Progress on Water-related Ecosystems

Mid-term status of SDG Indicator 6.6.1 and acceleration needs with a special focus on Biodiversity

2024

Austrian Development Agency

BMZ Federal Ministry for Economic Cooperation and Development

European Commission

Ministry of Foreign Affairs of the Netherlands

Ministry of Infrastructure and Water Management

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Swiss Agency for Development and Cooperation SDC

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United Nations | UN WATER

UN environment programme

ISBN no. 978-92-807-4170-4

Suggested citation
United Nations Environment Programme (2024). Progress on Water-related Ecosystems. Mid-term status of SDG Indicator 6.6.1 and acceleration needs, with a special focus on Biodiversity

Editing: Acolad

Design and layout: Dilucidar

Acknowledgements
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This report was produced as part of the UN-Water Integrated Monitoring Initiative for SDG 6 (IMI-SDG6). We gratefully acknowledge the contributions to the UN-Water Inter-Agency Trust Fund from the following entities: Austrian Development Agency, German Federal Ministry for Economic Cooperation and Development, the European Commission, Netherlands Ministry of Foreign Affairs, Netherlands Ministry of Infrastructure and Water Management, Swedish International Development Cooperation Agency, Swiss Agency for Development and Cooperation.

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Abbreviations

AMCOW	African ministers Council on Water
CBD	Convention on Biological Diversity
CODIA	Conference of Ibero-American Water Directors
COP	Conference of Parties
EA	Ecosystem Accounts
EO	Earth Observation
FEE	Freshwater Ecosystem Explorer
GBF	Global Biodiversity Framework
GHM	Global Hydrological Model
GMW	Global Mangrove Watch
GWW	Global Wetlands Watch
IAEG SDG	Inter Agency Expert Group on SDGs
IUCN GET	International Union for the Conservation of Nature Global Ecosystem Typology
IWRM	Integrated Water Resources Management
NBSAP	National Biodiversity Strategic Action Plan
NWI	National Wetlands Inventory
SDG	Sustainable Development Goal
SEEA	System of Economic and Environmental Accounts
UN	United Nations
UNEA	United Nations Environment Assembly
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNSD	United Nations Statistics Division
WEFE	Water Ecosystems Food Environment Nexus

Presenting the UN-Water Integrated Monitoring Initiative for SDG 6

Through the UN-Water Integrated Monitoring Initiative for SDG 6 (IMI-SDG6), the United Nations seeks to support countries in monitoring water- and sanitation-related issues within the framework of the 2030 Agenda for Sustainable Development, and in compiling country data to report on global progress towards SDG 6.

IMI-SDG6 brings together the United Nations organizations that are formally mandated to compile country data on the SDG 6 global indicators, and builds on ongoing efforts such as the World Health Organization (WHO)/United Nations Children's Fund (UNICEF) Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP), the Global Environment Monitoring System for Freshwater (GEMS/Water), the Food and Agriculture Organization of the United Nations (FAO) Global Information System on Water and Agriculture (AQUASTAT) and the UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS).

This joint effort enables synergies to be created across United Nations organizations and methodologies and requests for data to be harmonized, leading to more efficient outreach and a reduced reporting burden. At the national level, IMI-SDG6 also promotes intersectoral collaboration and consolidation of existing capacities and data across organizations.

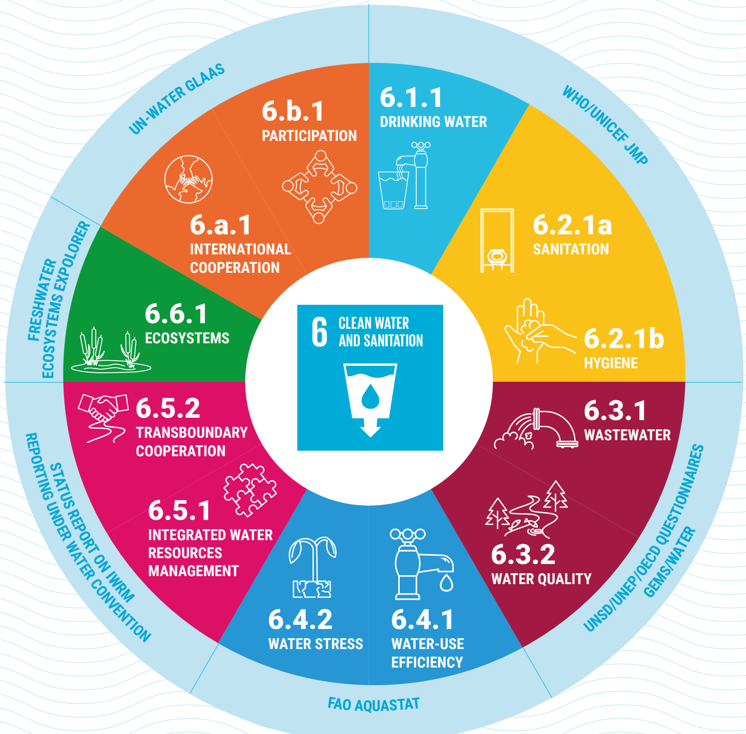
The overarching goal of IMI-SDG6 is to accelerate the achievement of SDG 6 by increasing the availability of high-quality data for evidence-based policymaking, regulations, planning and investments at all levels. More specifically, IMI-SDG6 aims to support countries to collect, analyse and report SDG 6 data, and to support policymakers and decision makers at all levels to use these data.

- Learn more about SDG 6 monitoring and reporting and the support available: http://www.sdg6monitoring.org

- Read the latest SDG 6 progress reports, for the whole goal and by indicator: https://www.unwater.org/publication_categories/sdg6-progress-reports/

- Explore the latest SDG 6 data at the global, regional and national levels: http://www.sdg6data.org

UN WATER INTEGRATED MONITORING INITIATIVE FOR SDG 6



INDICATORS	CUSTODIANS
6.1.1 Proportion of population using safely managed drinking water services	WHO, UNICEF
6.2.1 Proportion of population using (a) safely managed sanitation services, and (b) a handwashing facility with soap and water	WHO, UNICEF
6.3.1 Proportion of domestic and industrial wastewater flows safely treated	WHO, UN-Habitat, UNSD
6.3.2 Proportion of bodies of water with good ambient water quality	UNEP
6.4.1 Change in water-use efficiency over time	FAO
6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	FAO
6.5.1 Degree of integrated water resources management	UNEP
6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation	UNECE, UNESCO
6.6.1 Change in the extent of water-related ecosystems over time	UNEP, Ramsar
6.a.1 Amount of water and sanitation-related official development assistance that is part of a government-coordinated spending plan	WHO, OECD
6.b.1 Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management	WHO, OECD

UN-Water Foreword

We stand at a critical juncture. At the midpoint of the United Nations 2030 Agenda for Sustainable Development, we risk failing to meet the promise of SDG 6 – to ensure the availability and sustainable management of water and sanitation for all.

The 2024 series of indicator reports, published by the UN-Water Integrated Monitoring Initiative for SDG 6 (IMI-SDG6), depict a crisis with profound repercussions for many other SDGs, particularly those related to poverty, food, health, education, gender equality, sustainability and environmental integrity.

Billions of people worldwide are still living without access to safely managed drinking water and sanitation services. Water pollution levels are alarmingly high. Inefficient water use practices are common. Water scarcity is a growing problem. Degradation of water-related ecosystems continues unabated. Governance and transboundary cooperation on water resources are too weak, and every continent suffers the impacts of inadequate investment in water and sanitation infrastructure.

Despite concerted efforts and global commitments, we are compelled to acknowledge that progress so far has been insufficient to meet all eight targets of SDG 6. In some regions and countries, for some indicators, progress is even reversing.

However, over the past year, the UN-Water family has come together to develop a response that aims to accelerate progress through a more holistic and integrated approach.

After the UN 2023 Water Conference, in response to the high ambitions set by Member States, UN-Water released the Blueprint for Acceleration: SDG 6 Synthesis Report on Water and Sanitation 2023, which identifies two crucial needs: for Member States to develop a UN political process for water and for the UN system to better unify its water-related efforts to support Member States.

On the first, Member States adopted a resolution that, among other things, established two future UN water conferences – one in 2026 and one in 2028.

On the second, the resolution requested of the UN Secretary-General to present a United Nations system-wide water and sanitation strategy in consultation with Member States. The Secretary-General looked to UN-Water, under my leadership, to assist with this.

The strategy will be presented in July 2024: the middle of a year that marks a pivotal moment in our collective journey towards achieving SDG 6. It is time to redouble our efforts, recalibrate our strategies, and mobilize resources to make good on our commitments to global society and the future of our planet.

We face unprecedented challenges, but we now have unprecedented tools and political momentum. The data and insight gathered by the IMI-SDG6 must guide our prioritization of efforts and investments to the areas of greatest need, ensuring no one is left behind.

Thank you for your unwavering dedication to this vital cause.

Alvaro Lario,
President of the International Fund for Agricultural Development (IFAD) and Chair of UN-Water

UNEP Foreword

Water is vital to human and planetary health and the internationally agreed goals that back it, including the 2030 Agenda for Sustainable Development, the Kunming-Montreal Global Biodiversity Framework, the Sendai Framework and the Paris Agreement. Yet the triple planetary crisis – the crisis of climate change, nature and biodiversity loss and pollution and waste – is affecting the availability, distribution, quality and quantity of water.

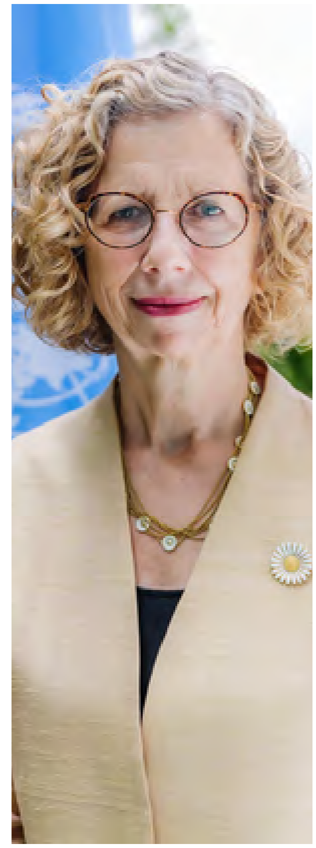
Sustainable Development Goal (SDG) 6 on water and sanitation for all is alarmingly off-track. About two billion people lack access to safe drinking water, while roughly half of the world's population experiences severe water scarcity for at least part of the year. The human rights to water and sanitation and to a clean and healthy environment are not being delivered. Climate change and population growth are expected to worsen the situation. Data indicates that the health and livelihoods of 4.8 billion people could be at risk by 2030 if water quality and monitoring is not improved.

