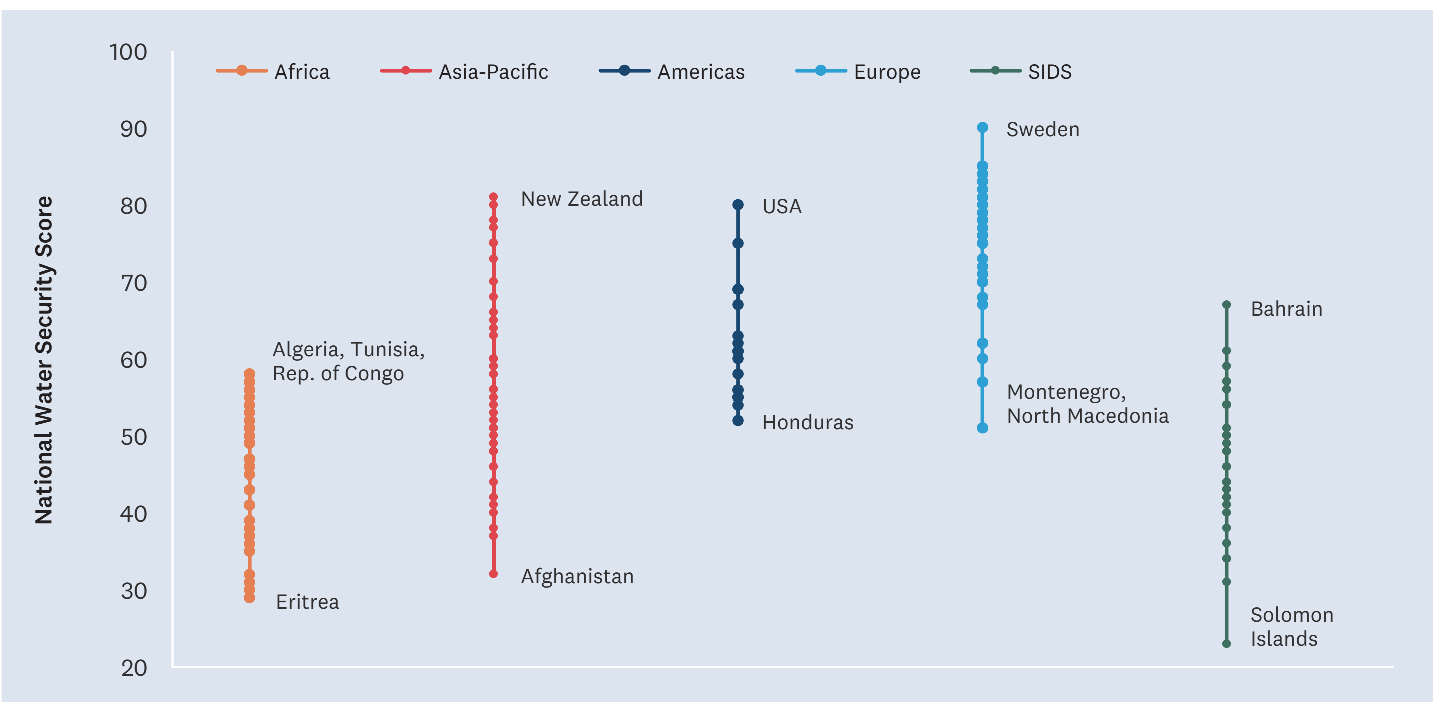


Figure B. National water security scores for 186 countries grouped in 4 regions plus SIDS globally.

Access to safely managed drinking water and sanitation are still a dream for more than half the global population. More than 10% of people (close to 800 million) do not have access to even basic drinking water, and more than 70% (close to 5.5 billion) do not have access to a safely managed drinking water service (the SDG 6.1 target). More than 22% (1.71 billion) do not have access to even basic sanitation, and more than 53% (over 4.12 billion) do not have access to safely managed sanitation.

Africa has the lowest levels of WASH worldwide. Regionally, Africa has the lowest levels of WASH access. Almost 31% (over 411 million) of people in the 54 African countries, including 33 LDCs and 6 SIDS, do not have access to a *basic* drinking water service. Only 201 million people (15%) have access to *safely managed* drinking water, which is the SDG 6.1 target. In the case of sanitation services, more than 58% of people (780 million) do not have access to even *basic* sanitation services, and 82% (1.1 billion) still live without access to a *safely managed* sanitation service.

Globally, significantly more people die from a lack of safe drinking water, sanitation, and basic hygiene services than as a result of water disaster. 25 countries in Africa are severely impacted by WASH-attributed mortality, with estimated rates of over 40 deaths per 100,000 people annually, while 20 Asian Pacific countries have mortality rates between 10-40 deaths per 100,000. This situation is not improving – in 2019, 164 of the countries assessed have increased rates of WASH-attributed mortality compared to 2016 WHO estimates. Clearly, efforts to improve WASH services and wastewater treatment and reduce associated deaths must be significantly accelerated to achieve good health goals globally.

Comprehensive and accurate water quality assessment at the national level remains a challenge despite a dedicated SDG 6 target. The level of industrial and domestic wastewater treatment could not be assessed in all countries as defined in SDG 6, due to insufficient data. This is a major failing halfway into the SDG era, as only 14 countries have data available on industrial wastewater treatment (2015 values). The level of domestic wastewater treatment, assessed by WHO using household sanitation statistics, remains very poor (below 30%) in Africa and large parts of the Asia-Pacific, and poor (below 50%) in most South American countries, though there are exceptions in all regions.

Abundant natural water availability does not necessarily ensure water security. Many countries in Africa, the Asia-Pacific, and the Americas with abundant freshwater resources (water stress of 10% or less) have low levels of WASH access and water treatment, high rates of WASH-related deaths, low economic water value, and potentially high losses due to flood or drought impacts.

High water values ('Water Use Efficiency') do not always translate into water security. Many national economies dominated by petroleum and mining activities have a high economic value per unit of water used (100 USD/m^3 or higher), but this does not necessarily result in increased water security in other components such as governance, WASH, or storage infrastructure. This is particularly true in countries with high levels of economic water value in African countries reliant on petroleum and mining industries.

The influence of climate change on water security is not well addressed by the water-related SDGs. Countries with high interannual freshwater variability worldwide experience less stable and reliable water availability, impacting livelihoods and all sectors, but the capacity to mitigate this variability through a range of water storage options is poorly represented in global policy agendas. Likewise, the capacity of some water-stressed countries to utilize intensive water resource management mechanisms, unconventional water supplies, and desalination infrastructure to fulfil their water needs and support water resource stability, in the Middle East for example, is not captured in current water-related SDGs.

Prosperity is not the main driver of water security. National wealth, measured by Gross National Income (GNI) per capita, is clearly related to the capacity to fund critical water infrastructure and governance. However, national wealth is not the only driver of water security, particularly when there are multiple determinants of water security with reinforcing effects on each other. Countries within the same income group can have distinctive water security levels as illustrated in Figure C. Countries categorized as low income, lower-middle income or upper-middle income (per capita GNI below US$ 12,535 – World Bank 2020 groups) have similar distributions and overlapping ranges in national scores, most of them being considered water insecure or critically insecure. At the extremes of rich and poor, the 29 low-income countries had water security scores ranging from 29 to 59, and the 50 high income countries had water security scores ranging from 36 to 90.

Water security assessment provides at best coarse national-level estimates that mask water security variability at finer scales. Where global data exist to assess water security at a national level, they clearly do not represent the individual or household experience of water insecurity. The national data currently available at a global extent, do not reflect rural-urban disparities, nor gender, age or social inequalities.

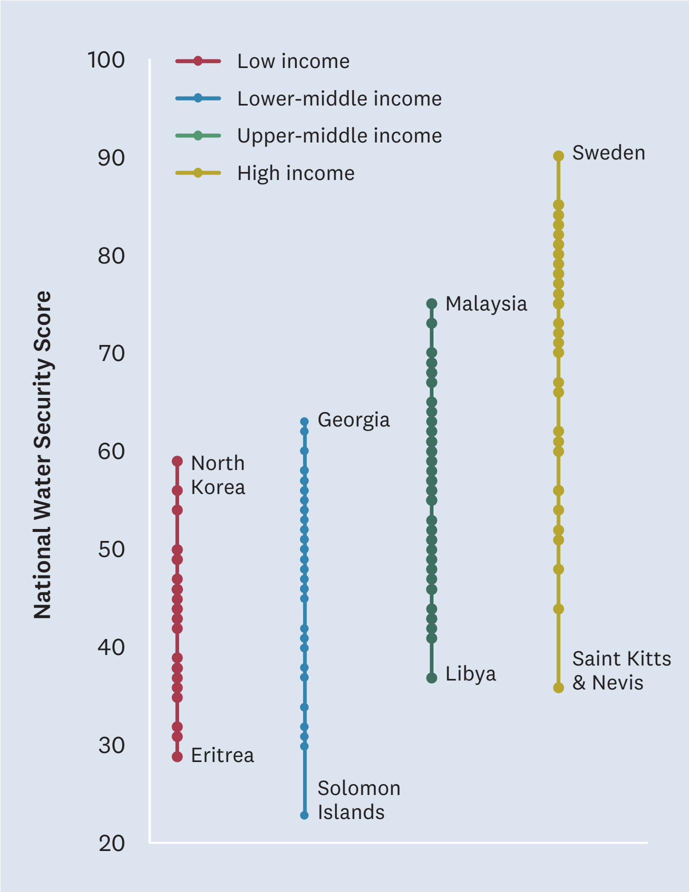


Figure C. National water security scores for all 186 countries assessed, classified according to 2020 World Bank income groups.

This assessment revealed that despite all efforts undertaken to date, the state of globally relevant water-related data on almost all water issues remains poor, with the notable exceptions of WASH and health data managed by Joint Monitoring Project (WHO and UNICEF), and nationally reported data on Integrated Water Resources Management (UNEP-DHI). Lack of water data manifests itself so strongly that some critical components of water security simply cannot be assessed without introducing surrogates. Global water resource data is old, and many hydrological features are still considered as 'constants' even though almost all components of the water cycle are in flux in a changing climate. No reliable, nationally reported, global data sets are available on the impacts of water-disasters on human safety or national economies, and research data proved the best indicator source. This represents a major challenge for the assessment and compensation of 'loss and damage'. Many SIDS and LDCs are highly exposed to water-disasters and at risk from low water resource stability suffer particularly from data shortage in these components.

The key underlying methodological assumption in this approach – that needs to be re-iterated from the introduction section above – is that the multi-dimensional nature of water security on one hand, and the mentioned simplicity and pragmatism – on the other, are already captured by the subset of water-related targets and indicators that currently feature in the SDG continuum. While it is accepted that the overall SDG structure and individual indicators themselves are not perfect and may not cover all aspects of water security, they collectively represent the most straightforward and standard way to quantify water security of any nation at present – till 2030 at least – as these should be routinely reported by the United Nations Member States, with the assistance of the custodian UN agencies responsible for SDG 6 indicator level methodology and metadata development.

Overall, poor data availability and quality were major limitations of this assessment, revealing that it is almost impossible to assess progress in water development indicators accurately at a global level. The water security components assessed represent a benchmark from which to assess future progress, but immediate action must be taken by all national governments to radically improve data collection, with support from international agencies and UN data custodians. Without this data, progress in water security towards at least half of SDG 6 (water) targets will remain 'guesstimates' at best. It may be argued that water data availability itself should be seen as an indicator in future water resources and security assessments.

Water professionals and policymakers worldwide recognize the importance of reliable data and accurate, up-to-date information for evidence-based decision making. These are essential building blocks of a future where all water resources should be recognised and treated as precious resources and highly valued as cornerstones of the circular economy. This assessment is a step in this direction and hopefully one that can be strengthened in future iterations.

This report targets: i) national water policy actors worldwide, tasked with implementation of relevant SDGs and reporting on progress, allowing assessment and comparison of the components of water security; ii) UN custodian agencies supporting water-related national monitoring and reporting efforts globally, highlighting data gaps and facilitating improvement in the reporting process; iii) NGOs and international donors, revealing water in-security hotspots that require priority support; and iv) researchers and technical staff concerned with design, monitoring and implementation of metrics of water security. The report is not a guide for water security assessment, not the least because the assessment methodology will continue to emerge and evolve with time.

Introduction

By Olivier Chassot, UN

Water security is a relatively recent concept and has been widely discussed globally over the past two decades (GWP, 2000; Grey and Sadoff, 2007; Lautze and Manthrithilake, 2012; Hall and Borgomeo, 2013; Lankford et al., 2013; Sadoff et al., 2015; UN Security Council, 2017). Its definitions range from as short as 'a tolerable level of water-related risk to society' (Grey et al., 2013) to more elaborate versions. UN-Water (2013) defines water security as 'the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socioeconomic development, for ensuring protection against waterborne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability'. The Asian Development Bank's definition is somewhat similar, i.e., 'the availability of adequate water to ensure safe and affordable water supply, inclusive sanitation for all, improved livelihoods, and healthy ecosystems, with reduced water-related risks toward supporting sustainable and resilient rural-urban economies…' (ADB, 2020a).

These later definitions and associated frameworks (ADB, 2020a; UNESCO, 2019; UN-Water, 2013) reflect the multi-dimensional nature of water security. This creates an opportunity to address water security comprehensively, but it also opens the door to various interpretations of water security, making it challenging to translate definitions into distinct components that can be applied universally across local and regional contexts. This is necessary if water security is to be quantified and operationalised at scale.

Attempts to quantify water security are ongoing. Octavianti and Staddon (2021) identified 80 metrics of water security published in 107 peer-reviewed papers, falling into two clear groups: experiential scale-based metrics focused on human and household well-being and resource-based metrics determined by different aspects of freshwater availability and water resource management. Doeffinger et al. (2020) suggest an alternative set of over 50 quantitative measures that, according to the authors, can facilitate a rapid assessment of a country's water security and may help design more in-depth water security diagnostic studies.

The Asian Development Bank assesses water security and development indicators by country across the Asia-Pacific in its Asian Water Development Outlook (AWDO). The AWDO applies water security definitions and water domains consistent with the SDGs and has evolved through progressive reports from 2007 to 2020 (ADB, 2020a) to include 49 countries, home to 4.2 billion people (ADB, 2020b). The ADB approach employs over 50 indicators and sub-indicators in five 'key dimensions' of national water security and ranks all the countries in the Region by a composite score. Data used in the AWDO come predominantly from well-maintained formal databases; when data are unavailable, the ADB relies on expert opinion (ADB, 2020b).

The AWDO is by far the most advanced initiative to quantify nation water security. However, this method and model has extensive data and human resource requirements, making it not easily transferable to other regions. In 2022, the United Nations University Institute for Water, Environment and Health, undertook the first regional assessment of water security for Africa (Oluwasanya et al., 2022). This assessment included 54 countries and attempted to overcome data challenges utilising Sustainable Development Goal (SDG) 6 indicator data where available.

The SDGs represent universally agreed targets and provide a framework to assess progress towards development objectives. The water-related SDG targets distinguish the various dimensions of water security, and as such, the SDG 6 indicators represent a universally agreed means of monitoring and reporting progress on water security. Building upon UNU-INWEH's previous approach, this global assessment of water security capitalises on this evaluative opportunity, integrating publicly available global water data sets where necessary, to provide comprehensive assessment for a maximum number of countries. At the very least, this assessment demonstrates the extent to which the existing system of water-related SDG targets and indicators quantify the water security status of United Nations Member States.

The world is halfway through the SDG era of 2015–2030, in addition to the 'Water Action Decade for Sustainable Development' (2018–2028), initiated by the UN to accelerate efforts to meet water security challenges. The upcoming UN high-level water Conference of 2023 will review the progress towards the objectives of the decade and is expected to solicit new practical commitments and pledges to accelerate this progress. In the wake of this global mega-event, it is time to summarise this progress for individual countries using water-related indicators from the SDGs.

This report provides a preliminary quantitative assessment of the state of water security in a maximum number of countries halfway into the Water Action Decade and Agenda 2030. The components of water security assessed are water development outcomes. More specifically, this report aims to:

- Quantify and compare current levels of the primary components of water security by country using SDG indicators, with the data revealing an explicit picture of global water security in the middle of the Water Action Decade and Agenda 2030.
- Highlight the overall status and availability of water data routinely reported by countries within the frame of the SDG targets and indicators, and identify data gaps that need to be filled to support accurate and confident analyses of water security moving forward.
- Support the improved data and information acceleration pillar of the UN-Water SDG 6 Global Acceleration Framework by ensuring that high-quality information on SDG 6 indicators is shared and easily accessible by any decision maker (UN-Water, 2020).
- Where gaps are identified, suggest improvements for SDG indicator reporting for the remaining period until 2030 and alternative indicators or improvements to the current ones for the SDG phase beyond 2030.

This report targets: i) national water policy actors in individual countries tasked with implementing the SDGs and reporting on their progress so that they can assess where they stand compared to other countries in terms of various components of water security; ii) UN custodian agencies that support national monitoring and reporting on water-related indicators globally so they can grasp the main data gaps and consider improvements for reporting process now and eventually; iii) NGOs and international donors that may see which water security components and in which countries require priority support; and iv) researchers and technical staff for their consideration in design, monitoring, and implementation of metrics of water security. The report is not a guide for water security assessment because the assessment methodology will continue to emerge and evolve with time.

General Principles and Assessment Structure

This report applies an inclusive approach to ensure that the maximum number of countries are represented and compared globally in terms of levels of their national water security. The national water security of every country is described in terms of 10 components. Each component is measured by the minimum number of indicators, ideally just one. As the methodology develops and as more and better-quality data become available, additional SDG-related indicators (or their most appropriate surrogates) can be introduced. However, the overall structure of the assessment should remain simple and commensurate with the water data available globally to date.

The main underlying methodological assumptions in this approach that need to be emphasized are the multi-dimensional nature of water security on one hand, and the necessity for a simple and pragmatic approach. These are already captured by the subset of water-related targets and indicators that feature in the SDG continuum. While it is accepted that the overall SDG structure and individual indicators themselves are not perfect and may not cover all aspects of water security, collectively they represent the most straightforward and standard way to quantify water security of any nation, until 2030 at least, as these should be routinely reported by the United Nations Member States assisted by custodian UN agencies responsible for indicator methodology and metadata development.

A related initial assumption of this assessment was that halfway through both the SDG period and the Water Action Decade, all water-related SDG indicators should have sufficient and consistent data through the global monitoring and reporting processes. Accordingly, all SDG 6 targets (6) and indicators (11) were initially considered for use, supplemented by relevant indicators from SDGs 1 (‘*No poverty*’), 3 (‘*Good health and well-being*’), 11 (‘*Sustainable cities*’) & 13 (‘*Climate Action*’). As this report indicates, the initial assumption was incorrect. This meant that some SDG 6 targets could not be included in the assessment and alternative metrics were needed for several indicators. Of the 10 components of water security eventually used in the assessment (Table 1), 6 components are equivalent to SDG 6 targets, three components are more closely aligned to SDGs 1, 3, 11, and 13 targets, and one final component is not part of the SDG continuum (further explained below). Most components are measured by one indicator, with two exceptions (Table 1).

The significant gaps in SDG reporting meant that indicator data are only available for seven components, and some of those data sets are incomplete, incorporate only part of the information required to meet the SDG targets, or are not available globally. The SDG indicators in Table 1 are those selected as components, but that does not mean they had sufficient data to use directly. Therefore, compromises and creative solutions were necessary to source data as close to the SDG indicators as possible. The ideal solution was to identify the closest possible indicator data set, which is described in the primary source of indicator data and data selected section for each water security component. SDG indicators for Components 1 and 2, drinking water and sanitation, had to be merged with data on service levels other than the SDG target. Component 4 (water quality) included data from an additional global data set to fill gaps. Component 6 (water value) uses the SDG 6.4.1 data, but this is insufficient to measure a change in the value attributed to water, and the most recent reported value is used instead. Indicator values for Component 8 (water disaster deaths), equivalent to SDG indicators 1.5.1, 11.5.1, and 13.1, were not available globally and were substituted from two other sources. Values for Component 9 (water disaster loss and damage), equivalent to indicators for SDG 1.5.2 and 11.5.2, were also not available. As no comprehensive global data set could be found, modelled data were used as a proxy for two sub-indicators.

Component 10 (water resource stability) has no equivalent SDG indicator and is based on a modelled sub-indicator 10.1 (interannual variability) and 10.2 (storage), which used a globally reported data set. The absence of such a component in the SDGs reflects their imperfection in context of water security. Water security components and indicators used to quantify them should reflect a country's physiographic and natural conditions, which determine its water endowment and do not significantly change with time, and a country's efforts to improve its water security. Water resource variability (particularly temporal) is a significant driver, affecting the water security of every nation (Tang and Lettenmaier, 2012; Haddeland et al., 2013; Jiménez Cisneros et al., 2014; Long et al., 2017), while water infrastructure development is the key to managing this variability and delivering water services to the population. Unfortunately, these elements of water security are underrated or only implicit in the SDG system; although they directly determine where each country initially stands in the water security domain and the level of effort and investment that needs to be made to improve national water security, similar to natural water endowment for example. It was decided to add this component to the assessment, despite the absence of relevant SDG indicators, to underline the importance of variability and infrastructure for water security overall and to include it in future SDGs. The indicator for this component is hybrid as it is based on one simulated sub-indicator and one globally reported data set.

The indicator data for each component is assessed and scored out of 10, and a national water security score is calculated as the sum of the 10 component scores, up to a maximum of 100.

Where available, SDG indicator data reported for 2020 are used, or the most recent reported year. The assessment initially considered over 230 countries and territories (SDG 6 data, JMP data, and UNDESA), but data were not available for many of these countries. Components 1 and 2, water and sanitation, are the only components with indicator data for over 230 countries up to the most recent data-year, 2020. Other components had much less data available, and Components 3, 5, and 6 (WASH mortality, availability, and value) only have data for 2019. Clearly, there is a significant lag between the present halfway point into the SDG period and the reported data-year for each SDG indicator.

The lack of data for many countries for so many components meant that during the assessment process, the number of countries included was reduced to 186, with data available for four or more of the seven SDG indicator data sets. This was necessary to avoid overstating water insecurity by assigning a score of 0 in cases where data is missing. For example, if a country did not report its SDG targets or their data has no value in the global data set, it cannot be scored for the corresponding component. As a result, when all 10 components are added up to calculate their national score, the score will be low because it will be composed of mainly zeros. This reflects their lack of reporting or inclusion in an independent global data set, which may or may not reflect their actual water security.

The lack of reported data for SDG 6 indicators was a significant challenge in this exercise and speaks to a major limitation in monitoring SDG six targets eight years into a 15-year global effort. Perhaps more striking is the countries that could not be included due to insufficient data: 58 Small Island Developing States (SIDS) were included in the original list. Only 24 could be included in the final list of 186 countries assessed, as 34 SIDS had no data for four or more water-related SDGs. Given the vulnerability of many SIDS, not least their exposure to climate-related risks, their water security should be a priority for the international community.

The 10 components of water security assessed are addressed individually in the following 10 sections of this report. Each component section includes:

- **Component and Indicator Background** describes the global relevance of the component and indicator selected.
- **Primary Data Sources and Indicator Data** Selected describes the availability of SDG indicator data where available and relevant, and the data finally used, including the solutions used to apply a single indicator globally, where data are not available for all countries.
- **Component Scoring Scheme** describes the system used to convert indicator data into a national component score out of 10.
- **National Water Security Scores** presents and discusses the global picture for each water security component. Broad regional differences and unusual or surprising results are discussed.

Finally, the **National Water Security Rating** compares 186 countries globally and groups them into four broad classes of water security: critical, insecure, moderately secure, and secure. The results are discussed in the context of four mega-regions: Africa, Americas, Asia-Pacific, and Europe, allowing for comparisons of components and national scores.

Table 1. Water security components, indicators, and data sources assessed at a national level.

	Water Security Component	Indicator(s) Used in this Assessment	Associated SDG Indicator(s)	Data Sources
1	**Drinking water**	Proportion of the population using basic to safely managed drinking water (%)	6.1.1: Proportion of the population using safely managed drinking water services	JMP (WHO and UNCICEF)
2	**Sanitation**	Proportion of the population using basic to safely managed sanitation (%)	6.1.2a: Proportion of the population using safely managed sanitation services	JMP (WHO and UNCICEF)
3	**Good health**	Mortality rate attributed to exposure to unsafe Water Sanitation and Hygiene (WASH) (deaths per 100,000 population)	3.9.2: Mortality rate attributed to unsafe water, unsafe sanitation, and lack of hygiene (exposure to unsafe Water, Sanitation, and Hygiene for All (WASH) services)	WHO
4	**Water quality**	Proportion of household wastewater treatment (%)	6.3.1: Proportion of domestic and industrial wastewater flows safely treated	WHO; Jones et al., 2021
5	**Water availability**	Level of water stress: freshwater withdrawal as a proportion of available freshwater resources (%)	6.4.2: Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	FAO AQUASTAT
6	**Water value**	Water Use Efficiency (USD/m^3)	6.4.1 Change in Water Use Efficiency over time	FAO AQUASTAT
7	**Water governance**	Degree of Integrated Water Resource Management (%)	6.5.1 Degree of Integrated Water Resource Management (%)	IWRM data portal UNEP / DHI
8	**Human safety**	Mortality due to water-disasters (deaths per 100,000 population)	1.5.1, 11.5.1, 13.1.1 Number of deaths, missing persons, and directly affected persons attributed to disasters per 100,000 population	EM-DAT IHME
9	**Economic safety**	Modelled economic impact of floods (% of national GDP) Modelled drought risk (non-dimensional integer)	1.5.2, 11.5.2: Direct economic losses attributed to disasters in relation to global gross domestic product (GDP)	WRI Aqueduct
10	**Water resource stability**	Interannual variability (non-dimensional integer) Large dam storage /capita (m^3/capita)	None None	WRI Aqueduct ICOLD WRD

Component 1
Drinking Water

Component and indicator background: Provision of basic to safely managed drinking water

By Axel Fassio, CIFOR

6 CLEAN WATER AND SANITATION

Ensure availability and sustainable management of water and sanitation for all

Target 6.1

By 2030, achieve universal and equitable access to safe and affordable drinking water for all.

Indicator 6.1.1

Proportion of population using safely managed drinking water services.

Access to safe drinking water is critical to all aspects of health, well-being, and development. A safe drinking water supply is the first step to achieving national water security and therefore represents Component 1. It is almost impossible to maintain a safe drinking water supply without safely managed sanitation, as represented by Component 2. Without these foundations, establishing a hygienic environment for human life is impossible, and so the consequences of inadequate water, sanitation, and hygiene (WASH) on human life are addressed by Component 3.

Access to safe drinking water and sanitation was first recognized as a human right by the 1966 UN General Assembly in the 'right to an adequate standard of living', Article 11(1) of the International Covenant on Economic, Social and Cultural Rights. In 2010, the General Assembly declared the 'right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of life and all human rights' (resolution A/RES/64/292). In 2015, the year that the Sustainable Development Goals were adopted, the General Assembly and the Human Rights Council recognised the rights to safe drinking water and sanitation to be closely related but distinct human rights. That year, 30% of the global population, over 2.2 billion people, still lived without safe drinking water (JMP data, 2022).

International human rights law 'obliges states to work towards achieving universal access to water and sanitation for all, without any discrimination, while prioritising those most in need' (UN OHCHR). The Committee on Economic, Social, and Cultural Rights (CESCR) monitors the implementation of the International Covenant on Economic, Social, and Cultural Rights. CESCR defines the five key elements constituting the right to safe water and sanitation as i) availability, continuous and sufficient water for personal and domestic uses with sanitation facilities near residential, health and educational institutions; ii) accessibility, safe and physically accessible for all; iii) affordability for all where no one should be denied access; iv) quality and safety, supplies must be free from micro-organisms, chemical substances and radiological hazards and sanitation facilities must be hygienic; and v) acceptability, culturally appropriate and sensitive to gender, life-cycle, and privacy requirements.

The five key elements defined by CESCR are intrinsic to the definition of WASH targets and directly relate to SDG target 6.1, which aims to 'achieve universal and equitable access to safe and affordable drinking water for all' by 2030 (Box 1). Progress towards this ambitious but critical target is assessed by the SDG indicator 6.1.1, the '*proportion of the population using safely managed drinking water services*'. A 'safely managed' service is defined as an '*improved drinking water source which is accessible on premises, available when needed and free from faecal and priority chemical contamination' including: piped water, boreholes, tube wells, protected dug wells, protected springs, rainwater, water kiosks, packaged and delivered water* (SDG 6.1 metadata; WHO and UNICEF, 2021). Progress towards achieving this target forms Component 1 of this assessment.

Despite the commitments described above, the most recent global data for 2020, five years into the SDGs, indicate that over 2 billion people still lack safely managed drinking water (WHO and UNICEF, 2021). If the trend that began in 2000 continues, 1.02 billion people will remain without safely managed drinking water in 2030 (based on JMP data from 2000-2020 and UNDESA 2030 global population projection of 8.5 billion). According to The World Health Organization (WHO) and the United Nations International Children's Emergency Fund (UNICEF), achieving the 2030 SDG targets 6.1 and 6.2 of universal access will require a four-fold increase in the current rate of progress (WHO and UNICEF, 2021). Without this effort, progress in other SDGs will be affected.

Table 2. Scoring system for Component 1. Drinking water based on indicator 'Provision of basic to safely managed drinking water' (%)

Score	1	2	3	4	5	6	7	8	9	10
Population with basic to safe access (%)	<10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100

Primary data sources and indicator data selected: Provision of basic to safely managed drinking water

The WHO and UNICEF are the global monitoring and data custodians for SDG 6.1. The WHO and UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) has reported on global progress on drinking water, sanitation, and hygiene since 1990, including monitoring the Millennium Development Goals (MDG) and SDG targets (WHO and UNICEF, 2022). The extensive JMP global database is the leading source and 'gold standard' of comparable estimates, with data detailing progress from rural to urban service coverage at national, regional, and global levels. Data from 2000-2020 are available online at www.washdata.org, along with regular reports on overall targets and WASH sectoral progress. Reporting on SDG indicator 6.1.1 refers specifically to domestic water supply, where household-level data are compiled from the national census, household survey, and administrative data sets, with gaps filled from other sources, including international or regional initiatives, studies conducted by research institutes, or technical advice received during country consultations (SDG 6.1.1 metadata).

The JMP defines the level of household services across a broad 'service ladder', from no service to unimproved, limited, basic, and safely managed. The SDG 6.1.1 indicator requires access to 'safely managed' drinking water which means water from an improved source accessible on the premises, when needed, and free from faecal and priority chemical contamination. 'Basic' is below safely managed on the service ladder and includes water collected from an improved source that requires a round-trip journey no longer than 30 minutes, including queuing. A 'limited' service requires a collection time of over 30 minutes, followed by 'unimproved' (e.g., dug well) and, finally 'surface water' (no service).

The SDG indicator 6.1.1 for drinking water reports on 'safely managed' service, the highest level of the service ladder. Where available, JMP provides data for all levels of the service ladder for each country, literally the steps to achieving a safely managed service: i) available when needed, ii) accessible on-premises, and iii) free from contamination (three of the CESCR key elements). This makes it possible to see what is needed to progress from 'basic' to 'safely managed'. The most recent JMP data on safely managed drinking water is available for 110 of the 186 countries in this assessment. While many countries might lack national values for 'safely managed' progress, they generally have data on services meeting 'basic' levels and for one or more of the three main CESCR components. For example, data will be available for on-site drinking water when needed, but no data on 'free from contamination'. Data on 'basic' drinking water are available for 173 countries. To include the maximum number of countries with data available, the water security indicator used in this assessment is defined as the 'provision of basic to safely managed drinking water'.

	2000		2015		2020		2030*
%	Billion people	%	Billion people	%	Billion people	%	Billion people
38	2.332	30	2.214	26	2,027	19	1.020

Figure 1. Global population living without access to a safely managed drinking water service (2000–2030).

**at the current rate of progress (JMP, 2021). Data from the JMP database for 2000-2020.*

Accepting that countries reporting a basic level of service provision are on the right track, this definition allows for a progression from 'basic' to 'safely managed', combining data for both levels of service and, where available, aggregated at a national level.

In 2020, data on 'safely managed' drinking water were missing for 76 countries, including 33 in Africa (four Small Island Developing States (SIDS) and 20 Least Developed Countries (LDCs)), 22 in the Americas (15 SIDS and one LDC), 20 in the Asia-Pacific (seven SIDS and three LDCs) and one in Europe (Croatia). The 13 countries missing data in 2020 include seven countries in the Americas (six SIDS + Argentina), four in Africa (2 SIDS), one in Asia (SIDS), and Croatia. There could be many reasons countries did not provide data, which may or may not reflect the level of access to the service, including limited human and financial resources, capacity, conflict, and since 2019, pandemic-related pressures. For this reason, and to build as complete a picture as possible, where countries retained in this assessment had 'no data' for 2020, values were sought for the 'basic' level of service reported in earlier years. Twelve of the 13 countries with missing 2020 data had values for at least basic levels of service in the period 2016-2019. Croatia's latest national drinking water record was for 2007, though urban totals were provided for 2020. Given the uncertainty associated with supplementing data from previous years, this was done only for the 'basic' level of service, which was assumed to be maintained even if 'safely managed' levels fell. Data for both levels are included in Appendix II.

Scoring Scheme Component 1: Drinking Water

Following the principle of inclusion and cognisant that many countries that did not report national data on safely managed drinking water access in 2020 have attained some components of a safely managed service, the national score used in the assessment also reflects a stepwise approach. The national score from 1 to 10, for the 'provision of basic to safely managed drinking water' is calculated as the percentage of the population with access to a basic service plus the population with access to a safely managed service, divided by two. Access to basic and safe water services are each worth up to half the national score. Scores 1 to 10 are assigned in steps of 10% (Table 2). Countries with only a basic level of service can score a maximum of 5 for Component 1.

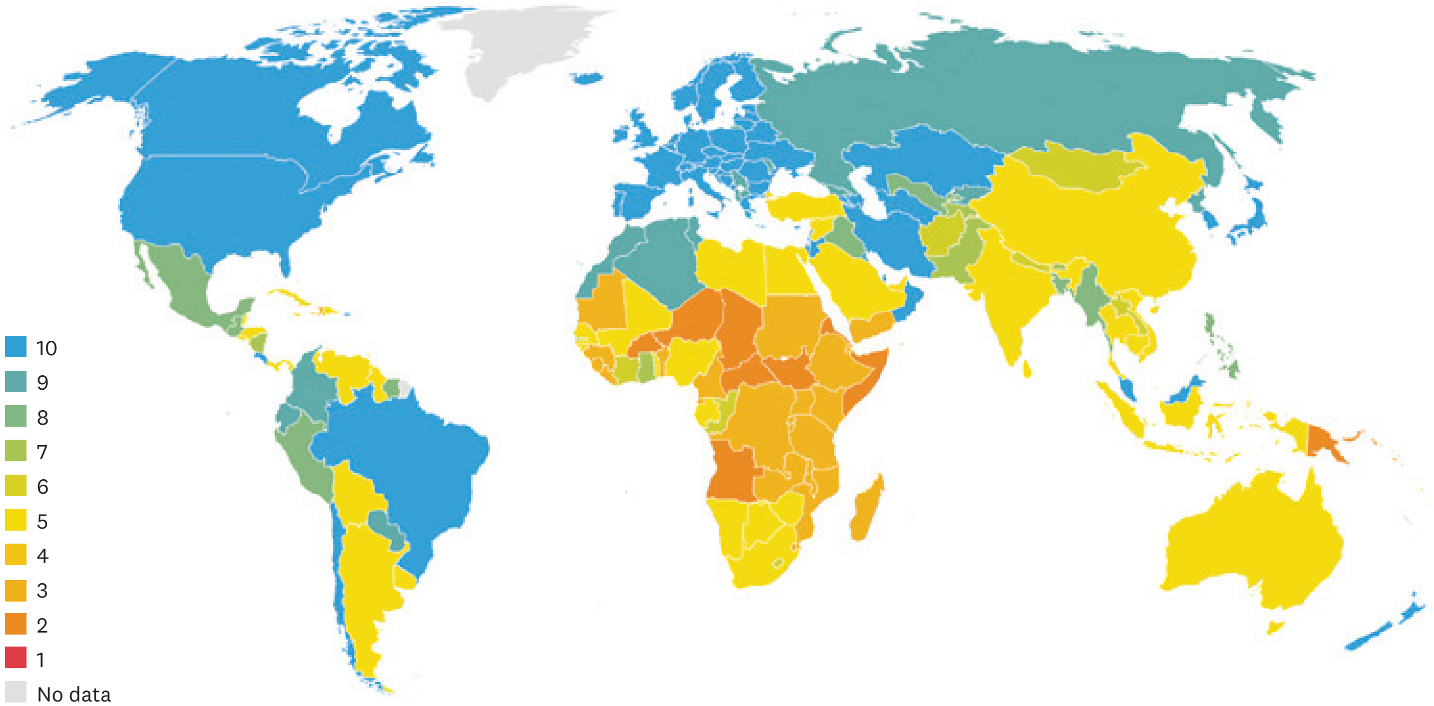
National Water Security Scores for Component 1: Drinking Water Access

The 2020 JMP data (WHO and UNICEF, 2022) used in this assessment represent national drinking water access five years into the SDGs. The distribution of national scores for access to a basic and/or safely managed drinking water service in the 186 countries assessed is illustrated in Figure 2, where 1 is the lowest level of access to drinking water by the proportion of the population. Eighty-seven countries included a score of 5 or lower, meaning that 50% of their populations had no reported access to either basic or safely managed drinking water at a national level in 2020. Nine countries scored 3, meaning that only 20% to 30% of those populations have access to basic or safely managed drinking water. Almost one-third of the 186 countries assessed are close to achieving universal access to safe drinking water.

Table 3 lists the 20 countries scoring the lowest for drinking water access in 2020. With the exceptions of Papua New Guinea and Yemen, all are in Africa, and only two are LDCs. Values for Eritrea and Equatorial Guinea are for basic service in 2016 and 2017, respectively. Only four countries in the bottom 20 have a value for 'safely managed', and six countries have less than 50% coverage for basic service, meaning that close to 40 million people in those six countries did not have access to a basic drinking water service in 2020.

Map 1 illustrates the distribution of low-scoring countries primarily in Africa and across the Asia-Pacific, in South and Southeast Asia and China. Out of the 54 African countries assessed, 45 scored 5 or lower. These countries account for almost 1.2 billion people and include 33 LDCs and six SIDS, representing 83% of the total countries assessed. In 2020, almost 31% of people in 54 African countries (over 411 million) did not have access to even basic services. Only 14.7% people (>196 million) had access to safe drinking water, meeting the SDG 6.1 target. Over 85% people (over 1.14 billion) did not have services meeting this target.

The picture is much brighter in the 36 countries assessed in the Americas, including 17 SIDS. Only Haiti, the one LDC assessed in the region, scored 4. Almost 96% of people (close to 980 million) have access to basic drinking water, while over 4% (41 million) still do not. Almost 70% of people (almost 708 million) have access to safe drinking water, and just over 30% do not (> 313 million).



Map 1. National scores for Component 1. Drinking water based on access from basic to safely managed service in 2020 (JMP, 2020 data).

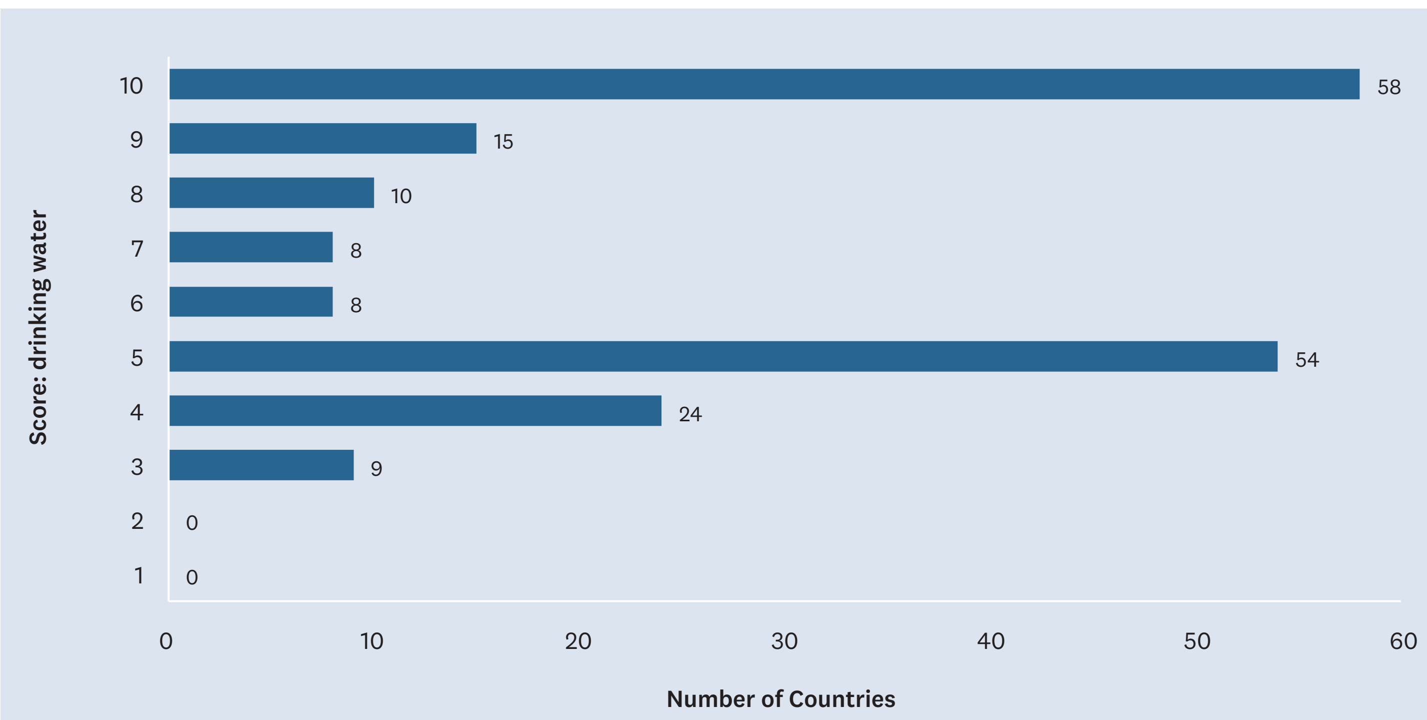


Figure 2. Distribution of national scores for Component 1:Drinking water in 2020.