Countries are taking positive steps. Following the 2023 UN Water Conference, countries and partners have secured over 800 commitments on water. Member States passed the UNEA 6 Resolution on Water, which aims to accelerate the achievement of SDG 6. Some 45 countries and the European Union have joined the Freshwater Challenge, which backs the restoration of 300,000 km of degraded rivers and 350 million hectares of degraded wetlands by 2030. But we must do more.

The key to increased ambition and action is decision-making based on accurate and timely data. This is where the SDG 6 indicators come in. UNEP has been working with Member States over the past three years to provide data for this series of reports on the three indicators for which the organization is custodian – water quality, integrated water resources management and changes to freshwater ecosystems.

UNEP's analysis of water-related ecosystem data shows that half of countries have one or more freshwater ecosystem type in degradation. River flow has significantly decreased in 402 river basins, a fivefold increase from 15 years ago. Surface water bodies are shrinking or being lost in 364 basins. Droughts, floods and water scarcity are impacting more people. There is ineffective revenue-raising to turn water laws, policies and plans on integrated water resources management into practice in 60 per cent of reporting countries.

While this is, of course, bad news, it does at least tell nations where to direct efforts to manage water resources and freshwater ecosystems better. Data matters, and countries are supplying more of it than ever. Some 120 countries reported on the water quality indicator in 2023 – significantly more than in 2020. Citizen science-generated data is also now being used. But we still need to fill critical gaps, because when we show that integrated water management bolsters other development objectives, we can secure political will, adequate resources and real progress on SDG 6.



Inger Andersen,
Under-Secretary-General of the United Nations and Executive Director of UNEP

Executive Summary

At the time of launching this report, little over 5 years remains before the world reaches the historic target timeline set by UN Member States to achieve the ambitions of the 2030 framework for sustainable development. SDG Target 6.6, which seeks to protect and restore water-related ecosystems, is a target that is fundamental to the achievement of sustainable development both within Goal 6 and across much of the framework. Our freshwater ecosystems are among our most valuable ecosystems, being not only biodiverse-rich, essential for food and water security, transport, power generation and so much more, but also critical for our health, prosperity and survival.

SDG Target 6.6 evolved from the Aichi biodiversity targets, and directly threads through the newly adopted Global Biodiversity Framework connecting with the environmental dimension of the SDG framework. The representation of freshwater ecosystems within biodiversity and development frameworks, alongside several multilateral environmental agreements, demonstrates the urgency that member states have placed on safeguarding freshwater ecosystems.

With data availability rapidly increasing through the update and use of Earth Observations (EO), data on freshwater ecosystem changes are now readily observable over long time periods, allowing us to glance back into the past and compare the state of ecosystems then with their state today. Through this lens, the direction of travel is clear. The data in this report speak loudly – that our freshwater ecosystems need our attention and action. As with many environmental concerns of our present time, the time to act is now. Now is the time for countries to take decisions to invest in the long-term restoration and protection of our freshwater ecosystems.

This report shines a light on the state of freshwater ecosystems today. Through EO data we can observe when and where ecosystems are degraded and although no comprehensive suite of data exist for each and every ecosystem the world over, the proxy information available from satellite imagery, does provide a strong evidence base for freshwater ecosystem changes, and the data through which to sound an alarm on the extent degradation is occurring. The report highlights trends, both positive and negative, occurring to surface water, river flow, lake pollution and mangroves.

While the report does not assess the extent, nature or impact of freshwater policies, laws and practices, the data trends observable through SDG indicator 6.6.1, point to the need for increased attention and action by governments towards greater freshwater ecosystem restoration and protection, through integrated management to address multiple pressures. We can attribute freshwater ecosystem changes to human interaction and the exacerbating effects of climate change. It comes as no surprise that land conversion, construction of dams and reservoirs, over abstraction, and pollution drive freshwater ecosystems loss and degradation in many countries. It is now the experience of many people that climate change is felt directly through changes to the quality, quantity and availability of water. Recognizing that freshwater ecosystems matter to each and every one of us today, and are crucial for future generations to live sustainably, it is hoped this report helps to expedite decisions and actions on freshwater ecosystems.

How SDG indicator 6.6.1 data are analysed, interpreted and presented in this report

This report offers a periodic update on global and regional status and trends of water-related ecosystem changes, assessed through the analysis and interpretation of data reported for SDG indicator 6.6.1. The report's findings and key messages benefit from a brief upfront explanation on the language of the target and the indicator, the agreed use of Earth observation data to assess ecosystem changes, and the analysis and interpretation approach used to present status and trends information.

Understanding indicator 6.6.1 and its relationship to the target

SDG Target 6.6 encompasses the broad and ambitious goal of **protecting and restoring water-related ecosystems, including mountains, forests, wetlands[1], rivers, aquifers, and lakes**. Notably, the target is not quantified at the global level. As such, the target exists without information on the level of ambition expressed as a number or area of water-related ecosystems needing protection and/or restoration.

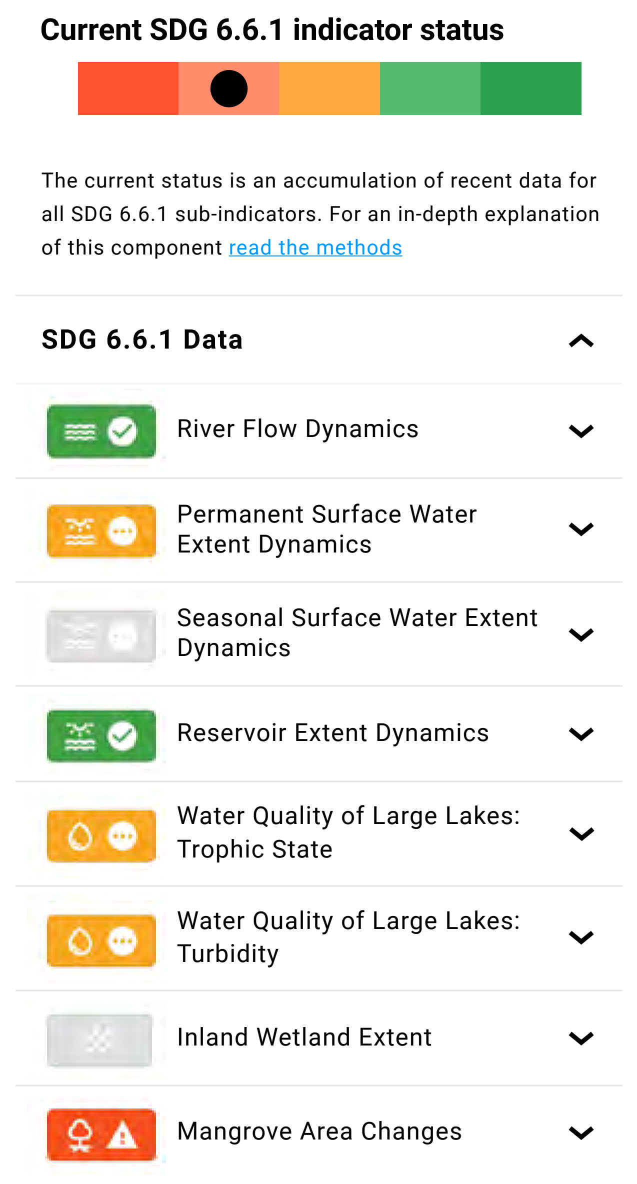
Target 6.6 has only one indicator, 6.6.1, which does not directly measure progress towards the target but provides provides information on the state of water-related ecosystems. The indicator assesses the **extent water-related ecosystems change over time.** While the target language speaks of *protecting and restoring ecosystems*, the indicator itself is not policy-oriented. Rather, it is designed to gauge the functional properties of an ecosystem and thereby determine if these properties and the ecosystem is in a state of degradation. As such the indicator assesses changes in three bio-physical characteristics, namely **ecosystem area**, the **quantity** and **quality** of freshwater within a range of different types of water-related ecosystems. As the indicator does not measure protection and restoration actions, the indicators' use of tracking biophysical changes is intended to show where freshwater ecosystems experience significant changes in water quantity, quality and area, over time, and therefore requires long time series data to enable comparison to a baseline reference period. Through this approach of assessing long-term physical changes, the indicator aims to observe statistically significant changes. Where a negative trend is identified for example reduced river flow or increased lake pollution, the ecosystem is considered to be in a state of degradation and in need of protection and/or restoration actions. The indicator does not assess the cause of the degradation, only that degradation has occurred, identifying also the ecosystem type, location and time period.

Data monitored and analysed by indicator 6.6.1

As a result of the complexity of monitoring dynamic ecosystem changes, the indicator is multifaceted by design. It aims to capture high-resolution, dynamic changes to ecosystem properties (area, quantity, quality) over time for many different types of freshwater ecosystems. Subsequently, there is no single time series of data being captured. Instead, eight distinct sub-indicators are measured using currently available data. Each one measures a specific characteristic of an ecosystem e.g. lake quality, river quantity, wetland area, permanent/seasonal water area, etc. The eight sub-indicators are: River flow, Permanent water area, Seasonal water area, Reservoir water area, Water quality (trophic state) of lakes, Water quality (turbidity) of lakes, Inland wetland area, and Mangrove area. Satellite Earth observation (EO) data, periodically approved by Member States, are used to assess the properties of the different freshwater ecosystems. These EO data are readily available, high resolution, statistically robust, and provide for international comparability and allow for the generation of long-term data trends.

1 The definition of wetlands used for SDG indicator 6.6.1 data as reported by UNEP refers to inland vegetated wetlands which are mapped according to the following definition: "Inland vegetated wetlands include areas of marshes, peatlands, swamps, bogs and fens, the vegetated parts of floodplains as well as rice paddies and flood recession agriculture". The method only measures inland vegetated wetlands and not coastal mangroves which are disaggregated and reported as a separate sub-indicator.

Categorizing ecosystems as degraded and determining the national indicator status



All sub-indicator statistics for 6.6.1 are reported to the United Nations Statistics Division, however, to aid interpretation and understanding of the enormous volume of EO data, UNEP perform analysis on the data to determine statistically significant deviations and to categorize the state of ecosystems (see image left). Sub-indicators are categorized using a traffic light colour system. Through this approach, the state of ecosystems can be identified as degraded (red), stable (orange), or improving (green), compared to a reference period.

As the example in the left image shows, a country can readily identify which ecosystem type may be experiencing degradation, allowing them to readily focus action and intervention towards that ecosystem. The national indicator information – as well as sub-national information on lakes and the basin – is provided online at UNEP's Freshwater Ecosystems Explorer (https://www.sdg661.app) where countries can also observe where degradation is occurring. Based on the status of the sub-indicators[2], a country's national indicator status is also determined. Country status is presented as a colour code that depict degradation status, determined by aggregating the sub-indicators[3] to identify national status within a five-tier traffic light. A country with one (light red) or more (dark red) of its sub-indicators is identified as degraded. To perform the regional and global analysis on the number of countries with degraded ecosystems', the country status, as presented in the key messages of this report, is assessed using absolute numbers and measured over time, in 5-year time intervals since 2000. This means the 185 countries for which we have indicator 6.6.1 data since the year 2000 are assessed every 5 years to generate global status and trend information.

2 Seasonal surface water data is excluded as part of the national aggregation because an increase or decrease in seasonal water cannot confidently be attributed to positive or negative changes in any given location, however these data are presented at national and basin levels on UNEP's Freshwater Explorer. Inland wetlands data are currently only available as a baseline and therefore also not included in the national score aggregation.

3 These scores are aggregated into a national status, applying the following principles: if one or more sub-indicators is a state of degradation, the national summary score indicates (red). When no sub-indicators are degraded, the national score indicates stability (amber). It shows improvement (green) if one or more sub-indicators are improving without any degraded ecosystems.

It is important to stress that UNEP's presentation of the information on global and regional status and trends is not a scientific method. Data used are collected from Earth observation and are themselves a proxy for ground-based measurements. A sub-indicator statistical scoring system has been applied, followed by an aggregation method. This report therefore presents information on the extent of ecosystem degradation, which may be understood as a proxy measure from which progress and achievement towards the target is only inferred.

The interpretation of national status does not infer that policies and practices aimed to protect and restore freshwater ecosystems are not in place. As such, information in this report should be treated as an indication of the state and trends of water-related ecosystems, recognizing the challenges and limitations of data availability associated with measuring high resolution, statistically robust changes to dynamic ecosystems the world over.

Main Findings and Messages

Key findings and messages from aggregated freshwater ecosystem indicator data

A global aggregated analysis of water-related ecosystem data reveals that in 50 per cent of countries, currently, one or more water-related ecosystem types are in a state of degradation. This equates to more than 90 of the 185 countries reporting on indicator 6.6.1. These degraded ecosystems deserve utmost attention in protection and restoration policies.

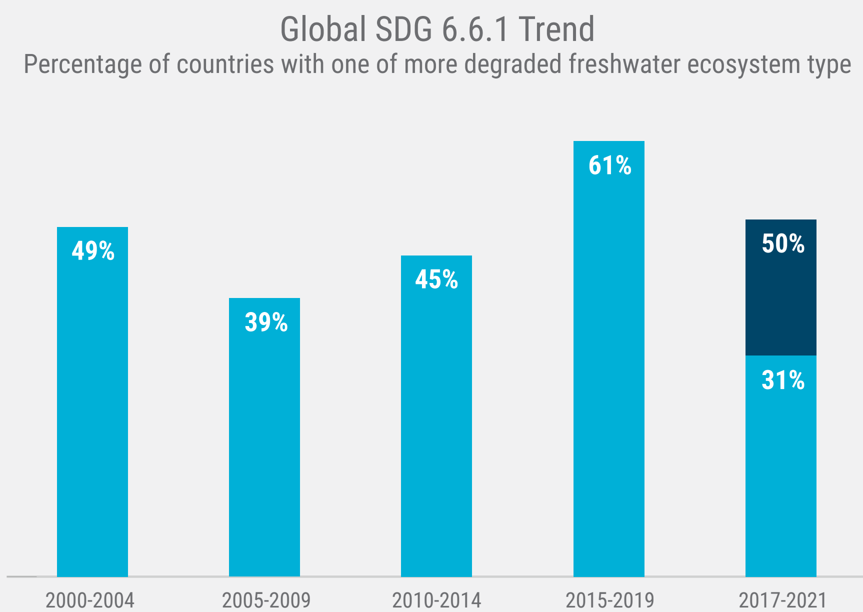


Figure 1: Graph showing the percentage of countries with one of more ecosystems in a state of degradation

During the observation period following the introduction of the SDGs in 2015, ecosystem degradation appears at its highest with 61 per cent of countries having one or more water-related ecosystem type in a state of degradation. The subsequent, and most recent, 5-year observation period (2017-2021) then shows an improvement with 31 per cent of countries having one or more water-related ecosystem type in a state of degradation. This is a positive trend of the comparable sub-indicator data that follows the introduction of the SDGs. However, as reflected within the statistics of the bar chart, following the introduction of newly available data on water quality within the recent observation period, the number of countries categorized with having degraded freshwater ecosystems rises by 19 per cent, and a resultant 50 per cent of countries are currently observed as having one or more water-related ecosystem type in a state of degradation.

The degradation of freshwater ecosystems, characterized by changes in the quantity and quality of water and/or loss of ecosystem area, directly impacts opportunities to develop sustainably and for nature to survive and thrive. The number of countries with degraded freshwater ecosystems is concerning because healthy and functioning freshwater ecosystems are essential for ensuring water and food security, mitigating climate impacts, and preserving biodiversity, as well as providing a broad range of ecosystem goods and services to society and the planet. The SDG 6.6.1 data trends show water-related ecosystems are continuing to face significant levels of degradation. This is primarily driven by pollution, dams, land conversion, over-abstraction, and climate change.

For people, the degraded freshwater ecosystem will be experienced through a loss of available drinking water, which can increase the time and effort of women and girls who often bear the primary responsibility for collecting water, affecting their health, education, and economic opportunities, as well as reducing capacity to sustainably irrigate food crops, and an increase in the severity and frequency of climate change impacts. For nature, freshwater ecosystem degradation can be catastrophic and, for example, has resulted in an enormous decline in freshwater species populations globally – 83 per cent since 1970 (WWF 2022) – and with 25 per cent of the world's freshwater fish species now threatened with extinction (Fennessy *et al.* 2018) due to changes in streamflow patterns, pollution, overfishing, climate change, and invasive alien species (IUCN 2023). Migratory animals, particularly migratory birds rely on the continued function of healthy freshwater ecosystems to survive but as recently reported in UNEP's State of World Migratory Species report (UNEP-WCMC 2024), half of the biodiversity areas needed for migratory species are not protected, with exploitation and habitat loss cited as the two greatest threats to migratory species' survival.

Transposed to a regional picture, four of the eight SDG regions have 50 per cent of their countries with a national indicator status score reflecting degraded freshwater ecosystems.

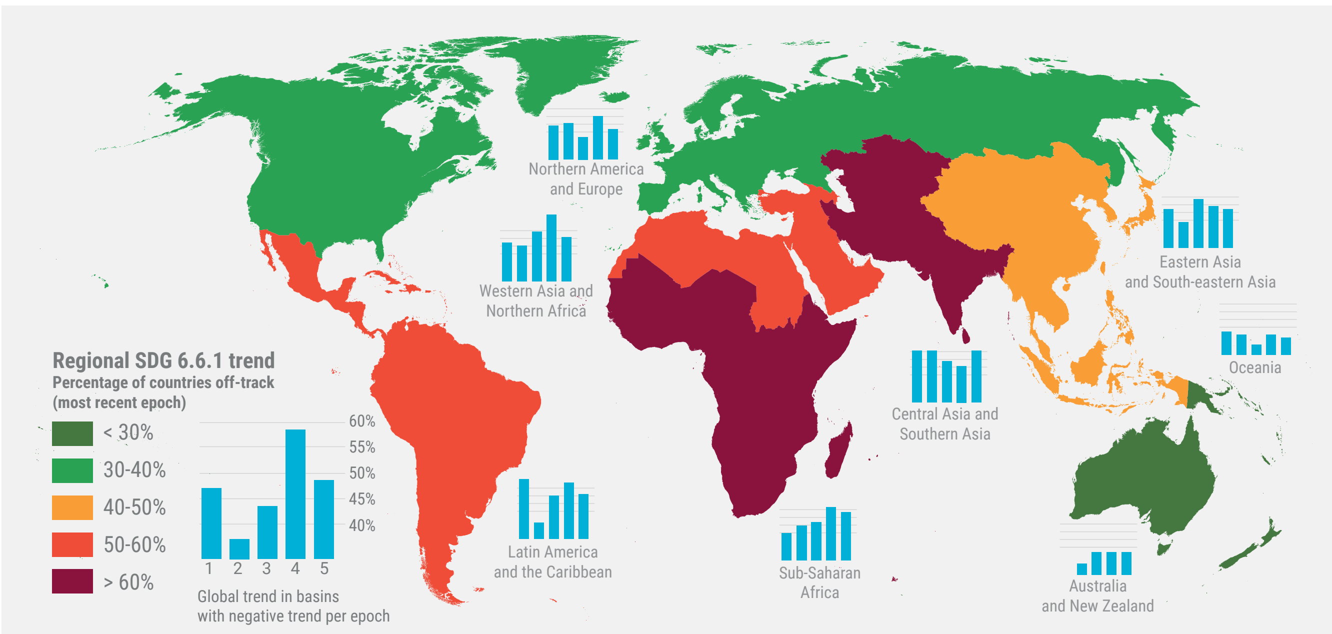


Figure 2: Map of SDG regions showing percentage of countries within each region each region with degraded freshwater ecosystems for for the current five-year observation period (2017-2019)

The need for urgent action, at scale, is apparent not only in the SDG 6.6.1 data but exists within the goals and targets committed to by countries through multilateral environmental agreements in addition to the SDG framework[4]. Countries can be encouraged that national actions to protect and restore freshwater ecosystems under SDG Target 6.6 directly contribute towards achieving climate, biodiversity, and other environmental goals and targets. However, approximately 50 per cent of countries report limited or ad-hoc management of water-related ecosystems and biodiversity (through SDG indicator 6.5.1 (UNEP 2024), Figure 3).