Of the 57 countries assessed in the Asia-Pacific, including 11 SIDS and 10 LDCs, three scored less than 5 (Papua New Guinea: 3, the Solomon Islands: 4, and Yemen: 4). Almost 93% of people (4.35 billion) had access to basic drinking water in 2020, and just over 7% of people (almost 334 million) had no basic drinking water service. Over 15% of people (almost 725 million) had access to safe drinking water, while a staggering 85.5% (almost 4 billion) did not have access to a safely managed drinking water service.

All the 39 European countries assessed scored 9 or 10, with 98.5% access to basic drinking water and almost 92% access to safe drinking water. That does mean, though, that access is yet to be universal as over 11.6 million people (1.5%) in Europe do not have access to basic drinking water, and over 60 million (8%) do not have access to safely managed drinking water.

Of the almost 7.78 billion people in the 186 countries assessed, over 10% (close to 800 million) did not have access to even basic drinking water, and over 70% (close to 5.5 billion) did not have access to safe drinking water service in 2020.

Australia stands out as the only High Income Country (HIC) in the Asia-Pacific to score 0 for access to safely managed drinking water. In 2020, Australia reported over 99% coverage for basic service and over 96% coverage for 'available' and 'accessible' drinking water but did not have a value for 'free from contamination' at a national level, and therefore has no value for 'safely managed'.

Only national data were considered in this assessment. It should be noted that the JMP data indicate significant differences between service levels in rural and urban populations, especially in LDCs and Low- and Middle-Income Countries (LMICs) where development is more rapid in urban areas. It should also be noted that reported physical access to drinking water does not always reflect the situation at a household or individual level, mainly when the figure reported is for the national situation.

Gender-disaggregated drinking water and sanitation access data are rare beyond community-level studies, with some exceptions (Young et al., 2021). Currently, national surveys do not capture individual demographics that describe needs according to gender, life stage, pregnancy, sexual identity, disability, or housing status (among others), all of which represent needs, barriers, or opportunities influencing access (Caruso et al., 2021). Where there is no safely managed supply, the collection of household water often falls on girls and boys, but girls and women continue to carry water throughout their lives, taking time from education and employment and exposing them to multiple risks (WaterAid Canada, 2018).

Table 3. Twenty countries scoring lowest in 2020 for access to drinking water, from basic to safely managed service in 2020.

Country	SIDS	LDC	% Basic	% Safe	National Score
South Sudan		X	41.0		3
Central African Republic		X	37.2	6.2	3
Papua New Guinea	X		45.3		3
Niger		X	46.9		3
Burkina Faso		X	47.2		3
Chad		X	46.2	5.6	3
Eritrea (2016)		X	51.8		3
Somalia		X	56.5		3
Angola		X	57.2		3
Sudan		X	60.4		4
Yemen		X	60.7		4
Tanzania		X	60.7		4
Kenya			61.6		4
Ethiopia		X	49.6	12.6	4
Burundi		X	62.2		4
Mozambique		X	63.4		4
Guinea		X	64.0		4
Equatorial Guinea (2017)			64.7		4
DR Congo		X	46.0	19.0	4
Zambia		X	65.4		4

Note: 2016 data for Eritrea and 2017 data for Equatorial Guinea.

Component 2
Sanitation

Component and Indicator Background: Provision of basic to safely managed sanitation

By Clive Chilvers, Shutterstock

6 CLEAN WATER AND SANITATION

Ensure availability and sustainable management of water and sanitation for all

Target 6.2

By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.

Indicator 6.2.1

Proportion of population using (a) safely managed sanitation services and (b) a hand-washing facility with soap and water.

By Stefano Ember, Shutterstock

Without safely managed sanitation that separates people from excrement it is almost impossible to maintain a safe drinking water supply. Safe sanitation and drinking water (Component 1) are essential to establishing a hygienic environment good health and well-being (Component 3). As noted, achieving universal access to water and sanitation for all is an obligation of all states (UN OHCHR), defined and monitored by CESCR. Yet in 2000, at the start of the MDG era, 71% of the global population did not have access to safely managed sanitation (almost 4.4 billion people) (JMP data, 2022). In 2015, when the SDGs were adopted, 53% (over 3.9 billion people) lived without safe sanitation (JMP data, 2022). SDG 6.2 aims to achieve access to adequate and equitable sanitation and hygiene for all by 2030 (Box 2).

Progress towards indicator 6.2.1a is assessed by the proportion of the population using a safely managed sanitation service defined as 'an improved sanitation facility, not shared with other households, where excreta are safely disposed of in situ or removed and treated off-site'. Improved sanitation facilities 'hygienically separate human excreta from human contact', including wet sanitation technologies such as flush and pour flush toilets connected to sewers, septic tanks or pit latrines, and dry sanitation technologies such as dry pit latrines with slabs, ventilated improved pit latrines, and composting toilets (6.2.1a metadata; WHO and UNICEF, 2021). Progress to achieving this target forms Component 2 of this assessment. SDG 6.2 has a second indicator, 6.2.1b, which follows from sanitation access, represented as the proportion of the population with access to soap and water for handwashing. Indicator 6.2.1b is not addressed explicitly in this assessment. Handwashing is implicit in basic hygiene and is addressed in the consequences of inadequate WASH access in Component 3.

Safe sanitation is essential to a healthy population and is foundational to all other aspects of social and economic development, the SDGs, and national water security. Yet, according to the most recent global data for 2020, five years into the SDGs, over 3.5 billion people still lack safely managed sanitation. If the trend established in 2000 continues, 2.81 billion will lack safe sanitation in 2030 (JMP WASH data 2000-2020; UNDESA 2030 population of 8.5 billion). The WHO and UNICEF JMP managed data indicates that achieving the 2030 SDG target 6.2 of universal access requires a four-fold increase in the current rate of progress. Without such an effort, progress in other SDGs will be affected.

Table 4. Scoring system for Component 2: Sanitation, based on indicator 'Provision of basic to safely managed sanitation' (%).

Score	1	2	3	4	5	6	7	8	9	10
Population with basic to safe access (%)	<10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100

Primary data sources and indicator data selected: Provision of basic to safely managed sanitation

WHO and UNICEF are the global monitoring and data custodians for SDG 6.2. As described in Component 1, the WHO and UNICEF JMP have reported country, regional, and global estimates of progress on WASH targets since 1990 (WHO and UNICEF, 2022). The extensive JMP global database includes data for 2000-2020.

The JMP defines the household level of WASH services across a broad 'service ladder', from essentially no service, to unimproved, limited, and basic to safely managed. SDG indicator 6.2.1a indicator is 'safely managed' sanitation, requiring facilities not shared with other households, where excreta are safely treated either in-situ or removed and treated off-site. 'Basic' facilities that are improved and not shared, but not safely treated, are next on the service ladder, and the service is considered 'limited' if shared with other households. Next are 'unimproved' facilities (e.g., bucket or pit toilet, no slab), and finally, 'open defecation' is equivalent to no service at all.

The SDG indicator is the proportion of the population using 'safely managed' sanitation, the highest level of the service ladder. Where available, JMP provides data for all levels of the service ladder and country progress towards the components of a safely managed service provided, reflecting the accessibility, availability, and safety components of the CESCR key elements (Introduction and Component 1). This makes it possible to see where improvements are needed to achieve 'safely managed' and proximity to water security. This assessment allows for the progression from basic to safely managed service by combining data for both service levels, where available, at a national level.

Of the 186 countries retained in this assessment, 112 had national data for safely managed sanitation in 2020. The 74 countries missing safe sanitation data in 2020 include 28 in Africa (4 SIDS and 15 LDCs), 20 in the Americas (14 SIDS and 1 LDC), 7 in the Asia-Pacific (7 SIDS and 4 LDCs), and Bosnia Herzegovina in Europe. National data on 'basic' sanitation are available for 170 countries. Sixteen countries have no data for 'basic' service in 2020, including four in Africa (4 LDCs and 2 SIDS), 8 in the Americas (7 SIDS), and 4 in the Asia-Pacific (1 SIDS). There can be many reasons countries do not provide data, which might reflect the level of access to the service, such as limited human and financial resources, capacity, conflict, and since 2019, pandemic-related pressures.

For this reason, and to build as complete a picture as possible, where countries retained in this assessment had 'no data' for 2020, values were sought for the 'basic' level of service reported in earlier years. Given the uncertainty associated with supplementing data from previous years, this was done only for the 'basic' level of service, which was assumed to be maintained even if 'safely managed' levels fell. A complete list of 'data year' used for basic and safely managed data for each country is given in Appendix I.

2000		2015		2020		2030*	
%	Billion people	%	Billion people	%	Billion people	%	Billion people
71	4.356	53	3.911	46	3,586	33	2.805

Figure 3. Global population without access to safely managed sanitation services (2000-2030).

**at the current rate of progress (JMP, 2021). Data from the JMP database for 2000-2020.*

Scoring Scheme Component 2: Sanitation

Following the principle of inclusion, and cognisant that many countries that did not report national safely managed sanitation access data in 2020 but have attained some components of a safely managed service, the national score also reflects a stepwise approach. The national score from 1 to 10 for ‘provision of basic to safely managed sanitation’ is calculated as the percentage of the population with access to a basic service plus the population with access to a safely managed service, divided by two. Access to basic and safe services are each worth up to half the national score. Scores 1 to 10 are assigned in steps of 10% (Table 4). The same simple scoring scheme was used for safely managed sanitation and drinking water. Countries with only a basic level of service can score a maximum of five for Component 2.

National Water Security Scores for Component 2: Sanitation Access

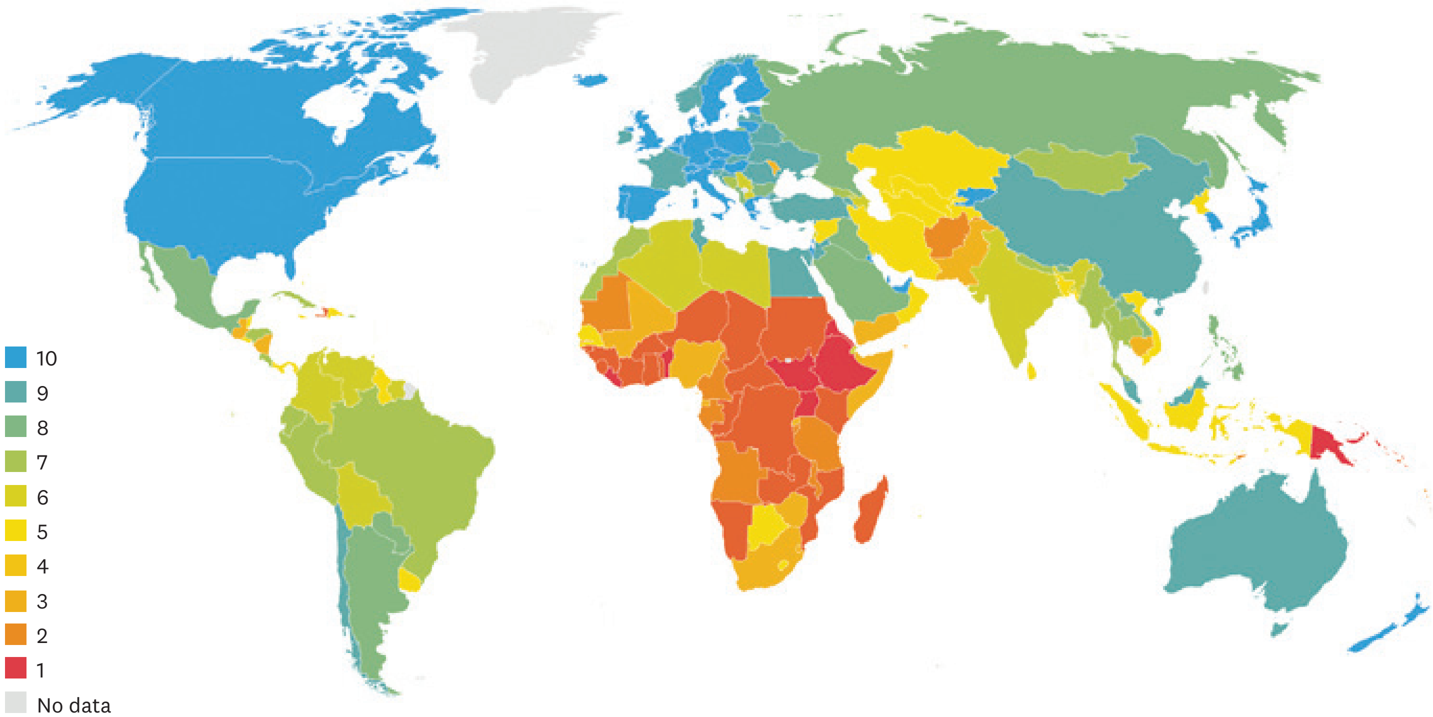
The 2020 JMP data (WHO and UNICEF, 2022) used in this assessment represent the situation at a national level five years into the SDGs. The distribution of national scores for access to basic and/or safely managed sanitation in the 186 countries assessed is illustrated in Figure 2, where 1 is the lowest level of access to sanitation by the proportion of the population. Almost half (92 of the 186 countries) score 5 or lower, meaning that at least 50% of their populations have no reported access to basic or safely managed sanitation nationally. Thirty-eight countries score 3 or less, meaning that 30% of the population has access to basic or safe sanitation. Of the 186 countries assessed, only 33 scored 10, indicating they are close to or have achieved universal access to safe sanitation.

Table 5 lists the 20 countries scoring lowest in access to safe sanitation globally. Similar to drinking water, 19 of the 20 lowest scores are in Africa, but the national scores for sanitation are much lower. Rates of basic access are low, ranging from 6% to 32%. Only nine of the 20 countries have reported safely managed service at a maximum of 16% access (Niger).

Table 5. Twenty countries scoring lowest in 2020 for access to sanitation, from basic to safely managed service in 2020.

Country	SIDS	LDCs	% Basic	% Safe	National Score
Eritrea (2016)		X	6.0		1
Ethiopia		X	8.9	6.7	1
South Sudan		X	15.8		1
Benin		X	17.0		1
Liberia		X	18.2		1
Papua New Guinea	X		19.2		1
Uganda		X	19.8		1
Republic of Congo			20.5		2
Burkina Faso		X	21.7		2
Chad		X	12.1	10.1	2
Madagascar		X	12.3	10.4	2
Central African Republic		X	14.1	13.6	2
Togo		X	18.6	9.1	2
DR Congo		X	15.4	12.7	2
Guinea		X	29.8		2
Guinea-Bissau	X	X	18.2	12.2	2
Sierra Leone		X	16.5	14.0	2
Niger		X	14.8	16.2	2
Zambia		X	31.9		2
Kenya			32.7		2

Note: 2016 data for Eritrea.



Map 2. National scores for Component 2: Sanitation, based on access from basic to safely managed service in 2020 (JMP, 2020 data).

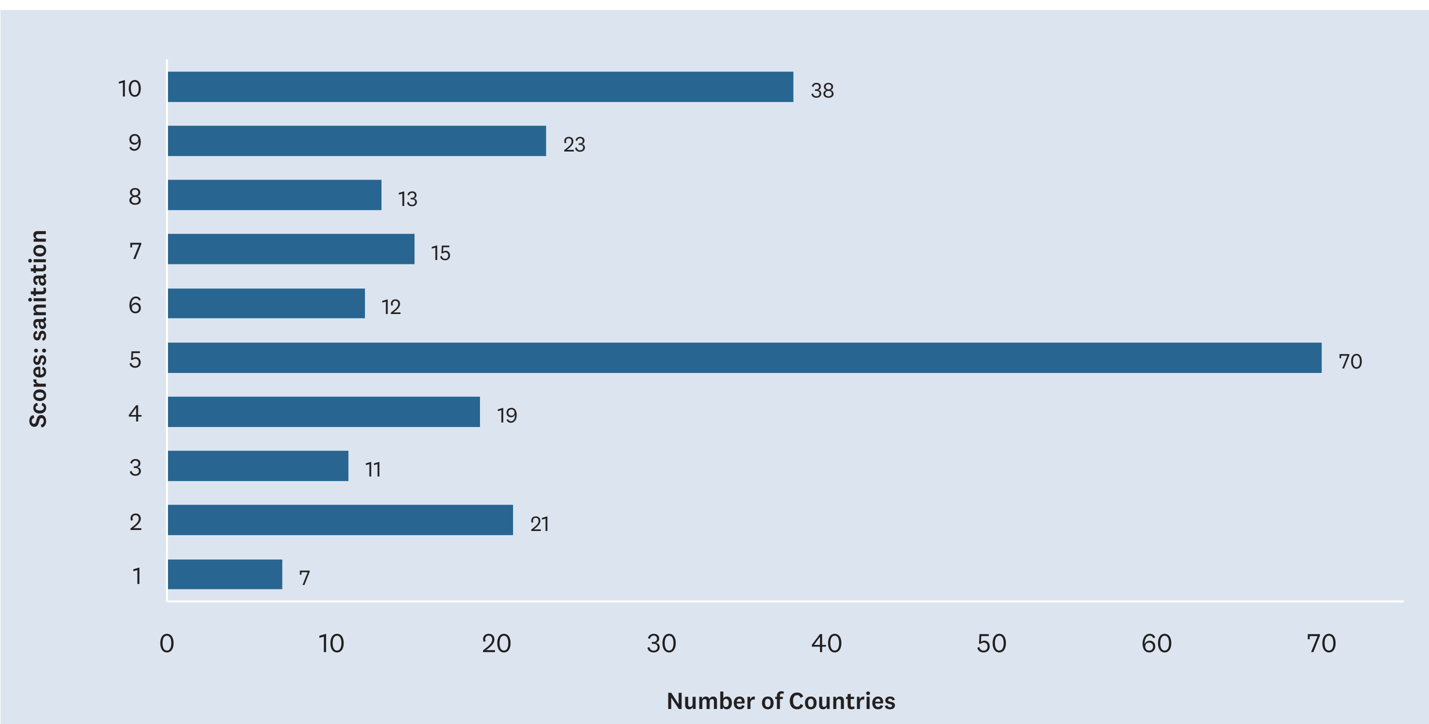


Figure 4. Distribution of national scores for Component 2, Sanitation.

Map 2 illustrates that many lowest-scoring countries are in Africa and a cluster in Southeast and Central Asia. Papua New Guinea in the Asia-Pacific and Pakistan also have low scores. While some Latin American and South Asian countries are lagging, they generally scored much higher than African countries.

Of the 54 African countries assessed, including 33 LDCs and 6 SIDS, and a population of 1.34 billion in 2020, five countries in North Africa and Djibouti scored over 5. Egypt and Tunisia reported over 97% coverage for basic and 67% to 81% safely managed sanitation, respectively. Libya reported 92% basic and almost 22% safely managed, Algeria reported 86% basic and almost 18% safely managed, Morocco has 87% basic and 39% safe, and Djibouti has 66% basic and 37% safely managed sanitation. While over 42% of the total population of 54 African countries (almost 600 million) had access to basic sanitation, over 58% of people (almost 780 million) did not have access. Only 18% of people (>238 million) in Africa did have access to safe sanitation services, meeting the SDG 6.2 target, but over 82% (over 1.1 billion) still live without access to safely managed sanitation service.

The picture is much brighter in the 36 countries in the Americas assessment, which includes 17 SIDS. Only Haiti (3), Guatemala (4), and Nicaragua (4) scored less than 5. Of the total population of the countries assessed, over 1.02 billion, almost 92% of people (close to 937 million) have access to basic sanitation, while over 8% (41 million) still do not. Almost 60% of people (over 612 million) have access to safe sanitation, and 40% do not (> 408 million).

Of the 57 countries assessed in the Asia-Pacific, including 11 SIDS and 10 LDCs, with a total population of over 4.67 billion, eight scored less than 5, including Papua New Guinea (1), the Solomon Islands (2), Afghanistan (3), Vanuatu (3), Timor-Leste (3), Pakistan (4), Cambodia (4) and Yemen (4). Over 82% of people (>3.85 billion) had access to basic sanitation in 2020 and over 17% of people (almost 334 million) had no basic sanitation service. Over 47% of people (almost 2.2 billion) had access to safe sanitation, while close to 53% (almost 2.48 billion) did not have access to a safely managed sanitation service.

Of the 39 European countries assessed, including a total population of over 747 million people, only Moldova scored less than 5. Over 96% of people (>720 million) had access to basic sanitation, and 82% (almost 611 million) had access to safe sanitation water. That means that almost 27 million people (3.6%) in Europe did not have access to basic sanitation services, and over 136 million people (>18%) do not have access to safely managed sanitation, failing to meet the SDG 6.2 target.

Of the almost 7.78 billion people in the 186 countries assessed, over 22% (1.71 billion) did not have access to even basic sanitation, and over 53% (4.12 billion) did not have access to safely managed sanitation services in 2020.

While this assessment focuses on national water security indicators only, JMP data show significant differences in service levels and data coverage between rural and urban populations (Component 1). The JMP's most recent global review includes data on safely managed sanitation for 120 countries, with approximately 25% greater coverage reported for urban areas, indicating that rural areas still lag behind urban services (WHO and UNICEF, 2021).

Like drinking water, reported physical access to sanitation does not always reflect household usage, particularly when the figure reported is for the national situation. National survey data compiled in the JMP do not capture individual demographics that describe needs according to gender, life stage, pregnancy, sexual identity, disability, or housing status (among others), representing needs, barriers, or opportunities influencing access (Caruso et al., 2021). Two critical elements of the CESCR outlined in the right to safe sanitation are 'safe and physically accessible for all, irrespective of age, gender and physical ability' and 'culturally acceptable, appropriate and sensitive to gender, life-cycle and privacy requirements'. Women and girls are exposed to risk and violence due to lack of access to safely managed sanitation and the related impacts of inadequate hygiene and menstrual health (WaterAid Canada, 2018). To date, it has not been possible to assess this because gender-disaggregated data are not available in SDG assessments.

Component 3
Good Health

Component and Indicator Background: Mortality rate attributed to exposure to unsafe Water Sanitation and Hygiene (WASH)

By Apag Annankra, WaterAid

3 GOOD HEALTH AND WELL-BEING

Ensure healthy lives and promote well-being for all at all ages

Target 3.9

By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.

Indicator 3.9.2

Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (exposure to unsafe Water, Sanitation and Hygiene for All (WASH) services).

By Martine Perret, UN

Deaths due to inadequate WASH provision are preventable and should no longer occur anywhere in the world in the 21st century. Doubling life expectancy from around 40 years in 1850 to 80 years in 2020 in Western Europe, North America, and many other countries now considered high income began during the first 'public health revolution' of the 19th century (Greene, 2001; Riley, 2005; UNDESA, 2022). This increase in longevity began before widespread medical interventions such as antibiotics, and was initially and significantly due to improved sanitation services, public water treatment, sewage, and waste management (Greene, 2001; Tulchinsky and Varavikova, 2014). Today, exposure to inadequate WASH still contributes directly to the disease burden of diarrhoea, respiratory infections, malnutrition, schistosomiasis, malaria, soil-transmitted helminth infections, and trachoma in many LMICs (Prüss-Ustün et al., 2019). According to the most recent global estimate, inadequate and unsafe WASH causes over a million deaths from infectious diseases annually, with a disproportionate burden on children younger than five-years-old (Prüss-Ustün et al., 2019; Wolf et al., 2022).

This is unacceptable, and so while SDGs 6.1 and 6.2 aim to achieve universal and equitable safe drinking water, sanitation, and hygiene for all, explicit success will be measured by SDG target 3.9, 'substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination' (Box 3). The SDG 3.9.2 indicator is the 'mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene'. This indicator is based on WASH service provision in the country and the health-related outcomes and provides critical information on the actual burden of disease caused by the risks measured in targets 6.1 and 6.2 (SDG 3.9.2 Metadata, 2022). The capacity to sanitise hands with soap and water, preventing ingestion of bacteria and other harmful substances, contamination of food, and spread of pathogens on surfaces and from person to person is based on access to and practice of safe WASH. While components 1 and 2 of this assessment track access to safely managed drinking water and sanitation, respectively, SDG target 6.2b, hygiene represented by handwashing, was not included in Component 2. This is because 6.2b is an intrinsic building block of SDG 3.9.2, and therefore the associated indicator, 'mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene' supports the stand-alone Component 3 ('good health'). Failing to secure this component of water security contravenes human rights law as declared by the UN in 1966, 2000, and 2015.

Table 6. Scoring system for Component 3 WASH-attributed mortality represented by mortality rate due to unsafe WASH per 100,000 population.

Score	1	2	3	4	5	6	7	8	9	10
Range in mortality rate	>40	20-40	10-20	5–10	2.5–5	1–2.5	0.5–1	0.1–0.5	0.05–0.1	0–0.05

Primary Data Sources and Indicator Data Selected: Mortality rate attributed to exposure to unsafe Water Sanitation and Hygiene (WASH)

The WHO is the Custodian Agency reporting on SDG indicator 3.9.2, mortality rate attributed to unsafe water, unsafe sanitation, and lack of hygiene defined as the number of deaths from exposure to unsafe WASH services in a year, divided by the population, and multiplied by 100,000 (SDG 3.9.2 metadata). Expressing mortality rate as deaths per 100,000 people allows direct comparison between countries with national populations of different sizes to global mortality rates and other causes of death, such as disaster-related mortality (Component 8).

The WHO estimates this burden of disease based on the following:

1. exposure, modelled from JMP data including drinking water, sanitation, and hygiene, defined as 'handwashing after potential faecal contact' (Wolf et al., 2018; Prüss-Ustün et al., 2019);
2. global disease and death envelopes (WHO Global Health Estimates);
3. exposure-response relationship (Wolf et al., 2022); and
4. global population data (UN DESA).

This SDG indicator is well documented, and several widely cited peer-reviewed publications support the methodology. The methodology uses reliable statistics on WASH services (SDG 6.1 and 6.2) available and assessed in most countries. Where countries do not yet have death registration systems, data are sourced by WHO in alternative systems (SDG 3.9.2 metadata). Where exposure data are not available in the JMP database for one or more required indicators, missing values are imputed using multilevel logistic modelling. WHO country offices also support the country-level calculation of WASH-attributable disease burden.

Estimates of the WASH burden of disease have been published for reference years 2012, 2015, and 2016 and the 2019 estimates were published in 2022 (WHO). National, regional, and global data are available for the total population, disaggregated into male and female populations, and for the population under age five. Water security Component 3 uses total national mortality rates, not disaggregated by age or gender. Data are available for 183 United Nations Member States, accessible via the WHO Global Health Observatory and the UNDESA SDG data portal. Of the 186 countries retained in this global assessment, 183 have values for 2016 and 2019. Data are not available for Dominica, Puerto Rico, Saint Kitts and Nevis, and the State of Palestine.

Scoring Scheme Component 3: Good Health

The WHO data used in this assessment to score Component 3 represent the situation at a national and global level, estimated for 2019, as close to 2020 as is available. A national score for each of the 183 countries with data was derived from the range in mortality rate and a non-linear scale illustrated in Table 6. Scores are based on the range in mortality rates from 0 to over 100 deaths per 100,000 population per year. Ten range classes are scored from 1 (> 40) to 10 (0–0.05), where high mortality rates score the lowest. The same scheme and associated scores are applied to Component 8, 'Human Safety' indicated by water disaster deaths, so both causes of water-related mortality can be compared directly on a global scale.

Table 7. Twenty-five countries most severely affected by WASH-attributed mortality in 2019.

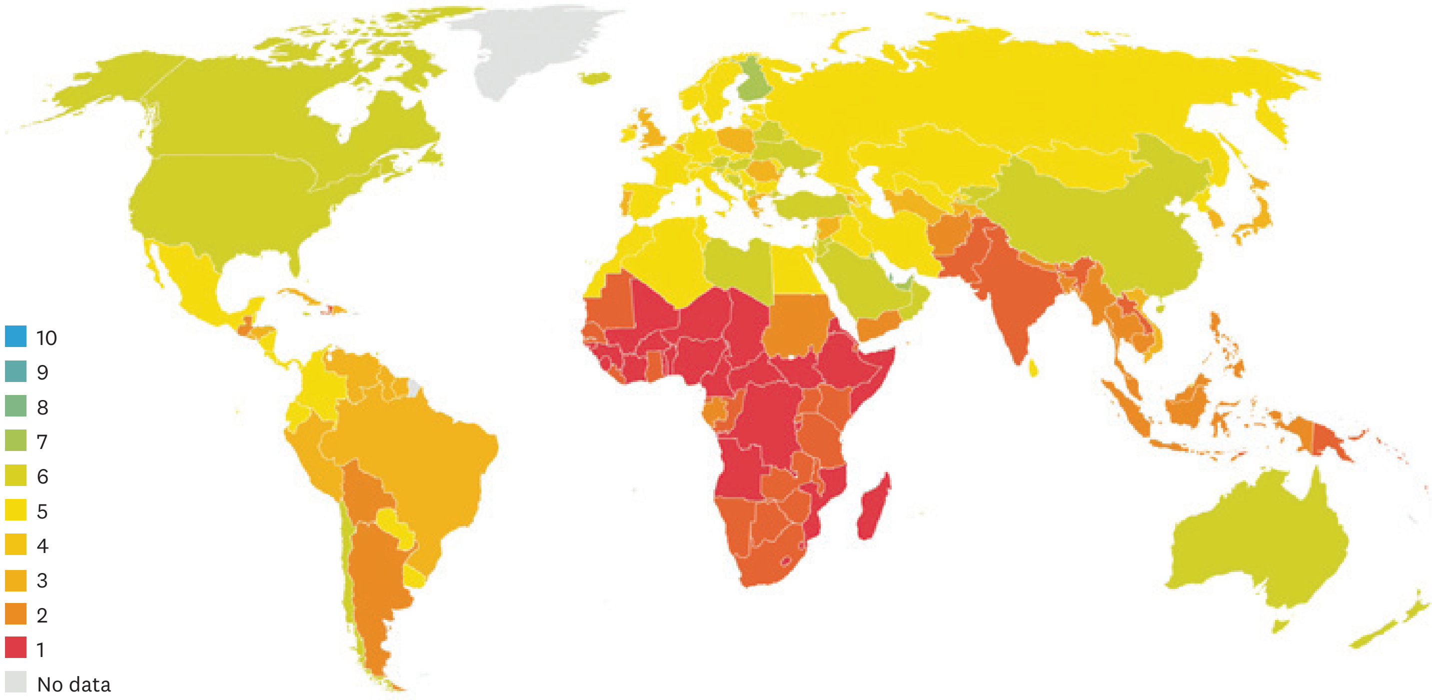
Country	SIDS	LDC	2019 Mortality rate /100,000 population	Component 3 Score
Lesotho		X	108.1	1
Chad		X	99.2	1
Somalia		X	99.2	1
Central African Republic		X	97.0	1
Nigeria			71.7	1
Niger		X	70.3	1
Sierra Leone		X	69.5	1
South Sudan		X	68.1	1
Eritrea		X	66.5	1
Mali		X	66.1	1
Burkina Faso		X	60.9	1
Benin		X	60.2	1
Guinea		X	57.8	1
Burundi		X	53.3	1
DR Congo		X	52.3	1
Guinea-Bissau	X	X	49.4	1
Angola		X	48.9	1
Cameroon			47.3	1
Côte d'Ivoire			47.0	1
Eswatini			46.5	1
Mozambique		X	45.6	1
Comoros	X	X	43.8	1
Togo		X	42.4	1
Ethiopia		X	40.7	1
Madagascar		X	40.1	1

National Water Security Scores for Component 3: Good Health

The distribution of national scores for Good Health, indicated by WASH-attributed mortality in the 186 countries assessed, is illustrated in Figure 5. A high score of 10 represents the lowest mortality rate due to inadequate WASH, which was not attained by any of the countries included. The scale used is not ideal considering only the high-rate portion of the frequency distribution of WASH-attributed mortality. However, this scale includes the range of data sets for mortality due to inadequate WASH and water-related disasters, allowing a global comparison of the two major causes of water-related mortality discussed later in this report (Figure 10).

In 2019, 178 of the 183 countries with data scored 6 or lower, having over one death per 100,000 population due to inadequate WASH. Even more shockingly, 72 countries scored 3 or lower with estimated mortality rates of over 10 people per 100,000 population. Twenty-five countries scored only 1, having estimated WASH-attributed mortality rates of over 40 individuals per 100,000 population in one year. Map 3 illustrates the spread of WASH-attributed mortality rates globally, with the highest deaths in Africa, followed by South and Southeast Asia and the Pacific, and elevated rates in Latin America, especially in Argentina and Bolivia.

Table 7 lists the 25 countries most severely affected by WASH-attributed mortality in 2019, scoring only 1 for component 3, with mortality rates of over 40 deaths per 100,000 people in one year. All 25 countries are in Africa, with a combined population of over 0.7 billion, and 22 are LDCs. Forty-eight of the 72 countries scoring 3 or lower (mortality rate >10/100,000) are in Africa. Estimated mortality rates are also high in some parts of Asia-Pacific. Twenty countries score 3 or lower having mortality rates between 10 and 40 people per 100,000 population, including Pakistan (mortality rate of 38.8 deaths/100,000), India (36.4/100,000), Solomon Islands (32.7/100,000), Vanuatu (25.0/100,000), Papua New Guinea (24.9/100,000), Lao PDR (20.5/100,000), Timor-Leste (20.4/100,000), Bangladesh (18.2/100,000), Nepal (17.8/100,000), Cambodia (17.1/100,000), Philippines (16.9/100,000), Afghanistan (16.6/100,000), Indonesia (15.8/100,000), Bhutan (15.7/100,000), Yemen (15.6/100,000), Malaysia (14.4/100,000), Micronesia (14.0/100,000), Myanmar (12.9/100,000), Thailand (11.8/100,000), and Fiji (10.8/100,000).



Map 3. National scores for Component 3: Good Health, indicated by WASH-attributed mortality.

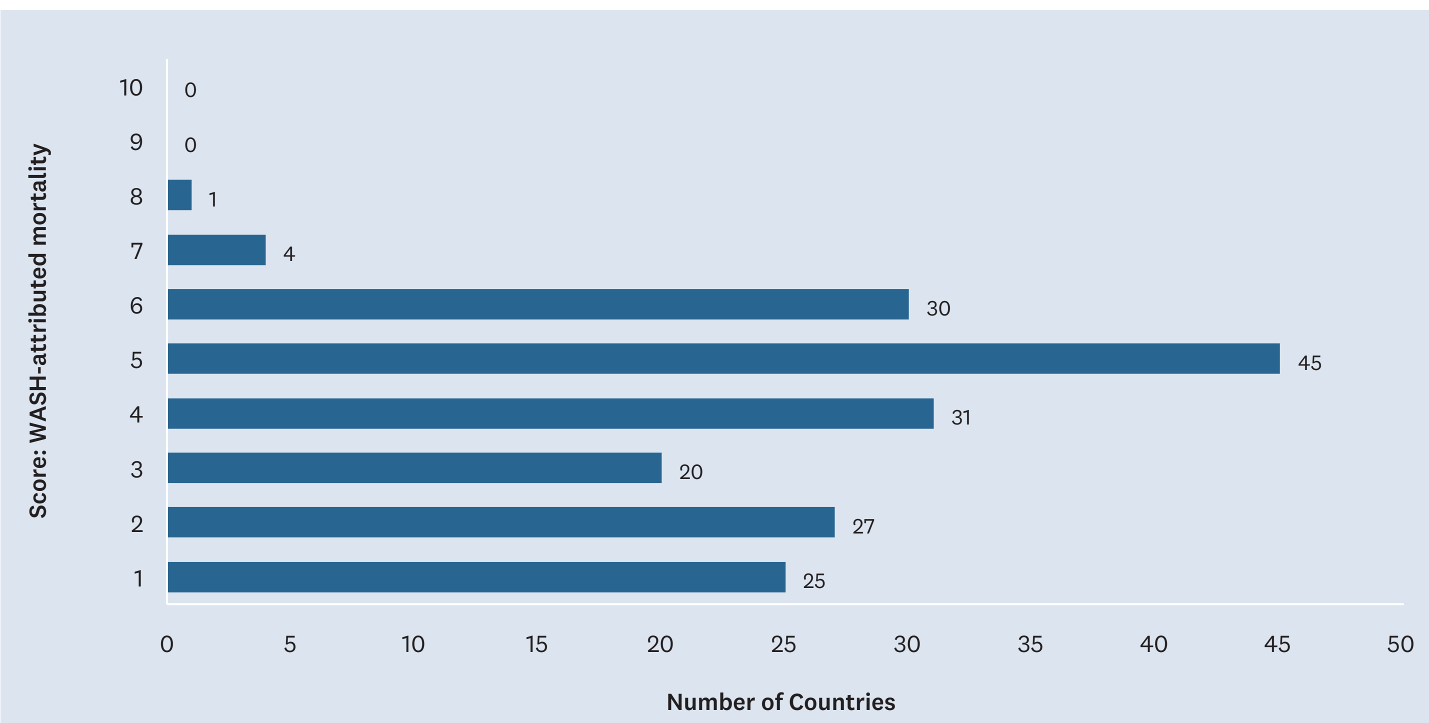


Figure 5. Distribution of scores for Good Health based on WASH-attributed mortality rates in 183 countries.

By Ivan Bruno de M, Shutterstock

While mortality rates in Africa continue to be of utmost global concern, Table 8 illustrates that 18 of 19 countries show a reduction in mortality rates between 2016 and 2019. The remaining 164 countries assessed all had increased rates of WASH-attributed mortality in 2019 compared to 2016 estimates. Clearly, the world is far from achieving SDG target 3.9, substantially reducing the number of deaths and illnesses from unsafe WASH. In most of the 183 countries with estimates, the situation is getting worse.

Table 8. Reduction in WASH-attributed mortality in 19 countries (2016-2019).

Countries with reduced rates	Mortality rate /100,000 population		
	2016	2019	Reduction
Kenya	51.15	29.04	-22.12
Congo	38.71	26.38	-12.33
Burundi	65.40	53.25	-12.15
Sierra Leone	81.29	69.54	-11.75
Tanzania	38.40	30.21	-8.19
DR Congo	59.76	52.28	-7.48
Liberia	41.54	34.62	-6.92
Comoros	50.74	43.85	-6.89
Mali	70.72	66.12	-4.60
Uganda	31.56	28.09	-3.47
Gabon	20.58	17.49	-3.09
Ethiopia	43.66	40.68	-2.98
Nepal	19.83	17.80	-2.03
Chad	101.04	99.20	-1.85
Sudan	17.32	15.78	-1.55
Mauritania	38.57	37.79	-0.78
Niger	70.81	70.26	-0.56
Côte d’Ivoire	47.16	46.95	-0.21
Gambia	29.66	29.53	-0.13

Component 4
Water Quality

Component and Indicator Background: Proportion of household wastewater treatment

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6 CLEAN WATER AND SANITATION

Ensure availability and sustainable management of water and sanitation for all

Target 6.3

By 2030, improve water quality by reducing pollution, eliminating dumping and minimising the release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally.

Indicator 6.3.1

Proportion of domestic and industrial wastewater flows safely treated.

Indicator 6.3.2

Proportion of bodies of water with good ambient water quality.

By Chad Davis

The availability of good quality water free of contaminants is critical to water security. The quality of water resources in a country or region can affect water availability overall, as water availability decreases when water quality deteriorates.

SDG target 6.3 emphasises the importance of water quality protection (Box 4). It requires an improvement in water quality by 2030 through a reduction of pollution, eliminating dumping and minimising the release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally.

SDG 6.3 is measured and evaluated by two interconnected global indicators, SDG 6.3.1 and 6.3.2 (Box 4). The SDG 6.3.1 indicator measures the ‘proportion of safely treated domestic and industrial wastewater flows’. Achieving the SDG 6.3.1 target relies significantly on progress towards universal safelyly managed WASH services, improved domestic wastewater treatment performance, and improved industrial wastewater source control and treatment. Indicator 6.3.2 measures the ‘proportion of bodies of water with good ambient water quality’ where ‘good’ indicates an ambient water quality that does not damage ecosystem function or human health according to several core ambient water quality parameter groups that are globally relevant. In this assessment, initially, both indicators (SDG 6.3.1 and SDG 6.3.2) were potential sub-indicators for a composite indicator of water quality. However, the data for SDG 6.3.2 from available global databases were very poor and inconsistent in terms of both coverage of countries and the quality of the data itself. In 2017, only 39 countries reported on SDG 6.3.2, while in 2020, the number increased to 89. Of the 89 countries, only 52 reported information about groundwater, which often represents the largest share of freshwater resources in many countries. The recent data reveals data gaps in low-GDP countries. Of the data reported on 75,000 water bodies in 2020, over 75% were from 24 high-GDP countries, while the poorest 20 countries reported data on just over 1,000 water bodies (i.e., only 1.3% of the data on SDG 6.3.2) (UNEP, 2021a). Consequently, SDG 6.3.2 was excluded from further analysis, but attempts were made to find the closest alternative.

A possible alternative to SDG 6.3.2 was a composite of lake water turbidity and tropic state determined by satellite imagery (UNEP, 2021b). However, the process for this approach is not highly developed, affecting the data’s accuracy and representativeness. Subsequently, nitrogen and phosphorus application rates to soils were considered a proxy for the impacts on water quality translated through eutrophication as diffuse pollution (World Bank, 2021). The major challenge in using this data was that agricultural

Table 9. Scoring System for Component 4: Water quality, based on the treatment of household wastewater at the national level.

Score	0	1	2	3	4	5	6	7	8	9	10
Wastewater treatment %	0	>0–10	10–20	20–30	30–40	40–50	50–60	60–70	70–80	80–90	90–100

areas also include permanent crops and pastures, which rarely apply fertilisers like field crops. Attempts to find a correlation between lake water quality parameters (tropic state and turbidity) and fertiliser applications (nitrogen and phosphorus) were not successful. Against this backdrop, the issues with datasets on SDG 6.3.2 suggest i) unrealistic expectations from such indicators questioning their formulations, and ii) as an expected consequence, expectations from countries resulting in poor and inconsistent quality of data reporting. Overall, no feasible alternative to Indicator 6.3.2 was identified; hence, the water quality aspect in the assessment is represented solely by the percentage of wastewater treated to wastewater generated at the national level (SDG 6.3.1).

Wastewater is just one aspect of water quality in a country. Wastewater treatment is not only relevant to protecting water quality, but it also offers opportunities for resource recovery and reuse within the scope of a circular economy. Once stigmatised as waste, municipal wastewater is increasingly recognised as a valuable source of water, nutrients, precious metals, and energy (Qadir et al., 2020). There is active interest in recovering such resources from municipal waste streams with the increase in wastewater volumes and innovations in resource recovery (Otoo and Drechsel, 2018). Beyond resource recovery and economic gains, there are critical environmental benefits, such as minimising the eutrophication of freshwater resources where otherwise untreated wastewater ends up (Qadir et al., 2020). Thus, countries with limited wastewater treatment need a radical rethinking of water resource planning to include the creative management of wastewater through its collection, treatment, resource recovery, and fit-for-purpose reuse based on the ambient quality of treated wastewater. The 2030 Agenda for Sustainable Development encourages national governments to introduce wastewater treatment measures to ensure that half the proportion of untreated wastewater undergoes treatment by 2030. An initial assessment of SDG 6.3.1 status reveals that most countries lag in achieving this target (United Nations, 2018).

Primary Data Sources and Indicator Data Selected: Proportion of household wastewater treatment

The international organizations responsible for global monitoring of SDG 6.3.1 are the United Nations Human Settlements Programme (UN-Habitat), the WHO, and the United Nations Statistics Division (UNSD). This SDG target is well documented (6.3.1 Metadata), and data are available from the SDG 6 data portal. Monitoring the total and industrial components of indicator 6.3.1 relies on aggregating standardised national statistics validated by governments (UN-Habitat and WHO, 2021). Wastewater generated and treated is extracted from UNSD, United Nations Environment Programme (UNEP) Questionnaire on Environment Statistics and the Organisation for Economic Co-Operation and Development (OECD)/Eurostat Joint Questionnaire on Inland Waters, and by contacting other national institutions, ministries, or statistical offices. In 2020, national data on industrial wastewater treatment proportions was available for only 14 countries (UN-Habitat and WHO, 2021; SDG 6 data portal). Therefore, this assessment did not include the proportion of industrial wastewater flows safely treated.

UN-Habitat and WHO (2021) consider 'household wastewater' as a combination of wastewater produced by services and households due to the relative similarity in the composition and because such wastewater usually excludes major hazardous pollutants associated with industrial processes. The data reported as the 'domestic' proportion of indicator 6.3.1 (wastewater treated) in 2020 are estimates of flows generated and safely treated using a combination of nationally reported data and, in their absence, household wastewater analysis draws on data from the UNSD and UNEP and OECD and Eurostat questionnaires, as well as data compiled directly from national statistical agencies, regulators, line ministries, utilities, and the JMP (UN-Habitat and WHO, 2021). The estimates of household wastewater treatment are reported as 2020, though components of the calculation are derived from multiple years of data, including the most recent data available.

Estimates of wastewater generated and treated at household and national level are based on i) total population; ii) the proportion of households with on- and off-site water supply; iii) average domestic water consumption for households with on- and off-site water supply; iv) ratio of domestic water consumed that is translated into wastewater generated; and v) sanitation facilities (i.e., households with toilets connected to sewer lines, those connected to septic tanks, and all other types of household sanitation) (UN-Habitat and WHO, 2021). The term 'septic tanks' was used as a generic category for a range of decentralised wastewater treatment systems that receive blackwater (and, in many cases, greywater) generated by households. Indicator 6.3.1 data ('domestic wastewater flows safely treated)' for 2020 are available for 128 countries, representing about 81% of the global population.

In developing results for component 4 of Water Security, wastewater treatment data from the SDG data custodians UN-Habitat and WHO (2021) were prioritised. As these were not available for all countries, selecting a proxy indicator was necessary. Jones et al. (2021) considered 'municipal wastewater' as a possible combination of i) domestic effluent consisting of black water from toilets, greywater from kitchen and bathing and other household uses; ii) waste streams from commercial establishments and institutions; iii) industrial effluent where it is discharged into the municipal sewerage systems; and iv) stormwater and other urban runoff ending up in municipal sewerage systems. The country wastewater data in Jones et al. (2021) were collated from four online databases: Global Water Intelligence (GWI, 2015), the Food and Agricultural Organisation of the United Nations (FAO-AQUASTAT, 2020), Eurostat (2020), and UNSD (2020). For consistency, they considered 2015 as the data-year for all wastewater. Where wastewater data from these sources was reported in a different year (up to a maximum of 10 years from 2006 onwards), the wastewater data was standardised to 2015 based on data from the most recent reporting year along with cross-examining the data from different sources to check for consistency and to remove implausible data. The datasets for a range of variables for regression analyses were downloaded from multiple sources, such as total and urban population, Gross Domestic Product, Human Development Index, water scarcity, land area, and agricultural land. The selected variables were expected to have a physical basis for correlation with wastewater production, collection, treatment, or reuse. Multiple linear regression was used to predict wastewater data for countries without reported data.

A regression analysis of the wastewater data from UN-Habitat and WHO (2021) and Jones et al. (2021) yielded an R^2 value of 0.785, and the correlation was statistically significant. In addition, the average global percentage of wastewater treatment from both data sources is close (i.e., 52% treated wastewater as reported by Jones et al., 2021, and 56% treated wastewater as reported by UN-Habitat and WHO, 2021). Therefore, if no country estimates were available from UN-Habitat and WHO (2021) for household wastewater treated, this study used municipal wastewater treated as reported by Jones et al. (2021). For the 186 countries retained in this assessment, data were available for 113 countries in the UN-Habitat and WHO (2021) dataset, and all other countries included estimates in the Jones et al. (2021) dataset, including countries with estimated water treatment values of zero. The value for the Russian Federation was replaced with the value reported by Jones et al. (2021) due to the lack of clarity in the nationally reported dataset (Federal Agency for Water Resources of the Russian Federation, 2019 Data Set, sourced from WHO).

Scoring Scheme Component 4: Water Quality

The data used in this assessment to score Component 4 are based on two sources: i) the percentage of household wastewater treated, representing the 2020 situation for 112 countries (UN-Habitat and WHO, 2021), and ii) the percentage of municipal wastewater treated using 2015 standardised estimates for 74 countries (Jones et al., 2021). The wastewater treatment percentage, ranging from 0% to 100%, was then scored on a scale from 0 to 10. A score of 1 was assigned if the percentage of wastewater treatment was over zero but less than 10%. If the data indicated a zero level of water treatment, the country score was '0'. The scores then increased linearly up to 10 for 100% wastewater treatment percentage in equal segments (i.e., score 2 >10–20%, 3 >20–30%, and so on) (Table 9).

National Water Security Scores for Component 4: Water Quality

Of the 186 countries included in this assessment, 26 countries (14%) have a zero value for wastewater treatment in the Jones data set and no reported value in the UN-Habitat and WHO datasets. The remaining 160 countries with wastewater treatment data have had scores in every range of wastewater treatment percentages (Figure 6). The maximum number of countries in a scoring category is 26, which is shared by countries with wastewater treatment percentages in the range of 30% to 40% treatment, and 90% to 100% treatment. The minimum number of countries in a scoring category is six, where the wastewater treatment percentage ranges from 50% to 60%.

The countries with a top score of 10 (>90-100% wastewater treatment) are Austria, Bahrain, Belgium, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Netherlands, Qatar, Republic of Korea, Singapore, Sweden, Switzerland, United Arab Emirates, United Kingdom, and USA. Countries with a score of 9 (>80-90% wastewater treatment) are Hungary, Ireland, Jordan, Kuwait, Malaysia, New Zealand, Poland, and Spain. Except for Jordan and Malaysia, all countries with scores of 9 and 10 are high-income countries based on the World Bank's classification of countries using per capita Gross National Income (World Bank, 2022). Jordan and Malaysia belong to the upper-middle-income category.

The aggressive approach to wastewater treatment in Jordan and Malaysia is based on their emphasis on water quality protection, water conservation and reuse, and water resource augmentation as defined in their national water policies. For instance, since the 1970s, Jordan has become a pioneer country in the Middle East and North Africa to consider water reuse as part of its national water plan. Jordan has increased the reallocation of water reuse toward the agricultural sector so it can serve as the primary water source for irrigation. This strategy has enabled Jordan to partially adapt to its water scarcity by reallocating substantial volumes of freshwater to priority domestic needs. This strategy relies on expanding sanitation services in urban areas to generate 184 million m^3 of treated wastewater annually (Mateo-Sagasta et al., 2022). In terms of regulatory actions, Jordan's current water strategy (2016-2025) includes these key policies: water substitution and reuse policy, water reallocation policy, and decentralised wastewater management policy.

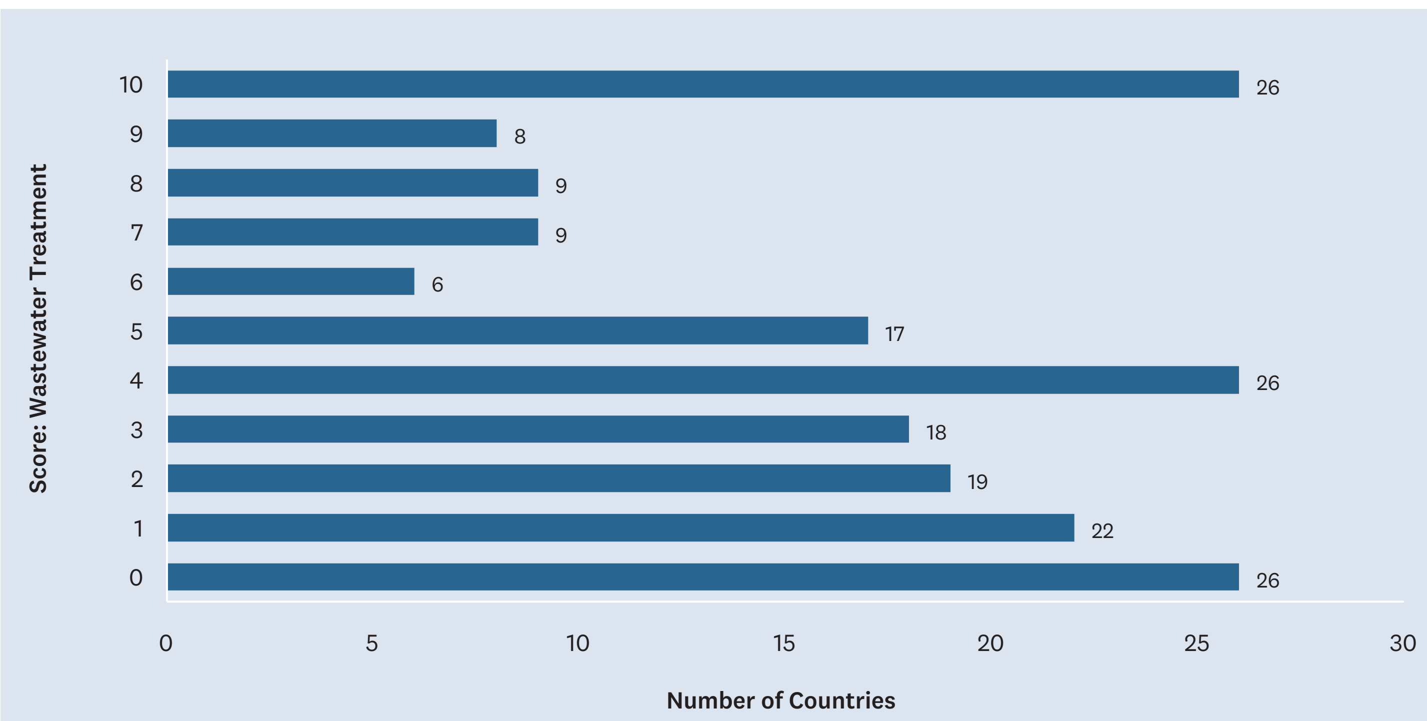
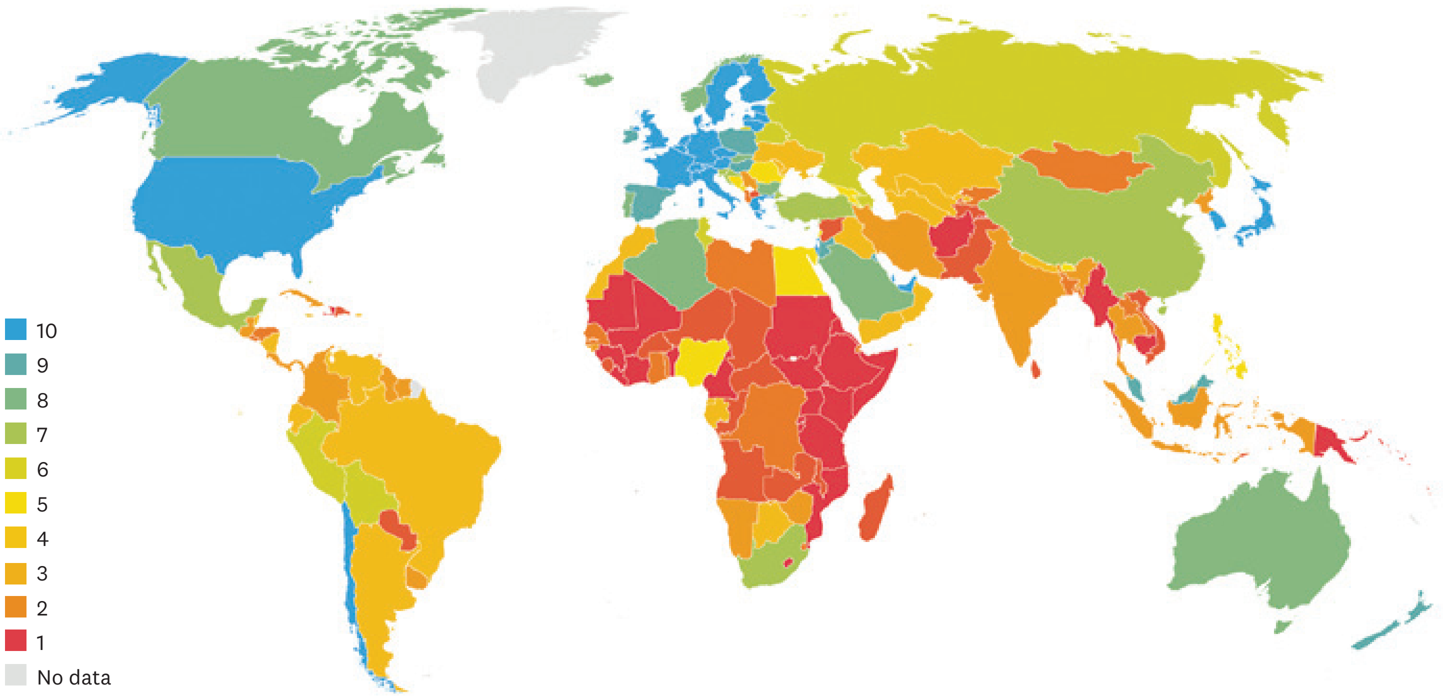


Figure 6. Distribution of countries based on their scores for wastewater treatment.

By Axel Fassio, CIFOR

Table 10. Twenty-six countries with an estimated zero level of wastewater treatment in 2020.

Region or Country	LDCs	SIDS
AFRICA		
Benin	X	
Burundi	X	
Cameroon		
Comoros	X	X
Côte d'Ivoire		
Eritrea	X	
Ethiopia	X	
Guinea	X	
Kenya		
Lesotho	X	
Liberia	X	
Mali	X	
Mauritania	X	
Mozambique	X	
Rwanda	X	
Somalia	X	
South Sudan	X	
Sudan	X	
Tanzania	X	
Uganda	X	
ASIA-PACIFIC		
Afghanistan	X	
Cambodia	X	
Myanmar	X	
Papua New Guinea		X
Solomon Islands	X	X
AMERICAS		
Haiti	X	X



Map 4. National score for water quality based on level wastewater treatment represented by the proportion of safely managed household wastewater.

In contrast to the countries with scores of 9 (eight countries) and 10 (26 countries), 26 countries scored 0, meaning they have no recorded wastewater treatment in place (Table 10). Of these countries, 20 are in Africa, five are in the Asia-Pacific, one is in the Americas, 23 are LDCs, and four are SIDs. There are 23 countries with a score of 1 based on their wastewater treatment status (<10% wastewater treatment), including Angola, Burkina Faso, Central African Republic, Chad, Republic of Congo, Dominican Republic, Madagascar, Malawi, Niger, North Macedonia, Pakistan, Paraguay, Sao Tome and Principe, Sierra Leone, Sri Lanka, Syrian Arab Republic, Tajikistan, Timor-Leste, Trinidad and Tobago, Vanuatu, Viet Nam, and Zambia. Another 19 countries with a score of 2 (>10-20% wastewater treatment) are Albania, Bangladesh, Cabo Verde, Democratic Republic of Congo, Djibouti, El Salvador, Eswatini, Gambia, Ghana, Honduras, Kyrgyzstan, Lao People's Democratic Republic, Libya, Malta, Mauritius, Federated States of Micronesia, Mongolia, Senegal, and Togo. Most countries with scores of 1 and 2 are low-income and lower-middle-income countries. Exceptions are Albania, the Dominican Republic, Libya, Mauritius, and North Macedonia, which are part of the upper-middle-income category. Despite having financial resources, these countries have yet to consider investments to ensure higher volumes of wastewater receive treatment and resource recovery practices from waste streams.

In terms of geographical dimensions, most high-scoring countries (scores 8, 9, and 10) are in Europe, North America, East Asia, Oceania, and the oil-rich part of the Middle East. The low-scoring countries (1, 2, and 3) are in Africa and South Asia, with a few from Latin America and the Caribbean (Figure 4.2). Africa is the centre of attention when considering wastewater treatment, which is the lowest among all major regions of the world. It is unlikely that most countries in the region can achieve SDG 6.3.1 by 2030.

Besides the limited allocation of financial resources to establish new wastewater treatment facilities, there are other factors for safely managed wastewater in low-scoring countries, such as i) wastewater treatment plants typically operate at capacities below the installed capacities; ii) wastewater plants may be non-functional after installation due to lack of maintenance or being installed or in pre-installation phase, yet the associated wastewater volumes are reported as treated; iii) numbers on wastewater treatment may include any form of wastewater treatment including simple filtration and sedimentation methods; and iv) wastewater treatment facilities may not be appropriately designed for the incoming wastewater, such as plants designed specifically for domestic wastewater treatment also receiving significant volumes of industrial effluent (Qadir et al., 2010).

As there is a considerable variation between the developed and developing countries and among countries within different economic groups, investments in treatment facilities in lower-middle-income countries and low-income countries have not kept pace with increases in population and the consequent increases in wastewater volume (Sato et al., 2013). Thus, large volumes of the wastewater generated are not treated or are inadequately treated and released to the environment or used for irrigation by smallholder farmers with little ability to optimise the volume or quality of the wastewater they receive (UNESCO-WWAP, 2017). Such practices lead to a range of health and environmental impacts (Grangier et al., 2012; Dickin et al., 2016).

Based on the anticipated increase in the urban population and economic growth in the coming years, there will be an increasing demand for water in urban areas vis-à-vis increasing volumes of wastewater. Wastewater production globally is expected to increase by 24% by the end of the SDG era in 2030 and 51% by 2050 over the current level (Qadir et al., 2020). These scenarios suggest that much higher volumes of wastewater will be available in coming years, revealing an opportunity to address water scarcity in dry areas through the collection, treatment, and fit-for-purpose use of wastewater in different sectors.

Access to accurate information and up-to-date data on different aspects of wastewater is central to evidence-based decision-making by policymakers and supportive institutions to develop national and local action plans aimed at safely managing wastewater. Until 2012, the availability and reliability of wastewater data were the major challenges to realising the potential of wastewater for resource recovery and reuse. While undertaking a comprehensive assessment of the status of wastewater data at the national level, Sato et al. (2013) searched for data in published and electronic forms for 181 countries. They found that only 30% of the countries had data available on three key parameters (wastewater production, treatment, and use), and there was no data or approximate numbers available for 31%. Most data accessed by Sato et al. (2013) was old (63%), while only 37% was classified as recent, dating from 2008-2012. Since 2012, there has been somewhat slow progress around wastewater data availability and its validation, although data scarcity and accuracy remain issues. Many countries do not report wastewater data regularly, and the data variables differ across countries (UN-Habitat and WHO, 2021).

Although this component reveals that data completeness remains a challenge, reporting SDG 6.3.1 remains crucial to promote the progress on safely managed wastewater and advocate for improved national monitoring initiatives to address data deficiencies (UNESCO-WWAP, 2017; Qadir, 2018). For countries lacking national strategies and targets for safely managed wastewater through adequate treatment, improving SDG 6.3.1 monitoring is expected to trigger action on the ground via a greater focus on the required investments in centralised and decentralised wastewater conveyance and treatment systems. Such efforts are needed to ensure water quality protection by minimizing the direct discharge of untreated or inadequately treated wastewater to the environment while maximizing the flows of adequately treated wastewater for safe and productive reuse or discharge by following environmentally feasible approaches (UN-Habitat and WHO, 2021).

Monitoring wastewater flows generated by different sources and associated economic and business activities is the key to enforcing regulations (including discharge permits) to reduce pollutant discharges and protect water resources (UN-Habitat and WHO, 2021). Monitoring treated wastewater flows will support the shift towards a circular economy in which wastewater is considered a valuable resource (Otoo and Drechsel, 2018). Quality and up-to-date wastewater statistics contribute to the momentum towards achieving SDG 6 as they can support sustainable water resources management and safe wastewater strategies that are both needed to ensure access to water and sanitation for all (UN-Habitat and WHO, 2021).

Component 5
Water Availability

Component and Indicator Background: Level of water stress, freshwater withdrawal as a proportion of available freshwater resources

By Nahom Tesfaye, UNICEF

6 CLEAN WATER AND SANITATION

Ensure availability and sustainable management of water and sanitation for all

Target 6.4

By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

Indicator 6.4.2

Level of water stress: freshwater withdrawal as a proportion of available freshwater resources (%).

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Water is a renewable but finite resource that becomes increasingly scarce with growing populations and resource-intensive economic development. This means that environmental and human systems will be under stress if available water is insufficient to meet human needs and economic activities while leaving sufficient resources for ecosystems and baseflows. For instance, increasing competition for water resources from growing populations in dense settlements and across all economic sectors can lead to demands that exceed supply, negatively affecting the sustainability of freshwater ecosystems. Climate change also imposes significant uncertainty on how much water will be available from season to season and year to year, resulting in or further aggravating water stress. To address these many challenges, Component 5 focuses on the level of water stress experienced by countries as the ratio of abstraction to availability at a national level.

With distinct characterizations of water availability (Falkenmark, 1989; IWMI, 2007; Baggio et al., 2021), water stress levels are included in SDG 6 target 6.4, which seeks to reduce stress by increasing water-use efficiency across all sectors and reduce water scarcity (Box 5). SDG Indicator 6.4.2 focuses specifically on the level of water stress, measured as freshwater withdrawal as a proportion of available freshwater resources and expressed as a percentage. This SDG Indicator 6.4.2 calculates water stress as:

$$\text{Water Stress (\%)} = TFWW / (TRWR-EFR) \times 100 \quad \text{(Eq. 5.1)}$$

where TFWW is total freshwater withdrawal, TRWR is total renewable freshwater resources and EFR is environmental flow requirements. TFWW is calculated as the volume extracted from freshwater sources (surface and groundwater), across all sectors including agriculture (irrigated agriculture, livestock, aquaculture), services (including domestic water withdrawal), and industries (including mining, manufacturing, cooling of thermoelectric and construction or municipal, industrial, mining, energy, and construction). However, it does not include unconventional water sources such as desalinated water or reuse, including treated wastewater and agricultural drainage. TRWR is calculated as the sum of internal (within national boundaries) and external renewable water resources (surface and groundwater flowing across national boundaries). EFR is defined as the quantity and timing of freshwater flow and levels necessary to sustain aquatic ecosystems, which in turn support human cultures, economies, livelihoods, and well-being (FAO, 2019c). Both TRWR and EFR are calculated at the basin level and aggregated at a national level.

Table 11. Scoring System for Component 5. Water Availability indicated by the level of water stress.

Score	1	2	3	4	5	6	7	8	9	10
Water stress	>90	80–90	70–80	60–70	50–60	40–50	30–40	20–30	10–20	<10

Primary Data Sources and Indicator Data Selected: Level of water stress, freshwater withdrawal as a proportion of available freshwater resources

The Food and Agriculture Organization of the United Nations (FAO) is the Custodian Agency reporting on SDG indicator 6.4.2 and has been compiling international water resource data since the 1990s, including components of this indicator. These water resource data are compiled through FAO Water and Agriculture questionnaires by country-assigned National Correspondents in a collaborative exercise. Specific guidelines are provided to assist countries in calculating the variables. These variables are used along with existing data to calculate, estimate, and impute various indicators, including SDG indicators. However, capacity, resources, and motivation can be challenging, and not all countries return FAO questionnaires. Data are not available for all years, and there is a lag between national consultation processes, FAO data-checking processes, and the distribution of checked data. The available data are compiled, documented, and provided through the AQUASTAT database.

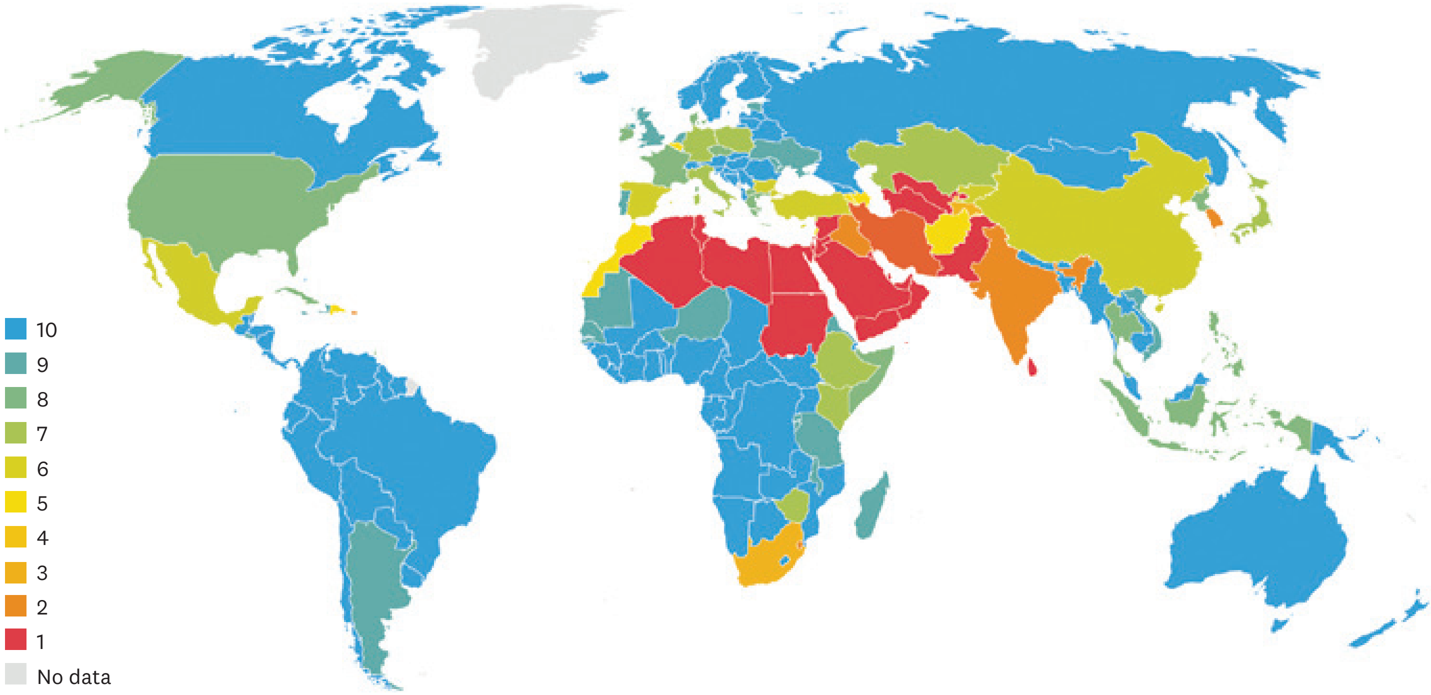
AQUASTAT contains the estimated values for sectoral withdrawals, total renewable water resources, and environmental flow requirements, and the most recent water stress data available in this database are for 2019. To understand and confirm the different sectoral and environmental demands, this assessment used these values of TFWW, TRWR, and EFR to calculate water stress using Eq. 5.1. The values for TRWR and EFR in AQUASTAT are constant for the period with records, with only the sectoral withdrawal values that constitute TFWW changing from year to year. While FAO was the Custodian Agency for the preceding Millennium Development Goal Indicator 7.5 on water stress, this earlier effort to monitor water stress globally did not incorporate environmental flow requirements. The calculation of water stress used in SDG Indicator 6.4.2 considers environmental flow requirements, and they are estimated based on the International Water Management Institute (IWMI) Global Environmental Flows Information System (GEFIS), which quantifies EFR as a percentage of long-term mean annual unregulated river flow for any part of the world (FAO, 2019a).

Of the 186 countries retained in this assessment, 178 had sufficient data to calculate water stress. Eight countries, including six SIDS, did not have data (Brunei Darussalam, Micronesia, Montenegro, Samoa, Seychelles, Solomon Islands, Tonga, and Vanuatu).

Scoring Scheme for Component 5. Water Availability

The AQUASTAT data used in this assessment to score Component 5 (water availability) represent the national estimates for the level of water stress in 2019, which is as close to 2020 as is available. The national values are percentages, so the scoring scheme of this water security component is a simple linear scale in steps of 10, which is inverted so countries with the highest levels of stress score the lowest. The lowest score according to this scheme is 1 for water stress levels above 90%. This includes 20 countries with water stress over 100%, which is far into the critical range. Therefore, the scale has no upper limit, and the lowest score applies to countries that use over 90% of their TRWR in a year. The eight countries with no data cannot be scored and received a zero score.

Based on the initial five years of monitoring SDG indicator 6.4.2, FAO considers five levels of water stress where values below 25% can be considered safe in any instance (no stress) and values above 25% should be regarded as potentially and increasingly problematic (FAO and UN-Water, 2021a; FAO, 2019b). Water stress levels between 25% and 50% are considered to be low, stress levels between 50% and 75% are medium, stress levels between 75% and 100% are high, and stress levels over 100% are critical.



Map 5. National scores for water availability based on stress levels.

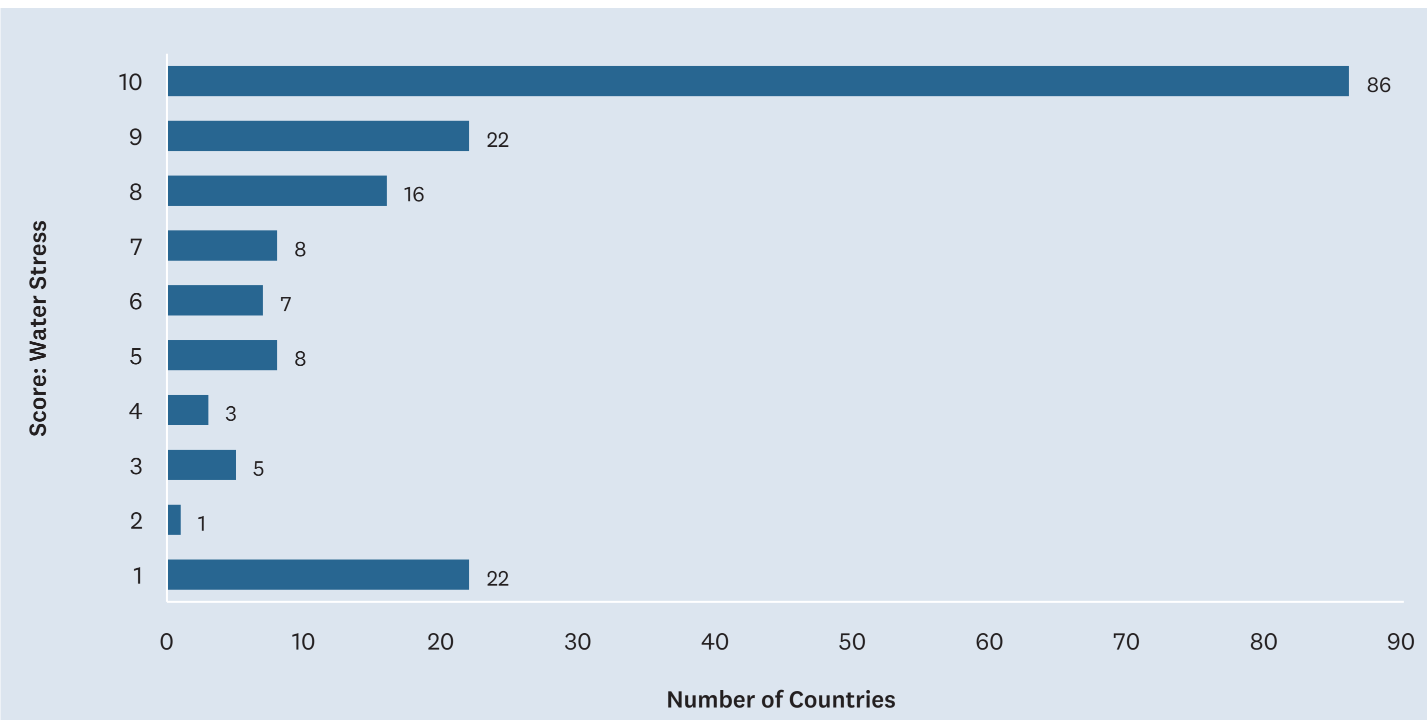


Figure 7. Distribution of 178 country scores for water stress in 2019.

National Water Security Scores for Component 5. Water Availability

The distribution of scores for the 178 countries with sufficient data to calculate and score water stress is illustrated in Figure 7.

Map 5 illustrates Component 5 scored at a national level. The results show a concentration of water-stressed countries stretching from North Africa, across the Arabian Peninsula, and Central Asia to South Asia. There are regions categorized as low stress where water stress would have been expected and where water shortages are well known, including the Horn of Africa, the Sahel, and countries such as Burkina Faso and Zimbabwe. The values used to score this component were confirmed in AQUASTAT for each sectoral withdrawal and the EFR and represent the official data available for SDG indicator 6.4.2. The low levels of water stress for some African countries could be due to their relatively low overall rate of reported water withdrawal, primarily by the agriculture sector (accounting for over 70% of all water use), which may not reflect actual water use, particularly in areas of rainfed agriculture. This means that the indicator for water stress used in this global assessment may not be appropriate in contexts where reported water withdrawals do not account for all the needs of society, economic activities, and ecosystems. This might be the case in developing countries and vulnerable communities where water infrastructure is inadequate and rainfed activities are not accounted for in official data. Renewable freshwater resources, including surface and groundwater, are considered constant over time according to the FAO methodology, which is not the case (Component 10). A complete analysis of water withdrawal and availability is thus required in further assessments of water security in these contexts.

Twenty countries have also reported water use levels far exceeding the total amount of renewable water available, resulting in water stress levels of over 100% (Table 12). In these cases, countries may be importing water from neighbouring states to meet their water demands. For example, Singapore has had a Water Agreement with the Government of Malaysia since 1961. The agreement entitles Singapore to draw and use 250 million gallons of raw water per day from the Johor River in Johor State. In return, Singapore

By Amir AghaKouchak

must provide Johor State with treated water up to 2% of the water imported (Ministry of Foreign Affairs, Singapore). This water-sharing agreement is addressed by SDG target 6.5 and implements integrated water resources management at all levels, including through transboundary cooperation as appropriate, and is represented by Component 7.

Water stress levels are high in the Arabian Peninsula and the Middle East, with no major water bodies such as rivers and lakes and limited groundwater (Table 12). Renewable freshwater resources and environmental flow requirements may be poorly reported in these cases. Additionally, many of these countries rely on extensive desalination facilities, which are not considered by the FAO methodology when estimating water availability. SDG indicator 6.4.2 needs improvement to capture changes in the dynamics of water stress in countries that have addressed water availability issues by economic and technological means.

Scoring water availability and stress at a national level has other disadvantages, especially in large countries. For instance, considering the entire USA does not highlight differences in the abundance of supply in some states like Alaska, while other states, such as California, face critical water shortages. In these contexts, the water stress indicator used in this global assessment is not able to capture subnational water stress, particularly in large countries with varying topography, economic conditions, and climates.

Despite these multiple limitations of the water stress indicator used in this global assessment, the results are relevant in the context of water security. When domestic agricultural and industrial demands and environmental flow requirements exceed available renewable resources, there is simply not enough water to sustainably support current populations and levels of development. Countries must tap into a range of options to close the water supply-demand gap, including water conservation, recycling and reuse, and conservative Integrated Water Resource Management practices (IWRM). Without taking such measures, supporting healthy ecosystems and the course of sustainable development will not be possible. Countries may also change their development trajectories to more water resource-efficient routes and develop unconventional water resources to address water stress. To addresses some of these challenges, Component 6 measures the efficiency of water use in terms of the economic value attributed to water by national economic sectors, and Component 7 considers water governance in terms of the current level of IWRM implementation.

Table 12. Twenty countries with a critical level of water stress in 2019 (scoring 1 for Component 5).

Countries scoring 1 with critical water stress	SIDS	LDCs	Calculated stress %
Kuwait			6250
United Arab Emirates			3380
Qatar			1581
Saudi Arabia			1083
Libya			832
Bahrain	X		374
Israel			187
Yemen		X	169
Uzbekistan			168
Syrian Arab Republic			149
Algeria			147
Turkmenistan			144
Egypt			141
Oman			133
Malta			124
Jordan			122
Sudan		X	118
Pakistan			112
Singapore	X		110
Barbados	X		101

Component 6
Water Value

Component and Indicator Background: Water Use Efficiency (WUE)

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6 CLEAN WATER AND SANITATION

Ensure availability and sustainable management of water and sanitation for all

Target 6.4

By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

Indicator 6.4.1

Change in water-use efficiency over time.

The efficiency of water use is critical for all users and sectors to maintain social and economic development, particularly in water-scarce areas. Water Use Efficiency (WUE), measured in USD (from local currency equivalent) per cubic metre of water used, is the Gross Value Added (GVA) to the volume of water withdrawn. It should not be confused with the physical or mechanical efficiency of withdrawal and use processes, such as irrigation efficiency or distribution system losses, or the biological efficiency of crop productivity. It does not rate how much water is needed to produce a volume of crop or product. Instead, it is the economic value gained by the volume of water used. WUE is closely related to water availability, and calculating WUE requires the same sectoral extraction volumes from freshwater sources (surface and groundwater) across the same major sectors: agriculture (irrigation, livestock, aquaculture), services (including municipal and domestic water withdrawal) and industry (mining, manufacturing, energy, construction). WUE is thus an economic indicator used to assess the economic value generated by each water-extracting sector at a very broad national scale. For example, a nation with a highly developed technology sector will use relatively less water to generate more revenue than a nation with an agricultural economic base producing less revenue per unit of water.

The importance of water use is considered by SDG target 6.4, which seeks to substantially increase WUE across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity. This target implies that the economic valuation of water is a critical driver of both social and economic development and is highly relevant to how water use from different sectors is addressed. Where water is scarce, the value of water and the prioritization of water use can accelerate or hinder economic development. Therefore, WUE is selected as a primary building block of water security, representing Component 6 and complementing water availability, Component 5. Both SDG 6.4 targets are closely related to the efficient and sustainable use of resources, which are relevant throughout the SDGs (Box 6).

WUE is calculated as the sum of the GVA (USD/m^3) by each of the three major sectors, weighted by the proportion of sectoral water use to total water use as:

$$WUE = AgWUE \times PAg + InWUE \times PIn + SvWUE \times PSv \quad \text{(Eq. 6.1)}$$

Where:

WUE = Water Use Efficiency (USD/m^3)

AgWUE = Agriculture WUE (USD/m^3)

InWUE = Industry WUE (USD/m^3)

SvWUE = Services WUE (USD/m^3)

PAg = Agricultural Water Use / TFWW (m^3)

PIn = Industry Water Use / TFWW (m^3)

PSv = Services Water Use / TFWW (m^3)

The water withdrawals and economic values of each of the three major sectors are needed for this calculation (FAO, 2019c; FAO and UN-Water, 2021b). Agriculture, for example, includes water use and GVA by each crop, livestock, and aquaculture sub-sectors, where crop-based value added is a product of total GVA minus the rainfed value-added. Hence, only the value added to water used by irrigated crops is included in this calculation. This is a significant weakness of the indicator when considering that, globally, rainfed agriculture accounts for 60% of crop production compared to 40% of irrigated production (IWMI, 2007). Another major flaw is that only valuing water used by these three major sectors ignores the value of water needed for social, cultural, environmental, and ecological sustainability, development, and security (Hellegers and van Halsema, 2021).

Table 13. Scoring System for Component 6. Water value indicated by water use efficiency.