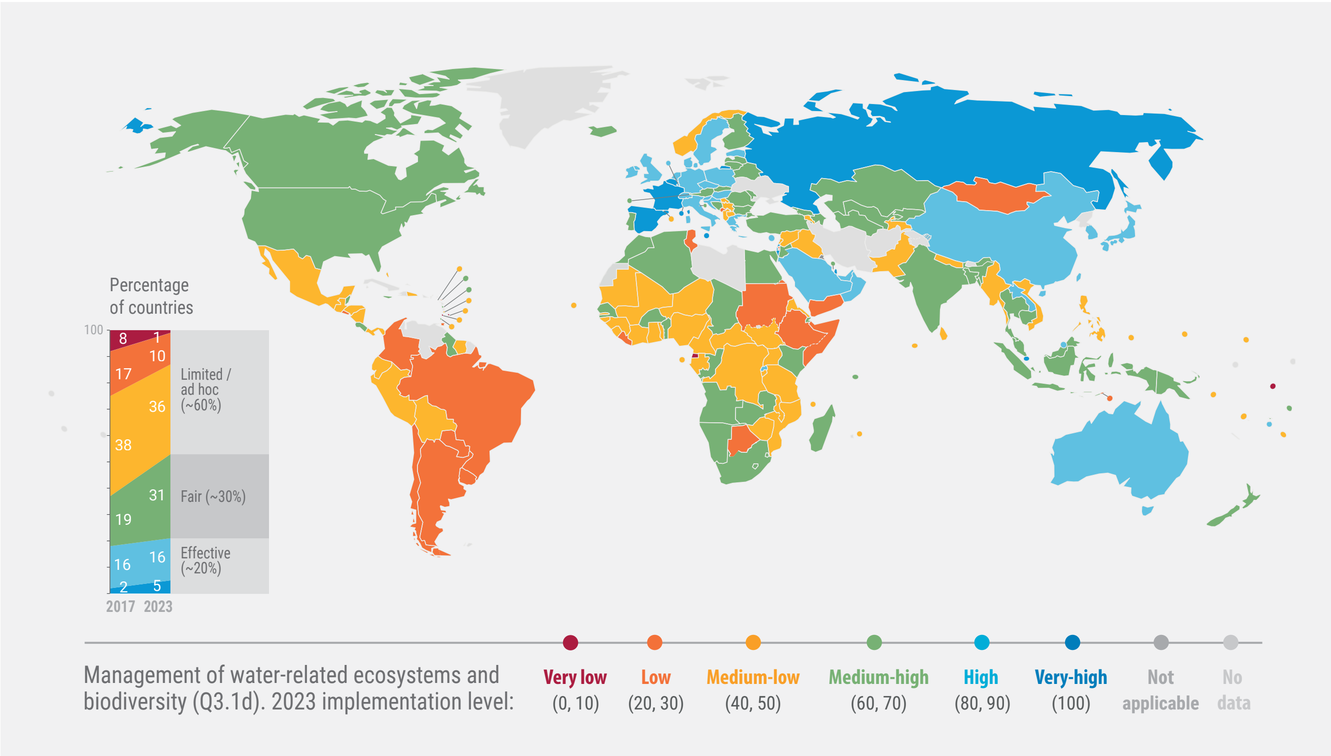


Figure 3: Degree of development and implementation of management instruments for water-related ecosystems and biodiversity (SDG indicator 6.5.1, question 3.1d) (Source UNEP 2024)

The interdependent and interconnected nature of freshwater ecosystems means that actions taken to address ecosystem degradation must ensure all freshwater ecosystems remain hydrologically connected, across rivers, lakes, wetlands, and groundwater systems.

Limiting degradation of water-related ecosystems is achievable but requires Member States to include action on those ecosystems in the protection and restoration plans and policies that they develop according to SDG Target 6.6.

To achieve this, it is important for environmental authorities to be able to communicate the value of ecosystems to various economic sectors and in disaster risk reduction. Applying frameworks such as integrated water resources management (IWRM, SDG 6.5.1) and the Water-Energy-Food-Ecosystems Nexus supports these objectives.

4 Action on SDG Target 6.6 directly contributes to the goals and targets of other multilateral environmental frameworks including the Kunming Montreal Global Biodiversity Framework, the Sendai Framework on Disaster Risk Reduction, the Ramsar Convention on Wetlands, and recent global resolutions like the United Nations Environment Assembly resolution on effective and inclusive solutions for strengthening water policies to achieve sustainable development in the context of climate change, biodiversity loss, and pollution.

Key findings and messages from the sub-indicator data

River flow has significantly decreased[5] in 402 (of 12,572) river basins worldwide. This is a fivefold increase from 15 years ago. An estimated 107.5 million people live in the 402 river basins impacted by reduced river flow.

Figure 4: Global map showing river basins experiencing a loss (red colour) or gain (green colour) in minimum river flow in the current observation period (2017-2021) compared to the baseline reference period (2000-2019)

The observed decrease in the quantity of water flowing through so many river systems globally is detrimental to nature, particularly freshwater biodiversity populations, and impedes crucial hydrological flows to other inter-connected and interdependent freshwater ecosystems, such as lakes, wetlands and groundwater aquifers. The changes in river flows can be attributed to land use change affecting runoff, and climate change affecting precipitation, temperature, and evapotranspiration.[6] In the broader context, river fragmentation through construction of dams and reservoirs impacts natural flow regimes and is highly detrimental to freshwater biodiversity. Today, just one-third of the world's longest rivers remain free-flowing (WWF 2019) mostly in remote regions of the Arctic, Amazon, and Congo basins.

There are positive developments happening to look to and build upon going forwards. At the United Nations Water Conference in March 2023, 842 commitments (UN-Water 2023) were made to boost action on water and many of these seek to protect and restore degraded freshwater ecosystems. More recently, a coalition of governments launched the Freshwater Challenge (UNEP 2023), the largest-ever initiative to restore degraded rivers, lakes, and wetlands, now joined by 46 countries, including the United States (The White House 2023). Such global political commitments and initiatives are a very positive step in the right direction, and these must now be translated into real action on the ground.

5 See Annex 1 methodology. The observations show statistical changes that are outside long-term natural variation.

6 The attribution to land use changes and climate change is because the Global Hydrological Model used to monitor river flows for SDG indicator 6.6.1 does not account for water abstraction from rivers. As such, the model only considers natural hydrological processes and changes including rainfall, runoff, and river discharge. See Annex 3 for more data and information on river flows global trends.

Surface water bodies, such as lakes, are shrinking or being lost entirely in 364 (of 13,894) basins worldwide. An estimated 93.1 million people live in the 364 river basins where permanent water has been receding.

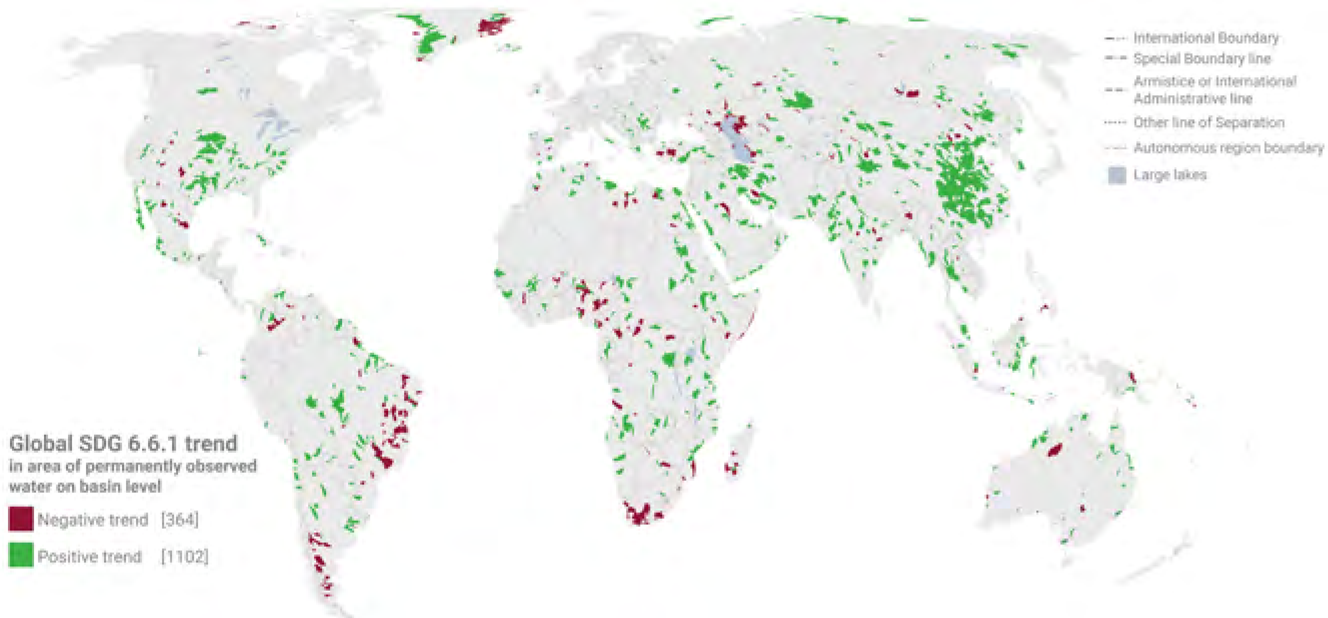


Figure 5: Global map showing river basins experiencing a loss (red colour) or gain (green colour) in permanently observed water in the current observation period (2017-2021) compared to the baseline reference period (2000-2019)

The demands on permanent[7] surface water bodies, predominantly lakes, from human activities to meet food, water, and energy security needs are substantial and increasing. These pressures are mainly responsible for the loss of surface water observed through the SDG 6.6.1 sub-indicator on surface water. However, climate change is contributing to the observed loss, with changes in rainfall impacting replenishment and rising temperatures increasing evapotranspiration and increasing the frequency and intensity of drought.

Lives and livelihoods are put at risk when surface water bodies decrease and such rapid changes in the availability of surface water can drive migration and exacerbate fragile socio-economic conditions. Implementing multi-sector basin management can effectively reduce the loss of surface water by enhancing collaboration across sectors and stakeholders, improving understanding on water use, water efficiency and the risks associated with mis-management.

7 Permanent water is defined as surface water that is present all 12 months of the year.

Many of the world's large lakes continue to have high to extreme levels of turbidity and eutrophication. These freshwater bodies support millions of livelihoods and are critical for freshwater biodiversity. In the 609 river basins where trophic state events have been increasing, an estimated 192.5 million people live, and in the 935 river basins where turbidity conditions have worsened, an estimated 437 million people.