Score	1	2	3	4	5	6	7	8	9	10
WUE USD/m^3	<2.5	2.5–5	5–7.5	7.5–10	10–20	20–40	40–60	60–80	80–100	>100

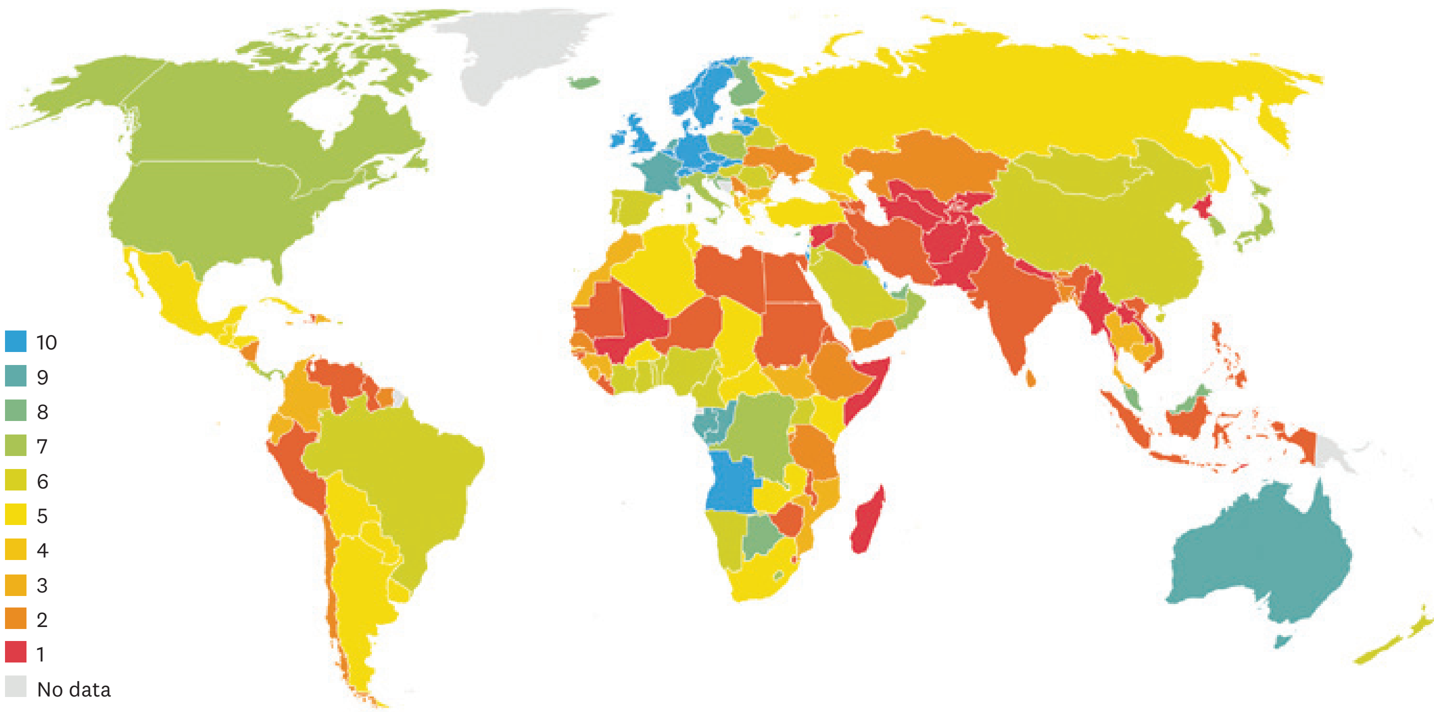
Primary Data Sources and Indicator Data Selected: Water Use Efficiency (WUE)

The Food and Agriculture Organization of the United Nations (FAO) is the Custodian Agency for SDG indicator 6.4.1. Data on sectoral water withdrawal are collected by country-assigned National Correspondents using the annual FAO Water and Agriculture questionnaire, and value-added in national currency is obtained from national statistics, converted to USD, and deflated to the baseline year (FAO, 2019c). Guidelines are provided to assist countries in calculating metrics used along with existing data, to calculate, estimate and impute other variables. In 2020, AQUASTAT sent questionnaires to 156 countries and received 71 returns (FAO and UN-Water, 2021b). This means that not all countries return the FAO questionnaires, and there is a lag between national consultation processes, FAO data-checking processes, and distributing checked data. Data available are compiled, documented, and made freely available through the AQUASTAT database.

As the foremost global effort to estimate water use efficiency, SDG indicator 6.4.1 measures the change in WUE over time (Box 6), or CWUE (i.e., the CWUE is calculated as the ratio of increase in the current WUE compared to a previous WUE value, expressed as a percentage). This approach to water use efficiency can cause problems when calculated over a short period or when reported values are missing and therefore imputed from earlier values. CWUE can also be negative if WUE fell over the change period. In 2021, FAO reported water use data for 86 countries from 2006 to 2018 (FAO and UN-Water, 2021b) and calculated the average change in WUE across the 86 countries as a proxy for global change. This resulted in estimated increases in agriculture WUE from 0.5 USD/m^3 to 0.8 USD/m^3, in industrial WUE from 18.5 USD/m^3 to 31 USD/m^3, and the service sector from 104 USD/m^3 to 135.9 USD/m^3 (FAO and UN-Water, 2021b). These averages do not tell us how the change is distributed regionally or globally. Across those 86 countries, the service sector has the highest WUE and demonstrates the highest net efficiency gain from 2006 to 2018. But when these increases are represented as CWUE (%) the increase in agricultural WUE of 0.3 USD/m^3 represents a CWUE of 60%, the increase in industrial WUE of 12.5 USD/m^3 is a CWUE of 68%, and the service WUE increase of 31.9 USD/m^3 is a CWUE of 31%. The same issue arises at the country level. For example, between 2015–2019, Libya's WUE doubled, resulting in a CWUE of over 100%, but its actual WUE remained low at 2.4 USD/m^3 in 2015 and 4.9 USD/m^3 in 2019.

Missing country water-use data also represents a problem when calculating CWUE. In AQUASTAT, missing data are normally imputed or derived from earlier records and interpolated from a trend. But measuring change requires multiple actual data points recorded over a long enough period to demonstrate significant change. At the time of this report, WUE data were available for 168 of the 186 countries retained in this assessment. However, only 46 of those values were estimated from official values. The remaining 122 were imputed by carry forward, vertical imputation, or linear interpolation. Estimating change based on a low number of imputed data points is not reliable.

The logic of using change rather than actual WUE for Indicator 6.4.1 is largely unclear, as all SDG indicators can and should be measured progressively over time, and hence, change should be indicated progressively in the course of annual monitoring. In this context, this global assessment uses only the WUE values for 2019, as reported in AQUASTAT.



Map 6. National scores for water value scored based on water use efficiency.

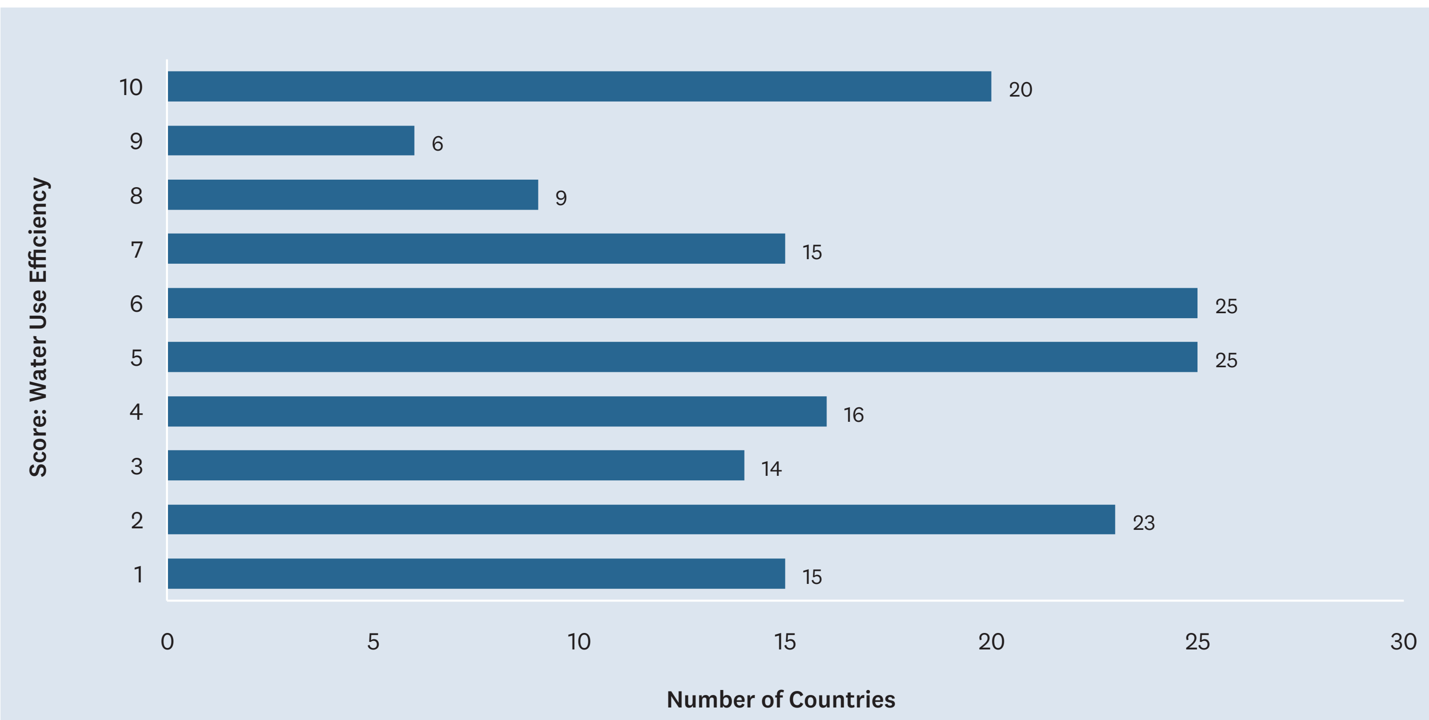


Figure 8. Distribution of 168 country scores for Water Use Efficiency (WUE) in 2019.

Table 14. Twenty lowest-scoring countries for water use efficiency in 2019.

Country	SIDS	LDCs	Water stress %	Component Score 5 Stress	2019 WUE USD/ m^3	Component Score 6 WUE
Somalia		X	24	8	0.20	1
Madagascar		X	11	9	0.80	1
Afghanistan		X	55	5	0.82	1
Kyrgyzstan			49	6	0.91	1
Tajikistan			65	4	0.92	1
Syria			149	1	1.01	1
Turkmenistan			144	1	1.33	1
Timor-Leste	X	X	28	8	1.42	1
Uzbekistan			168	1	1.56	1
Pakistan			112	1	1.57	1
North Korea			27	8	1.68	1
Mali		X	8	10	1.92	1
Lao PDR		X	4	10	1.94	1
Myanmar		X	5	10	1.98	1
Nepal		X	8	10	2.35	1
Guyana	X		3	10	2.58	2
Niger		X	11	9	2.66	2
Viet Nam			18	9	2.70	2
Sudan		X	118	1	2.97	2
India			78	3	3.12	2

Scoring Scheme for Component 6. Water Value

The AQUASTAT data used to score Component 6 (water value) represent the nationally reported or FAO estimates for WUE in 2019, which are as close to 2020 as is available. The national values range from 0.2 USD/m^3 for Somalia to 1,190 USD/m^3 for Luxembourg. As no published scale could be found to rate WUE across all sectors globally, a non-linear scoring scheme (Table 13) was developed to incorporate the broad distribution of values and many countries with low WUE (Figure 8). The scale has no upper limit, and the 18 countries with no data, mostly SIDS (Annex II), could not be scored and received a score of zero.

National Water Security Scores for Component 6. Water Value

Figure 8 illustrates the distribution of scores for 168 countries with sufficient data to calculate WUE. Within this component, the gap between the highest and lowest WUE is significant, and the scores represent a large range in the values attributed to water in each country. In 2019, Luxembourg had the highest overall WUE at 1,190 USD/m^3 and Somalia had the lowest at 0.2 USD/m^3. Leaving aside other development, peace and stability issues, there are clear differences between sectoral values and withdrawal in these two countries. Luxembourg's sectoral water withdrawal is dominated by municipal and service sector withdrawals at 89% of total freshwater use, valued at 1,177 USD/m^3. Though its industrial withdrawals only account for 9% of freshwater use, they are valued at 1,484 USD/m^3. Somalia's water use is dominated by agriculture, which accounts for almost 99% of total withdrawals, but has a WUE value of only 0.034 USD/m^3.

Table 15. Twenty highest-scoring countries for water use efficiency in 2019.

Country	SIDS	LDCs	Water stress %	Component Score 5 Stress	2019 WUE USD/m³	Component Score 6 WUE
Luxembourg			4	10	1190	10
Switzerland			6	10	415	10
United Kingdom			14	9	328	10
Denmark			24	8	316	10
Ireland			20	8	243	10
Qatar			1581	1	209	10
Sweden			3	10	201	10
Malta			124	1	188	10
Lithuania			2	10	164	10
Latvia			1	10	147	10
Slovakia			2	10	141	10
Angola		X	0.5	10	139	10
Israel			187	1	135	10
Norway			2	10	132	10
Czech Republic			22	8	126	10
Antigua and Barbuda	X		-0.01	10	123	10
Germany			39	7	113	10
Kuwait			6250	1	107	10
Austria			9	10	105	10
Belgium			52	5	102	10

Table 16. Sectoral water use and WUE in African countries with high scores for Component 6. Water value, illustrating no clear relationship to WASH-related scores.

	Sectoral Water Use (%) and WUE (USD/m³)						National WUE USD/m³	Component Score		
	Agricultural		Industrial		Services					
	% of total	USD/m³	% of total	USD/m³	% of total	USD/m³		6. Water Value	1. Drinking water	3. WASH mortality
Angola	21	0.23	34	199	45	158	139	10	3	1
Gabon	29	0.25	10	495	61	80	99	9	5	3
Rep. of Congo	4	0.17	26	165	69	69	91	9	6	2
Botswana	37	0.08	14	161	50	102	73	8	5	2
DR Congo	11	0.22	21	109	68	38	50	7	4	1

Map 6 illustrates scores for estimated WUE globally. The results show that agricultural-based economies in Asia, Africa, and Latin America often score lower. There is a concentration of high-scoring countries in Europe with more industrial and service-based economies, plus several Asian-Pacific countries, including Australia, Japan, Oman, Philippines, Malaysia, South Korea, and UAE.

Table 14 includes WUE for the 20 countries with the lowest scores in 2019, including 14 countries in Asia, five in Africa, and one in Latin America (Guyana). Half of the lowest-scoring countries for this component are LDCs, as WUE can be related to economic outputs. The table also includes the value and score for Component 5 (water availability) determined from the ratio of freshwater withdrawal to available freshwater resources (SDG 6.4.2). The sectoral water withdrawal values used to calculate WUE and water stress are the same. However, there is no clear correlation between water stress levels and WUE, even when outliers are removed. As the table illustrates, countries with the lowest water use values score both highest (e.g., Mali, Lao PDR, Myanmar, Nepal, Guyana, and Niger) and lowest (e.g., Syria, Turkmenistan, Uzbekistan, Pakistan, and Sudan) in terms of water stress. This illustrates how calculating WUE based on GVA by sectors is not necessarily linked to water balances through water availability.

Table 15 includes WUE for the 20 countries with the highest scores in 2019, including 15 countries in Europe, one in Africa (Angola), three in Asia, and one (Antigua and Barbuda) in the Americas. The table is dominated by high-scoring European countries with strong service and industrial sectors and, as with the lowest-scoring countries, there is no clear correlation between WUE and water availability, with countries scoring highest for WUE scoring both maximum and minimum for water stress.

As a SIDS, Antigua and Barbuda may seem to have an unusually high WUE. In fact, eight SIDS scored 7 or higher for Component 6 (Antigua and Barbuda, Barbados, Bahrain, Comoros, Cabo Verde, Fiji, Seychelles, and Trinidad and Tobago), although their size makes them invisible on Map 6. These countries have high WUE values, attributed largely to the service sector and municipal water use. In Antigua and Barbuda, scoring 10, service sector water use accounts for 63% and is valued at 156 USD/m^3. The Seychelles, scoring 9, has a service sector that accounts for 66% of water use, valued at 135 USD/m^3. Bahrain scores 8, with a service sector accounting for 63% of water use valued at 74 USD/m^3, but an industrial sector based on aluminium, petrochemicals, and plastics (Kingdom of Bahrain, 2023) accounting for 3% of total water use but valued at 983 USD/m^3.

Similarly, Angola stands out as an LDC scoring 10 in this component, while Botswana, Gabon, Congo DRC, and the Republic of Congo all score 7 or higher for this component (Table 16). Angola, Gabon, and the Republic of Congo all have petroleum-dominated economies and high values attributed to industrial outputs. Other African countries also have high industrial water use values attributed to mining, including Botswana (score 8) with diamond mines and DR Congo (score 7) with copper, cobalt, tin, tungsten, and tantalum mining. As the sectoral breakdown illustrates (Table 16), while the service sector shows high water use efficiency in these five countries, this does not necessarily reflect municipal service delivery or adequate water management mechanisms. Overall, WUE is an economic indicator measuring sectoral economic outputs and may not reflect whether the country has implemented strong water efficiency and management policies. As the scores for drinking water and WASH-related deaths indicate, all five countries have challenges delivering safe drinking water, contributing to high rates of WASH-related mortality.

Water Value, as applied in this assessment and defined in SDG indicator 6.4.1 as water use efficiency, may not necessarily represent well the aspects of efficiency most relevant to water security. This indicator highlights important aspects of economic development and performance, including the dominant economic sector (industry, agriculture, and services) and the extent to which associated outputs generate wealth for the country as measured by Eq. 6.1. However, it does not capture other aspects of water use efficiency as demonstrated by the example of countries in Africa that benefit from higher WUE from the petroleum and mining industries despite significant lack of access to safely managed water and sanitation and high rates of WASH-related deaths. These countries received high scores for Component 5, which suggests that new water use efficiency indicators must consider the limitations observed in this global assessment.

Component 7
Water Governance

Component and Indicator Background: Degree of Integrated Water Resource Management (IWRM)

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6 CLEAN WATER AND SANITATION

Ensure availability and sustainable management of water and sanitation for all

Target 6.5

By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.

Indicator 6.5.1

Degree of integrated water resources management implementation (0100).

By Amir AghaKouchak

Water governance can be considered the most important of the 10 components of water security assessed. Our planet has sufficient water for society and nature's needs, but it is not always available to meet community needs, livelihoods, and economic demands in a sustainable way. Historically, the location of human settlements and industrial development was governed by the availability of abundant water resources, typically fertile river basins. However, as populations and economic demands have grown, so has the pressure on water resources. This pressure can result from competing demands and often leaves insufficient environmental flows to maintain ecosystems and the services they provide, leading to the degradation of freshwater ecosystems. Besides ever-increasing complexity and demand, climate change and the shift in timing and intensity of precipitation means that balancing development trajectories and environmental requirements with available renewable water resources has never been more urgent. Thus, meeting the needs of the environment, society, and the economy requires an Integrated Water Resource Management (IWRM) approach that balances competing demands without compromising ecosystem sustainability. IWRM is defined by GWP (2000) as the process that promotes the coordinated development and management of water, land, and related resources to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. This requires coordinated evidence and data-based management, policy, regulation, and financing.

To address these challenges, SDG 6 target 6.5 aims to implement IWRM, including through transboundary cooperation as appropriate, and is supported by SDG indicator 6.5.1 to measure the degree of IWRM implementation at the national level (Box 7). Essentially, this indicator tracks key components of IWRM, including enabling environments, institutions and participation, management instruments, and financing mechanisms, which are all determinants of water governance. According to the latest global reporting on SDG 6 and IWRM (UNEP, 2021c), the rate of implementation of IWRM must double to come close to meeting SDG target 6.5 by 2030 in the best scenario. In countries facing significant capacity and development challenges, doubling progress will likely be insufficient. Thus, to provide a comprehensive global assessment of water governance in the context of water security, this assessment focuses on IWRM implementation, which falls largely within national jurisdictions.

Table 17. Scoring System for Component 7. Indicator, IWRM implementation.

Score	1	2	3	4	5	6	7	8	9	10
% IWRM implementation	>0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100

Primary Data Sources and Indicator Data Selected Degree of Integrated Water Resource Management (IWRM)

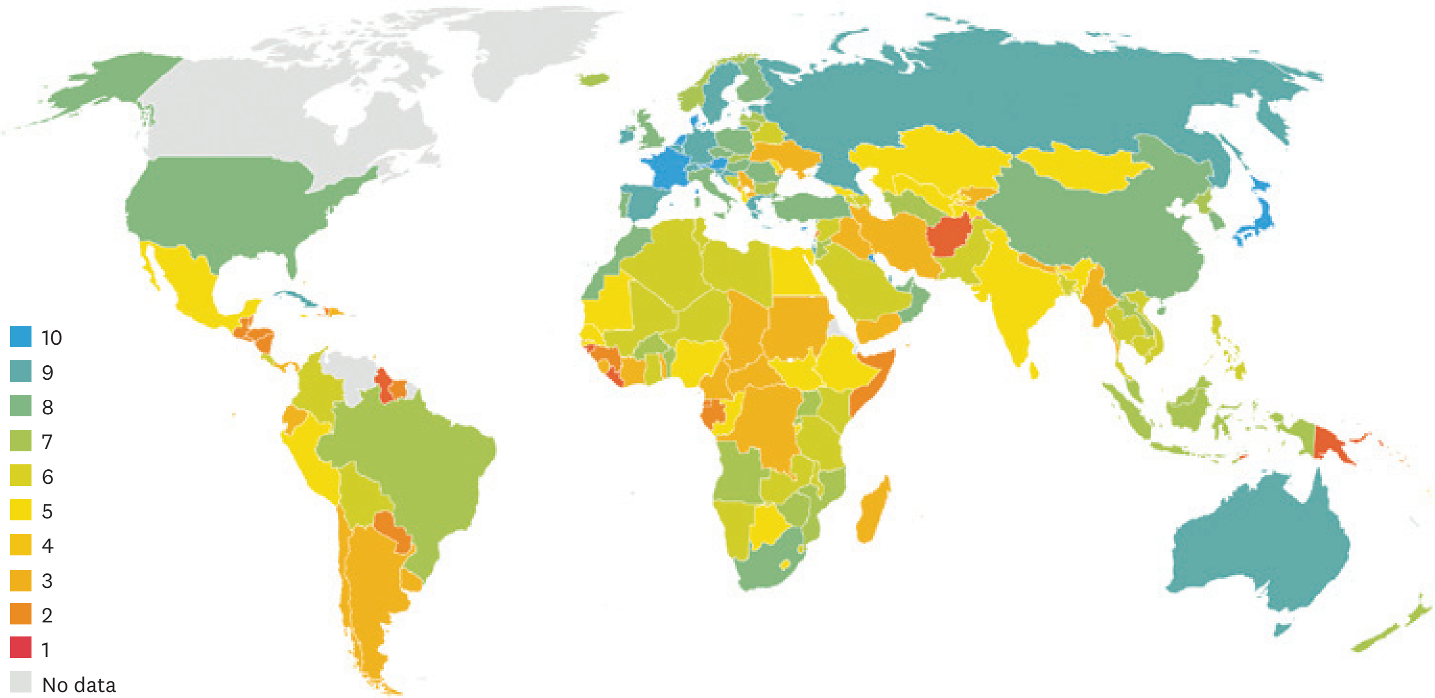
The United Nations Environment Programme (UNEP) is the Custodian Agency for reporting on SDG indicator 6.5.1, and data are compiled, documented, and provided via the IWRM Data Portal. Data for 2017 and 2020 are also available via the SDG indicator database and the UN-Water SDG 6 portal. This SDG indicator, the methodology, and the associated capacity-building and governance process supporting the exercise are well documented. National assessments are expected to be undertaken by responsible national agencies of United Nations Member States every three years. The national process assesses four key dimensions of IWRM:

1. Enabling environment (laws, policies, plans)
2. Institutions and participation (cross-sectoral coordination, capacity, gender, stakeholders)
3. Management instruments (monitoring, management programmes, data, and knowledge sharing)
4. Financing (budgeting, financial mechanisms, revenue streams)

These dimensions are assessed through a national survey of 33 questions, scored out of 100. The survey is used within a national consultation process engaging stakeholders (e.g., national and subnational line ministries and institutions involved in water resources management and other stakeholders such as NGOs, academia, and business) to generate the country data submitted to UNEP. Of the 186 countries retained in this assessment, 173 countries reported in 2017, and in 2020, 158 countries submitted updates, 13 reported for the first time, and 14 reused their baseline, totalling 186 country reports for 2020 (UNEP, 2021c). Argentina reported in 2017 but was still working on its update when the 2020 data collection concluded so the 2017 value was used to provide a score in this assessment. In total, seven countries have yet to submit data (Canada, Djibouti, Eritrea, Kiribati, Nauru, Palau, and Venezuela). As Puerto Rico and Palestine are not included in UNEP's regular data collection process for SDG Indicator 6.5.1, data were not available for these countries.

Scoring Scheme for Component 7. Water Governance

The SDG indicator 6.5.1 data were used in this assessment to score Component 7 (water governance), which represents the IWRM implementation status at a national level, estimated for 2020, or as close to 2020 as is available. The national values, compiled by UNEP-DHI, are scored out of 100, so the scoring of this water security component is a simple linear scale in steps of 10. The six countries with no data cannot be scored and will receive the equivalent of zero.



Map 7. National scores for water governance based on IWRM implementation.

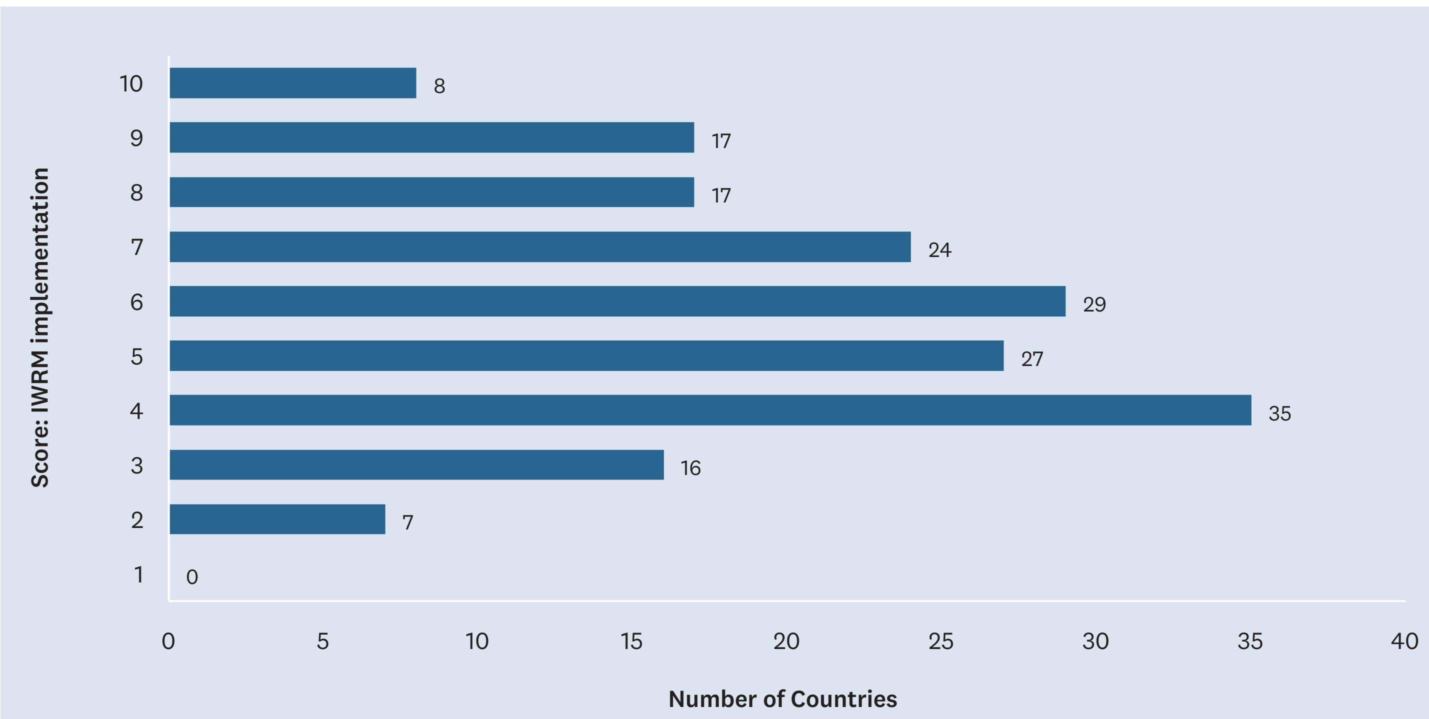


Figure 9. Distribution of 180 country scores for IWRM implementation in 2020.

National Water Security Scores for Component 7. Water Governance

Figure 9 illustrates the distribution of scores for the 180 countries with data for Component 7, measured by estimated IWMR implementation.

Map 7 illustrates the spread of reported IWRM implementation globally. There is a strong level of implementation in Europe, plus Australia and Japan, with some low levels in Central Africa, Latin America, and Asia-Pacific.

Table 18 lists the 20 lowest-scoring countries. In total, nine countries are in the Americas, seven are in Africa, and four are in the Asia-Pacific, while seven are LDCs, and almost half are SIDS. In 2020, the majority of the countries retained in this assessment have clarified improvements in their reported IWRM implementation since the first year of SDG reporting on this indicator (2017). Regionally 43 African countries, 38 countries in the Asia-Pacific, 23 countries in the Americas, and 29 European countries improved their reported IWRM implementation.

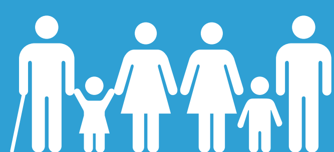
In this context, many challenges prevent countries from implementing IWRM. For instance, lack of coordination and alignment of policies and institutional collaboration in water-related sectors, insufficient financing, poor coordination and lack of capacity to absorb and disburse funds, weak institutional and professional capacity to enforce legislation, develop and implement cross-sector programmes, insufficient monitoring, and data- and information-sharing, outdated or ineffective legal frameworks, and lack of appreciation of the value of implementing IWRM are all aspects observed from the experience of countries (UNEP, 2021c). Due to its critical relevance to other aspects of water security considered in this assessment, IWRM implementation must overcome these multiple and often compounding barriers.

In terms of data accuracy, the SDG indicator 6.5.1 used in this global assessment represents an ongoing effort to produce systematic and comparable evidence of water governance worldwide. As noted by UNEP (2021c), the data collection process in 2020 was more robust for most countries compared with 2017, and for a few countries, this may have resulted in significant changes in the IWRM status. However, these changes are more likely to result from improvements in the data collection process rather than significant improvements in the IWRM implementation. Thus, this global assessment of water security takes stock of discussions on data accuracy to reiterate the critical importance of data collection efforts. This report also highlights the importance of sustained efforts to strengthen data collection processes aligned with one of the key dimensions of IWRM.

Table 18. Twenty countries scoring lowest for IWRM implementation in 2020.

Country	SIDS	LDC	% IWRM Implementation	Component 7 Score
Afghanistan		X	12	2
Timor-Leste	X	X	14	2
Liberia		X	15	2
Guinea-Bissau	X	X	19	2
Guyana	X		19	2
Papua New Guinea	X		19	2
Comoros	X	X	20	2
Belize	X		21	3
Guatemala			21	3
Somalia		X	22	3
El Salvador			23	3
Equatorial Guinea			23	3
Saint Kitts and Nevis	X		23	3
Suriname	X		23	3
Saint Vincent and Grenadines	X		24	3
Guinea		X	25	3
Honduras			25	3
Lebanon			25	3
Paraguay			27	3
Gabon		X	29	3

Component 8
Human Safety



Component and Indicator Background: Mortality due to water-related disasters (deaths per 100,000 population)

By UNDP Thailand

1 NO POVERTY

End poverty in all its forms everywhere

Target 1.5

By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social, and environmental shocks and disasters.

Indicator 1.5.1

Number of deaths, missing persons, and directly affected persons attributed to disasters per 100,000 population.

11 SUSTAINABLE CITIES AND COMMUNITIES

Make cities and human settlements inclusive, safe, resilient, and sustainable

Target 11.5

By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to the global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.

Indicator 11.5.1

Number of deaths, missing persons, and directly affected persons attributed to disasters per 100,000 population.

13 CLIMATE ACTION

Take urgent action to combat climate change and its impacts

Target 13.1

Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.

Indicator 13.1.1

Number of deaths, missing persons, and directly affected persons attributed to disasters per 100,000 population.

Sendai Global target A

Substantially reduce global disaster mortality by 2030, aiming to lower the average per 100,000 global mortality between 2020–2030 compared to 2005–2015.

Indicator A-1 (compound)

Number of deaths and missing persons attributed to disasters per 100,000 population.

By Fayez Abu Bakr

Table 19. Scoring system for water disaster human impact indicated by range in mortality rate per 100,000 population.

Score	1	2	3	4	5	6	7	8	9	10
Range in mortality rate	>40	20-40	10-20	5-10	2.5-5	1-2.5	0.5-1	0.1-0.5	0.05-0.1	0-0.05

Threats to human safety resulting from too much or insufficient water at the wrong time and place are closely related to climate change in the present context. These threats include extreme hydrological, meteorological, and climatological events, such as floods and droughts, severe storms and storm surges, mud and landslides, water infrastructure failure, and wildfires. The impact of disasters on communities is a function of the severity of the event (hazard); physical exposure to the hazard; vulnerability, determined by social, economic, and environmental conditions; and capacity to prepare for, manage and adapt to disaster impacts. These factors can be considered at the individual scale, household, community, and regional level, and at multiple levels of complexity. Changes to global and local climate also pose new challenges and risks, specifically at the extremes of climate norms. All these risks can cause water disasters that impact human safety with localized and globalized short and long-term impacts and widespread, long-lasting implications for mental and physical health, compounded by pre-existing and disaster-driven vulnerabilities.

The most immediate and irreversible impact of water disasters on communities is loss of life; therefore, this component assesses human safety in this context. The Centre for Research on the Epidemiology of Disasters (CRED) reported that in the decade 2006–2015, around 140 million people were affected worldwide, and close to 10,000 people died annually from water-related disasters (IFRC, 2016). Thus, this global assessment considers data for the period since the SDGs commenced until the most recent data, 2016 to 2020. In these 5 years, data from CRED (EM-DAT database) recorded close to 600 million people directly affected globally by all disasters and 50,000 deaths.

Given the severity of water disasters on human safety and the subsequent wide-ranging development outcomes, the impact on national mortality rates is critical to water security and is represented in Component 8. SDGs 1, 11, and 13 targeting poverty, communities, and climate change, respectively, all include reduced disaster mortality as an indicator (Box. 8). In all three SDGs, this is expressed as the number of deaths, missing persons, and directly affected persons attributed to disasters per 100,000 population. This indicator is equivalent to the Sendai Framework for Disaster Risk Reduction 2015-2030 indicators A1 and B1, and the international organization responsible for global monitoring of this goal is the Sendai custodian, the UN Office for Disaster Risk Reduction (UNDRR). This assessment considers deaths and missing presumed dead. This is a straightforward indicator of disaster-related mortality, not vulnerable to differences in interpretation, and it can be compared to other sources of water-related mortality.

Beyond the immediate impact of water disasters on human safety, the economic impacts, in terms of livelihoods and economic safety and stability of all sectors, are critical to disaster recovery and all development outcomes. While mortality and economic impact are both essential metrics of the severity of water disasters and exposure to associated water insecurity, quantifying these impacts is very different. Given the severity and finality of disaster-related mortality, the recording and reporting of lives lost are relatively accessible but not always consistent (see primary data sources below). Economic impacts are harder to assess and are less readily accessible globally. A country's exposure to the economic impacts of water disasters is assessed by Component 9 (economic safety).

Primary Data Sources and Indicator Data Selected: Mortality due to water-related disasters (deaths per 100,000 population)

UNDRR supports United Nations Member States in implementing the Sendai Framework for Disaster Risk Reduction 2015-2030, monitoring and reviewing progress. The nationally appointed Sendai Framework Focal Points in each country are responsible for data reporting through the Sendai Framework Monitoring System (UNDRR, 2022), and data on the SDG and Sendai targets are compiled UNDRR. Data on human and economic impacts of disasters are available via platforms hosted by UNDRR (DESINVENTAR; preventionweb) and the SDG data portal. Other important sources of data and information include EM-DAT, a project of the Centre for Research on the Epidemiology of Disasters (CRED), and Université Catholique de Louvain. EM-DAT aims to provide an objective basis for vulnerability assessment and rational decision-making in disaster situations, including the human impact of disasters, the number of people killed, the number injured or affected, disaster-related economic damage estimates, and disaster-specific international aid contributions. Sources of EM-DAT information include, but are not limited to, United Nations agencies, national governments and their public health, meteorological and disaster agencies, Inter-Governmental Organisations, NGOs, multilateral development banks, reinsurance companies, and the media. The ADB Asian Water Development Outlook uses EM-DAT population-affected data for the 10 years preceding the report in its assessment of hazard exposure (ADB, 2020a). The database from the Institute for Health Metrics and Evaluation (IHME), University of Washington, is an additional, highly comprehensive source of epidemiological data. The IHME database includes exposure to forces of nature as a cause of death, although this cannot be disaggregated into hazard types.

The SDGs 1, 11, and 13, and Sendai target A data are available in the UNDESA SDG Indicators Data Base. For 2016–2020, 140 countries have records for the number of deaths and missing persons attributed to disasters per 100,000 population, but it is impossible to disaggregate deaths from water disasters from the total figure. As this is an SDG indicator, this was the data set of choice for this assessment, and it was initially assumed that most disasters would be water related. However, high values for some countries made this unlikely. For example, Sweden has a value of 9,265 deaths in total for 2020. While Sweden has suffered from flash floods in recent years, these did not cause thousands of deaths. As no other cause could be determined, it is assumed that the mortalities reported are due to the Covid pandemic or simply incorrect. Other anomalous values included Iraq, with 110,047 deaths reported in 2016–2018. Again, floods have certainly caused deaths in this period, but these would likely have been several orders of magnitude lower. EM-DAT reports 39 deaths in Iraq due to flooding in 2016–2020, which translates to an annual water disaster mortality rate of 0.1 deaths per 100,000 population. Without requested input from the data custodians, it was impossible to determine why around 20 countries have high values and around 10 have low values when compared to other data sources. Overall, there are multiple inconsistencies in the SDG indicator database for indicators in Box 8 above, which makes the use of these data in the assessment, and other global assessments that require the use of these indicators unfeasible. These inconsistencies also point to the urgent need to verify these data and ensure consistency in reporting by countries.

For 2016–2020, the CRED EM-DAT database contains data on disaster mortality for 185 countries which can be disaggregated into the disaster subgroups (meteorological, hydrological, climatological) and identified as the disaster types (drought, extreme temperature, flood, landslide, storm, and wildfire). It is assumed that mortality figures include confirmed deaths and missing presumed dead. For the same period, the IHME database contains data on the cause of death and exposure to forces of nature for 204 countries.

Without clarity on country-reported data managed by UNDRR, the CRED EM-DAT was considered the most reliable and consistent data source. These data can still represent the SDG targets and are specific to water-related disasters. For the final 186 countries retained in the global assessment, data for 168 countries were derived from EM-DAT specifically for meteorological, hydrological, and climatological disasters. Data for the remaining 18 countries were obtained from IHME for death due to exposure to forces of nature. The IHME values used in this assessment reported mortality rates of less than 1 per 100,000 population with the exceptions of Iceland (1 death in 2017), Kazakhstan (15 deaths in 2017), and New Zealand (2 deaths in 2016 and 2 deaths in 2019). All data sources are listed in Annex I.

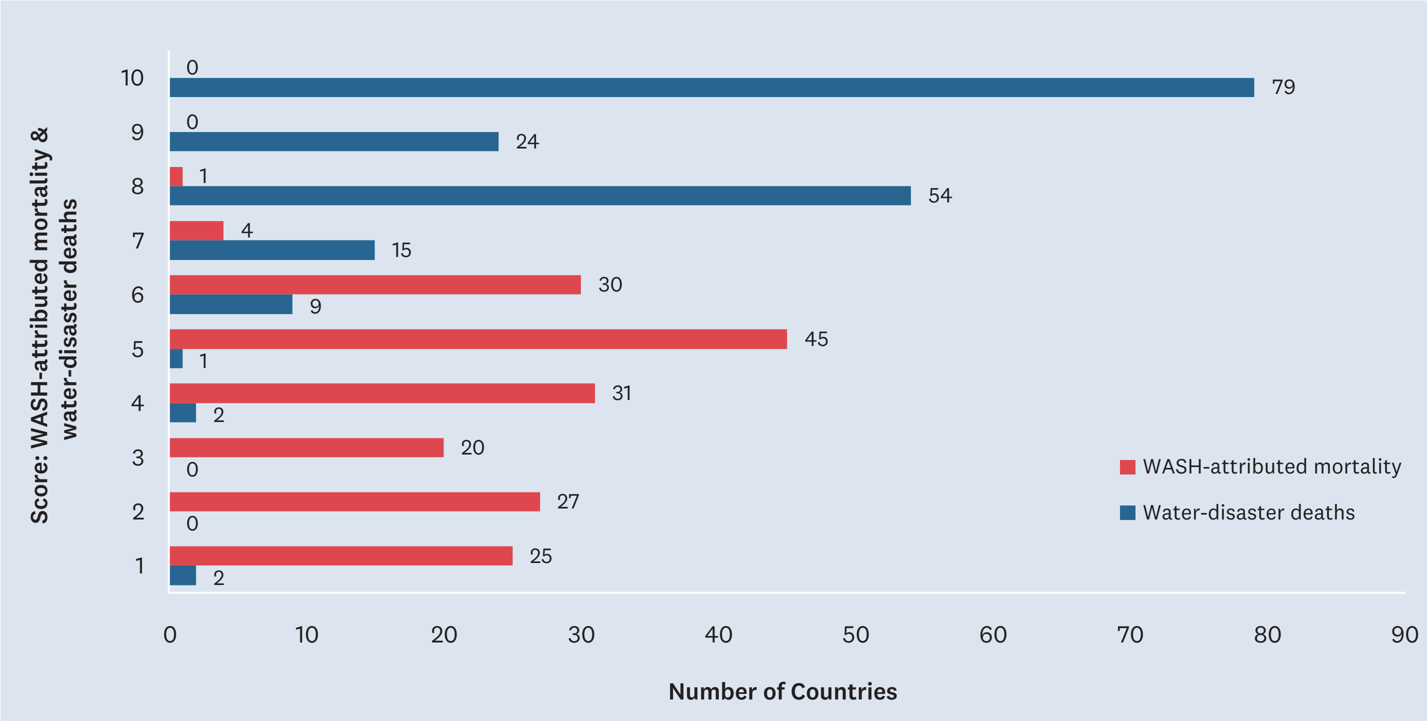


Figure 10. Distribution of scores for 186 countries based on the range in mortality rate per 100,000 population due to water disasters and unsafe WASH.

The mortality rate attributable to disasters is expressed as deaths per 100,000 people, allowing direct comparison between national populations of different sizes and the total global mortality rate. This includes both confirmed deaths and missing presumed dead. Providing this statistic for one year only does not represent the stochastic nature of disasters; therefore, the average annualized mortality rate was calculated by country for disasters during the 2016–2020 period; if no disasters occurred at any year during this period, they were not included in the average calculated. In this way, the value represents the severity of disasters that did occur rather than good years when no disasters occurred. The global 5-year total of 48,161 deaths is equivalent to an annualized global mortality rate of 0.13 deaths per 100,000 over the period 2016–2020. At a country level, for example, 39 deaths were reported in Iraq due to flooding in 2016–2020. This translates to an average annual water disaster mortality rate of 0.03 deaths per 100,000 population, which can be compared to its neighbours Iran, Syria, and Turkey with mortality rates of 0.05, 0.01, and 0.04, respectively.

Scoring Scheme for Component 8. Human Safety

A national score for each of the 186 countries assessed was derived from the range in mortality rate and a non-linear scale illustrated in Table 19. For this scheme, we applied the same range in mortality and associated score as in Component 3, WASH-attributed mortality, so that both causes of water-related mortality can be compared directly on a global scale. Following the example above, Iraq, Iran, Syria, and Turkey, with mortality rates for deaths due to water disasters of 0.03, 0.05, 0.01, and 0.04, respectively, all scored 10.

National Water Security Rating for Component 8. Human Safety

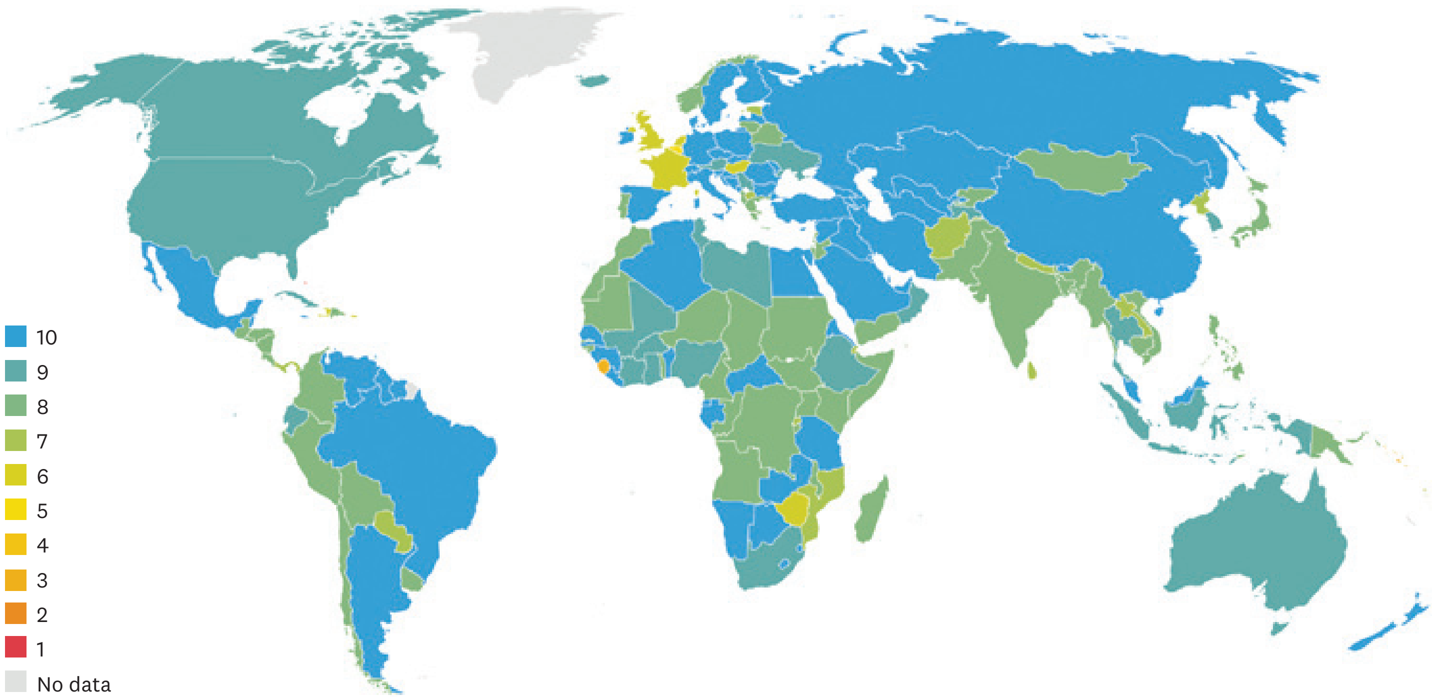
Deaths caused by water disasters are among the most severe and irreversible threats to human safety a community or nation can experience and are, therefore, a critical component of water security. Figure 10 illustrates the distribution of scores in 186 countries for Component 8, human safety, and Component 3, WASH-attributed mortality, based on the mortality rate range per 100,000 population. Based on the most recently available data, both component scores use an equivalent scoring scheme, allowing a global comparison of the two major causes of water-related mortality.

During 2016-2020 period, 172 countries suffered a maximum annualized mortality rate of one death per 100,000 people scoring from 7 to 10 on the scale; 14 countries had an annualized mortality of over 1, scoring between 1 and 6, of which only two countries had a high mortality rate above 10 per 100,000. According to EM-DAT records, these fatalities resulted from storms in Dominica (Hurricane Maria in 2017) and the Bahamas (Hurricane Dorian in 2019), demonstrating the devastating impact of tropical storms on life in Small Island Developing States (SIDS), with inherently low populations.

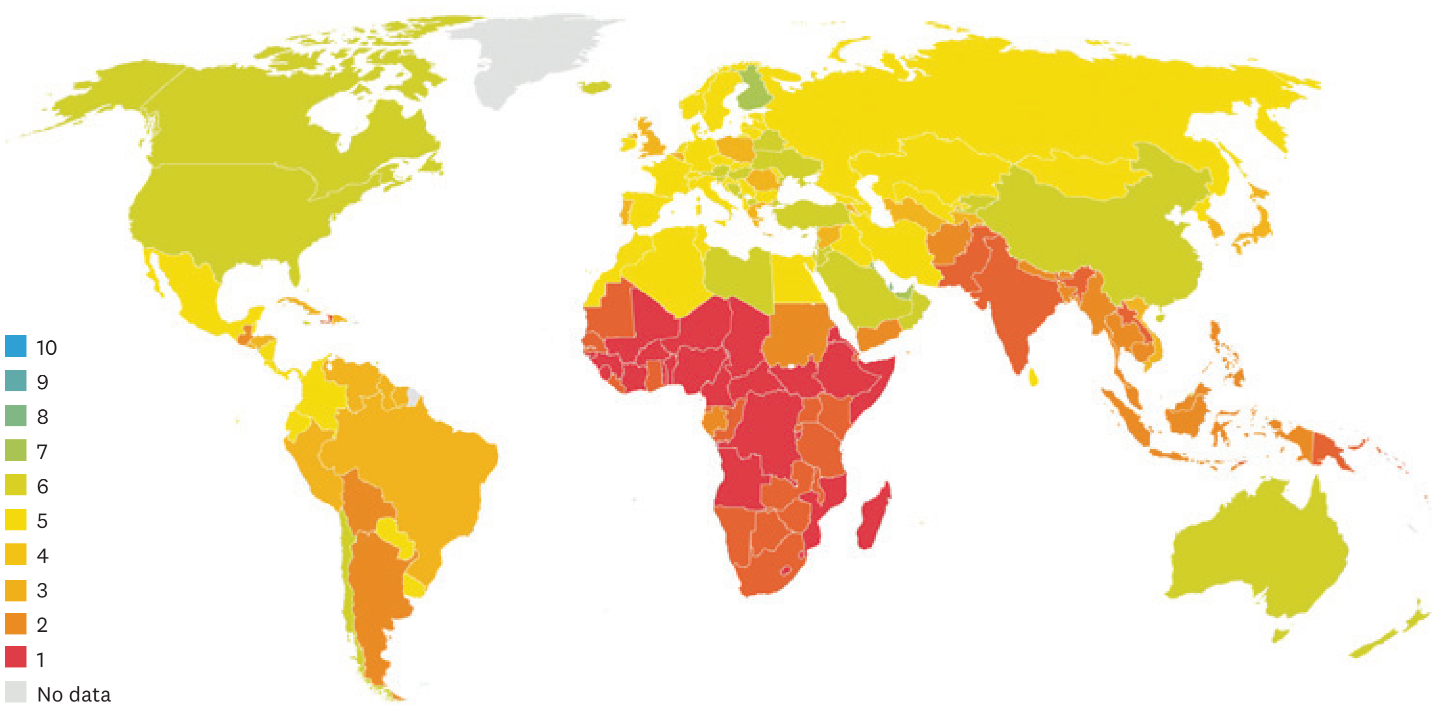
Table 20 lists the 20 countries suffering the most severe impacts of water disasters on human safety from 2016 to 2020. The high exposure to tropical storms means that 10 out of the 20 most severely affected countries are Small Island Developing States (SIDS), spread across Africa, the Americas, and Asia-Pacific regions. The most severely affected countries are not all in the Least Developed Countries (LDCs). Of these 20 low-scoring countries, three are in Africa, five in the Asia-Pacific, seven are in the Americas, and five are in Europe. Belgium scored 5, and the United Kingdom, Hungary, the Netherlands, and France scored 6, with mortality rates of 4.7, 2, 1.8, 1.6, and 1.1, respectively, predominately due to extreme temperature events during 2018–2020.

Table 20. Twenty countries with the lowest levels of human safety from water disasters (2016-2020).

Country	SIDS	LDC	Annualized mortality rate/100,000	National score
Bahamas	X		91.40	1
Dominica	X		89.56	1
Sierra Leone		X	7.40	4
Solomon Islands	X	X	6.99	4
Belgium			4.71	5
Zimbabwe			2.15	6
United Kingdom			2.01	6
Hungary			1.84	6
Fiji	X		1.80	6
Haiti	X	X	1.58	6
Netherlands			1.56	6
Puerto Rico	X		1.06	6
France			1.05	6
Antigua and Barbuda	X		1.05	6
Vanuatu	X		0.98	7
Comoros	X	X	0.94	7
St Vincent and Grenadines	X		0.91	7
Panama			0.84	7
North Korea			0.80	7
Nepal		X	0.73	7



Map 8. National scores for Component 8. Water disaster deaths.



Map 3. National scores for Component 3. WASH-attributed mortality *repeated for comparison*.

By Bilal Al-Hammoud

Map 8 illustrates the impact of water disasters on the safety of populations of 186 countries, with the Global South suffering the highest mortality rates regionally and Africa and South Asia having the largest number of countries affected with lower scores, with areas in Latin America and SIDS sharing similarly high mortality rates. There are 86 countries (approximately 45%) with a score of 10, and about 81% of countries score 8 to 10. Only 14 countries (8%) scored 5 or less for Component 8 implying that international efforts on disaster risk reduction, implementation of early warning systems, and capacity development programmes can contribute significantly to reducing disaster mortality.

The comparison between the scores for indicators of WASH-attributed mortality and human safety from water disasters (Figure 10, Map 3, and Map 8) is more extreme. The regional patterns are similar for both components of water security, with Africa and South and South East Asia scoring the lowest scores for both components. But the scores illustrated in Map 3 and Map 8 indicate much higher mortality rates due to unsafe WASH than due to water disasters. The distribution of national scores plotted in Figure 10, clearly illustrates how, when compared using the same scale, most countries score significantly higher for human safety and are most severely impacted by unsafe WASH. Scored based on WHO data, 148 out of 186 countries score 5 or lower, with mortality rates over 2.5 per 100,000 population, due to unsafe WASH in 2019. Only five countries scored as low for water disaster deaths 2016–2020.

Comparing deaths due to these two causes, far more people die globally from lack of safe drinking water, sanitation, and basic hygiene than die because of water disasters. And critically, they live in Africa and Asia. The data used in this assessment represent the situation at a national level, five years into the SDGs. If we want to reduce the number of water-related deaths, clearly progress towards providing safe WASH, SDGs 6.1 and 6.2, supported by 6.3, must be accelerated, and progress in Africa and South Asia must be prioritised. This is even more critical when considering the JMP WASH data trends that indicate that a 4-fold increase in progress is needed to meet 2030 WASH targets (WHO and UNICEF, 2021; WHO and UNICEF, 2022).

Component 9
Economic Safety

Component and Indicator Background: Modelled economic impact of a flood (9.1) and modelled drought risk (9.2)

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1 NO POVERTY

End poverty in all its forms everywhere

Target 1.5

By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social, and environmental shocks and disasters.

Indicator 1.5.2

Direct economic loss attributed to disasters in relation to global gross domestic product (GDP).

11 SUSTAINABLE CITIES AND COMMUNITIES

Make cities and human settlements inclusive, safe, resilient, and sustainable

Target 11.5

By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.

Indicator 11.5.2

Direct economic loss attributed to disasters in relation to global gross domestic product (GDP).

Indicator 11.5.3

(a) Damage to critical infrastructure and (b) the number of disruptions to basic services attributed to disasters.

Sendai Global Target C

Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030.

Indicator C-1

Direct economic loss attributed to disasters in relation to global gross domestic product.

By Scott Book, Shutterstock

Table 21. Scoring system for sub-indicator 9.1. The economic impact of a 100-year flood as % of GDP at the national level.

Score	1	2	3	4	5	6	7	8	9	10
% GDP loss	>15	>10–15	>7.5–10	>5–7.5	>4–5	>3–4	>2–3	>1–2	>0.5–1	<0.5

Table 22. Scoring system for sub-indicator 9.2. Drought risk at the national level.

Score	1	2	3	4	5	6	7	8	9	10
Risk level	High risk		Medium-high risk		Medium risk		Low-medium risk		Low risk	
WRI score	4-5		3-4		2-3		1-2		0-1	

Around 30% of the global population is estimated to reside in areas and regions routinely affected by either flood or drought events (UNESCO-WWAP, 2018), resulting in significant economic impacts over the past 50 years (WMO, 2021). Worldwide, floods have been the most frequent natural disaster, accounting for 31% of economic losses from 1970 to 2019, and close to 10,000 deaths are recorded annually due to water-related disasters (Component 8). Typically, we think of countries as susceptible to either floods or droughts. However, most countries experience both. It is the extent, magnitude, and frequency that vary. Heavy rainfall following a period of drought (or droughts followed by periods of heavy rainfall) results in compounded risk (He and Sheffield, 2020; Wasko et al., 2021). The impact of water disasters on human safety, measured by mortality is addressed by Component 8 of this assessment. Beyond losing human life, the safety of an economy from losses due to water-related disasters can have a major influence on all aspects of development and countries prosperity.

Examples of these impacts on economic safety are numerous, universal, and growing in numbers. In 2022, unprecedented rainfall and flooding in Pakistan affected approximately 33 million people, with estimates of total damages exceeding USD14.9 billion and total economic losses reaching about USD15.2 billion (Altaf, 2022). Damage to water supply systems and sanitation facilities resulted in millions without access to safe drinking water (UNICEF, 2022). In the same year, large areas of Ethiopia, Somalia, and Kenya experienced the longest and most severe drought on record, with around 20 million people suffering from loss of income, high food prices, and reduced ability to grow crops and raise livestock (UN OCHA, 2022). In 2021, rainfall triggered severe floods in Europe, with Germany alone experiencing losses of USD40 billion (Munich RE, 2022) and disruption of local water and sanitation services for several months (Koks et al., 2021).

Recognizing these wide-reaching economic impacts, both the SDGs and the Sendai Framework for Disaster Risk Reduction 20152030 consider the rippling effects of disasters on sustainable development. SDG 1 (no poverty), SDG 11 (sustainable cities), and Sendai Framework Target C all include indicators measuring the economic loss attributed to disasters (Box 9).

The influence of climate change on water disasters has major implications for the safety of national economies and global water security. A clear impact of global climate change is the increase in intensity and frequency of both floods and droughts (Kundzewicz et al., 2013; Gudmundsson and Seneviratne, 2016; Taylor et al., 2017; Hoegh-Guldberg et al., 2018; Blöschl et al., 2019; Seneviratne et al., 2021) as this trend becomes more severe throughout the 21st century (Arnell and Lloyd-Hughes, 2013; Alfieri et al., 2017; Greve et al., 2019; Seneviratne et al., 2021). The IPCC's 6th Assessment Report acknowledges that as the magnitude of climate change increases, so does the likelihood of surpassing the adaptation limits of human and natural systems (Pörtner et al., 2022). This means that floods and droughts will likely impact society in ways that can disrupt the conditions that support water security, potentially leading to the degradation of ecosystems, damage to infrastructure, and water shortages. Acknowledging the potentially disastrous consequences, the 2022 United Nations Climate Change Conference or Conference of the Parties of the UNFCCC (COP27) proposed a loss and damage fund for developing countries. The fund will target economic loss caused by extreme weather events and climate change, including damage to critical infrastructure, forced displacement, and impacts on cultural heritage, human mobility, and the livelihoods of local communities (UNFCCC, 2022).

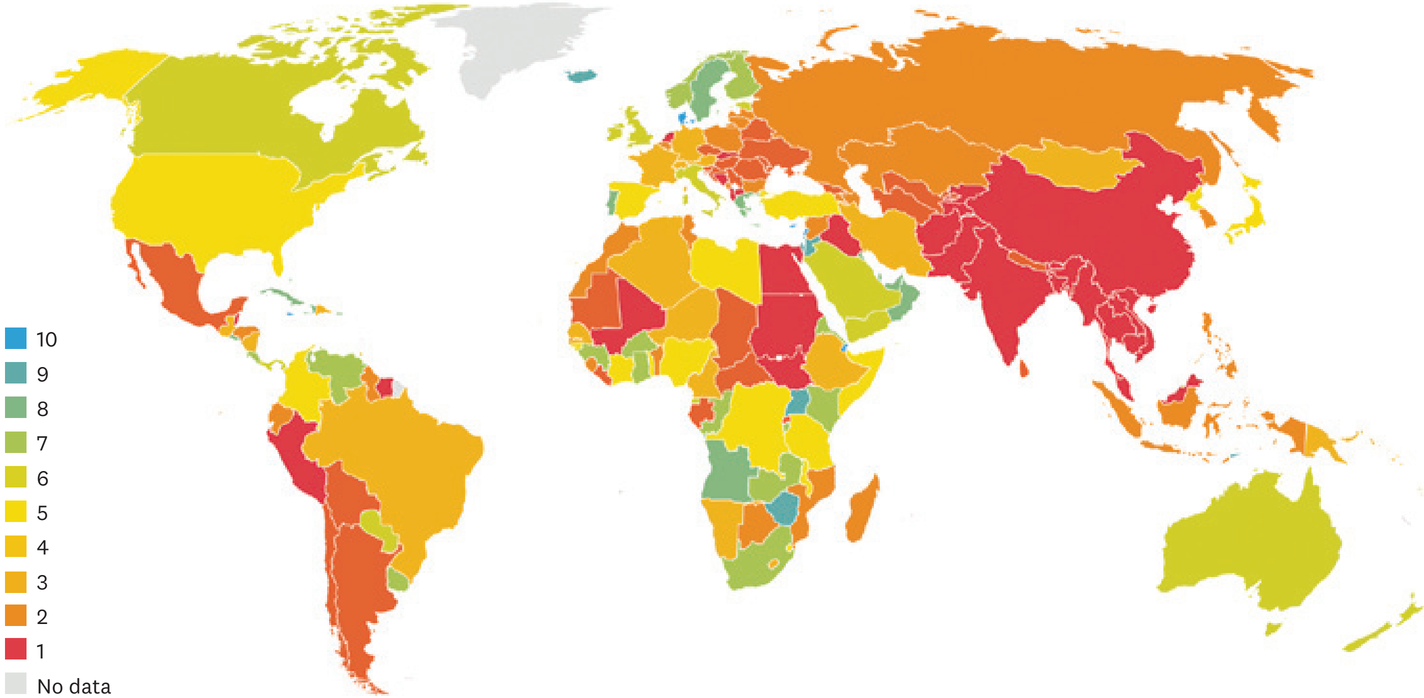
To address the multiple impacts of water disasters and their cascading effects on sustainable development, this component of the global water security assessment considers the combined impact of floods and droughts on the safety of national economies. Two sub-indicators of flood impact and drought risk were applied in this global assessment. The sub-indicator 9.1 quantifies the economic impact of floods on GDP at a national level. This indicator tracks the SDG indicators 1.5.2 and 11.5.2 and Sendai indicator C-1, direct economic loss attributed to disasters in relation to the global gross domestic product (Box 9). Rather than the global GDP specified in the Sendai/SDG indicator, this assessment considers loss to GDP caused by local flood events aggregated at the national level. Considering the proportion of losses of national GDP can explicitly point to the degree of the economic vulnerability of a country to water-related disasters. The sub-indicator 9.2 assesses drought risk by considering the exposure and vulnerability of countries to drought hazards. The availability of data for this assessment of water-related disaster impacts is challenging in both sub-indicators and the limitations of this assessment in the context of water security are discussed below.

Primary Data Sources and Indicator Data Selected: Modelled economic impact of a flood (9.1) and modelled drought risk (9.2)

As an SDG indicator, data on the impact of water-related disasters on GDP should be readily available for all member countries required to systematically collect data on the economic impact of disasters (UNSD, 2022). But, for the 2016-2020 period, since SDG monitoring commenced, approximately 150 countries do not have economic impact data for the SDG and Sendai targets in their respective UNDRR or SDG data platforms (DESINVENTAR; preventionweb; SDG data portal). It was also not possible to distinguish water-related and other disasters from the data available for the SDG targets, making it impossible to derive meaningful statistics on the economic impact of water-related disasters at a global scale from these data sources. Further, the most recent data reported in the SDG portal at the time of this analysis were highly inconsistent with previous updates (accessible via the SDG data archive). Attempts to seek clarity via the data custodians were unsuccessful, and finally, other data sources had to be explored.

The other important source of international disaster data, EM-DAT (Component 8), distinguishes disaster subgroups and types, including hydrological, meteorological, and climatological, and includes total damage USD per event. Unfortunately, this resource has no records for approximately 150 countries during the same 5-year period. Additionally, data are not reported directly to EM-DAT. They are sourced from a range of agencies and actors. Other important sources of disaster impact data include reinsurance databases, such as the Munich Reinsurance Company NatCatSERVICE. However, at the time of this study, the NatCat service was offline, and no data were available[1]. Established regional water indices need to incorporate disaster impact. The Asian Development Bank 2020 Asian Water Development Outlook (AWDO) Key Dimension 5: Water-Related Disaster Security (KD5) includes 19 measures of hazard, vulnerability, and capacity, sorted into 12 indicators and sub-indicators (ADB, 2020a). The AWDO KD5 hazard-exposure metric is population affected, not economic impact, and these data are derived from EM-DAT. Where raw data were missing for any country, regional experts estimated the value of the normalized sub- or sub-sub-indicator by considering the values of normalized indicators where data were available (ADB, 2020a, p.72).

1 According to direct communication with the MunichRe NatCat team the service is anticipated to be reinstated sometime in 2023.



Map 9. Sub-indicator 9.1. Modelled economic impact of a 100-year flood at the national level.

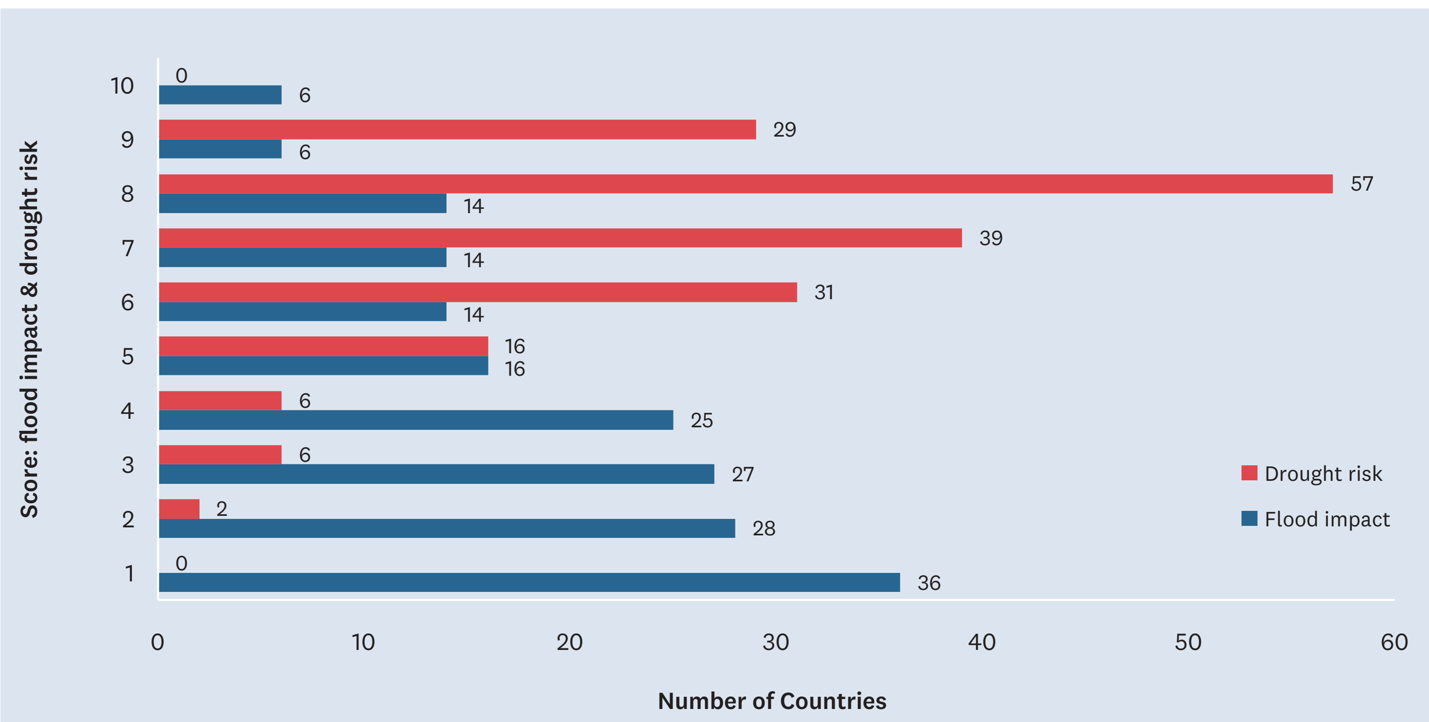


Figure 11. Distribution of 186 country scores for sub-indicators 9.1 flood impact and 9.2 drought risk.

Beyond this assessment, it is essential to have accurate and up-to-date information on loss and damage, primarily to national economies. Commitments made at the November 2022 UN Climate Change COP27 that funding to compensate vulnerable countries affected by climate disasters cannot be met without reliable and systematic information on the location and severity of disaster impacts on economies, including flood and drought impacts.

Other metrics are necessary to address the lack of data on the economic impact of water-related disasters in the SDG, UNDRR, and EM-DAT platforms. Hydro-climatological models provide estimates of where and when floods and droughts may occur (Brunner et al., 2021). When combined with other socioeconomic metrics, these models can estimate the impacts of floods and droughts on local to national economies. A further advantage of these models is that they can potentially project future flood and drought risks for various climate change scenarios (Huang et al., 2014; Roudier et al., 2015; Markus et al., 2019; Shiru et al., 2020). Thus, considering the current status of global data on recorded economic impacts of water-related disasters, modelled flood and drought impact data provided useful proxy data for this component.

One source of modelled impact data is Aqueduct Floods. This global tool maps GDP affected by floods and is somewhat aligned with the SDG and Sendai indicators assessment of economic impact in terms of GDP affected. Aqueduct Floods was developed by a consortium of Amsterdam Vrije Universiteit's Institute for Environmental Studies (IVM), Deltares, the Netherlands Environmental Assessment Agency (PBL), Utrecht University (UU), and the World Resources Institute (WRI) that hosts the overall online Aqueduct platform (Ward et al., 2020). These estimates are based on the Global Flood Risk with IMAGE Scenarios (GLOFRIS) framework (Winsemius et al., 2013) that simulates flood risk and assesses the influence of natural climate variability on river flood risk (Ward et al., 2014). GLOFRIS also simulates flood risk by combining information on hazard, exposure, and vulnerability used by the Aqueduct Floods geodatabase (Ward et al., 2020). Flood hazard is mapped as gridded flood extent and depth for return periods between 2 and 1,000 years at a resolution of 5 × 5 arc minutes. Flood exposure is measured by the affected GDP, represented by gridded maps of GDP at a resolution of 30 × 30 arc seconds, while the vulnerability of GDP to floods is assessed using a binary function that considers that any GDP within a flooded grid cell is entirely lost (Ward et al., 2020).

To estimate the economic impacts of floods at the national level (sub-indicator 9.1), flood impact data were extracted from the Aqueduct Floods geodatabase for the model run illustrating a 2010 baseline scenario, established using climate data from 1960–1999[2], and 2010 socioeconomic data. The data extracted are considered to represent the climate and validated hydrological conditions rather than a modelled future scenario. As this global assessment of water security aims to illustrate the economic impact of floods, a 100-year flood return period was chosen to represent a large, catastrophic event, rather than a flood most likely to re-occur every 10 years for example. The gridded data obtained from the Aqueduct Floods geodatabase provided the total adjusted USD value of GDP lost in the 2010 baseline scenario. Finally, the gridded data were aggregated by country to produce the national estimates for sub-indicator 9.1. The advantage of this approach is that the model simulates flood impact anywhere flooding is possible and does not exclude areas that may not monitor or report disaster data, with exception of some SIDS. The major disadvantage is that the modelled data assumes that all impacted economy, represented by gridded GDP, is lost to flood damage, likely resulting in an overestimation of economic impacts. Modelled flood impact on national GDP was available for 161 countries of the 186 countries retained in this assessment.

Modelled data on drought risk were obtained from the WRI's Aqueduct Water Risk Atlas geodatabase and were also available for 161 countries of the 186 countries retained in this assessment (Appendix I). These data were produced at a resolution of 5 × 5 arc minutes by assessing where drought hazards were likely to occur in the 2000-2014 period, the population and assets exposed, and the vulnerability of the exposed population and assets for each hydrological sub-basin (Hofste et al., 2019). Drought hazard data were derived from an analysis of historical precipitation deficits, while drought exposure data were based on population and livestock densities, crop cover and water stress indicators. To produce national values of sub-indicator 9.2, the gridded data available at Aqueduct Water Risk Atlas geodatabase were aggregated by country level. The advantage of this approach is that estimates are available for most countries, even where droughts have not been systematically monitored and reported. The disadvantage is that national estimates of drought risk may not well represent regional drought risks within the same country. This modelled drought risk relies on hazard, exposure, and vulnerability data from 20002014, which implies that recent droughts in Ethiopia, Somalia, Kenya, and other regions are not accounted for.

2 Details of the GLOFRIS and PCR-GLOBWB model setup and meteorological data can be found in Ward et al., 2020.

Scoring Scheme for Component 9. Economic Safety

In this global water security assessment, the impact of water-related disasters is represented using two sub-indicators based on national modelled data. Sub-indicator 9.1 estimates the direct economic loss attributed to 100-year floods related to national GDP, and sub-indicator 9.2 quantifies drought risk. Modelled data for 9.1 (impact floods on GDP) were missing for 24 SIDS and Bahrain. Modelled data for 9.2 (drought risk) were missing for 21 SIDS and Bahrain, Eswatini, and Palestine. Considering that the data for these sub-indicators were modelled rather than reported, and to prevent exaggerating the risk to the countries with no data, countries without data for sub-indicators 9.1 and 9.2 (21 and 24 SIDS, Bahrain, Eswatini, and Palestine) received the value of a nearby country with similar characteristics (e.g., geographically close of similar size and GDP).

The risk levels attributed to both sub-indicators are aligned to a large extent with the WRI methodology (Hofste et al., 2019; Ward et al., 2020). The scoring scheme used for sub-indicator 9.1 (flood impact on GDP) is illustrated in Table 21. Scores were calculated on a scale of 1 to 10, where 1 equates to a critical impact on GDP, and 10 is the lowest risk level likely to be attributed to severe floods in the country.

The scoring scheme used for sub-indicator 9.2 (drought risk) consisted of rescaling WRI's risk score (Hofste et al., 2019) into a scale of 1 to 10, where 1 equates to severe drought risk, and 10 is the lowest risk level associated with droughts (Table 22).

Finally, to produce a single overall national score (1 to10) for economic safety in each country assessed, the score equivalent to the maximum risk was used to represent the most severe national risk (i.e., if the score for flood impact on GDP was the lowest between the two sub-indicators), that score was selected as the national score. If the score for drought risk was the lowest between the two sub-indicators it was selected as the national score. This approach avoids the effect whereby countries with a low risk of one type of water-related disaster but a high risk of another receive a moderated score and appear to be at a low risk when they are in a high-risk category (Figure 11.)

National Water Security Rating for Component 9. Economic Safety

Figure 11 illustrates the distribution of scores based on sub-indicator 9.1, 100-year flood impact on GDP, and sub-indicator 9.2, drought risk, according to the national scoring scheme for economic safety. The distribution of scores indicates that globally, a larger number of countries are likely to suffer economic impacts from severe flooding than are at risk from drought, based on modelled flood impact and drought risk data.

Mapped globally, the economic impacts of severe floods, in terms of GDP loss, vary widely across countries and regions (Map 9) and are most concentrated in Asia, parts of Africa and Latin America, and Central and Eastern Europe. These results are aligned with other studies of flood impacts. For instance, monsoonal South and Southeast Asia flood risk has been associated with high population density and relatively low socioeconomic development. These two factors contribute to high exposure to floods and weaker regional disaster risk protection infrastructure (Winsemius et al., 2015). Risks to floods in Europe are also associated with socioeconomic changes, including the increase in wealth concentration in flood-prone areas, leading to the growth of the economic damage potential, despite flood risk reduction efforts and high expenditures on structural defences (Kundzewicz et al., 2017). Socioeconomic change in African countries is also an important driver of flood-induced economic impacts, mainly due to the region's increasing economic development and inadequate disaster risk reduction efforts (Winsemius et al., 2015).

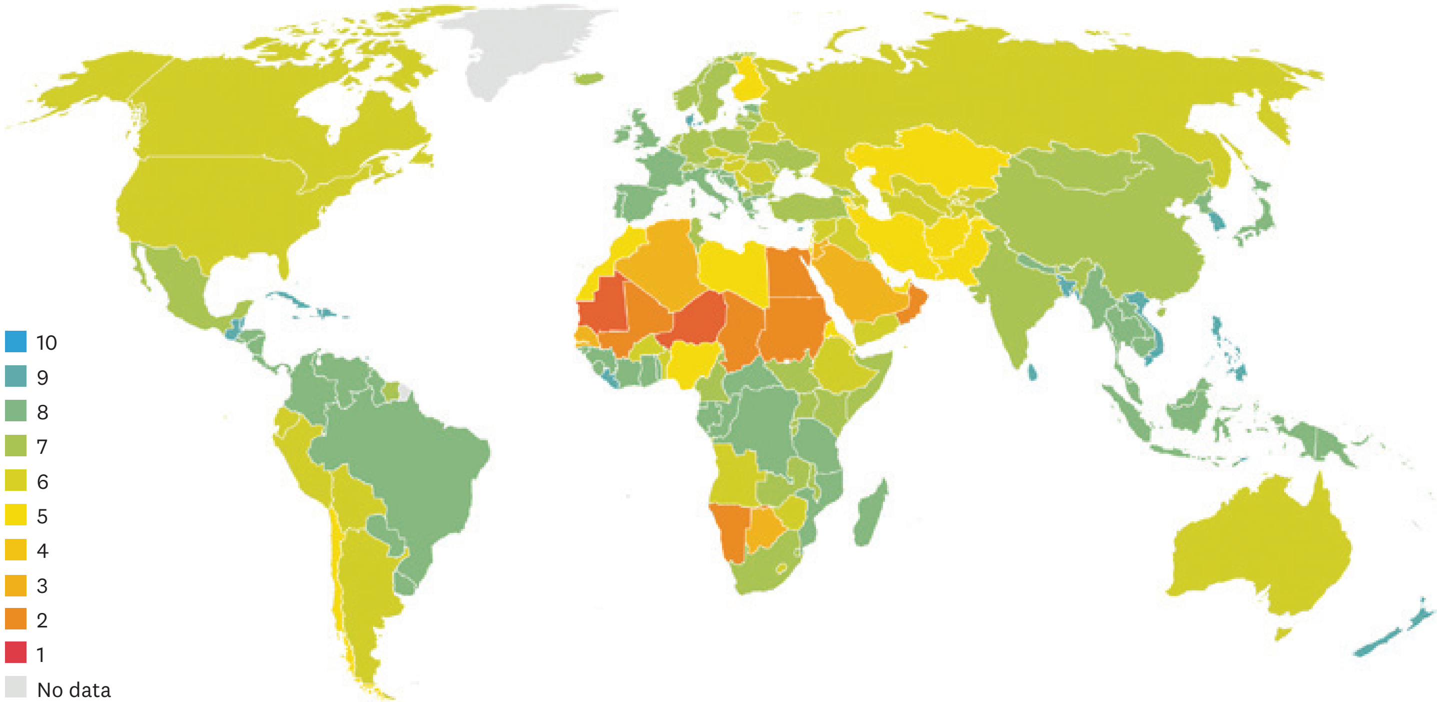
Of the countries most likely to be most severely affected by severe 100-year floods, modelled impacts range from around 17% of GDP loss in Slovakia to 60% of GDP loss in Bangladesh (Table 23). Because of a modelled 100-year flood, three countries (Bangladesh, Viet Nam, and Lao PDR) have a GDP loss higher than 50%, while 13 countries have a GDP loss between 20% and 50%. An event of this scale would have a devastating impact on the national economies. The Asia-Pacific region has the highest number of countries on the list, followed by Europe and Africa. While most countries on the list are categorized as middle-income and higher-middle-income countries, six countries (Afghanistan, Bangladesh, Bhutan, Cambodia, Lao PDR, and South Sudan) are categorized as LDCs. The Netherlands and Slovakia are the only high-income countries on the list of 20 countries most severely affected.

Table 23. Twenty countries most severely flood affected (by economic impact).

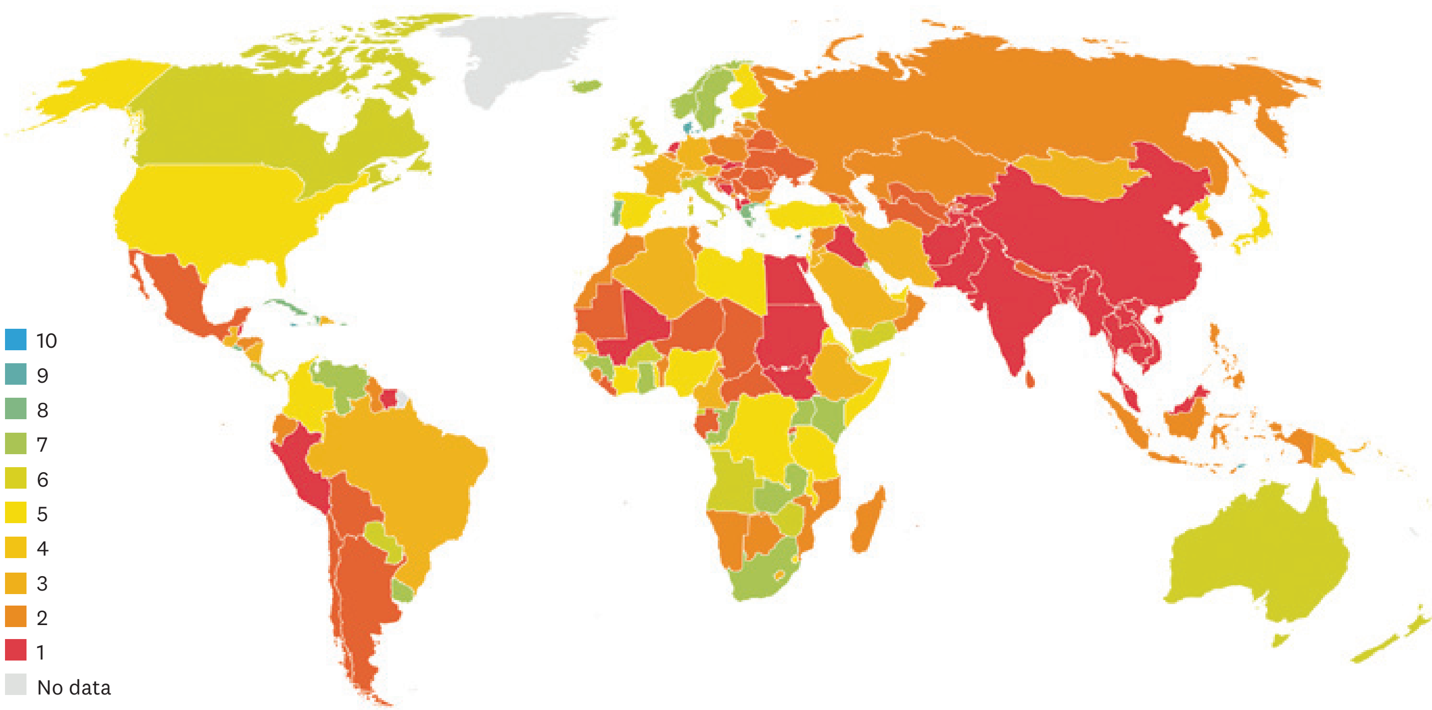
Country	SIDS	LDCs	% of GDP loss	9.1 Score
Bangladesh		X	60.0	1
Viet Nam			59.5	1
Lao PDR		X	55.3	1
Cambodia		X	42.3	1
Egypt			31.9	1
Afghanistan		X	30.0	1
Bosnia Herzegovina			28.4	1
Thailand			27.7	1
Netherlands			27.6	1
North Macedonia			26.7	1
Pakistan			26.4	1
India			22.6	1
Iraq			22.3	1
Bhutan		X	21.1	1
Belize	X		20.4	1
Kyrgyzstan			20.2	1
South Sudan		X	19.3	1
China			18.0	1
Tajikistan			17.9	1
Slovakia			17.6	1

Modelled national drought risk, mapped globally (Map 10), indicates that countries in North Africa and the Middle East are at the highest risk from drought. These countries are at particularly high risk due to rainfall variability, and high temperatures as water supplies become increasingly scarce for human needs and agricultural, energy, and industrial activities. Other studies have also shown that the extent of drought impacts varies largely across countries due to a combination of hazard, exposure, and vulnerability factors. For instance, drought mortality is highest in Sub-Saharan Africa, whereas economic losses are greatest in more affluent countries in Western and Southern Europe, North and Central America, and the Middle East and North Africa (Oluwatayo and Braide, 2022). Other socioeconomic trends, such as rapid population growth, urbanization, and land-use change, have been associated with decreasing water resource availability in many countries (Shukla et al., 2019; Baggio et al., 2021), while lack of access to clean water and sanitation (Components 1 and 2) has been shown to affect people's capacity to cope with droughts due to health concerns (Yusa et al., 2015). Studies have also focused on the socioeconomic determinants of drought risk. For instance, even mild drought events can cause yield losses and have disastrous consequences for vulnerable rural communities globally. Many of these communities cannot gather sufficient assets to buffer losses, resulting in a downward spiral in well-being and deteriorating livelihoods, making people and communities more vulnerable to future droughts (Wilhite and Pulwarty, 2018). In urban contexts, droughts are often associated with water scarcity and deficits in water supply and quality, public service disruption, and public health risks (Stanke et al., 2013; Dilling et al., 2019).