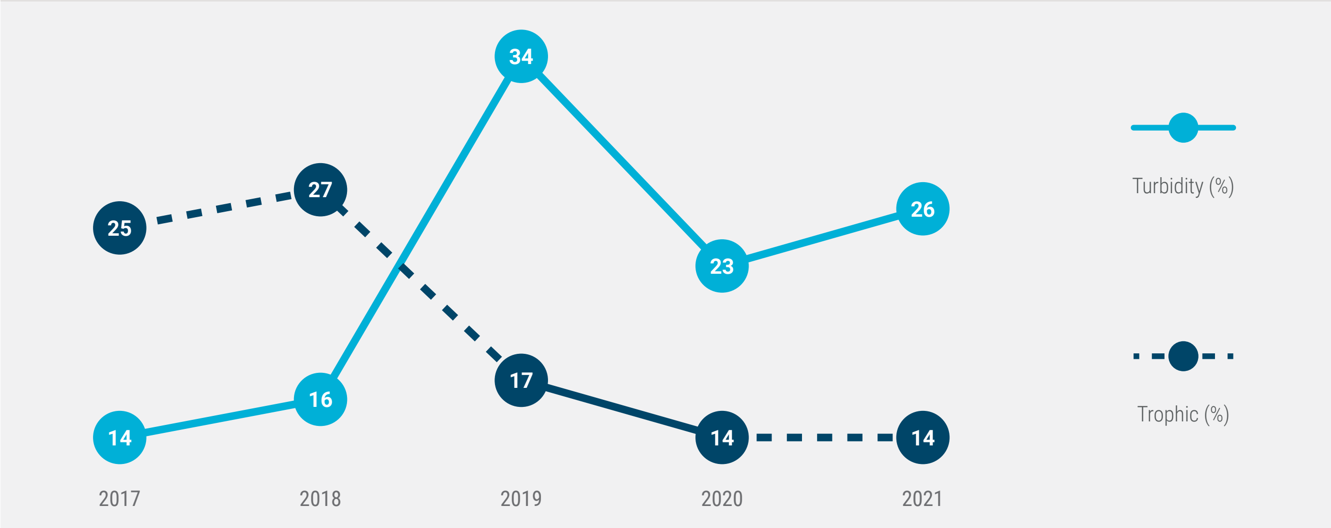


Figure 6: Graph showing global percentages of large lakes with high to extreme changes in levels of turbidity and trophic state

Monitoring water quality changes in the context of SDG indicator 6.6.1 tracks both turbidity (water cloudiness) and trophic state (also referred to as eutrophication) within 4000 large lakes globally.[8] Human activities significantly drive the observed degradation of water quality (UNEP 2023), with eutrophication, originally a natural process of nutrient enrichment in water, now predominantly driven by land clearance for agriculture, urban runoff, urbanization, and industrialization, leading to increased nutrient discharges into water bodies. The global trend is predominantly driven by developments in North America and Europe, which are home to most large lakes (~65 per cent).

Lakes are the source of around 90 per cent of our readily available, unfrozen, surface water. Apart from being a key source of drinking water, they provide important services for people including transportation, energy, cooling, food, and recreation. The inadequate access to drinking water results in increasing inequalities and disproportionately affects women and girls, the poor and the most vulnerable populations (that is slums, people living with disabilities or in remote areas, indigenous peoples and minorities) who suffer most of the impacts of inadequate delivery of drinking water. Urgent action is needed to halt declines in the availability of good quality freshwater. Pollution remains a major driver of aquatic wildlife decline, and globally, water pollution has continued to worsen over the last two decades, increasing the threats to freshwater ecosystems and human health. According to UNEP's 2021 flagship report, Making Peace with Nature (UNEP 2021), in the six years remaining until 2030 a business-as-usual approach will not suffice. A comprehensive step change in the pace of implementation is imperative to close the global gap on SDG target 6.6. In March 2022, the United Nations Environment Assembly passed a resolution on Sustainable Lake Management (UNEP 2022). Such political commitment by Member States to address lake health is essential.

8 Large lakes are defined as those with a size of 300 metres x 300 metres or greater, which equates to 3988 observed lakes. Annual observations, available since 2017, are compared with a historic 5-year baseline period (2006-2010).

To move from commitment to action in a world where degraded lakes are restored and have good water quality requires political will but also financial resources. However, official development assistance commitments to the water sector decreased by 12 per cent from 2015 to 2021, and actual disbursements decreased by 15 per cent over the same period, despite the increased funding needed to meet SDG 6 targets (UN Water 2023).

Increased international investment in nature-based solutions to restore, maintain, and sustainably use freshwater ecosystems is desperately needed. Investing in lakes, other freshwater ecosystems and nature more broadly should embrace innovative technologies (GEO 2023) that help countries with water-related ecosystems and enable joined-up landscape-to-seascape planning.

Contextual Information on the SDG 6.6.1 Indicator Method, Data, Analysis and Presentation

Use of satellite Earth Observations to track changes to water-related ecosystems for Target 6.6

SDG indicator 6.6.1 measures the change in the extent of water-related ecosystems over time, relying on data derived from satellite Earth Observations (EO) to provide consistent temporal and spatial information for monitoring. Satellite data enables the observation of changes in surface water bodies' area and quality, as well as alterations in the area of inland wetlands and mangrove ecosystems. Additionally, hydrological models help assess changes in water quantity and river flow.

Satellite observations now serve as a cornerstone for monitoring several indicators[9] within the 2030 framework for SDGs. With an increasing number of satellites offering free and open data policies and global observation capabilities, the Inter-Agency and Expert Group on the Sustainable Development Goal Indicators (IAEG-SDGS) Working Group on Geospatial Information considers EO data reliable, systematic, and cost-effective, making it an effective complement or substitute for nationally-derived data where absent. SDG indicator 6.6.1 is well-suited to using EO-derived data due to its provision of high-resolution, consistent, and accurate information over time and across various ecosystem types, which would otherwise require significant time and resources for national institutions to collect comparatively.

The IAEG-SDGs, tasked with developing and implementing the global indicator framework for the 2030 Agenda's Goals and Targets, has designated the SDG indicator 6.6.1 as a Tier 1 methodology.[10] This designation confirms the application of statistically robust metadata, enabling international comparability of data and coverage of at least 50 per cent of countries.

Several international organizations pursue EO-based programs to monitor changes to surface water bodies and freshwater ecosystems. UNEP collaborates actively with various international partners to support national monitoring and reporting of SDG indicator 6.6.1. For instance, UNEP receives data from the European Commission's Joint Research Centre (EC-JRC) on surface water changes,[11] which analyses over 3 million satellite images from NASA's Landsat archive between 1984-2020. This data quantifies long-term surface water dynamics globally at a 30-metre resolution. The EC-JRC also provides UNEP with data on changes in lake water quality[12] using EO.

Additionally, the multi-partner programme Global Mangrove Watch[13] offers UNEP geospatial information on mangrove extent changes since 1996. DHI,[14] another partner organization, demonstrates how vegetated wetlands can be mapped globally in high-resolution using various satellite imagery (Tøttrup *et al.* 2020). Recently, DHI provided UNEP with a new global dataset tracking river flow since 2000, derived from a new global hydrological model (Murray *et al.* 2023).

These partner organizations collectively provide data for seven sub-indicators monitoring different aspects of water-related ecosystems under SDG indicator 6.6.1, including changes in surface water area, reservoirs, lake water quality, inland wetlands, mangroves, and river flow.

SDG 6.6.1 indicator data are updated annually and shared with countries for no-objection approval, with the most recent global validation occurring in 2023.

9 Earth Observation for sustainable development: Earth Observation in Support of Water Action UN Water Conference Virtual Side Event

10 Metadata 06-06-01a. SDG indicator metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-06-06-01a.pdf

11 Global Surface Water Explorer: https://publications.jrc.ec.europa.eu/repository/handle/JRC109054

12 Copernicus Land Monitoring Service, Lake Water Quality 2019-present (raster 100 m), global, 10-daily – version 1: https://land.copernicus.eu/en/products/water-bodies/lake-water-quality-v1-0-100m

13 Global Mangrove Watch: https://www.globalmangrovewatch.org/

14 DHI: https://www.dhigroup.com

Accessing national, river basin, and lake data on UNEP's Freshwater Ecosystem Explorer

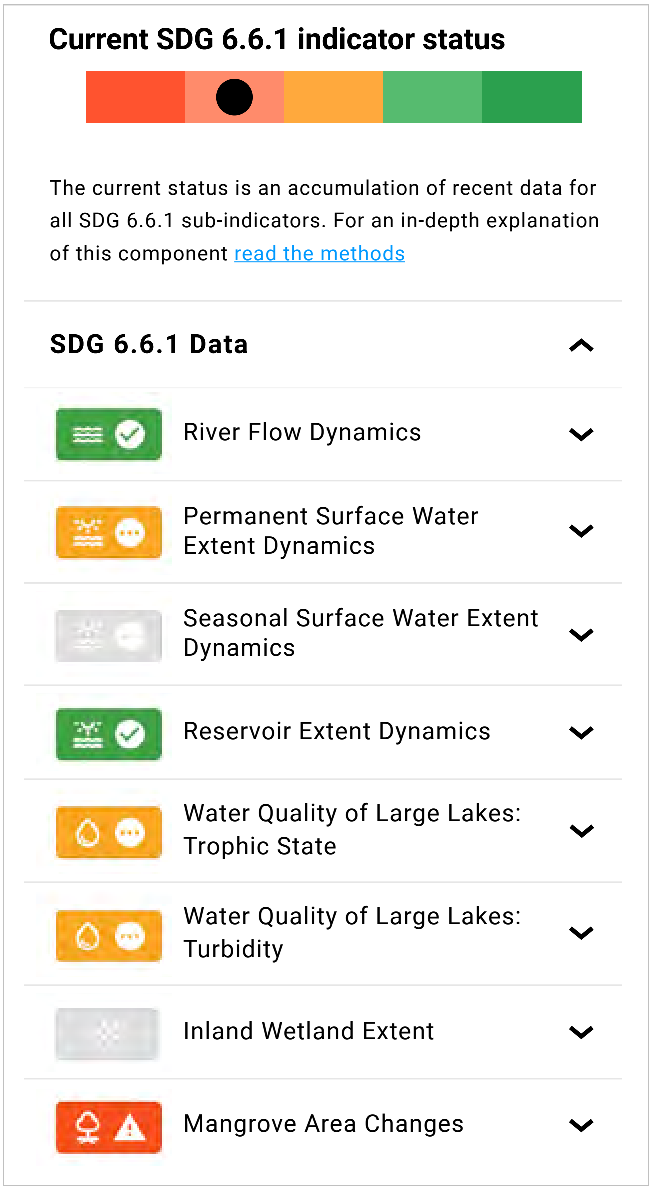
All SDG 6.6.1 data and analysis are consolidated into the Freshwater Ecosystem Explorer (www.sdg661.app), offering countries comprehensive insights into the status and trends of their freshwater ecosystems. This platform integrates data from various ecosystems and properties, providing a holistic understanding of ecosystem changes over time. Key properties measured for indicator 6.6.1 include spatial area (such as the surface area of lakes or inland vegetated wetlands), water quantity (changes in water volumes within lakes or aquifers), and water quality (indicated by water cloudiness or nutrient load within lakes).

In addition to national statistics, the platform also offers data at the river basin level. While national-level statistics are essential for SDG reporting, river basin-level data provide added value by revealing localized changes and highlighting areas within basins experiencing significant changes across one or more sub-indicators. This granularity enables targeted action in specific geographical areas, where water operates within its natural hydrological state.

Figure 7: Screenshot of the Freshwater Ecosystem Explorer SDG 661 data portal (UNEP 2022)

By offering data at both national and river basin levels, the Freshwater Ecosystem Explorer empowers decision-makers, comprising both men and women, with actionable insights to effectively manage and protect freshwater ecosystems.

Interpreting results online on the Freshwater Ecosystem Explorer



National indicator statistics for each of the eight sub-indicators are reported annually to the United Nations Statistics Division (UNSD) as numerical data series in an Excel sheet. While this full suite of numerical data is submitted as official SDG 6.6.1 indicator statistics to UNSD, UNEP also provides interpretation of the data by assessing statistical deviations and applying a traffic-light scoring system to identify significant statistical changes outside of normal variations (see Annex 1). To observe the status and trends of SDG 6.6.1 indicator results on the Freshwater Ecosystems Explorer, and therefore progress towards the target, a traffic-light scoring system is applied which provides status and trends per sub-indicator as well as a national status depending on the number of sub-indicators that are considered degraded or improving. This scoring approach enhances data interpretation and enables observation of national and sub-indicator performance over time, typically in five-year periods. The traffic light score (red, amber, green) visually indicates the status of a sub-indicator and its trend over the previous five-year periods. These scores are aggregated into a national status, applying the following principles: if one or more sub-indicators is a state of degradation, the national summary score indicates degraded (red). When no sub-indicators are degraded, the national score indicates stability (amber). It shows improvement (green) if one or more sub-indicators are improving without any degraded ecosystems.

While this scoring system is purely intended to aid interpretation of freshwater data within the Freshwater Ecosystem Explorer, these statistical evaluations are not reported to UNSD; only the raw national annual data are submitted. However, for global assessment and analysis, evaluating the data using this traffic light approach provides a meaningful way to observe and convey progress over time.

Interpreting results within this report

The approach, as outlined above, used to categorize sub-indicator degradation status, forms the basis for which global and regional level analysis is possible and is presented within this report.

Data series are available between 2000 and 2021 for four of the eight sub-indicators, and in addition, for the most recent 5-year observation period, 2017-2021, two water quality sub-indicators assessing turbidity and trophic state are also included in the global assessment. Prior to this, 2017 water quality data was not available. As such, for the most recent observation period, six sub-indicators are assessed. Seasonal surface water data are excluded from the global assessment because changes in seasonal water cannot confidently be attributed to positive or negative changes, however these data are still presented at national and basin levels on the Freshwater Explorer. Inland wetlands data are currently only available as a baseline and is therefore also not included in this current global assessment, however UNEP intends to include data on changes to inland wetlands within the next global assessment as these data become available in 2025.

How the indicator is performing in the context and requirements of the SDG framework

The performance of SDG 6.6.1 is assessed based on the national approval of statistics during the 2023 reporting cycle. All 193 UN member states were contacted and requested to approve the national statistics available on the Freshwater Ecosystem Explorer[15].

Data availability and coverage vary across sub-indicators:

For surface water sub-indicators (permanent[16], seasonal[17], and reservoirs[18] water area), reliable global data are available from 2000 up to the current data provision period of 2021. However, further historical data from 1984 is available but not utilized due to annual data coverage gaps. Surface water data are accessible for all countries and available at both national and river basin scales.

Water quality[19] sub-indicators rely on data for two parameters, turbidity, and trophic state, to monitor water quality in 4 300 large lakes. Annual data are available for 2017 to 2021, compared to a historic baseline from 2006-2010. Data are available at national and lake-specific scales, excluding smaller lakes.

For the inland wetland[20] sub-indicator, only a global baseline area is available, capturing aggregated peat, marsh, fen, and paddy data from 2016-2018 to create a reference period. New disaggregated inland wetland data will be available in 2026 to show changes over time. Baseline data are accessible for national and basin scales.

15 Freshwater Ecosystem Explorer: www.sdg661.app

16 Permanent water is defined as being present all 12 months per year.

17 Seasonal water is defined as being present less than 12 months per year.

18 Reservoirs are artificial (or human-made) bodies of freshwater, as opposed to lakes which are naturally occurring. The reservoirs dataset represents surface area data on artificial water bodies including reservoirs formed by dams, flooded areas such as opencast mines and quarries, flood irrigation areas, and water bodies created by hydro-engineering projects such as waterway and harbour construction

19 Turbidity is an indicator of water clarity, quantifying the haziness of the water and acting as an indicator of underwater light availability. Trophic State refers to the degree at which organic matter accumulates in the water body and is most commonly used in relation to monitor eutrophication. In this context both water parameters may be used to infer a particular state, or quality, of a freshwater body. The data on the Freshwater Explorer represent the number of lakes impacted by a degradation of their environmental conditions (i.e. showing a deviation in turbidity and trophic state from the baseline) compared to the total number of lakes within a country. The values produced account for different sized lakes, and are categorized into low, medium, high and extreme changes.

20 Inland vegetated wetlands have been mapped on the Freshwater Explorer according to the following definition: Inland vegetated wetlands include areas of marshes, peatlands, swamps, bogs and fens, the vegetated parts of floodplains as well as rice paddies and flood recession agriculture. The available data show the total area of wetland extent in both percentage (relative to total country/basin) area and km^2 units.

Mangrove sub-indicator data include annual area data from 1996 to 2020, with a new annual data series for recent years expected in 2024. Data are available at the national scale.

River basin sub-indicators feature monthly mean river flow data from 2000 to 2021. These data, available at national and basin scales, will be shared for national approval during the new global reporting cycle in 2026.

Interpreting progress towards the target faces challenges due to the lack of an approved aggregation method for the sub-indicators. Raw data per sub-indicator is submitted to UNSD each year and validated by countries every three years (2017, 2020, 2023, 2026, 2029). UNEP has attempted to provide a score at each sub-indicator and nationally using a traffic light scoring system, although these scores are not reported to UNSD. Instead, they are conveyed as analysis on UNEP's indicator data portal, the Freshwater Ecosystem Explorer, forming the basis for global and regional-level analysis in progress reports for SDG indicator 6.6.1.

Limitations of the indicator include its focus solely on water-related ecosystems, excluding other elements mentioned in the target such as forests and mountains. Additionally, the language of the target is not quantified, posing challenges for countries in determining the area of water-related ecosystems to protect and restore. While the indicator aims to interpret the health of water-related ecosystems, challenges remain in assessing ecosystem health subjectively. Core parameters of changes to ecosystems, such as extent, area, quality, and quantity of water, are used instead. The use of EO data helps fill global data gaps but has limitations concerning trust, ownership, replicability of statistical methods, and the challenge of disaggregating ecosystem boundaries across biomes at a global scale.

Full Results from Global and Regional Analysis

The following section presents global and regionally aggregated sub-indicator status and trends, and then each sub-indicator is presented separately.

Globally aggregated status and trends

For the current 5-year observation period, half of all countries have one or more of the six assessed SDG 661 sub-indicators in a state of degradation.

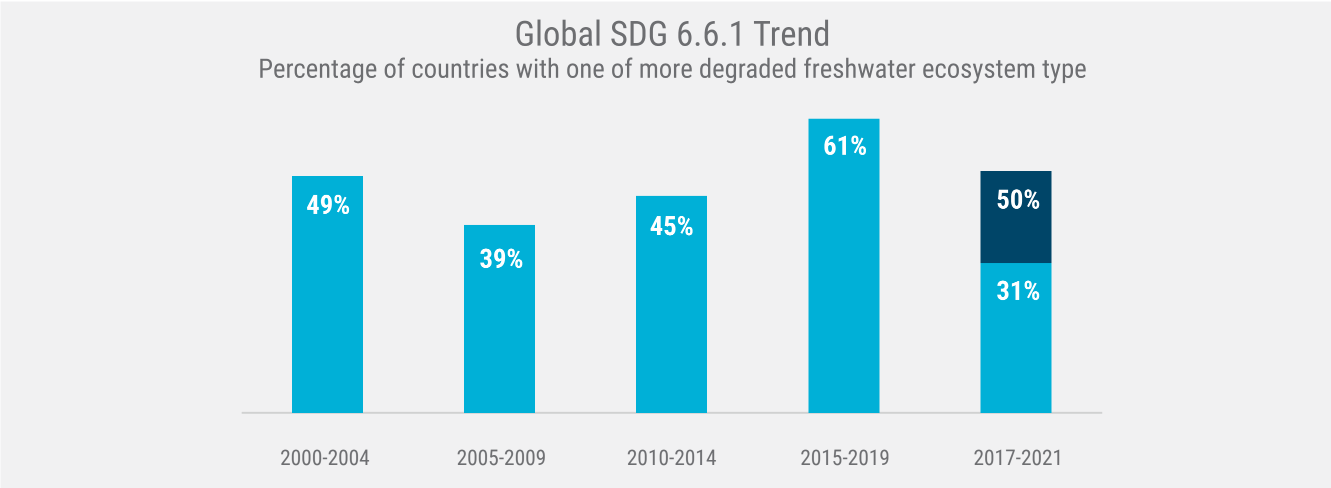


Figure 8: Graph showing percentage of countries with degraded freshwater ecosystems every five years from aggregating the SDG 6.6.1 sub-indicators

A global aggregated analysis of water-related ecosystem indicator data revels that 50 per cent of countries have one of more ecosystem type in a state of degradation currently. This equates to more than 90 countries having one or more water-related ecosystem types in a state of degradation. For the current observation period 2017-2021, two water quality sub-indicators assessing turbidity and trophic state are included in the global assessment. Prior to this period, water quality data was not available. As can be seen from figure 8, these water quality data increase the number of countries globally by an additional 19 per cent. Without these additional water quality data, the global trend would have been positive, with 31 per cent of countries with degraded freshwater ecosystems, however the inclusion of water quality data, although not part of observations prior to 2017, provides an important insight into the state of the world's large lakes and how this essential aspect of freshwater ecosystem health changes the global picture considerably.

The drivers of freshwater changes are numerous and interrelated and, for example, include climate change and variability, land use modifications, pollution, water extraction, infrastructure development, and a lack of protection and effective governance of ecosystems and river basins. To accelerate action, the specific drivers of ecosystem change need to be understood at the ecosystem/river basin level (for example water extraction), and nationally (for example lack of ecosystem protection policy), so that effective, enforceable policy and legislation are tailored to the country context and responsive to the specific causes of freshwater changes within each country.

The construction of dams, reservoirs, and the implementation of water diversion projects significantly modify the natural flow and distribution of inland waters, impacting both ecosystems and the availability of water for human use. Furthermore, the extraction of water for agricultural, industrial, and domestic purposes stands as a major driver of change within inland water bodies. Urbanization, deforestation, and agricultural expansion also contribute significantly to the alteration of landscapes, which in turn affects water infiltration, runoff, and the sediment loads carried into rivers and lakes. Pollution resulting from agricultural runoff, industrial discharges, and untreated wastewater introduces eutrophication, degrades water quality, and leads to the loss of biodiversity in all freshwater ecosystems.