Amongst the 20 countries with the highest modelled drought risk (Table 24.), three LDCs rank first (Mauritania, Niger, and Sudan), followed by other countries in Africa and the Asia-Pacific regions. In total, 12 countries most at risk of droughts are in Africa, followed by seven countries in the Asia-Pacific region. Chile is the only country from the Americas on the list. While the list of countries at risk of droughts includes high-income countries (Bahrain, Saudi Arabia, United Arab Emirates, Qatar, and Chile), most countries are categorized as low-income and lower-middle-income.



Map 10. Sub-indicator 9.2. Modelled drought risk at the national level.



Map 11. Component 9. Economic safety from water disasters at the national level.

Table 24. Twenty countries most at risk from droughts (2000-2014).

Country	SIDS	LDCs	National Score
Mauritania		X	2
Niger		X	2
Sudan		X	3
Egypt			3
Oman			3
Chad		X	3
Namibia			3
Mali		X	3
Botswana			4
Algeria			4
Jordan		X	4
Cabo Verde	X		4
Senegal			4
Saudi Arabia			4
United Arab Emirates			5
Bahrain	X		5
Qatar			5
Libya			5
Chile			5
Iran			5

The overall risk represented by Component 9, economic safety, is mapped at a national level in Map 11. The results illustrate the risks of floods and droughts by considering a combination of modelled hazards, exposure, and vulnerability factors aggregated at the national level. The national score for the potential impact of water-related disasters represents the most severe risk, either flood or drought, and the global map indicates that very few countries are immune to these risks. Based on sub-indicators 9.1 and 9.2 used in this assessment, the regions at the most severe risk of the economic impacts of water disasters are Asia, North Africa, and parts of Latin America, followed by the Middle East and Eastern Europe.

Countries at risk of floods and droughts have compounded challenges that threaten their economic safety. By region, Africa has the highest number of countries at high risk of droughts while also experiencing accelerated population growth, urbanization, and industrialization. Coupled with poor infrastructure and capacity to manage the impact of floods and droughts, this further increases water insecurity. Table 25 lists the 11 countries scoring 4 or lower for both sub-indicators of economic safety (the most vulnerable to water disaster impacts on economic safety), modelled economic impact of floods and drought risk and therefore scoring 4 or less overall. All 11 countries in this list are in Africa.

In Asia, recurrent floods and monsoon-related droughts can exacerbate poverty, food insecurity, and the spread of waterborne diseases. Europe has also been struggling with floods and droughts despite its relatively higher access to disaster risk management and protective infrastructure. Floods and droughts can also limit access to safe drinking water and sanitation, decrease crop yields and reduce livestock productivity, destabilize fragile economies, cause displacement, create vector-borne and water-related diseases, and lead to conflicts over scarce resources. These impacts result in significant economic losses and can lead to long-term water insecurity.

None of the countries in this assessment received an overall score of 10, which would indicate the least severe impact of either flood or drought risk. It is important to reiterate that in this assessment Sub-indicator 9.1, the economic impact of floods, is assessed against the risk posed by a 100-year flood. This is an extreme flooding event with severe consequences, resulting in maximum loss and damage and severely affecting economic safety. However, floods once considered likely to re-occur once in 100 years are becoming more common under climate change (Wasko et al., 2021). The countries with the lowest modelled flood impact (sub-indicator 9.1) and drought risk (Sub-indicator 9.2) were Cyprus, Denmark, and Jamaica scoring 10 and 9, respectively, and Timor-Leste scoring 9 for both sub-indicators. Fifty-four countries scored above 5 for flood impact, and 156 countries scored over 5 for drought risk.

While the impacts of floods and droughts on water security vary according to the country's capacity to respond to hazards, the exposure to water disasters has been increasing globally due to population growth in flood-prone areas, changes in hydrological regimes, and economic development and wealth concentration in urban areas. Vulnerability to water disasters also has a role in determining the impact of floods and droughts. However, as the methodology used in this assessment relied on a binary function to determine flood vulnerability and limited socioeconomic indicators to quantify drought vulnerability, local vulnerabilities or capacity to mitigate risks are not well represented in this assessment. Further assessments of economic safety as a component of water security should better capture local vulnerability dimensions by including more disaggregated data on water-related disasters. Another important aspect to consider is the role of climate change, which can expose countries to a greater probability and increased severity of floods and droughts. Ultimately, this assessment provides a global water security benchmark but does not quantify floods and droughts risks under specific climate change scenarios. Local vulnerabilities, climate change, and population dynamics, among other factors, should be considered when assessing countries' capacity to respond to floods and droughts.

Table 25. Eleven countries scoring 4 or lower for both flood impact and drought risk.

Most severely affected countries	SIDS	LDCs	Score		
			Flood impact (9.1)	Drought risk (9.2)	9. Economic safety
Egypt			1	3	1
Mali		X	1	3	1
Sudan		X	1	3	1
Chad		X	2	3	2
Mauritania		X	2	2	2
Niger		X	4	2	2
Botswana			3	4	3
Namibia			4	3	3
Algeria			4	4	4
Cabo Verde	X		4	4	4
Senegal		X	4	4	4

Component 10
Water Resource Stability

Component and Indicator Background: Interannual variability (10.1) and large dam storage per capita (10.2)

By Alexandru Chiriac, Shutterstock

NO SDG – proposed interim indicators

Goal

Water resource stability.

Target

Sufficient freshwater resources are available throughout the year (intra-annual) and between years (interannual) to meet human and environmental needs.

Indicator

Burden of intra and interannual variability.

Indicator

Available per capita water storage.

Predicting water availability is a crucial component of human development, as countries worldwide all depend on limited water resources to fulfil the needs of multiple and often competing environmental, social, and economic requirements. Water resources can be unstable, and water availability varies seasonally and annually due to a range of factors. Natural variability is also exacerbated by climate change, associated with large-scale changes in precipitation, runoff, groundwater recharge, and glaciers catchments (Jiménez Cisneros et al., 2014; Srivastava and Azam, 2022), contributing to a change in the frequency and magnitude of droughts and floods (Component 9). Human interventions to mitigate the impacts of water variability, such as damming, river diversion, and groundwater extraction, have also led to significant impacts on water availability over time (Destouni et al., 2012). Global hydrological models have even suggested that direct human impacts on water availability may be of the same order of magnitude as climate change impacts (Haddeland et al., 2013).

In this context, temporal water variability is an essential indicator for monitoring changes in the water resources available in rivers, lakes, reservoirs, and aquifers to support economies and livelihoods and sustain freshwater ecosystems and biodiversity (Baggio et al., 2021). However, despite being a critical component of any country's water security, temporal water variability is not explicitly mentioned in water-related SDGs (Box 10).

The risks and impacts of temporal water variability are wide-ranging and have broad environmental, economic, and social implications. Fluctuations in water availability, for instance, can trigger changes in ecosystems and associated biodiversity and disrupt water supplies for human activities. In the broader context of sustainable development, water variability can cause water shortages, exacerbate pollution and water scarcity, and increase the risk of water-related disease. Water variability can also alter how water is cycled through the different components of the earth's hydrological cycle and disrupt nature-based climate adaptation mechanisms. To consider these potential risks to water security, this global assessment quantified water resource stability by estimating the risk associated with interannual water variability and the water storage per capita. These two sub-indicators capture important dynamics of temporal water variability, first by explicitly quantifying interannual water variability at the national level and second by considering water storage per capita as a critical mitigation mechanism against water variability (Perera et al., 2021).

Primary Data Sources and Indicator Data Selected: Interannual variability (10.1) and large dam storage per capita (10.2)

Limited ground-based observations make assessing changes in hydrologic conditions at the global scale exceedingly difficult (Rodell et al., 2015). Thus, other measures are required to quantify interannual water variability at the national level. One method for obtaining these data is to estimate water availability from year to year using the output of global hydrological models (Bierkens et al., 2014). These models have become essential tools representing the global terrestrial water cycle at a high resolution due to their capacity to replicate the hydrological response to weather and climate fluctuations, and the effects of human activities have improved.

Table 26. Scoring system for Indicator 10.1 based on interannual variability.

Score	0	1	2	3	4	5
Risk level	No data	High risk	Medium-high risk	Medium risk	Low-medium risk	Low risk
WRI risk score	N/A	5 4	4 3	3 2	2 1	1 0

Table 27. Scoring system for Indicator 10.2 large dam storage per capita.

Score	0	1	2	3	4	5
Indicator range m^3/capita	No data	100 ≥	100 500	500 1,500	1,500 3,000	> 3,000

This global water security assessment obtained modelled interannual water variability data from WRI's Aqueduct Water Risk Atlas (Hofste et al., 2019). To generate these data, Aqueduct Water Risk Atlas relies on PCR-GLOBWB 2, a gridded hydrological model at a resolution of 5 × 5 arc minutes. This model contains a representation of hydro-climatic variables and sector-specific water withdrawals to produce a time series of annual water available in rivers, lakes, reservoirs, and aquifers 1960-2014 (Sutanudjaja et al., 2018). Essentially, interannual water variability estimates are calculated as the coefficient of variation of the time series for each grid cell (Hofste et al., 2019). For this global water security assessment, the data available at Aqueduct Water Risk Atlas geodatabase were aggregated as the average national interannual water variability. The advantage of using these modelled data is that estimates of interannual water variability are available in countries where ground-based observations are not available or systematically produced. However, modelled interannual water variability data may be used with discretion. PCR-GLOBWB 2 relies on various assumptions affecting the model's ability to accurately inform this global water security assessment. To reduce these uncertainties, future assessments must consider ways to validate modelled interannual water variability against observational data.

Large dam water storage per capita at the national level was estimated based on the International Commission on Large Dams database (ICOLD, 2020). The ICOLD database includes records of 60,000 large dams, based on reports provided by national agencies. The data are available online with a fee and are not georeferenced. Open-source global repositories are growing in geographic scope and recognition, including the Global Reservoir and Dam database (GRanD) and GeoDAR (georeferenced global dams and reservoirs dataset) (Wang et al., 2022) and will be explored further in future assessments. As the ICOLD database includes nationally reported records on reservoir storage, these data were selected as the most readily available, on a scale sufficient to calculate this indicator. The total capacity of large dams in each country was normalised by population estimates to obtain water storage per capita at the national level. Large dams include structures with a minimum height of 15 metres, from the lowest foundation to crest, or a dam between 5 metres and 15 metres, impounding over 3 million cubic metres of water. Due to the lack of data, excluding other types of storage, such as lakes, ponds, and aquifers, can underestimate this indicator. Therefore, these omissions should be addressed in future assessments of water security.

Scoring scheme Component 10. Water Resource Stability

In this component, each indicator was scored from 0 to 5, where a score of 1 indicates the most severe water variability risk, and a score of 5 represents a low risk. A 1 indicates low reservoir storage, and 5 represents high reservoir storage capacity. To produce a national score from 0 to 10, the scores of both indicators were summed up to a maximum score of 10 for each country.

For interannual variability, the modelled data from WRI's Aqueduct Water Risk Atlas geodatabase were re-scaled in intervals from 1 through 5 (Table 26). Interannual variability data were available for 163 of the 186 countries retained in this assessment. Considering that the data for Indicator 10.1 are modelled rather than reported, and to prevent exaggerating the extent of variability in countries with no data, countries without data (19 SIDS plus Eswatini and Palestine) received the value of a nearby country with similar characteristics (e.g., geographically close, of similar size).

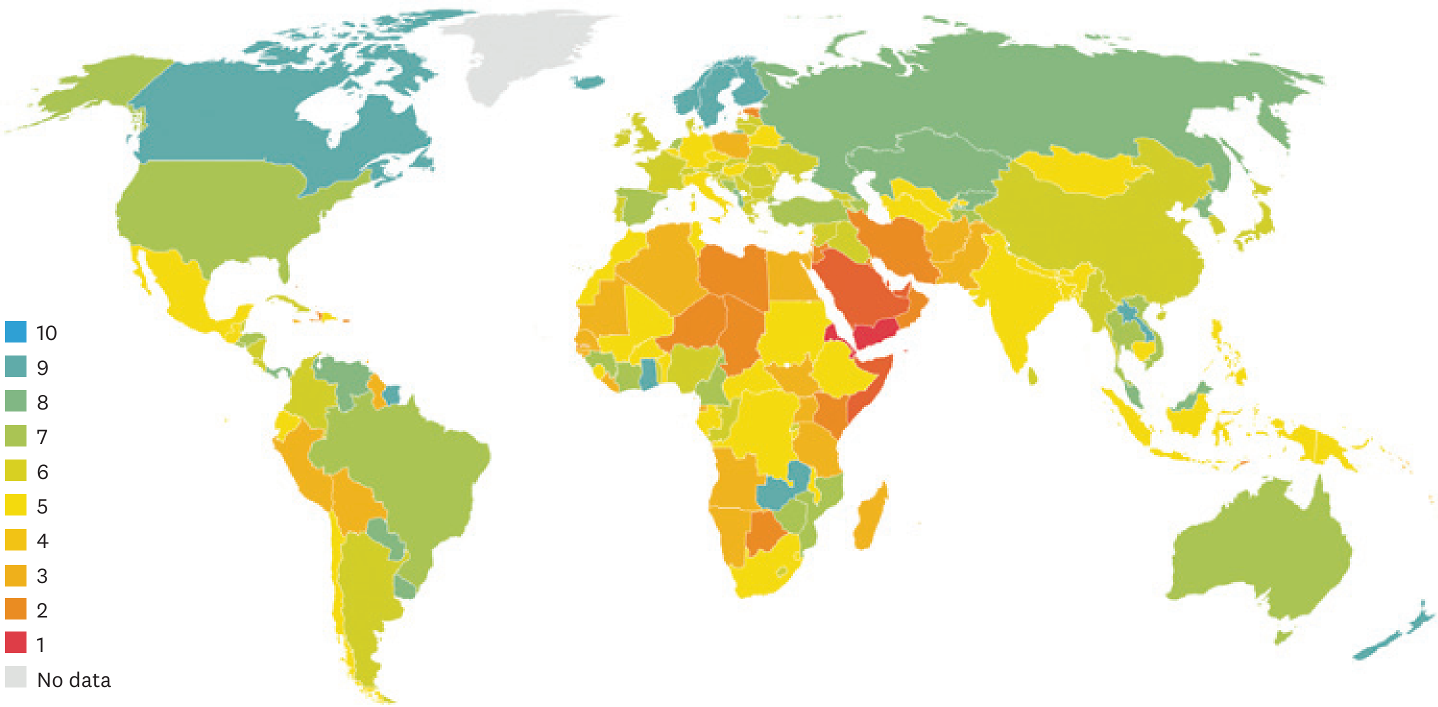
For water storage per capita, the score range (Table 27.) followed the same classification used in the African Water Security Assessment to differentiate levels of storage development across countries (Oluwasanya et al., 2022). Data for this indicator were available for 157 countries, and countries without records of water storage received a score of 0.

National Water Security Rating for Component 10. Water Resource Stability

The distribution of scores for the 186 countries considered in this assessment is illustrated in Figure 12. In total, 29 countries do not have reported water storage, and 95 countries scored 1 or 2, reporting 100-500 m^3 per capita storage. In contrast, 150 countries scored 3 or 4, with a medium and low-medium interannual water variability risk. Eight countries scored 1, classified as having high interannual water variability risk.

Table 28 lists the 20 countries scoring the lowest for water resource stability. Of these countries, Djibouti, Yemen, Eritrea, Somalia, Gambia, and Timor-Leste are classified as LDCs with high interannual water variability risk and either none or little reported water storage per capita. Not surprisingly, six of the lowest-scoring countries are SIDS, with high interannual water variability risk and no reported water storage per capita. The ICOLD database, used to estimate water storage per capita in Indicator 10.2, only includes large dams that are physically infeasible in many small islands. In its current form, indicator 10.2 does not consider water storage types such as lakes, ponds, and tanks and does not include groundwater storage. These features mitigate water variability, and they are not represented in the storage indicator 10.2, so storage is likely to be underestimated in many cases. Future assessments

By Mursal Ali



Map 12. Component 10. Water resource stability measured by modelled interannual freshwater variability (186 countries) and water storage per capita (157 countries).

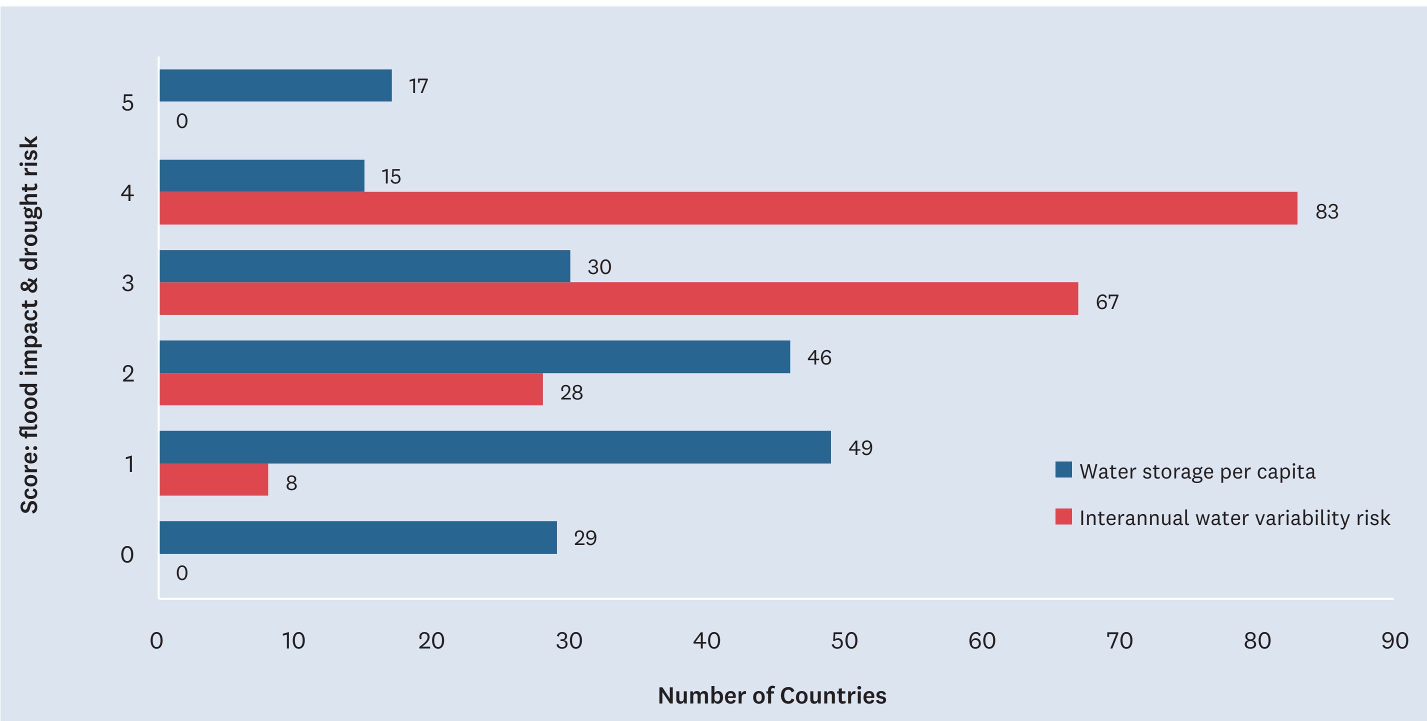


Figure 12. Distribution of 186 country scores for water resource stability measured by modelled interannual freshwater variability and water storage per capita.

should incorporate these other forms of storage. It is also not surprising that many LDCs lack large dam storage due to economic and infrastructure constraints.

The final national scores for water resource stability are in presented Map 12. In this component, no country scored 10 overall. Nine countries scored 9, including Sweden, Zambia, Norway, Iceland, Ghana, Canada, New Zealand, Finland, Laos, and Suriname.

The countries showing the highest interannual water variability with limited water storage per capita are seen throughout Africa, with some exceptions in West and Southern Africa. High variability and low storage also translate into low stability across the Middle East and the Asia-Pacific. Northern Europe and North America, and most of Latin America show low interannual water variability and relatively high large dam water storage per capita, while Southern Europe and Central Asia show higher interannual water variability. The highest regional variation of water resource stability is within Africa. Central Africa, including Cameroon, the Central African Republic, Equatorial Guinea, Gabon, the Republic of Congo, and the Democratic Republic of Congo are more hydrologically stable with low interannual water variability compared to other African countries, which have suffered from consecutive floods and droughts. For instance, between 2018 and 2020, some countries in East Africa witnessed exceptionally high levels of precipitation, resulting in floods and landslides and creating ideal circumstances for devastating crop diseases that ravaged food production and disrupted livelihoods. At the same time, below-average precipitation and temperature anomalies contributed to Somalia, Eritrea, and Djibouti droughts during the same period. Although these events were not captured by the modelled interannual water variability period (1960-2014), countries in East Africa have the lowest scores for water resource stability globally. Djibouti and Eritrea have the highest variability in Africa, closely followed by Somalia, with no or low water storage (Table 28). To assess the impacts of water variability, previous studies associated changes in water resources in the region with migration and conflicts (IOM, 2020; Nelson and Khan, 2021). For instance, the combination of interannual variability in rainfall and water resources in East Africa has been shown to have an important effect on human-ecological systems, leading to large-scale population displacement and creating the potential for conflict. Because this region relies on rainfed agriculture and pastoralism, livelihoods and water security are closely intertwined and influenced by environmental changes and natural disasters that alter local water availability.

Many countries in the Arabian Peninsula, including Yemen, Saudi Arabia, and Oman, also have high interannual variability. These countries are distinguished by high rainfall variability, low renewable groundwater resources, groundwater salinity issues (Odhiambo, 2016), and inexistent or limited water storage. Precipitation in the Arabian Peninsula is low and erratic, and the region's water supplies are especially vulnerable to drought, with groundwater withdrawals for irrigated agriculture exceeding the annual recharge capacity (Turner et al., 2019). In addition, the risks of highly variable water resources are compounded in vulnerable contexts in this region. In Yemen, for instance, scarce freshwater resources aligned with changes in precipitation regimes, population growth, and unsustainable water withdrawals, including for agriculture, have been associated with significant security deterioration and low socioeconomic development (Jafarnia, 2022).

Water variability has also been associated with major environmental and socioeconomic risks in Latin America. Countries in this region are characterized by rapid urbanization, large-scale agriculture, and hydropower that lead to competing water demands and exacerbate the risk of water variability. In Brazil, for instance, excessive freshwater withdrawals for industrial and agricultural use, and the energy sector, have drastically reduced surface freshwater in some regions (World Bank, 2016). However, the country has benefited from relatively high water storage per capita compared with other countries in the region. In Mexico, the risk of freshwater variability is high, given the country's dependence on rainfall for water storage, particularly in agricultural areas. Studies have also highlighted the role of the El Niño Southern Oscillation in exacerbating the impacts of interannual water variability in the region, with El Niño-related droughts often leading to reduced water availability, decreased food security, and economic losses (Canedo-Rosso et al., 2021).

Table 28. Twenty lowest-scoring countries for Component 10. Water resource stability.

	SIDS	LDCs	10.1 Inter-annual variability	10.2 Storage per capita	10. Water resource stability
Djibouti		X	1	0	1
Yemen		X	1	1	1
Eritrea		X	1	1	1
Somalia		X	2	0	2
Qatar			2	0	2
Malta			2	0	2
Bahrain	X		2	0	3
Saudi Arabia			1	1	3
United Arab Emirates			1	1	3
Kenya			2	1	3
Palestine			3	0	3
Kuwait			3	0	3
Oman			2	1	3
Puerto Rico	X		3	0	4
St Kitts and Nevis	X		3	0	4
St Vincent and Grena-dines	X		3	0	4
Gambia		X	3	0	4
Timor-Leste	X	X	3	0	4
Bahamas	X		3	0	4
Botswana			1	2	4

By Amir AghaKouchak

This component indicates the links between water security and water resource stability in different national and regional contexts, but this assessment also highlights that the indicators of water resource stability are largely unavailable or poorly integrated into policy discussions. Hydrological models, such as PCR-GLOBWB 2, can aid in assessing freshwater variability risk by simulating the hydrological cycle. However, the results of such models should be carefully validated against observational data and used with other data sources to understand the complex relationships between water resource stability and sustainable development. This assessment also relied on data from large dams and did not consider other potential mitigation mechanisms, including water allocation, water conservation, and water reuse, which may be employed in developing countries or contexts of high water resource variability. Thus, more indicators are also needed to capture mitigation mechanisms against variability in water resources. Due to its potential implications across all water-related SDGs, water resource stability must also be included in assessments that consider the multiple interlinkages between SDGs. These interlinkages are critical in vulnerable contexts where water resources directly support the livelihoods of community members and where freshwater ecosystems may be at risk of degradation.

National Water Security

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Scoring National Water Security

Each of the 186 countries retained in this global assessment received a final national score, calculated as the sum of the 10 component scores, with the maximum water security score of 100 representing the highest level of national water security. All component scores for the 186 countries are included in Appendix II. The final national scores were classified into four range-based levels of national water security, described in Table 29, and analysed in two ways: (1) by geographic regions (Figure 13, Map 13, and Appendix III); (2) and by income groups (Figure 14).

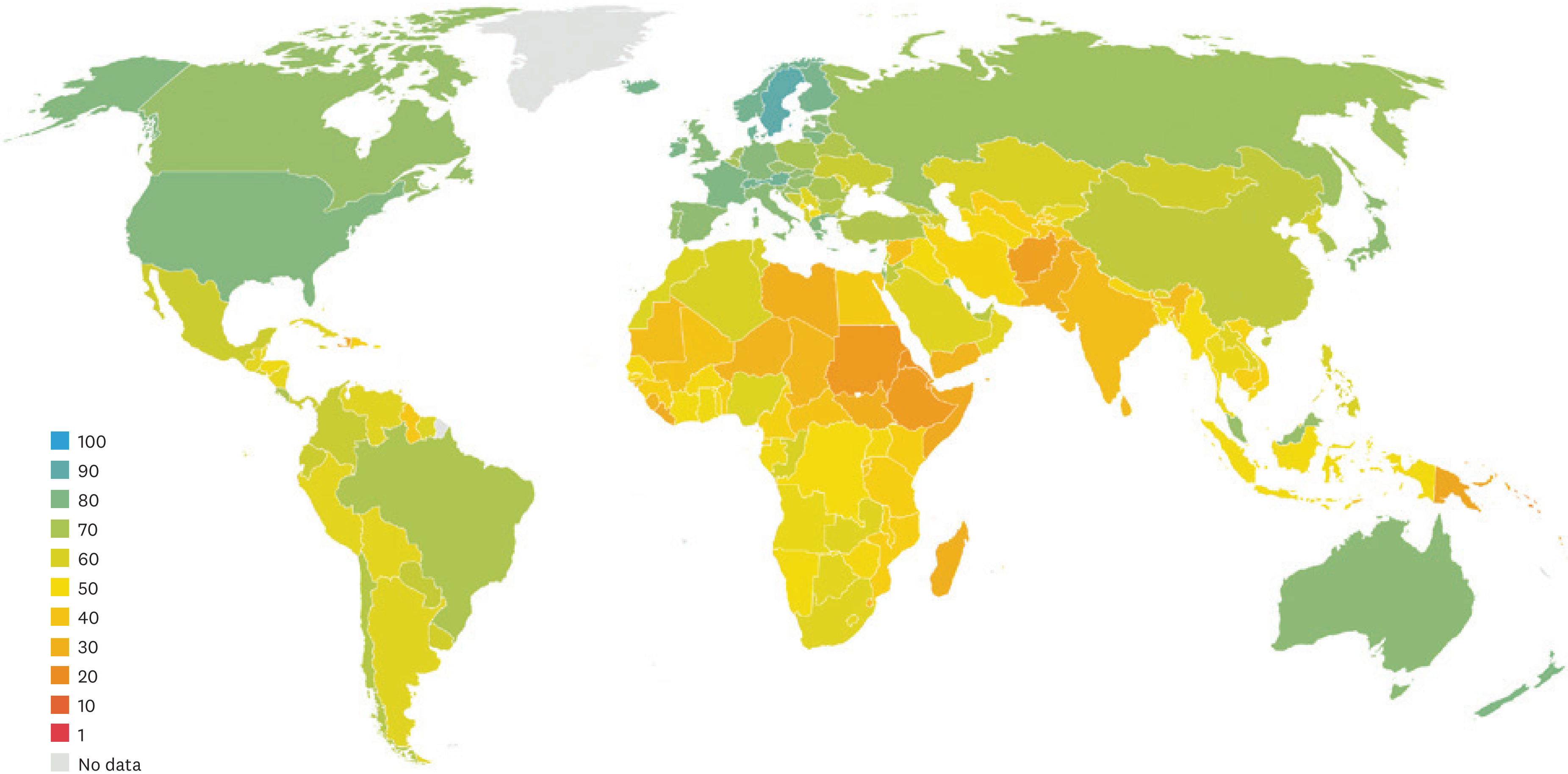
These water security thresholds were determined by groups observed within the frequency distribution of national scores and by the empirical observation that the countries with lower national scores (particularly below 65) displayed a larger variance in their component scores. Countries with low national scores (e.g., Benin, Chad, Djibouti, and Haiti) typically had a range of scores for the different components of water security assessed, such as a score of 1 or 2 for some and 9 or 10 for others. But countries with high national scores (e.g., Sweden, Australia, Denmark, and France) consistently had high scores for all components. This implies that countries with low national scores have not achieved a level of water security in most or all components, with many components receiving low scores. Based on these observations, the water security thresholds were determined empirically by considering that countries cannot be classified as water secure if some or any components received a low score.

The water security thresholds used in this global assessment aim to classify countries according to their performance against all components and have several advantages. Essentially, these thresholds provide a simple means of assessing the relative performance of countries, comparing their current state of water security, and capturing the widespread and cumulative impacts of the components considered in this global assessment across different global regions or income groups. This approach of classifying water security based on country scores is not perfect but is transparent and can be improved in future iterations as the quality and availability of data improve.

Table 29. Water security thresholds based on national score ranges.

National Score Range	Level of Water Security
> = 75	Secure
65 – 74	Moderately secure
41 – 64	Insecure
< = 40	Critically insecure

By USAID Pakistan



Map 13. National water security in 186 countries. Scored 1 to 100, based on 10 components.

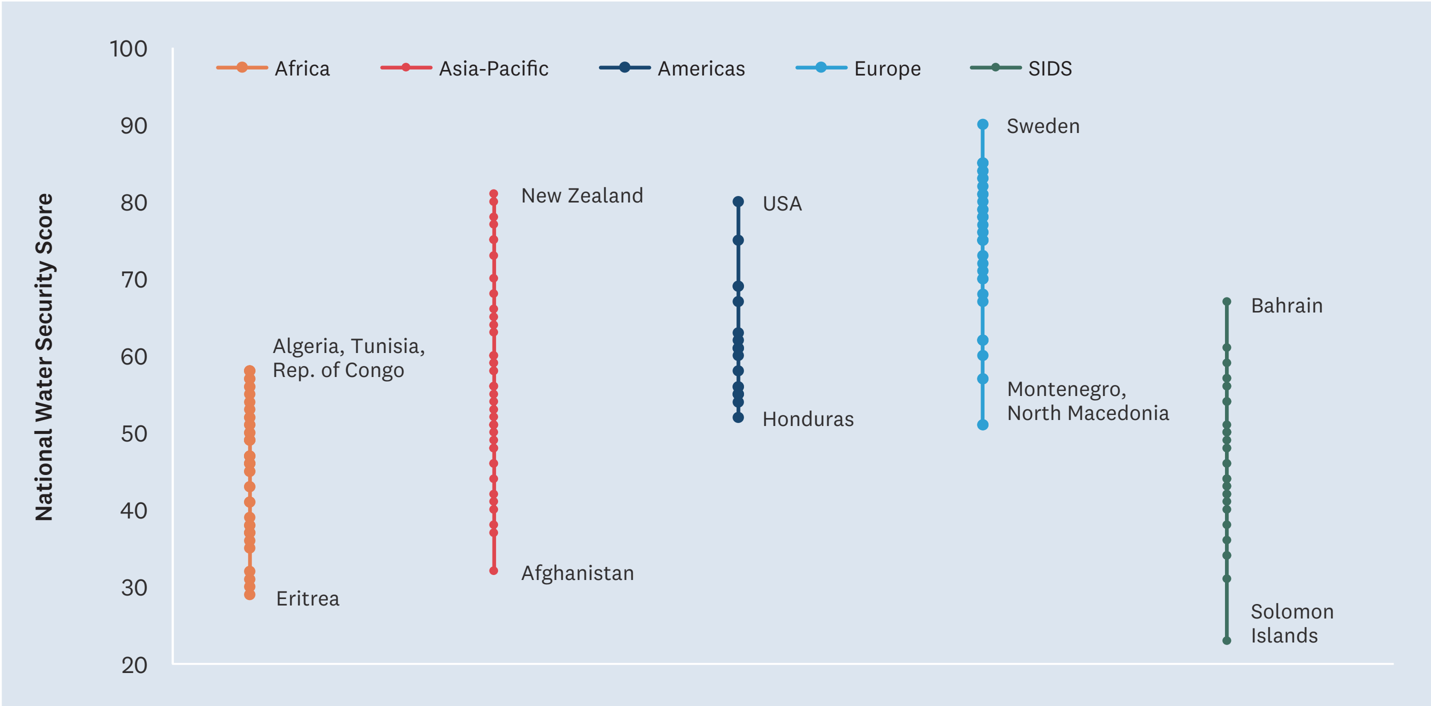


Figure 13. National water security score distribution in 186 countries according to global region.

National Water Security Ranking: Global and Regional

This global assessment of water security, combining all 10 components of water security, shows a range of results (Map 13), with the lowest score attributed to the Solomon Islands (23) and the highest to Sweden (90).

According to these results, about 6.3 billion people live in countries considered critically water insecure or water insecure. Of this amount, 4.3 billion people are in the Asia-Pacific region, 1.4 billion live in Africa, 415 million in the Americas, and 65 million in Europe. People living in moderately water-secure and water-secure countries amount to 1.6 billion people, of which 1.3 billion are in Europe and the Americas. These numbers suggest marked water security trends (Figure 13): the least water-secure countries are in Africa, including the Sahel, the Horn of Africa, parts of West Africa, and South Asia, besides SIDS worldwide. Europe and the Americas are more water secure than other global regions. There are exceptions within the more water-secure regions, with Eastern Europe markedly less secure than Northern Europe and South and Central America considerably less secure than North America.

There are 23 countries with a critical level of water security, scoring 40 or less. This group includes 16 LDCs and 7 SIDS. The group of critically insecure countries includes two countries from the Americas, Haiti (34) and St Kitts and Nevis (36). The group of eight Asia-Pacific countries contains four SIDS, including the lowest-scoring country globally, the Solomon Islands (23), plus Vanuatu (31), Papua New Guinea (34), and Micronesia (38), along with Afghanistan (32), Pakistan (37), Yemen (38), and Sri Lanka (40). The largest regional group in this critical water security category is Africa, with 13 countries scoring 40 or less, including Eritrea (29), Sudan (30), Ethiopia (31), Djibouti (32), Somalia (35), Liberia (36), Libya, Madagascar and South Sudan (37), Niger and Sierra Leone (38), Chad (39), and Comoros (40). While SIDS are home to a relatively small population on a global scale, they have a large presence in this critically water-insecure group and could be considered a stand-alone region. A further 114 countries are classified as water insecure, the largest group of countries identified in this assessment scoring between 41 and 64, out of which 41 are in Africa, 36 in Asia-Pacific, 29 in the Americas, and eight in Europe.

At the opposite end of the national water security classification, 33 countries are considered water secure, scoring 75 or over. This group includes 24 European countries, and 7

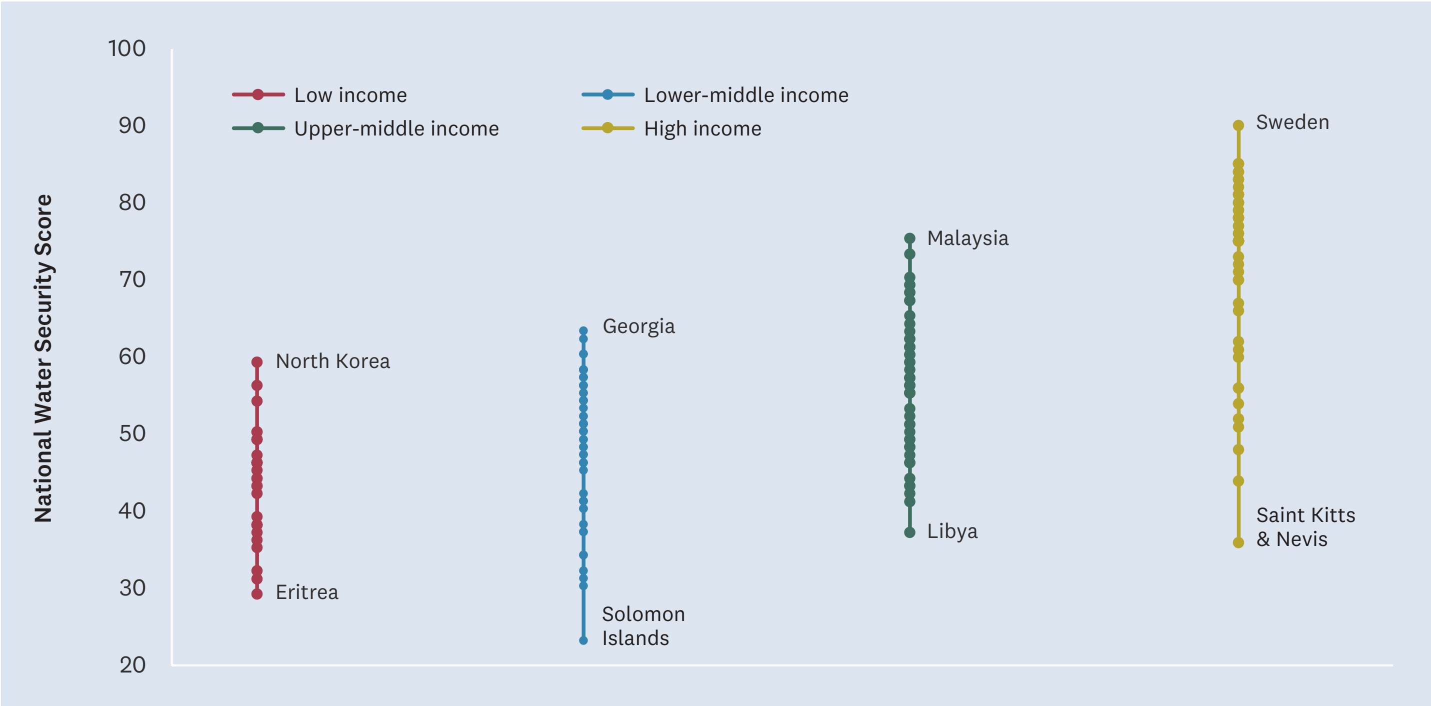


Figure 14. National water security score distribution in 186 countries according to 2020 World Bank income groups.

countries in the Asia-Pacific, Canada, and the USA. Sweden (90) is the only country to score over 85. The 23 other European countries scoring over 75 include Denmark, Luxembourg, and Austria (85), Norway and Switzerland (84), Finland and Iceland (83), Ireland (82), France and Lithuania (81), Greece (80), Germany and UK (79), Estonia, Italy, and Latvia (78), Spain (77), Slovakia and Slovenia (76), Croatia, Czechia, Hungary and Portugal (75). The seven countries in the Asia-Pacific scoring 75 or over are New Zealand (81), Cyprus (80), Australia (78), Japan (77), Israel, Kuwait, and Malaysia (75). Only the USA (80) and Canada (75) make it into the water-secure group of the Americas. The remaining 16 countries are in the moderately secure group, scoring 65 to 74.

By relying on a series of components of water security and in alignment with data collection efforts from water-related SDGs, this global assessment finds that the least water-secure countries are in Africa, the Asia-Pacific, and most of the Americas, among which many are SIDS. Country rankings within these four regions are illustrated in Figure 15 to Figure 18. As the 24 SIDS with sufficient data to generate a national score are numerous in the critical category and spread across three of the four global regions, they are plotted within their regional rankings and as a stand-alone group in Figure 19.

Each global region faces water security challenges. Many countries with naturally high freshwater endowments have yet to overcome the challenges of providing adequate infrastructure for WASH services (Components 1 and 2), resulting in high WASH-attributed mortality rates (Component 3). Countries with rapidly developing economies may have water treatment facilities that lag behind population and industrial growth, further limiting freshwater of acceptable quality (Component 4). Countries facing water shortages may have over-used limited renewable freshwater resources (Component 5) and, where faced with highly variable water resources from year to year, have yet to develop adequate water storage (Component 10). Alternately, water-rich countries may have agricultural-based economies that put a low economic value on the water used to produce crops. Or they may be water-scarce countries with economies that put a high value on water used for services or products (Component 6). These challenges are compounded when countries have yet to establish good-governance mechanisms (Component 7). And all countries, regardless of infrastructure and economic development, face water disasters that can severely affect human life (Component 8) and cause significant loss and damage (Component 9). When combined, these challenges can have a multiplier effect, which is illustrated to some effect in the regional charts below.

None of the 54 African countries assessed (Figure 15) scored 65 or over and are therefore all classified as water insecure. The drivers of this insecurity are evident in the individual components. Many African countries score highly (9 or 10) for water availability (Component 5), including 31 of the 41 countries in the water-insecure group. This may indicate that large portions of renewable freshwater resources are untapped, but half (26) African countries have low scores for water value (Component 6), with agriculture-dominated economies placing a relatively low value (10 USD/m^3 or less) on water used. This component could be somewhat undervalued, where agriculture is commonly dominated by rainfed production, as this is not included in the SDG indicator 6.4.1 valuation. There are high-scoring African countries in this component of water security, primarily where major oil and mineral exporters score 8 or over for water value (equivalent to 60 USD/m^3 or over), including Angola (10), Botswana (8), Gabon (9), and Republic of Congo (9). Some African SIDS score 8 or over in this component, where a high value is attributed to water used in the service sector, including Seychelles (9), Comoros (8), and Cabo Verde (7).

Water availability and the limited cases of high water value do not translate into water security in the WASH sector and water quality in Africa. Only 21 countries report some level of safely managed drinking water, the SDG target, but amongst this group, only Algeria, Morocco, and Tunisia reported basic drinking water levels at over 90% national coverage. The remaining 33 countries could only receive a score based on national coverage of basic drinking water services, scoring a maximum of 5. Amongst this group, Botswana, Egypt, Libya, Mauritius, and South Africa reported over 90% coverage of basic drinking water services. The situation for sanitation is similar: 26 countries reported on the SDG target of safely managed sanitation, but in that group, only Egypt, Libya, and Tunisia reported over 90% coverage of sanitation services. Of the 28 countries that reported only basic sanitation coverage, the Seychelles reported 100% basic coverage and 35 countries reported less than 50%. This low level of safe WASH coverage translates into a very high burden of disease. Libya has the lowest estimated deaths due to unsafe WASH, still high at over 2 deaths per 100,000 people in 2019. Algeria, Egypt, Mauritius, Morocco, Seychelles, and Tunisia has estimated WASH-attributed mortality rates between 3 and 8 deaths/100,000 people in 2019, and the remaining 47 countries in Africa had estimated WASH-attributed mortality rates of between 8 to 50 deaths/100,000 people and 15 countries had high rates between 50 and 108 deaths/100,000 (Lesotho). Domestic wastewater treatment, the only global water quality data set available to assess SDG target 6.3.1, is also low in Africa. Only Algeria, South Africa, and Tunisia score 6 or over, with 76%, 61%, and close to 60% treatment, respectively, followed by Egypt (45%), Nigeria (48%), and Seychelles (almost 50%). The remaining 48 countries all have low levels of household wastewater treatment well below 40% of effluent produced.

Countries in the Americas host vast freshwater reserves and primarily benefit from high water availability (Component 5), although challenges exist particularly in SIDS, such as Puerto Rico (51), the Dominican Republic (46), Barbados (44), and St. Kitts and Nevis (36). National water security scores in the region were impacted by low levels of safely managed drinking water and sanitation services (Components 1 and 2), affecting 21 out of 36 countries in the region, including SIDS such as Antigua and Barbuda (56), Bahamas (48), St. Lucia (46), Barbados (44), St. Vincent and the Grenadines (42), and St. Kitts and Nevis (36), as well as Colombia (62), Uruguay (60) and Bolivia (55). National mortality rates attributed to unsafe WASH services (Component 3) also contribute to lowering water security levels in the region, affecting 27 countries in the region, including countries such as Mexico (61), Ecuador (61), and Argentina (56). Lack of adequate water treatment (Component 4) is another critical driver of water insecurity in the region, affecting 31 of 36 countries. Haiti (34) has the lowest score despite low water stress due to its poor performance in assuring adequate access to water and sanitation services, water treatment and water management, and the economic impacts of water disasters. Countries classified as moderately water secure and water secure include the USA (80), Canada (75), Brazil (69), Costa Rica (69), and Chile (67).

Within the Asia-Pacific, eight countries, including 4 SIDS and 3 LDCs, have critical levels of water security from a global total of 23 critical countries. The Solomon Islands (23) received the lowest score globally, followed by Vanuatu (31), Afghanistan (32), Papua New Guinea (34), Pakistan (37), Micronesia (38), Yemen (38), and Sri Lanka (40). These lowest-scoring countries in the region are affected by low levels of water availability and high levels of water variability, besides inadequate drinking water and sanitation, water treatment, and water management. Countries in Asia-Pacific increasingly face the challenge of providing access to safely managed drinking water and sanitation services (Components 1 and 2) for a rapidly growing population. This challenge impacts 27 out of 57 countries in the region, including Azerbaijan (60), Bangladesh (51), Cambodia (46), Afghanistan (32), and SIDS, including Fiji (57), the Maldives (49), and Micronesia (38). High mortality rates attributed to unsafe WASH services (Component 3) are also driving water insecurity in the region, impacting staggering 52 countries, including Thailand (53), Myanmar (50), Nepal (48), and Yemen (38). Water variability (Component 10) is another key driver, affecting 45 countries in the region, including countries such as Japan (77), China (64), and most countries in the Middle East and Central Asia. The economic impact of floods (Component 9) is the major regional marker of water insecurity, affecting a staggering 47 out of 57 countries in the region, compared with 23 countries affected by droughts. Countries categorised as moderately water secure, and water secure include several arid countries with energy-intensive desalination facilities and complex management systems, such as Israel (75), Kuwait (75), and Qatar (73), as well as New Zealand (81), Australia (78), Japan (77), Malaysia (75), Republic of Korea (70), and Turkey (68).

Europe is the most water-secure region, with 24 of the 33 countries considered water secure globally, seven countries classified as moderately water secure but also eight countries classified as water insecure. The most water-secure countries worldwide are Sweden (90), followed by Austria (85) and Denmark (85). These countries achieved high scores for most components despite the potential impacts of water-related disasters (Component 9) and water variability (Component 10). The other European countries with high levels of water security are Luxembourg (85), Norway and Switzerland (84), Finland and Iceland (83), Ireland (82), France and Lithuania (81), Greece (80), Germany and the United Kingdom (79), Estonia, Italy and Latvia (78), Spain (77), Slovakia and Slovenia (76), Croatia, Czechia, Hungary and Portugal (75). The high levels of water security are supported by high (but not universal) access to safely managed drinking water and sanitation services (Components 1 and 2) and low WASH-attributed mortality rates (Component 3), adequate water treatment (Component 4), high water values (Component 6) and high levels of water governance (Component 7).

The eight European countries classified as water insecure include Bosnia Herzegovina, Malta, and Ukraine (62), Albania (60), Moldova and Serbia (57), Montenegro, and North Macedonia (51). All eight countries score low (maximum score of 3) for water disaster loss and damage (Component 9), and are also affected by water quality (Component 4) with household water treatment rates below 50%, scoring 5 or lower (Albania, 13%, Bosnia Herzegovina 47%, Malta 15%, Montenegro 45%, North Macedonia 9%, Moldova 38%, Serbia 27%, and Ukraine 34%). Albania, Moldova, Serbia, and Ukraine score low for water value (Component 6), with estimated water values lower than 10 USD/m^3. Malta scores only 1 for water availability (Component 5) with a high level of water stress, using about 125% of renewable freshwater available annually. Several other countries in the region also demonstrate that low water availability can be a driver of water insecurity in Europe, affecting countries such as Spain (77), Belgium (71), and Bulgaria (67).

The natural physical characteristics of islands limit SIDS's access to freshwater resources, not least their ability to receive water from neighbouring countries except Singapore (Component 7). And while historically vulnerable to water disasters caused by tropical storms, they are also severely affected by the effects of climate change. Not surprisingly, therefore, the SIDS group includes many of the lowest national water security scores, including the Solomon Islands (23), Vanuatu (31), Papua New Guinea, and Haiti (34). These countries are significantly impacted by low levels of access to safely managed drinking water and sanitation services (Components 1 and 2), high rates of WASH-attributed mortality (Component 3), low water quality (Component 4), and low levels of water governance (Component 7). As formulated in SDG Indicator 6.4.2, water availability (Component 5) does not appear to be a major limitation in the 34 SIDS assessed. There is a high range in Component 5 scores with 12 SIDS scoring 5 or less but the remaining 22 scoring 8 or higher with no evident stress on water resources and several islands in the Caribbean and Africa showing high levels of water availability. However, this component of water security contrasts with the fact that most SIDS face high interannual variability and low storage per capita to mitigate variability (Component 10). Bahrain (67) and Singapore (61) achieved the highest scores among SIDS, marked mainly by higher rates of access to safely managed drinking water and sanitation services (Components 1 and 2), low WASH-attributed mortality rates (Component 3), adequate water quality (Component 4), despite facing stress from low water availability (Component 5) and potentially high exposure to water disaster loss and damage (Component 9).

Given the multiple water security challenges faced by SIDS, particularly those SIDS identified as LDCs, they should prioritize water development and water security investment.

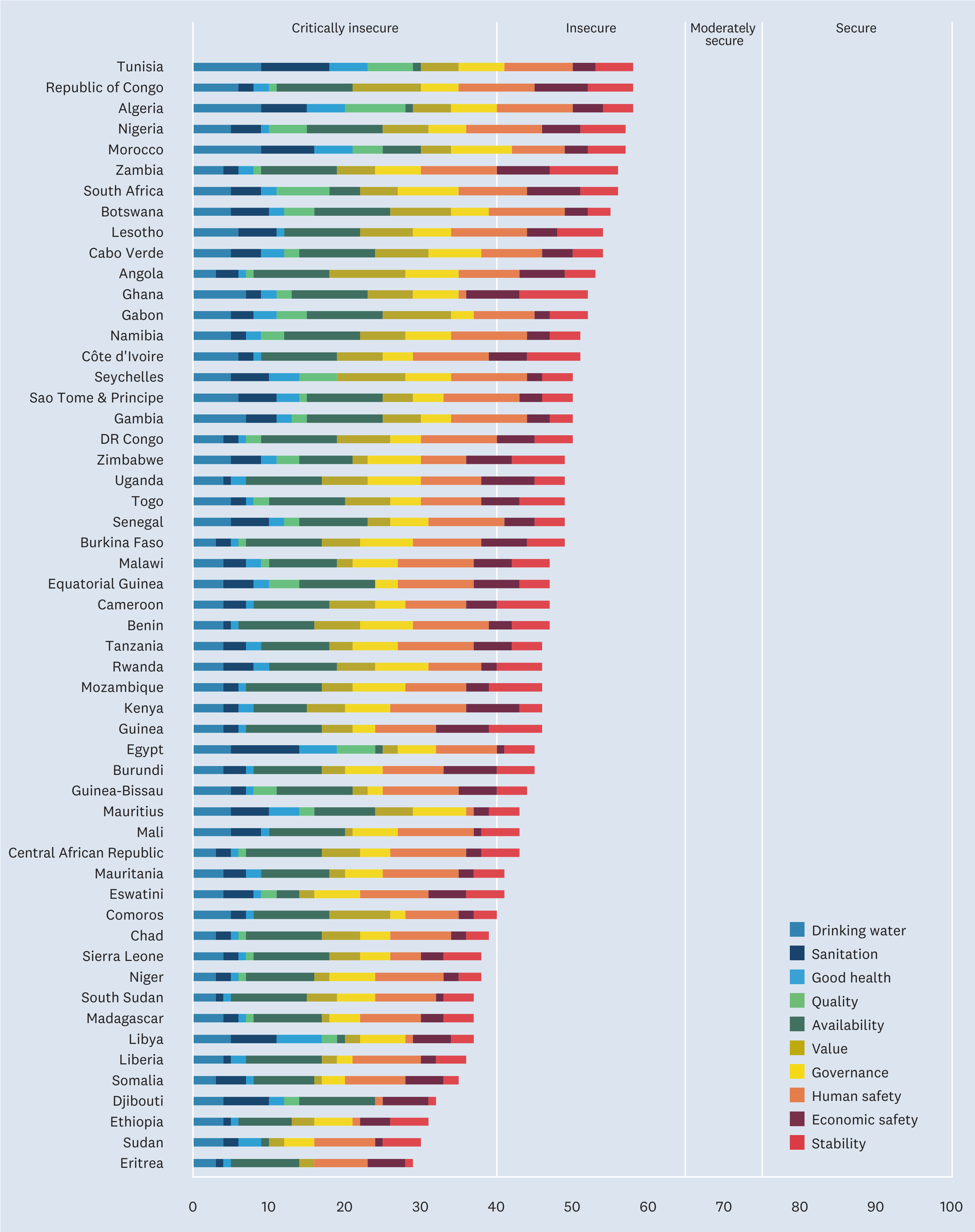


Figure 15. National water security scores ranked for the African region. Scored by 10 components.

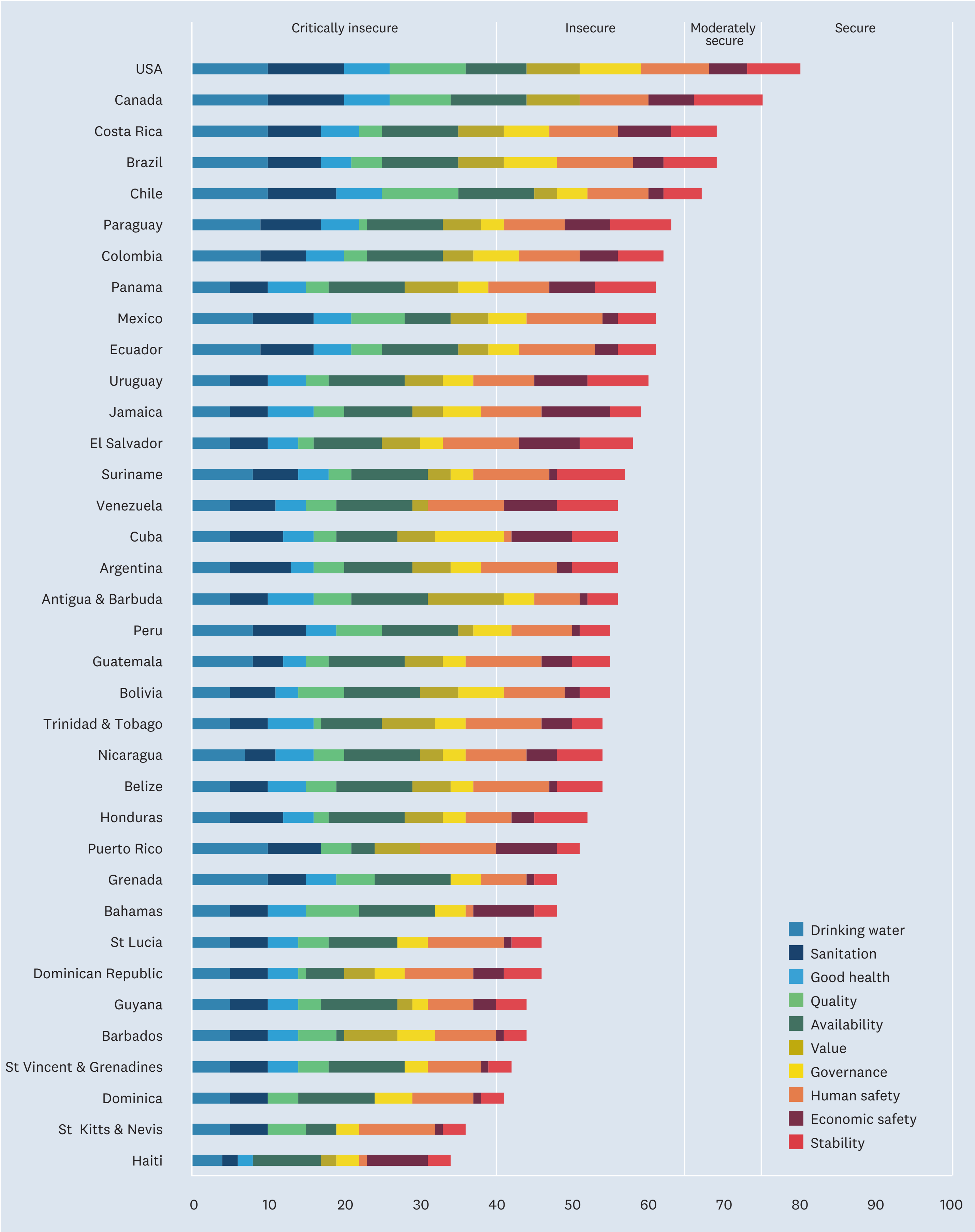


Figure 16. National water security scores ranked for the Americas. Scored by 10 components.

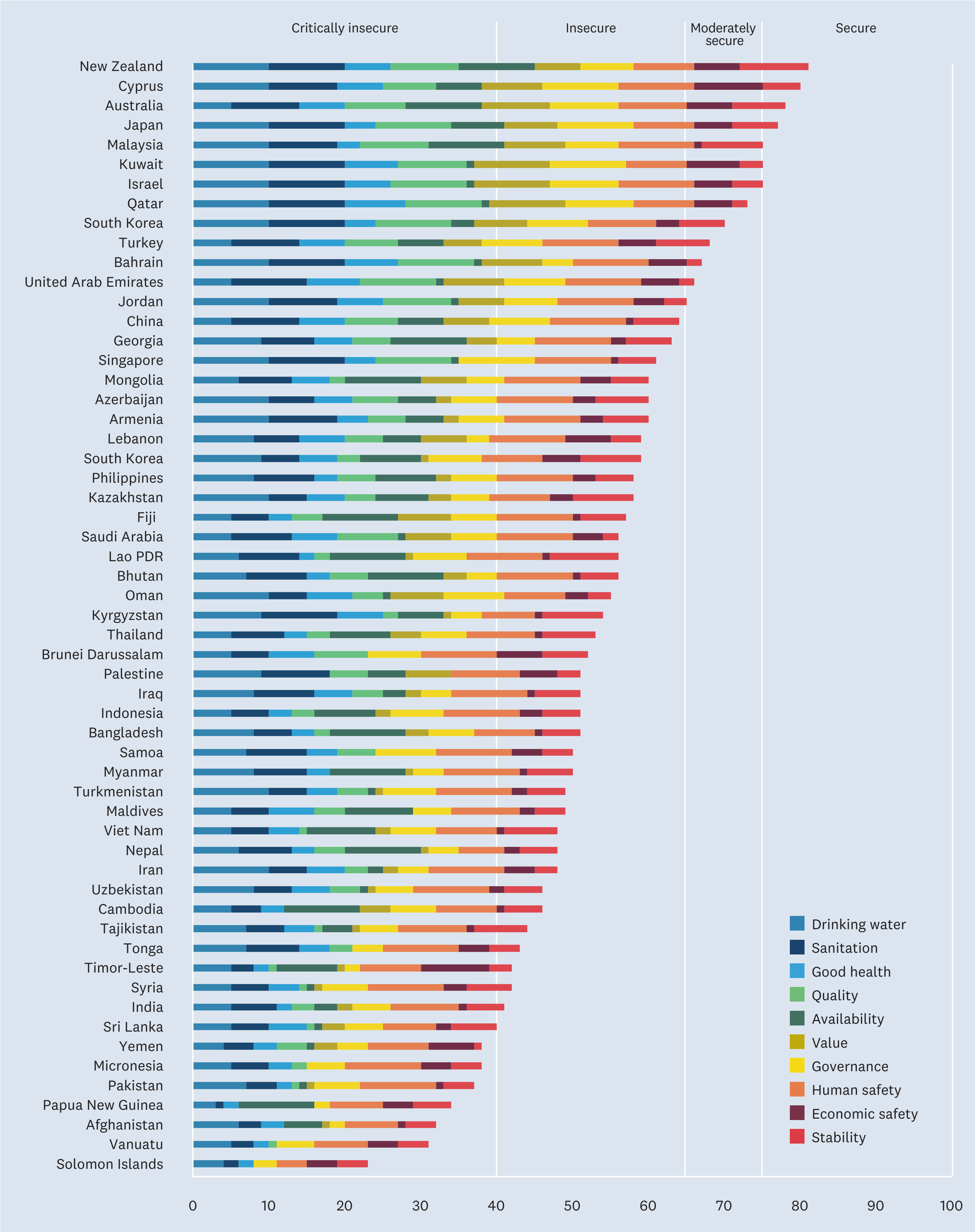


Figure 17. National water security scores ranked for the Asia-Pacific. Scored by 10 components.

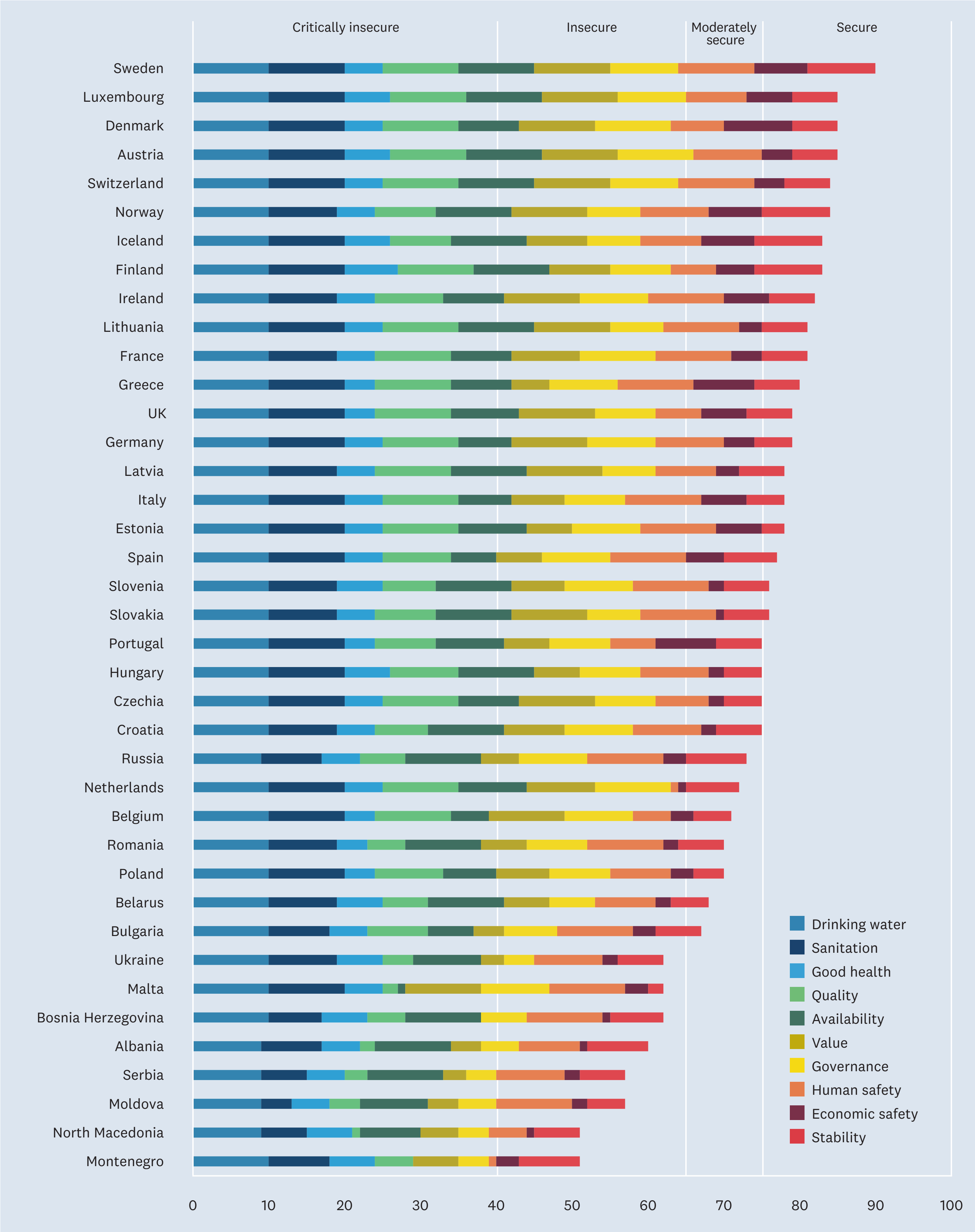


Figure 18. National water security scores ranked for Europe. Scored by 10 components.

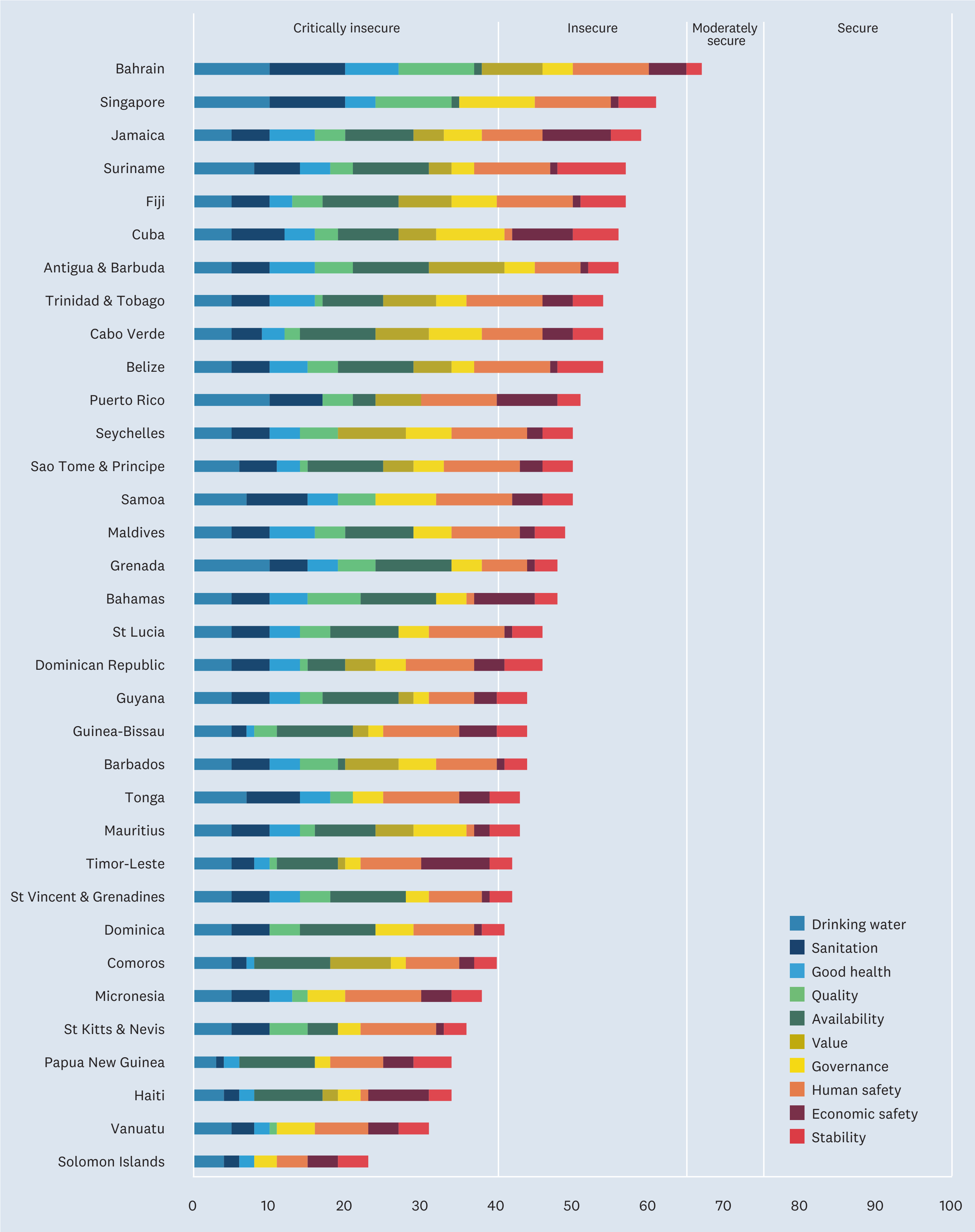


Figure 19. National water security scores ranked for SIDS globally. Scored by 10 components.

National Water Security Ranking: Income groups

When analysing national scores according to the World Bank's 2020 income groups, closest to the data-year, this global assessment reveals that all low-income (GNI per capita of USD1,085 or less) and lower-middle income (GNI per capita of USD1,036 to USD4,045) countries were either categorized as critically insecure or insecure. The group of upper-middle-income (GNI per capita of USD4,046 to USD12,535) countries has 39 countries categorized as critically insecure or insecure and nine as moderately secure or secure. Among high-income countries (GNI per capita of >USD12,535), 39 are categorized as moderately secure or secure and 11 as critically insecure or insecure.

Two important trends can be observed in this assessment. The first trend shows that all income groups have a large range of national scores, illustrated in Figure 14. Amongst lower-middle-income countries, for instance, the Solomon Islands scored 23 (critically insecure), and Georgia scored 63 (insecure), and among upper-middle-income countries, Libya scored 37 (critically insecure), while Malaysia scored 75 (moderately secure). To explain the range of national scores within income groups, further studies should look into the development trajectories of countries to better understand to which extent countries can support water security regardless of economic constraints by supporting IWRM implementation and disaster risk reduction strategies (including nature-based solutions) in national policies and programming. Further research should also assess the political, institutional, and environmental factors with the greatest influence on a country's higher score than others within the same income group so these mechanisms can be targeted and strengthened.

The second trend is more complicated, and the determinants are less noticeable. When analyzing per capita GNI against water security scores, there is no apparent relationship between the wealth of a country and its population and the national level of water security (Appendix III). Countries categorized as low-income, lower-middle, or upper-middle income (per capita GNI below USD12,535 according to the World Bank's 2020 categories) show a similar distribution, with overlapping ranges in national scores, most or all of them being considered critically insecure or insecure. This trend is also shown in the comparison of national water security scores and GNI per capita (Figure 14).

This observation suggests that while national income level is an important factor often linked to the capacity of countries to fund their critical water infrastructure and hence assure a high score against water security components, it is not the only determining factor for a country's water security. For example, the Democratic Republic of the Congo (low income), Nepal (lower-middle income), Viet Nam (upper-middle income), and the Bahamas (High income) are all classified as water insecure with similar scores between 48 and 51 despite different GNI per capita. Further research is thus needed to better understand the underlying role and impact of national income and each component considered in this global assessment.

By Amma, UNICEF

Addressing Data Limitations to Advance Water Security

By Noyan Yilmaz, Shutterstock

Table 30. Summary of data limitation across 10 components of water security assessed.

Component	Data and major methodological limitations
1. Drinking water	• 2020 data on safely managed drinking water services (SDG indicator 6.1.1) were missing for 76 of the 186 countries considered in this assessment, including 33 in Africa, 22 in the Americas, 20 in the Asia-Pacific, and one in Europe. • The 13 countries missing data on basic drinking water services in 2020 include seven countries in the Americas, 4 in Africa, 1 in Asia, and one in Europe.
2. Sanitation	• 2020 data for safely managed sanitation (SDG indicator 6.1.2) were missing for 74 of 186 countries, including 28 in Africa, 20 in the Americas, seven in the Asia-Pacific, and one in Europe. • 16 countries had no data for basic sanitation services in 2020, including 4 in Africa, 8 in the Americas, and 4 in the Asia-Pacific.
3. Good health	• No major limitations data estimated by WHO available for all 186 countries.
4. Water quality	• Data on the proportion of domestic wastewater flows safely treated (SDG indicator 6.3.1) were available for 128 countries in 2020, representing about 81% of the global population. Missing values are substituted from a published research study. • The estimates of household wastewater treatment are reported as 2020, though components of the calculation are derived from multiple years of data. • In 2020, national data on industrial wastewater treatment proportions was available for only 14 countries in 2015. Therefore, this assessment did not include the proportion of industrial wastewater flows safely treated.
5. Water availability **and** **6. Water value**	• According to the FAO methodology, renewable freshwater resources, including surface and groundwater and environmental flows reported as 2017 estimates, are considered constant over time. This is not the case due to changing hydrological features, not least the interannual water variability and climate change. • The assessment of water stress (SDG indicator 6.4.2) may not be appropriate in contexts where reported water withdrawals do not account for all economic activities, such as areas reliant on rainfed agriculture. • Most SIDS lack some or all water resource data in the FAO data set and this major limitation contributed to excluding 24 SIDS from this assessment. • Many countries from the Arabian Peninsula and the Middle East rely on large desalination infrastructures not considered by the methodology to estimate water availability.
7. Water governance	• No major limitations, no data reported for six countries in 2020.
8. Human safety	• 140 countries have records for deaths and missing persons in the Sendai database for the 2016-2020 period, but it is not possible to disaggregate deaths from water disasters from the total figure for all disasters such as earthquakes. • Values included could not be reconciled with data from other sources, including national records, research sources, and earlier versions of the global data set.
9. Economic safety	• For the 2016-2020 period, since the start of SDG monitoring, approximately 150 countries do not have economic impact data of disasters in the UNDRR or SDG data platforms. • UNDRR or SDG data platforms do not distinguish water-related disaster data from other disasters, making it impossible to derive meaningful statistics on the economic impact of water-related disasters at the national level. • Other important sources of disaster impact data, including reinsurance databases, were offline and unavailable at the time of this study.
10. Water resource stability	• Limited ground-based observations make assessing changes in water resource stability at the global scale exceedingly difficult. • Modelled interannual water variability data relies on various assumptions that can affect the model's ability to accurately inform this global water security assessment. • Water storage indicator data available only account for reservoirs contained by large dams. Other types of storage, such as small dams, lakes, ponds, and aquifers, could not be included at this time due to a lack of data globally consistent data. This undoubtedly results in an underestimation of storage.

By Bergwitz, Shutterstock

This global assessment aims to provide a comprehensive outlook of the water security status of 186 countries, based primarily on the SDG 6 indicator data available in 2022 and early 2023. This aim was largely constrained by data limitations found across all critical components, even in those components based on SDG 6 indicators with established methodologies and data collection mechanisms. Measurement of some components also instigated discussions on the suitability of data available to represent critical aspects of water security. Table 30 summarises the data and methodological limitations experienced in this assessment.

To address these data and methodological limitations, this global assessment adopted a range of approaches described in the component chapters. Although not ideal for all cases, these approaches allowed us to include countries commonly excluded from comprehensive global studies, including many LDCs and SIDS. In some cases, however, data availability was still the main constraint for assessing water security at the national level. Besides data availability, this global assessment also faced other limitations. Many components with complex interlinkages are condensed into one score, which might not capture the full range of different aspects of water security at other levels.

Ultimately, this report brings analytical clarity and evidence to support the understanding of water security from a global perspective, but much more needs to be done to fill data gaps and strengthen the evidence on water security. Robust data collection and monitoring systems are also a critical aspect of water security (Component 7), and countries can use the existing IWRM framework and efforts led by United Nations Custodian Agencies to strengthen and expand their data collection systems. Additionally, local participatory efforts are needed to address the concerns of vulnerable communities, such as human displacement and access to unconventional water resources not included in this water security assessment.

Conclusions: Building a Water-Secure World

By Liz Loh-Taylor, OCHA

By Warren Parker, Shutterstock

With the adoption of the 2030 Agenda for Sustainable Development, United Nations Members States embraced a long overdue goal of achieving universal and equitable access to safe drinking water and sanitation services by 2030 and reducing untreated wastewater and substantially increasing water recycling and safe reuse, improving water-use efficiency across all sectors to ensure sustainable withdrawals and freshwater supply, implementing integrated water resources management at all levels, and protecting and restoring freshwater ecosystems that support biodiversity, livelihoods, and economic activities. These global ambitions, embodied in Sustainable Development Goal 6, represented an unprecedented step forward in building a water-secure world.

In this context, this global assessment attempts to characterize water security status in 186 countries, with sufficient data to apply SDG-defined indicators while considering their limitations and the opportunities for improvement as countries carry on with their national data collection efforts. This global assessment gives a clear picture of national water security status and illustrates regional and economic trends. Halfway into the Water Action Decade and Agenda 2030, this global assessment also renews the discussion on water security by explicitly linking critical aspects of SDG 6 with components of SDGs 1 (no poverty), 3 (good health and well-being), 11 (sustainable cities and communities) and 13 (climate action). The evidence is clear that significant progress is needed and can be achieved in the remaining years, even in contexts where water resources are not abundantly available and financial resources or institutional capacity do not match those of countries considered water secure.

This global assessment allows countries to visualize what it means to be water secure with WASH services as the foundation of development, alongside water resource management to balance demands, quality, and quantity, and the threats posed by water-disasters. The assessment considered these components as essential to assuring that any progress made against Sustainable Development Goal 6 will have a better chance of withstanding the impacts of climate change, economic crisis, and geopolitical instability. Using the best available data, the components assessed here translate into what it takes to be water secure in rapidly changing global, national, and local contexts. To achieve this task, this global assessment gathered and analysed numerous datasets to include as many countries as possible for all 10 components. The assessment provides a benchmark for the status of the ten water security components in 186 countries with a total population of almost 7.78 billion people in 2020, as close to the present (2023) as data is available. The water security status compared between countries and across global regions and income groups reveals that:

- In 2020, 6.13 billion people were living in critically water-insecure or water-insecure countries, including 4.31 billion people in the Asia-Pacific region, 1.34 billion in Africa, 415 million in the Americas, and almost million people in Europe.
- In 2020, 1.65 billion people were living in moderately water-secure and water-secure countries, including 1.28 billion in Europe and the Americas.
- The least water-secure regions are Africa, including the Sahel, the Horn of Africa, parts of West Africa, and South Asia, besides Small Island Developing States (SIDS). Europe and the Americas are more water secure than other global regions. Eastern Europe is markedly less secure than Northern Europe, and South and Central America are less secure than North America.
- Twenty-three countries are assessed as having critically low levels of water security, including 16 Least Developed Countries (LDCs) and seven SIDS including, the Solomon Islands, Eritrea, Sudan, Ethiopia, Vanuatu, Afghanistan, Djibouti, Haiti, Papua New Guinea, Somalia, Liberia, St Kitts and Nevis, Libya, Madagascar, Pakistan, South Sudan, Micronesia, Niger, Sierra Leone, Yemen, Chad, Comoros, and Sri Lanka. These countries are marked by low levels of access to safe drinking water and sanitation services, high WASH-attributable mortality rates, water depletion, contaminated and scarce supplies of freshwater, high exposure to droughts and floods, and low levels of integrated water resources management implementation.
- Of the 7.78 billion people living in the 186 countries assessed in 2020, over 10% (close to 800 million) did not have access to even basic drinking water, and over 70% (close to 5.5 billion) did not have access to a safe drinking water service (SDG 6.1 target).
- Almost 31% of people (over 411 million) in 54 African countries, including 33 LDCs and 6 SIDS, with a total population of 1.34 billion, did not have access to even basic drinking water services. Almost 15% of people (>196 million) in Africa did have access to safe drinking water, meeting the SDG 6.1 target, but over 85% of people (1.14 billion) did not meet this target. Almost 96% of people (close to 980 million) in the 36 countries assessed in the Americas, including 17 SIDS, had access to basic drinking water, while over 4% of people (41 million) still do not. Almost 70% of people (708 million) have access to safe drinking water, and just over 30% do not (>313 million). In the 57 Asia-Pacific countries assessed, including 11 SIDS and 10 LDCs, almost 93% of people (4.35 billion) had access to basic drinking water, and around 7% (almost 334 million) had no basic drinking water service. Over 15% of people (almost 725 million) had access to safe drinking water, but a staggering 85.5%, almost 4 billion people, did not have access to a safely managed drinking water service. In the 39 European countries assessed, 98.5% of people had access to basic drinking water, and almost 92% had access to safe drinking water. That means that over 11.6 million people (1.5%) in Europe do not have access to basic drinking water, and over 60 million (8%) do not have access to safely managed drinking water.
- Over 22% (1.71 billion) of the 7.78 billion people assessed in 2020 did not have access to even basic sanitation, and over 53% (4.12 billion) did not have access to a safely managed sanitation service in 2020.
- Of the 54 African countries assessed in 2020 (total population of 1.34 billion), over 58% of people (almost 780 million) had no access to basic sanitation services. Only 18% (>238 million) had access to safe sanitation services, meeting the SDG 6.2 target, but over 82% (1.1 billion) did not meet this target and still live without access to a safely managed sanitation service. Five countries in North Africa (Algeria, Egypt, Libya, Morocco, and Tunisia) had higher rates of access and progress to achieving the SDG target, with rates of basic sanitation from 67% to 97% and safely managed 22% to 81%. In 36 countries in the Americas, including 17 SIDS with a total population of 1.02 billion, close to 8% (41 million) do not have access to basic sanitation and 40% (>408 million) do not have access to basic sanitation. In the 57 Asia-Pacific countries, including 11 SIDS and 10 LDCs, with a total population of over 4.67 billion, over 17% (almost 334 million) had no basic sanitation service. Over 47% (almost 2.2 billion) had access to safe sanitation. Of the 39 European countries assessed, with a total population of over 747 million people, 3.6% (almost 27 million people) did not have access to basic sanitation services and over 8% (136 million people) did not have access to safely managed sanitation, failing to meet the SDG 6.2 target.
- Far more people die globally from a lack of safe drinking water, sanitation, and basic hygiene services than die from water disasters and are more likely to live in Africa and Asia. This situation is not improving. In 2019, 164 countries assessed had increased rates of WASH-attributed mortality compared to 2016 WHO estimates. In Africa, 25 countries were severely affected by deaths attributed to unsafe WASH, with an

estimated annual mortality rate of over 40 deaths per 100,000 people. Twenty countries in Asia-Pacific had mortality rates between 10 and 40 people per 100,000. Clearly, the world is far from achieving SDG Target 3.9 to substantially reduce the number of deaths and illnesses from unsafe WASH.