Globally, climate variability, exemplified by phenomena such as El Niño and La Niña, has a profound impact on precipitation and temperature patterns, influencing the levels and flows of inland waters and leading to more frequent and severe droughts or floods. These global influences affect river flows and lake levels, and these factors are very likely contributing to the observable changes captured in the sub-indicator data of SDG 6.6.1.

Recognizing that the scope of SDG indicator 6.6. data is intended only to capture information on the extent to which changes are occurring, this information is intended to drive responsive action. To translate the data into action, countries are encouraged to use the Freshwater Ecosystem Explorer data portal (www.sdg661.app) to identify which specific sub-indicator is degraded with the country, understand where the change is occurring that is which river basin or lake, and determine the drivers and responses needed to address water changes for the degraded basin.

To supplement this data, countries are encouraged to use national SDG 6.5.1 data specifically on the management of freshwater ecosystems and biodiversity (question 3.1d in the SDG 6.5.1 survey). The most recent data shows that approximately 50 per cent of countries report limited or ad-hoc management of water-related ecosystems and biodiversity (UNEP 2024 Figure 9)[21]

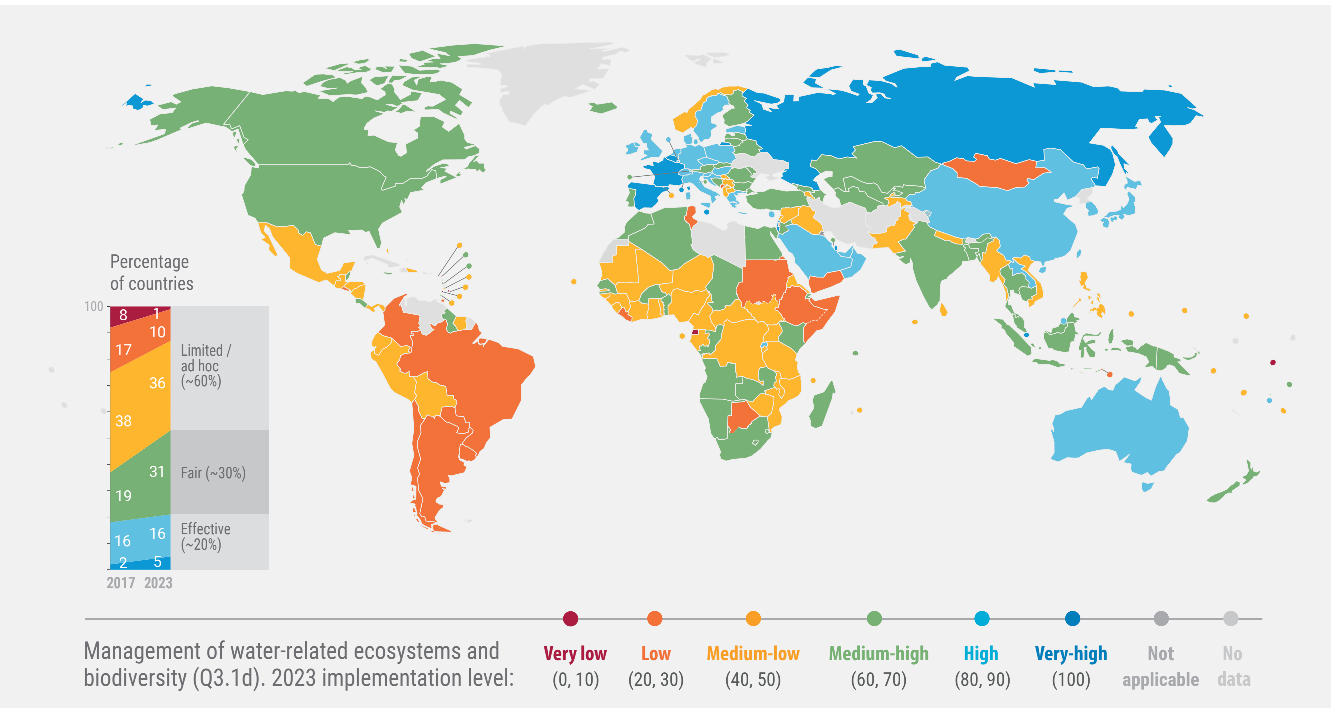


Figure 9: Degree of development and implementation of management instruments for water-related ecosystems and biodiversity (SDG indicator 6.5.1, question 3.1d). (Source UNEP 2024)

21 [1] The free text responses to survey question 3.1d in the 6.5.1 survey provide further information on the management frameworks in place, as well as barriers to implementation and future action. These are available on the IWRM Data Portal: https://iwrmdataportal.unepdhi.org/country-reports.

Regionally aggregated status and trends

Freshwater ecosystem changes are not globally uniform, and there exist significant regional differences, as can be observed through the regional charts, which show the percentage of countries with one of more degraded freshwater ecosystem type within each SDG region, every five years starting in 2000.

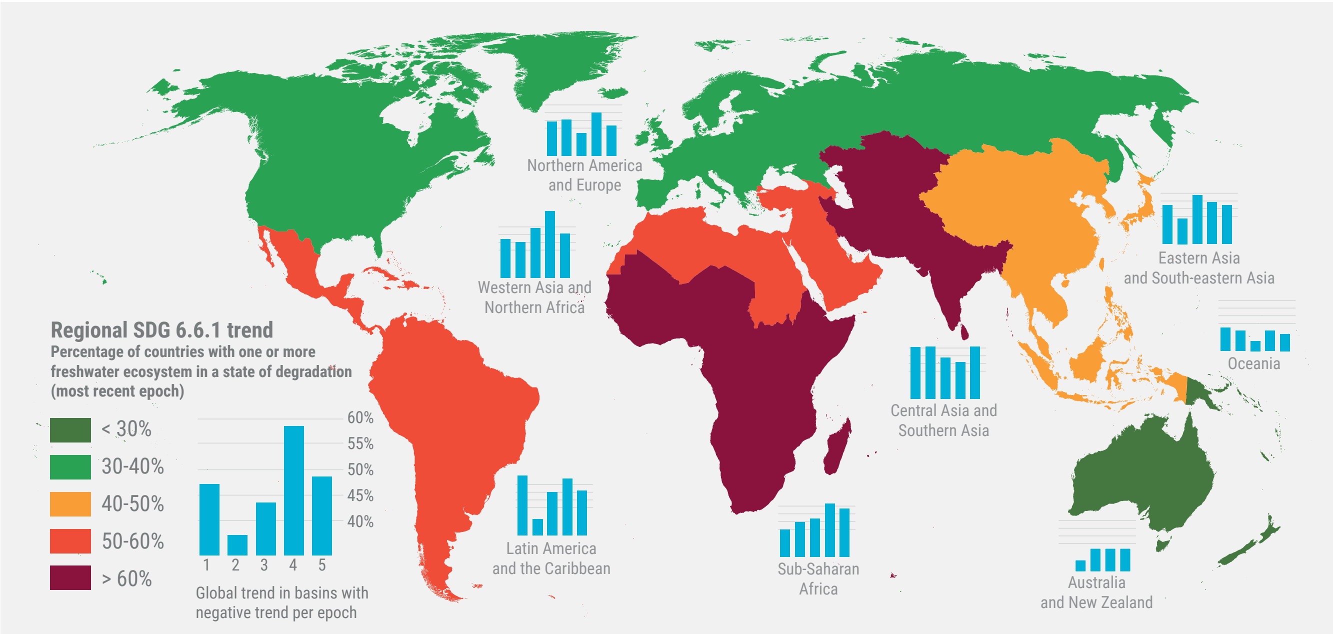


Figure 10: Maps and graphs of each SDG region showing percentage of countries within each region with degraded freshwater ecosystems every five years compared to the reference period (2000-2019)

Analysing the aggregated sub-indicator data across the SDG regions[22] since 2000, shows that Central Asia, Southeastern Asia, and Sub-Saharan Africa are currently reporting over 60 per cent of their countries with degraded freshwater ecosystems. Additionally, Latin America and the Caribbean, as well as Western Asia and Northern Africa, have more than half of the countries represented in these regions classified classified with degraded freshwater ecosystems.

Graphs showing the trends over time, per region, are available in the Annex (see Annex 3). These trend graphs show that the sub-Saharan African region shows a concerning trend of ecosystem decline since 2000, with 30 per cent more countries in the region currently having one or more sub-indicators in a state of degradation compared to 20 years previously. The regions of North America and Europe, Australia and New Zealand, and Oceania represent the three regions with the lowest scores, with 39%, 28%, and 21%, respectively, as the percentage of countries with degraded ecosystems within each of these regions. The only region with a positive trend since 2000 is Oceania.

These trends underscore the diversity of environmental and developmental challenges across regions. They also highlight the importance of developing regional and transboundary solutions for effective environmental management based on regional-level climate variability, geography, and regional socio-economic development priorities.

Inter-governmental regional water coalitions play a vital role in incentivizing countries to accelerate actions to restore degraded freshwater ecosystems and put in place

22 SDG regions and country lists can be found at UNSD: https://unstats.un.org/sdgs/report/2019/regional-groups/

integrated water resources management measures that protect them. The African Ministers Council on Water (AMCOW) and the Conference of Ibero-American Water Directors (CODIA), for example, are two regional level inter-governmental bodies with the mandate and broad political leverage to drive data into action on the ground in their regions and leverage senior political support to raise water-related ecosystems up the political agenda. Further details on regional trends over time are outlined in the Global and Regional Analysis section of this report and time series graphs per region are presented in Annex 3.

SDG 6.6.1 Sub-indicator Analysis

River flow: Global and regional status and trends

Rivers are the lifeblood of human civilization, yet in too many places, they — along with the animals and plants that call them home — are in peril. The 20th century saw population growth and industrialization leading to pollution, damming, excessive logging, and habitat fragmentation, severely impacting fish stocks.

The river flow sub-indicator measures the changes in the volume of water flowing downstream in rivers and estuaries, also referred to as river discharge. The indicator is derived from a global hydrological modelling (GHM) approach (see Annex 2) that produces monthly river discharge data for all river basins globally since 2000.

Globally or regionally-aggregated numbers on changes in minimum river flows, in absolute changes, are not provided as the analytical approach within this report. Analysis of this kind would result in a loss of data accuracy, where, for example, data for a river basin with decreased river flow may be obscured if aggregated with a neighbouring basin with increased river flow. Instead, the data are presented on a global map to highlight river basins observed to have significant changes in their minimum river flow during the 2017-2021 period. The global data are provided as a global trend depicting the proportion of basins (see Annex 1) in a country where minimum river flow has been significantly less than the long-term natural variability observed through the 20year reference period (2000-2019).