- Water quality could not be assessed as defined in SDG 6 (for Indicator 6.3.1 domestic and industrial flows or Indicator 6.3.2 ambient water quality of water bodies) due to insufficient quality halfway through the SDG period. Domestic wastewater treatment was assessed by WHO using household sanitation statistics and remains very poor (below 30% treatment) in Africa, and large parts of Asia-Pacific and poor (below 50%) in most countries in South America, with exceptions in all regions. It is a major failure that halfway into the SDG period, industrial water treatment data were only available for 14 countries in 2015, and data on the ambient water quality of water bodies were only available for 20 countries from 2017.

- Water availability does not necessarily result in water security. Many countries with abundant fresh water in Africa, Asia-Pacific, and the Americas have reported low levels of access to drinking water and sanitation services, inadequate water treatment, and high rates of WASH-related deaths. Some arid countries in North Africa and the Middle East rely on intensive water resource management mechanisms and desalination infrastructure to fulfil their water needs and support water resource stability.

- High levels of water value also do not always translate into water security. For instance, in many national economies dominated by petroleum and mining activities, high economic values placed on water used by the sector can be attributed to industrial outputs rather than robust water management mechanisms. Revenues from these sectors do not appear to translate into delivery of safely managed drinking water and sanitation services or decreasing rates of WASH-attributed mortality.

- While the national income level measured by Gross National Income (GNI) is often linked to the capacity of countries to fund their critical water infrastructure, it is not the only determining factor for a country's water security. For example, the Democratic Republic of the Congo (low income), Nepal (lower-middle income), Viet Nam (upper-middle income), and the Bahamas (high income) are all classified as water insecure despite significantly different GNI per capita. Alternatively, countries within the same income group presented very different water security levels. For example, among upper-middle-income countries, Libya is categorized as critically insecure, while Malaysia is moderately secure.

- Mitigating the effects of water variability is an important component of sustainable development because countries worldwide rely on limited water resources to meet multiple and often conflicting environmental, social, and economic needs. However, water resources vary significantly over time due to climate change and limited water storage options in many countries. The countries showing high water variability from year to year and limited water storage per capita are seen throughout Africa, with some exceptions in West and Southern Africa. Many countries in the Arabian Peninsula are also considered to have high interannual water variability. These countries are distinguished by rainfall variability, low renewable groundwater resources, and non-existent or limited water storage. Northern Europe, North America, and most of Latin America have low interannual water variability and relatively high water storage per capita, while Southern Europe and Central Asia show higher interannual water variability than other countries in the region.

To strengthen the conditions for water security, this global assessment proposes that countries can leverage success by reinforcing progress across different components. For instance, strengthening water resource stability through the integrated development of different storage types (Component 10) can help countries provide access to drinking water (Component 1), reduce WASH-related mortality (Component 3), and mitigate the impacts of water stress (Component 5). Advancing access to sanitation services (Component 2) and water treatment (Component 4) is intrinsically related to good health (Component 3) and public health goals. Building more resilient infrastructure and mechanisms for climate adaptation are critical to human and economic safety (Components 8 and 9) and water resource stability (Component 10), especially in extreme weather events and increasing climate variability. Water governance (Component 7) is also closely related to all these components due to the critical importance of robust policies, legal and institutional capacity, funding mechanisms, and monitoring systems across all aspects of water security.

This global research approach to water security assessment demonstrates the inconsistent state of SDG indicator data availability and the critical nature of up-to-date information to provide a clear picture of progress toward water-related SDGs. More than ever, countries must strengthen and expand their data collection systems to increase accountability and fill the many gaps identified in this report across all components. Missing data were particularly critical for specific groups, such as low-income countries and SIDS, and some components, such as human and economic safety, were finally assessed using modelled data due to inadequate SDG indicator datasets. Beyond the ten com-

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ponents in this assessment, many other components are considered essential for water security and their indicators bring value to the assessment. The SDG 6 indicators were initially considered for inclusion in this assessment, but eventually, only five out of 11 had sufficient data to assess, and one more (6.3.1) had to be supplemented with proxy values. Component 3 (good health) relies on an SDG 3 indicator, and data on the two water disaster components were missing or inconsistent, so alternate indicators were sourced. The SDGs do not directly address the critical influence of climate change on the stability of water resources and so this was added as a supplemental Component 10, indicated by modelled and reported data.

Identified threats to water security that could not be incorporated due to a lack of indicator data at a global level include conflict and human displacement. Several important indicators were considered including the mental health consequences of water insecurity at the individual, household, and community level, gender, and multiple social inequities, not least affordability, besides the quantification of more complex water resource components, including rainfed agriculture and unconventional water resources not currently accounted. Going beyond the range in scale from the individual to the nation, this assessment, like all national development targets, does not account for the range in geographic extent of a country. Small nations like the Solomon Islands or Luxembourg, are directly compared with very large and geographically diverse countries like the Russian Federation and Brazil. Further research is needed to adequately address this disparity in future analyses.

UN Custodian Agencies for SDG 6 targets and indicators rely on significant national data collection efforts to improve the databases that support this assessment. There are many reasons countries do not report, not least capacity, resources, and motivation. There are good models to assist countries, such as the blueprint developed by UNEP to help them improve Integrated Water Resource Management data collection efforts. Such efforts must be expanded to all water resources related to SDGs and beyond. This is critical to assure that progress toward achieving development goals can be assessed and supported. Future iterations of this global assessment will likely provide an even more comprehensive and reliable picture of water security globally.

Finally, this global assessment highlights that while water security can be assessed at the national level, it is a multilevel challenge. National scores can be useful to contrast different development trajectories and opportunities, but much more attention is needed to local contexts and their implication for achieving SDG 6. This assessment brought many examples of local manifestations of water security to critically discuss the relevance of the components and issues with data availability. However, more effort is needed to capture the water security needs of vulnerable communities in all countries and truly ‘leave no one behind’ in assessing water security. Ultimately, this global assessment is not a prognostic conclusion for the countries categorized as water insecure. On the contrary, it aims to renew discussions on water security as a possible and desired outcome of global efforts in the coming years.

Appendix I

Component	1. Drinking water		2. Sanitation		3. WASH- mortality	4. Quality	5. Availability	6. Value	7. Governance	8. Disaster deaths	9.1 Flood impact	9.2 Drought risk	10.1 Interannual Variability	10.2 Storage
Data source	JMP (data year)		JMP (data year)		WHO (2019)	WHO (2020) Jones (2015)	AQUASTAT (2019)	AQUASTAT (2019)	UNEP-DHI (2020)	EM-DAT IHME	Aqueduct Flood (AF) & proxy country	Aqueduct Risk Atlas (ARA) or proxy country	Aqueduct Risk Atlas (ARA) or proxy country	ICOLD (2020)
	Basic	Safe	Basic	Safe										
Afghanistan	2020	2020	2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
Albania	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Algeria	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Angola	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Antigua & Barbuda	2017		2017		2019	2015	2019	2019	2020	EM-DAT	Belize	Puerto Rico	Puerto Rico	no data
Argentina	2016		2016		2019	2020	2019	2019	2017	EM-DAT	AF	ARA	ARA	2020
Armenia	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
Australia	2020		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Austria	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Azerbaijan	2020	2020	2019		2019	2020	2019	2019	2020	IHME	AF	ARA	ARA	no data
Bahamas	2019		2019		2019	2015	2019	no data	2020	EM-DAT	Cuba	ARA Cuba	ARA	no data
Bahrain	2020	2020	2020	2020	2019	2020	2019	2019	2020	IHME	United Arab Emirates	Qatar	ARA	no data
Bangladesh	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Barbados	2020		2020		2019	2015	2019	2019	2020	EM-DAT	Belize	Trinidad & Tobago	Trinidad & Tobago	2020
Belarus	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Belgium	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
Belize	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
Benin	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Bhutan	2020	2020	2020	2020	2019	2020	2019	2019	2020	IHME	AF	ARA	ARA	2020
Bolivia	2020		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Bosnia Herzegovina	2020	2020	2018		2019	2020	2019	no data	2020	EM-DAT	AF	ARA	ARA	2020
Botswana	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
Brazil	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Brunei Darussalam	2020		2015		2019	2015	no data	no data	2020	IHME	AF	ARA	ARA	no data

Bulgaria	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Burkina Faso	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Burundi	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Cabo Verde	2020		2020		2019	2015	2019	2019	2020	EM-DAT	Senegal	Senegal	Senegal	no data
Cambodia	2020	2020	2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Cameroon	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
Canada	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Central African Republic	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Chad	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Chile	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
China	2020		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
Colombia	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
Comoros	2019		2019		2019	2015	2019	2019	2020	EM-DAT	Madagas-car	Madagas-car	Madagas-car	2020
Republic of Congo	2020	2020	2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Costa Rica	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Côte d’Ivoire	2020	2020	2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Croatia	2007		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Cuba	2020		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Cyprus	2020	2020	2020	2020	2019	2020	2019	2019	2020	IHME	AF	ARA	ARA	2020
Czech Republic	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
North Korea	2020	2020	2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
DRC Congo	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Denmark	2020	2020	2020	2020	2019	2020	2019	2019	2020	IHME	AF	ARA	ARA	2020
Djibouti	2020		2020	2020	2019	2020	2019	no data	2020	EM-DAT	AF	ARA	ARA	2020
Dominica	2017		2017		2019	2015	2019	no data	2020	EM-DAT	Belize	Trinidad & Tobago	Trinidad & Tobago	2020
Dominican Republic	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Ecuador	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Egypt	2020		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
El Salvador	2020		2020		2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Equatorial Guinea	2017		2017		2019	2015	2019	no data	2020	IHME	AF	ARA	ARA	no data
Eritrea	2016		2016		2019	2015	2019	2019	2020	IHME	AF	ARA	ARA	no data
Estonia	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Eswatini	2020		2020		2019	2020	2019	2019	2020	EM-DAT	AF	South Africa	South Africa	2020
Ethiopia	2020	2020	2020	2020	2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Fiji	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	Papua New Guinea	Papua New Guinea	2020
Finland	2020	2020	2020	2020	2019	2020	2019	2019	2020	IHME	AF	ARA	ARA	no data
France	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Gabon	2020		2020		2019	2015	2019	2019	2020	IHME	AF	ARA	ARA	2020
Gambia	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Georgia	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Germany	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020

Ghana	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Greece	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
Grenada	2017		2017		2019	2015	2019	no data	2020	IHME	Belize	Trinidad & Tobago	Trinidad & Tobago	2020
Guatemala	2020	2020	2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
Guinea	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
Guinea-Bissau	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Guyana	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Haiti	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Honduras	2020		2020	2020	2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Hungary	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Iceland	2020	2020	2020	2020	2019	2020	2019	2019	2020	IHME	AF	ARA	ARA	2020
India	2020		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Indonesia	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Iran	2020	2020	2020		2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
Iraq	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
Ireland	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Israel	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Italy	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Jamaica	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	Cuba	Cuba	2020
Japan	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Jordan	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Kazakhstan	2020	2020	2020		2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Kenya	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Kuwait	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Kyrgyzstan	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Lao PDR	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Latvia	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Lebanon	2020	2020	2020	2020	2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Lesotho	2020	2020	2020	2020	2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Liberia	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Libya	2020		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Lithuania	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Luxembourg	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Madagascar	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Malawi	2020		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Malaysia	2020	2020	2018		2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Maldives	2020		2020		2019	2015	2019	no data	2020	EM-DAT	Sri Lanka	Sri Lanka	Sri Lanka	2020
Mali	2020		2020	2020	2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Malta	2020	2020	2020	2020	2019	2020	2019	2019	2020	IHME	Tunisia	Tunisia	ARA	2020
Mauritania	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Mauritius	2020		2017		2019	2020	2019	2019	2020	EM-DAT	Madagas-car	Madagas-car	Madagas-car	2020
Mexico	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Micronesia	2019		2019		2019	2015	no data	no data	2020	EM-DAT	Papua New Guinea	Papua New Guinea	Papua New Guinea	2020
Mongolia	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020

Montenegro	2020	2020	2020	2020	2019	2020	no data	2019	2020	EM-DAT	AF	ARA	ARA	2020
Morocco	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Mozambique	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Myanmar	2020	2020	2020	2020	2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Namibia	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Nepal	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Netherlands	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
New Zealand	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Nicaragua	2020	2020	2020		2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Niger	2020		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Nigeria	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
North Macedonia	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Norway	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Oman	2020	2020	2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Pakistan	2020	2020	2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Panama	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Papua New Guinea	2020		2020		2019	2015	2019	no data	2020	EM-DAT	AF	ARA	ARA	2020
Paraguay	2020	2020	2020	2020	2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Peru	2020	2020	2020	2020	2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Philippines	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Poland	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Portugal	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Puerto Rico	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	Cuba	ARA	ARA	2020
Qatar	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	United Arab Emir-ates	ARA	ARA	no data
South Korea	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Moldova	2020	2020	2020		2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Romania	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Russian Federation	2020	2020	2020	2020	2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Rwanda	2020	2020	2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Saint Kitts & Nevis	2017		2017		2019	2015	2019	no data	2020	EM-DAT	Belize	Puerto Rico	Puerto Rico	2020
Saint Lucia	2020		2020		2019	2015	2019	no data	2020	EM-DAT	Belize	Puerto Rico	Puerto Rico	no data
St. Vincent & Grenadines	2018		2018		2019	2015	2019	no data	2020	EM-DAT	Belize	Puerto Rico	Puerto Rico	2020
Samoa	2020	2020	2020	2020	2019	2020	no data	no data	2020	EM-DAT	Papua New Guinea	Papua New Guinea	Papua New Guinea	2020
Sao Tome & Principe	2020	2020	2020	2020	2019	2015	2019	2019	2020	IHME	Equatorial Guinea	ARA	ARA	2020
Saudi Arabia	2020		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Senegal	2020		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Serbia	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Seychelles	2019		2020		2019	2015	no data	2019	2020	IHME	Madagas-car	Madagas-car	Madagas-car	2020

Sierra Leone	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Singapore	2020	2020	2020	2020	2019	2020	2019	no data	2020	IHME	Malaysia	ARA	ARA	2020
Slovakia	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Slovenia	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Solomon Islands	2020		2020		2019	2015	no data	no data	2020	EM-DAT	Papua New Guinea	Papua New Guinea	Papua New Guinea	no data
Somalia	2020		2020	2020	2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
South Africa	2020		2020		2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
South Sudan	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Spain	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Sri Lanka	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Palestine	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	Israel	Israel	2020
Sudan	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
Suriname	2020	2020	2020	2020	2019	2020	2019	2019	2020	IHME	AF	ARA	ARA	2020
Sweden	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Switzerland	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Syria	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Tajikistan	2020	2020	2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Thailand	2020		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Timor-Leste	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Togo	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	no data
Tonga	2020	2020	2020	2020	2019	2020	no data	no data	2020	EM-DAT	Papua New Guinea	New Zealand	New Zealand	2020
Trinidad & Tobago	2020		2020		2019	2015	2019	2019	2020	EM-DAT	Dominican Rep.	ARA	ARA	2020
Tunisia	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Turkey	2020		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Turkmenistan	2020	2020	2020		2019	2015	2019	2019	2020	IHME	AF	ARA	ARA	2020
Uganda	2020	2020	2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Ukraine	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
United Arab Emirates	2020		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
United Kingdom	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Tanzania	2020		2020	2020	2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
USA	2020	2020	2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Uruguay	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Uzbekistan	2020	2020	2020		2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Vanuatu	2020		2020		2019	2015	no data	no data	2020	EM-DAT	Papua New Guinea	Papua New Guinea	Papua New Guinea	2020
Venezuela	2020		2020	2020	2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Viet Nam	2020		2020		2019	2015	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Yemen	2020		2020	2020	2019	2020	2019	2019	2020	EM-DAT	AF	ARA	ARA	2020
Zambia	2020		2020		2019	2015	2019	2019			AF	ARA	ARA	2020
Zimbabwe	2020	2020	2020	2020	2019	2020	2019	2019			AF	ARA	ARA	2020

Appendix II

Country	Region	LDC	SIDS	1. Drinking Water	2. Sanitation	3.Good Health	4. Water Quality	5. Water Availability	6. Water Value	7. Water Governance	8. Human Safety	9. Economic Safety			10. Water Resource Stability			National Water Security Score	National water security level
				National	National	National	National	National	National	National	National	9.1 Flood Cost	9.2 Drought Risk	National	10.1 Interannual Variability	10.2 Storage	National		
Afghanistan	Asia-Pacific	X		6	3	3	0	5	1	2	7	1	5	1	3	1	4	32	Critical
Albania	Europe	X		9	8	5	2	10	4	5	8	1	8	1	4	4	8	60	Insecure
Algeria	Africa			9	6	5	8	1	5	6	10	4	4	4	2	2	4	58	Insecure
Angola	Africa			3	3	1	1	10	10	7	8	8	6	6	2	2	4	53	Insecure
Antigua and Bar-buda	Americas		X	5	5	6	5	10	10	4	6	1	9	1	3	1	4	56	Insecure
Argentina	Americas			5	8	3	4	9	5	4	10	2	6	2	2	4	6	56	Insecure
Armenia	Asia-Pacific			10	9	4	5	5	2	6	10	3	5	3	3	3	6	60	Insecure
Australia	Asia-Pacific			5	9	6	8	10	9	9	9	6	6	6	2	5	7	78	Secure
Austria	Europe			10	10	6	10	10	10	10	9	4	7	4	4	2	6	85	Secure
Azerbaijan	Asia-Pacific		X	10	6	5	6	5	2	6	10	3	6	3	3	4	7	60	Insecure
Bahamas	Americas			5	5	5	7	10	0	4	1	8	9	8	3	0	3	48	Insecure
Bahrain	Asia-Pacific		X	10	10	7	10	1	8	4	10	8	5	5	2	0	2	67	Moderate
Bangladesh	Asia-Pacific		X	8	5	3	2	10	3	6	8	1	9	1	4	1	5	51	Insecure
Barbados	Americas	X		5	5	4	5	1	7	5	8	1	9	1	3	0	3	44	Insecure
Belarus	Europe			10	9	6	6	10	6	6	8	2	6	2	4	1	5	68	Moderate
Belgium	Europe		X	10	10	4	10	5	10	9	5	3	7	3	4	1	5	71	Moderate
Belize	Americas			5	5	5	4	10	5	3	10	1	9	1	4	2	6	54	Insecure
Benin	Africa	X		4	1	1	0	10	6	7	10	3	6	3	4	1	5	47	Insecure
Bhutan	Asia-Pacific			7	8	3	5	10	3	4	10	1	8	1	4	1	5	56	Insecure

Bolivia (Plurinational State of)	**Americas**	X		5	6	3	6	10	5	6	8	2	6	2	3	1	4	55	Insecure
Bosnia and Herzegovina	**Europe**			10	7	6	5	10	0	6	10	1	8	1	4	3	7	62	Insecure
Botswana	**Africa**			5	5	2	4	10	8	5	10	3	4	3	1	2	3	55	Insecure
Brazil	**Americas**			10	7	4	4	10	6	7	10	4	8	4	3	4	7	69	Moderate
Brunei Darussalam	**Asia-Pacific**			5	5	6	7	0	0	7	10	6	7	6	4	2	6	52	Insecure
Bulgaria	**Europe**			10	8	5	8	6	4	7	10	3	7	3	3	3	6	67	Moderate
Burkina Faso	**Africa**	X		3	2	1	1	10	5	7	9	7	6	6	3	2	5	49	Insecure
Burundi	**Africa**	X		4	3	1	0	9	3	5	8	7	7	7	4	1	5	45	Insecure
Cabo Verde	**Africa**	X		5	4	3	2	10	7	7	8	4	4	4	3	1	4	54	Insecure
Cambodia	**Asia-Pacific**	X		5	4	3	0	10	4	6	8	1	8	1	4	1	5	46	Insecure
Cameroon	**Africa**			4	3	1	0	10	6	4	8	4	7	4	4	3	7	47	Insecure
Canada	**Americas**	X		10	10	6	8	10	7	0	9	6	6	6	4	5	9	75	Secure
Central African Republic	**Africa**		X	3	2	1	1	10	5	4	10	2	8	2	4	1	5	43	Insecure
Chad	**Africa**			3	2	1	1	10	5	4	8	2	3	2	2	1	3	39	Critical
Chile	**Americas**			10	9	6	10	10	3	4	8	2	5	2	2	3	5	67	Moderate
China	**Asia-Pacific**			5	9	6	7	6	6	8	10	1	7	1	3	3	6	64	Insecure
Colombia	**Americas**			9	6	5	3	10	4	6	8	5	8	5	4	2	6	62	Insecure
Comoros	**Africa**	X	X	5	2	1	0	10	8	2	7	2	8	2	3	0	3	40	Critical
Republic of Congo	**Africa**			6	2	2	1	10	9	5	10	7	8	7	4	2	6	58	Insecure
Costa Rica	**Americas**			10	7	5	3	10	6	6	9	7	8	7	4	2	6	69	Moderate
Côte d'Ivoire	**Africa**			6	2	1	0	10	6	4	10	5	8	5	4	3	7	51	Insecure
Croatia	**Europe**		X	10	9	5	7	10	8	9	9	2	8	2	4	2	6	75	Secure
Cuba	**Americas**			5	7	4	3	8	5	9	1	8	9	8	3	3	6	56	Insecure
Cyprus	**Asia-Pacific**			10	9	6	7	6	8	10	10	10	9	9	3	2	5	80	Secure
Czech Republic	**Europe**			10	10	5	10	8	10	8	7	2	6	2	3	2	5	75	Secure
Democratic People's Republic of Korea	**Asia-Pacific**	X		9	5	5	3	8	1	7	8	5	8	5	4	4	8	59	Insecure
Democratic Republic of the Congo	**Africa**			4	2	1	2	10	7	4	10	5	8	5	4	1	5	50	Insecure
Denmark	**Europe**			10	10	5	10	8	10	10	7	10	9	9	4	2	6	85	Secure
Djibouti	**Africa**	X		4	6	2	2	10	0	0	1	10	6	6	1	0	1	32	Critical
Dominica	**Americas**		X	5	5		4	10	0	5	8	1	9	1	3	0	3	41	Insecure
Dominican Republic	**Americas**		X	5	5	4	1	5	4	4	9	4	9	4	3	2	5	46	Insecure

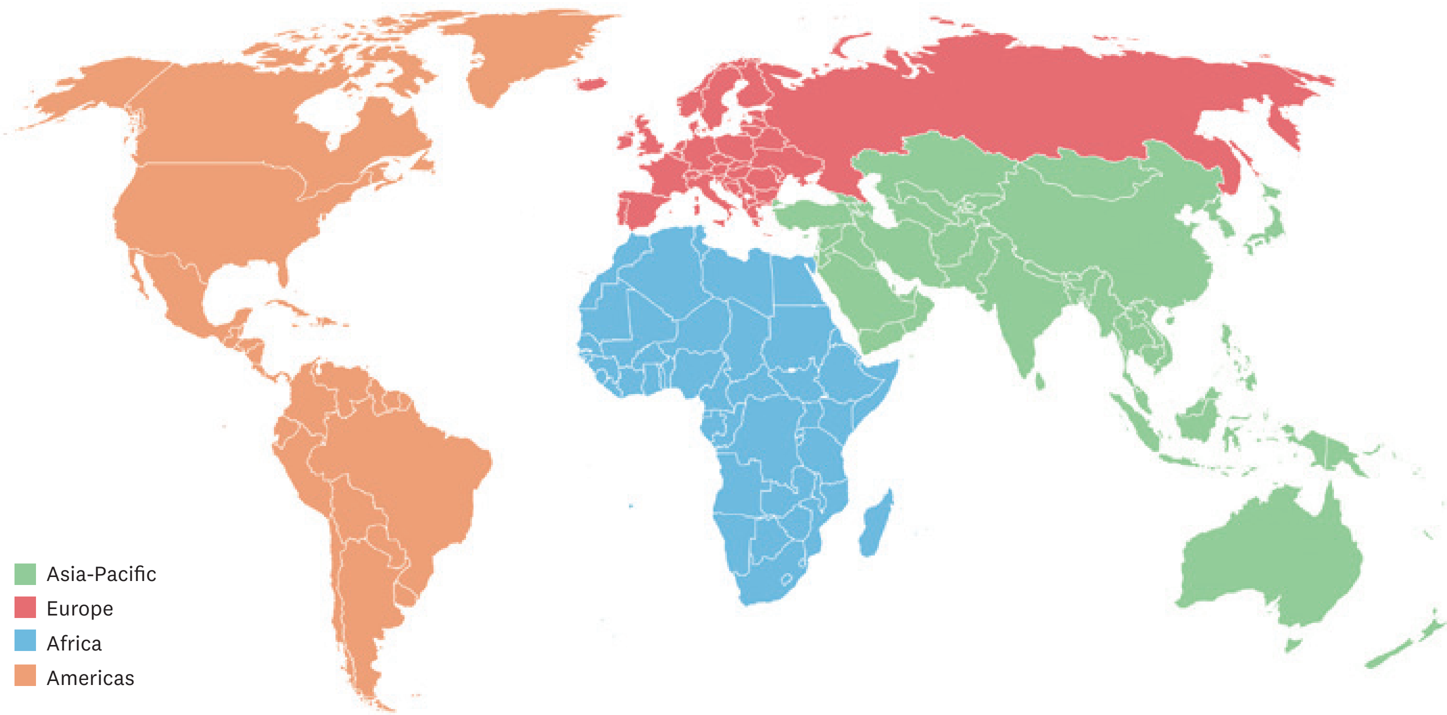
Ecuador	**Americas**			9	7	5	4	10	4	4	10	3	6	3	3	2	5	61	Insecure
Egypt	**Africa**			5	9	5	5	1	2	5	8	1	3	1	1	3	4	45	Insecure
El Salvador	**Americas**	X		5	5	4	2	9	5	3	10	8	8	8	4	3	7	58	Insecure
Equatorial Guinea	**Africa**			4	4	2	4	10	0	3	10	6	8	6	4	0	4	47	Insecure
Eritrea	**Africa**			3	1	1	0	9	2	0	7	7	5	5	1	1	1	29	Critical
Estonia	**Europe**			10	10	5	10	9	6	9	10	6	8	6	3	0	3	78	Secure
Eswatini	**Africa**	X		4	4	1	2	3	2	6	9	5	7	5	2	3	5	41	Insecure
Ethiopia	**Africa**			4	1	1	0	7	3	5	1	4	6	4	2	3	5	31	Critical
Fiji	**Asia-Pacific**		X	5	5	3	4	10	7	6	10	1	8	1	4	2	6	57	Insecure
Finland	**Europe**			10	10	7	10	10	8	8	6	7	5	5	4	5	9	83	Secure
France	**Europe**	X		10	9	5	10	8	9	10	10	4	8	4	4	2	6	81	Secure
Gabon	**Africa**			5	3	3	4	10	9	3	8	2	8	2	4	1	5	52	Insecure
Gambia	**Africa**			7	4	2	2	10	5	4	10	3	6	3	3	0	3	50	Insecure
Georgia	**Asia-Pacific**			9	7	5	5	10	4	5	10	2	7	2	4	2	6	63	Insecure
Germany	**Europe**			10	10	5	10	7	10	9	9	4	7	4	4	1	5	79	Secure
Ghana	**Africa**		X	7	2	2	2	10	6	6	1	7	8	7	4	5	9	52	Insecure
Greece	**Europe**			10	10	4	10	8	5	9	10	8	8	8	3	3	6	80	Secure
Grenada	**Americas**			10	5	4	5	10	0	4	6	1	9	1	3	0	3	48	Insecure
Guatemala	**Americas**	X	X	8	4	3	3	10	5	3	10	4	9	4	4	1	5	55	Insecure
Guinea	**Africa**	X	X	4	2	1	0	10	4	3	8	7	8	7	4	3	7	46	Insecure
Guinea-Bissau	**Africa**		X	5	2	1	3	10	2	2	10	5	8	5	4	0	4	44	Insecure
Guyana	**Americas**	X		5	5	4	3	10	2	2	6	3	8	3	3	1	4	44	Insecure
Haiti	**Americas**			4	2	2	0	9	2	3	1	8	9	8	2	1	3	34	Critical
Honduras	**Americas**			5	7	4	2	10	5	3	6	3	8	3	4	3	7	52	Insecure
Hungary	**Europe**			10	10	6	9	10	6	8	9	2	6	2	4	1	5	75	Secure
Iceland	**Europe**			10	10	6	8	10	8	7	8	9	7	7	4	5	9	83	Secure
India	**Asia-Pacific**			5	6	2	3	3	2	5	9	1	7	1	3	2	5	41	Insecure
Indonesia	**Asia-Pacific**			5	5	3	3	8	2	7	10	3	8	3	4	1	5	51	Insecure
Iran (Islamic Republic of)	**Asia-Pacific**			10	5	5	3	2	2	4	10	4	5	4	2	1	3	48	Insecure
Iraq	**Asia-Pacific**			8	8	5	4	3	2	4	10	1	6	1	3	3	6	51	Insecure
Ireland	**Europe**			10	9	5	9	8	10	9	10	6	8	6	4	2	6	82	Secure
Israel	**Asia-Pacific**			10	10	6	10	1	10	9	10	9	5	5	3	1	4	75	Secure
Italy	**Europe**		X	10	10	5	10	7	7	8	10	6	8	6	3	2	5	78	Secure
Jamaica	**Americas**			5	5	6	4	9	4	5	8	10	9	9	3	1	4	59	Insecure
Japan	**Asia-Pacific**			10	10	4	10	7	7	10	8	5	8	5	4	2	6	77	Secure
Jordan	**Asia-Pacific**			10	9	6	9	1	6	7	10	9	4	4	2	1	3	65	Moderate
Kazakhstan	**Asia-Pacific**			10	5	5	4	7	3	5	8	3	5	3	3	5	8	58	Insecure

Kenya	**Africa**			4	2	2	0	7	5	6	10	7	7	7	2	1	3	46	Insecure
Kuwait	**Asia-Pacific**			10	10	7	9	1	10	10	8	8	7	7	3	0	3	75	Secure
Kyrgyzstan	**Asia-Pacific**			9	10	6	2	6	1	4	7	1	6	1	3	5	8	54	Insecure
Lao People's Democratic Republic	**Asia-Pacific**	X		6	8	2	2	10	1	7	10	1	8	1	4	5	9	56	Insecure
Latvia	**Europe**	X		10	9	5	10	10	10	7	8	3	7	3	3	3	6	78	Secure
Lebanon	**Asia-Pacific**			8	6	6	5	5	6	3	10	10	6	6	3	1	4	59	Insecure
Lesotho	**Africa**			6	5	1	0	10	7	5	10	4	6	4	3	3	6	54	Insecure
Liberia	**Africa**	X		4	1	2	0	10	2	2	9	2	9	2	4	0	4	36	Critical
Libya	**Africa**			5	6	6	2	1	2	6	1	5	5	5	2	1	3	37	Critical
Lithuania	**Europe**	X		10	10	5	10	10	10	7	10	3	7	3	4	2	6	81	Secure
Luxembourg	**Europe**	X		10	10	6	10	10	10	9	8	6	7	6	4	2	6	85	Secure
Madagascar	**Africa**			4	2	1	1	9	1	4	8	3	8	3	3	1	4	37	Critical
Malawi	**Africa**			4	3	2	1	9	2	6	10	5	7	5	4	1	5	47	Insecure
Malaysia	**Asia-Pacific**		X	10	9	3	9	10	8	7	10	1	8	1	4	4	8	75	Secure
Maldives	**Asia-Pacific**			5	5	6	4	9	0	5	9	2	9	2	4	0	4	49	Insecure
Mali	**Africa**	X		5	4	1	0	10	1	6	10	1	3	1	2	3	5	43	Insecure
Malta	**Europe**	X		10	10	5	2	1	10	9	10	3	7	3	2	0	2	62	Insecure
Mauritania	**Africa**		X	4	3	2	0	9	2	5	10	2	2	2	2	2	4	41	Insecure
Mauritius	**Africa**			5	5	4	2	8	5	7	1	2	8	2	3	1	4	43	Insecure
Mexico	**Americas**		X	8	8	5	7	6	5	5	10	2	7	2	2	3	5	61	Insecure
Micronesia (Federated States of)	**Asia-Pacific**	X		5	5	3	2	0	0	5	10	4	8	4	4	0	4	38	Critical
Mongolia	**Asia-Pacific**	X		6	7	5	2	10	6	5	10	4	7	4	3	2	5	60	Insecure
Montenegro	**Europe**	X		10	8	6	5	0	6	4	1	3	8	3	4	4	8	51	Insecure
Morocco	**Africa**			9	7	5	4	5	4	8	7	3	5	3	2	3	5	57	Insecure
Mozambique	**Africa**			4	2	1	0	10	4	7	8	3	8	3	3	4	7	46	Insecure
Myanmar	**Asia-Pacific**			8	7	3	0	10	1	4	10	1	8	1	4	2	6	50	Insecure
Namibia	**Africa**			5	2	2	3	10	6	6	10	4	3	3	1	3	4	51	Insecure
Nepal	**Asia-Pacific**			6	7	3	4	10	1	4	6	2	8	2	4	1	5	48	Insecure
Netherlands	**Europe**	X		10	10	5	10	9	9	10	1	1	7	1	4	3	7	72	Moderate
New Zealand	**Asia-Pacific**			10	10	6	9	10	6	7	8	6	9	6	4	5	9	81	Secure
Nicaragua	**Americas**			7	4	5	4	10	3	3	8	4	8	4	4	2	6	54	Insecure
Niger	**Africa**			3	2	1	1	9	2	6	9	4	2	2	2	1	3	38	Critical
Nigeria	**Africa**			5	4	1	5	10	6	5	10	5	5	5	4	2	6	57	Insecure
North Macedonia	**Europe**			9	6	6	1	8	5	4	5	1	7	1	3	3	6	51	Insecure
Norway	**Europe**		X	10	9	5	8	10	10	7	9	7	7	7	4	5	9	84	Secure
Oman	**Asia-Pacific**			10	5	6	4	1	7	8	8	8	3	3	2	1	3	55	Insecure

Pakistan	**Asia-Pacific**			7	4	2	1	1	1	6	10	1	5	1	2	2	4	37	Critical
Panama	**Americas**			5	5	5	3	10	7	4	8	6	8	6	4	4	8	61	Insecure
Papua New Guinea	**Asia-Pacific**			3	1	2	0	10	0	2	7	4	8	4	4	1	5	34	Critical
Paraguay	**Americas**			9	8	5	1	10	5	3	8	6	8	6	3	5	8	63	Insecure
Peru	**Americas**			8	7	4	6	10	2	5	8	1	6	1	2	2	4	55	Insecure
Philippines	**Asia-Pacific**		X	8	8	3	5	8	2	6	10	3	9	3	4	1	5	58	Insecure
Poland	**Europe**			10	10	4	9	7	7	8	8	3	7	3	3	1	4	70	Moderate
Portugal	**Europe**			10	10	4	8	9	6	8	6	8	8	8	3	3	6	75	Secure
Puerto Rico	**Americas**			10	7		4	3	6	0	10	8	9	8	3	0	3	51	Insecure
Qatar	**Asia-Pacific**			10	10	8	10	1	10	9	8	8	5	5	2	0	2	73	Moderate
Republic of Korea	**Asia-Pacific**			10	10	4	10	3	7	8	9	3	9	3	4	2	6	70	Moderate
Republic of Moldova	**Europe**			9	4	5	4	9	4	5	10	2	7	2	3	2	5	57	Insecure
Romania	**Europe**			10	9	4	5	10	6	8	10	2	6	2	3	3	6	70	Moderate
Russian Federation	**Europe**			9	8	5	6	10	5	9	10	3	6	3	4	4	8	73	Moderate
Rwanda	**Africa**		X	4	4	2	0	9	5	7	7	2	7	2	4	2	6	46	Insecure
Saint Kitts and Nevis	**Americas**		X	5	5		5	4	0	3	10	1	9	1	3	0	3	36	Critical
Saint Lucia	**Americas**	X		5	5	4	4	9	0	4	10	1	9	1	3	1	4	46	Insecure
Saint Vincent and the Grenadines	**Americas**		X	5	5	4	4	10	0	3	7	1	9	1	3	0	3	42	Insecure
Samoa	**Asia-Pacific**	X		7	8	4	5	0	0	8	10	4	8	4	4	0	4	50	Insecure
Sao Tome and Principe	**Africa**		X	6	5	3	1	10	4	4	10	3	9	3	4	0	4	50	Insecure
Saudi Arabia	**Asia-Pacific**	X	X	5	8	6	8	1	6	6	10	6	4	4	1	1	2	56	Insecure
Senegal	**Africa**			5	5	2	2	9	3	5	10	4	4	4	3	1	4	49	Insecure
Serbia	**Europe**			9	6	5	3	10	3	4	9	2	6	2	4	2	6	57	Insecure
Seychelles	**Africa**	X		5	5	4	5	0	9	6	10	2	8	2	3	1	4	50	Insecure
Sierra Leone	**Africa**		X	4	2	1	1	10	4	4	4	3	8	3	4	1	5	38	Critical
Singapore	**Asia-Pacific**	X	X	10	10	4	10	1	0	10	10	1	7	1	4	1	5	61	Insecure
Slovakia	**Europe**		X	10	9	5	8	10	10	7	10	1	6	1	4	2	6	76	Secure
Slovenia	**Europe**			10	9	6	7	10	7	9	10	2	8	2	4	2	6	76	Secure
Solomon Islands	**Asia-Pacific**			4	2	2	0	0	0	3	4	4	8	4	4	0	4	23	Critical
Somalia	**Africa**	X		3	4	1	0	8	1	3	8	5	7	5	2	0	2	35	Critical
South Africa	**Africa**	X		5	4	2	7	4	5	8	9	7	7	7	2	3	5	56	Insecure
South Sudan	**Africa**			3	1	1	0	10	4	5	8	1	7	1	4	0	4	37	Critical
Spain	**Europe**			10	10	5	9	6	6	9	10	5	8	5	3	4	7	77	Secure
Sri Lanka	**Asia-Pacific**	X		5	5	5	1	1	3	5	7	2	9	2	4	2	6	40	Critical
State of Palestine	**Asia-Pacific**			9	9		5	5	6	0	9	10	5	5	3	0	3	51	Insecure

Sudan	**Africa**			4	2	3	0	1	2	4	8	1	3	1	3	2	5	30	Critical
Suriname	**Americas**			8	6	4	3	10	3	3	10	1	7	1	4	5	9	57	Insecure
Sweden	**Europe**		X	10	10	5	10	10	10	9	10	8	7	7	4	5	9	90	Secure
Switzerland	**Europe**			10	10	5	10	10	10	9	10	4	7	4	4	2	6	84	Secure
Syrian Arab Republic	**Asia-Pacific**			5	5	4	1	1	1	6	10	3	6	3	3	3	6	42	Insecure
Tajikistan	**Asia-Pacific**			7	5	4	1	4	1	5	9	1	6	1	3	4	7	44	Insecure
Thailand	**Asia-Pacific**			5	7	3	3	8	4	6	9	1	8	1	4	3	7	53	Insecure
Timor-Leste	**Asia-Pacific**	X	X	5	3	2	1	8	1	2	8	9	9	9	3	0	3	42	Insecure
Togo	**Africa**		X	5	2	1	2	10	6	4	8	5	8	5	4	2	6	49	Insecure
Tonga	**Asia-Pacific**	X		7	7	4	3	0	0	4	10	4	9	4	4	0	4	43	Insecure
Trinidad and Tobago	**Americas**		X	5	5	6	1	8	7	4	10	4	9	4	3	1	4	54	Insecure
Tunisia	**Africa**			9	9	5	6	1	5	6	9	3	7	3	3	2	5	58	Insecure
Turkey	**Asia-Pacific**			5	9	6	7	6	5	8	10	5	7	5	3	4	7	68	Moderate
Turkmenistan	**Asia-Pacific**	X		10	5	4	4	1	1	7	10	2	6	2	3	2	5	49	Insecure
Uganda	**Africa**			4	1	2	0	10	6	7	8	9	7	7	3	1	4	49	Insecure
Ukraine	**Europe**			10	9	6	4	9	3	4	9	2	7	2	2	4	6	62	Insecure
United Arab Emirates	**Asia-Pacific**			5	10	7	10	1	8	8	10	8	5	5	1	1	2	66	Moderate
United Kingdom	**Europe**			10	10	4	10	9	10	8	6	6	8	6	4	2	6	79	Secure
United Republic of Tanzania	**Africa**	X		4	3	2	0	9	3	6	10	5	8	5	3	1	4	46	Insecure
United States of America	**Americas**			10	10	6	10	8	7	8	9	5	6	5	3	4	7	80	Secure
Uruguay	**Americas**			5	5	5	3	10	5	4	8	7	8	7	3	5	8	60	Insecure
Uzbekistan	**Asia-Pacific**		X	8	5	5	4	1	1	5	10	2	6	2	3	2	5	46	Insecure
Vanuatu	**Asia-Pacific**			5	3	2	1	0	0	5	7	4	8	4	4	0	4	31	Critical
Venezuela (Bolivarian Republic of)	**Americas**			5	6	4	4	10	2	0	10	7	8	7	3	5	8	56	Insecure
Viet Nam	**Asia-Pacific**			5	5	4	1	9	2	6	8	1	9	1	4	3	7	48	Insecure
Yemen	**Asia-Pacific**	X		4	4	3	4	1	3	4	8	6	6	6	1	1	1	38	Critical
Zambia	**Africa**	X		4	2	2	1	10	5	6	10	7	7	7	4	5	9	56	Insecure
Zimbabwe	**Africa**			5	4	2	3	7	2	7	6	9	6	6	2	5	7	49	Insecure

Appendix III



Four geographic regions considered

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