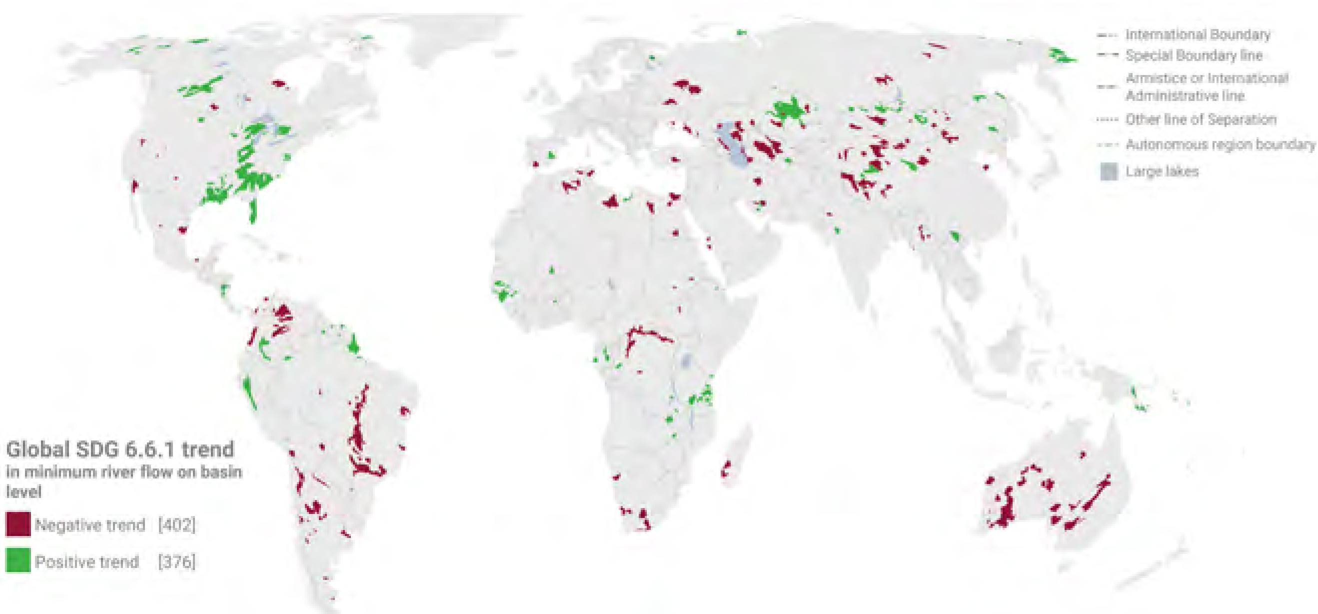


Figure 11: Map showing river basins experiencing a loss or gain in minimum river flow in the current observation period (2017-2021) compared to the baseline reference period (2000-2019)

The above figure shows that 402 out of 12,572 river basins worldwide depict a significant decrease in minimum river flows within the current 5-year observation period (2017-21), compared to the 20-year baseline (2000-2019). While this can be viewed as a small fraction of basins, the value attributed to any one river basin should be determined individually, and the socio-economic cost associated with reduced river water can be extremely high[23]. An estimated 107.5 million people live in the 402 river basins impacted by reduced river flow. Basin-scale assessment is needed to determine the full social, cultural, and economic costs and impacts associated with the loss of river water within these 402 river basins. The significant reduction in the quantity of water flowing through these river systems will impact freshwater biodiversity populations and the quantity and quality able to reach lakes, wetlands, and groundwater aquifers. The global trend over time also reveals that decreased river flows are now occurring within more than five times the number of river basins than was observed 15 years previously.

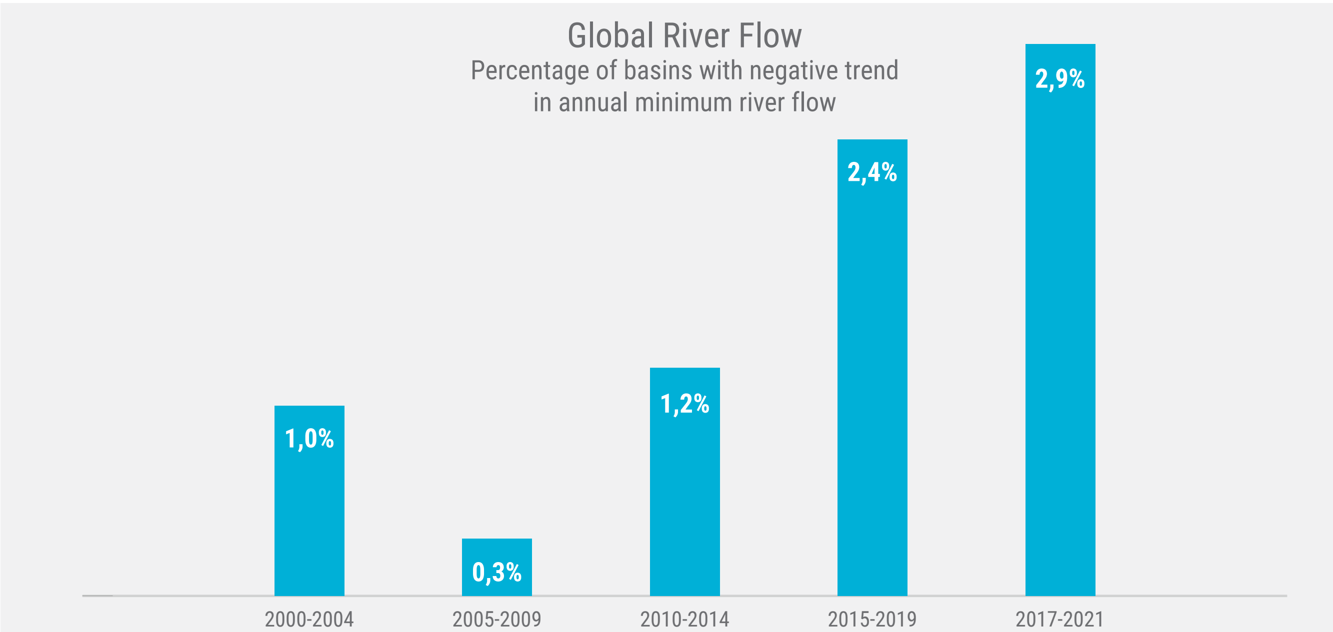


Figure 12: Graph showing the fraction of basins globally with negative trend in minimum river flow, measured every 5 years and compared to a 20-year baseline

In Figure 12, we show the same trend but broken down per SDG region to show the fraction of basins per region with a negative trend in minimum river flow when compared to the 20-year baseline.

The Global Hydrological Model applied to monitoring river flows for SDG indicator 6.6.1 does not account for water abstraction (from human sources) from rivers, and as such, the observed changes in river flow can be attributed to specific causes, namely, land use change which is affecting runoff and climate change which is affecting precipitation, temperature, and evapotranspiration.

23 Murray Darling Basin case study: drought hit Australia: https://stories.sdg661.app/#/story/0/1/0

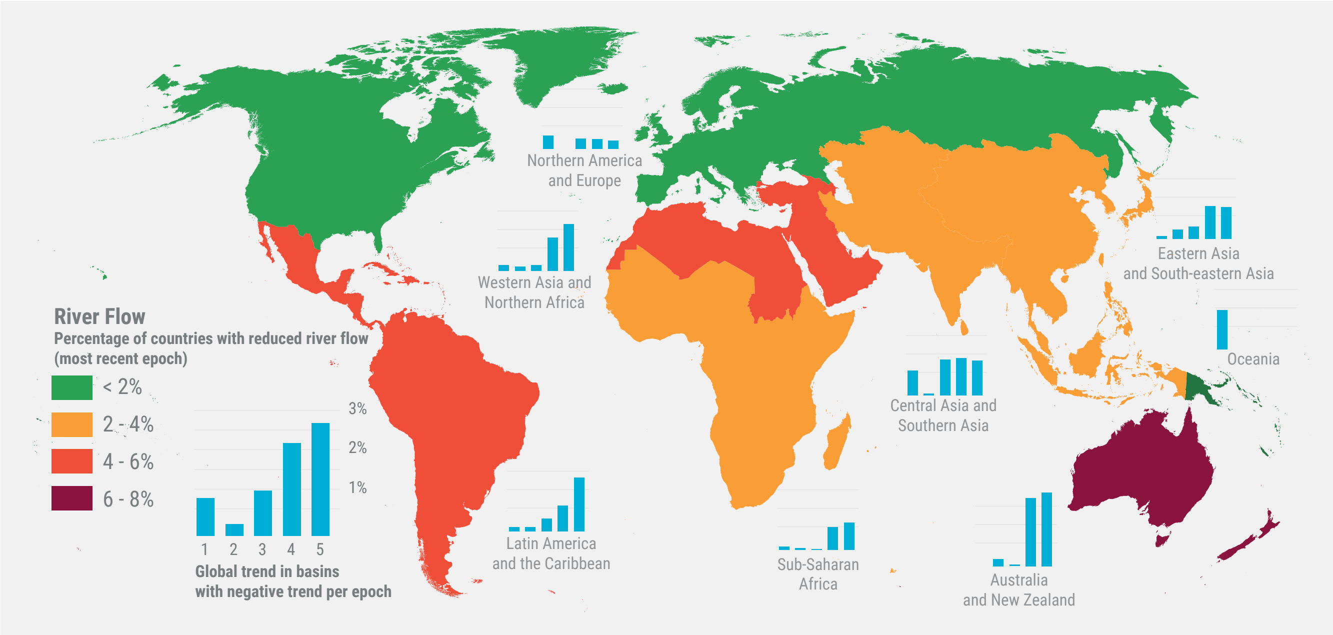


Figure 13. Fraction of basins within each SDG region where minimum river flow is significantly less than the long-term natural variability

Each regional level observation is concerning because they reveal that the percentage of river basins with a significant decline in minimum flow has increased steadily in most regions and globally since the 2005-2009 period. However, there is good news on rivers. As mentioned in the key messages, the Freshwater Challenge shows strong leadership and political ambition by 46 countries.

In addition, in the Netherlands, a 30-year project to restore a 45 km stretch of the river Meuse (Maas in Beeld 2024) has reduced flood risk, diversified nature, and boosted the local economy through tourism. Additionally, some old dams that prevent fish from reaching their spawning grounds are being removed in Europe and North America. Efforts over the past 50 years to restore the Hudson River and its many tributaries have also begun to bear fruit (UNEP 2023).

Permanent surface water: Global and regional status and trends

Permanent water refers to surface water bodies that remain observable throughout the entire year, primarily natural surface water bodies like lakes. However, satellite observations might not distinguish wide rivers or permanently inundated wetlands, though they represent a small fraction of globally-observable permanent surface water within the SDG 6.6.1 dataset.

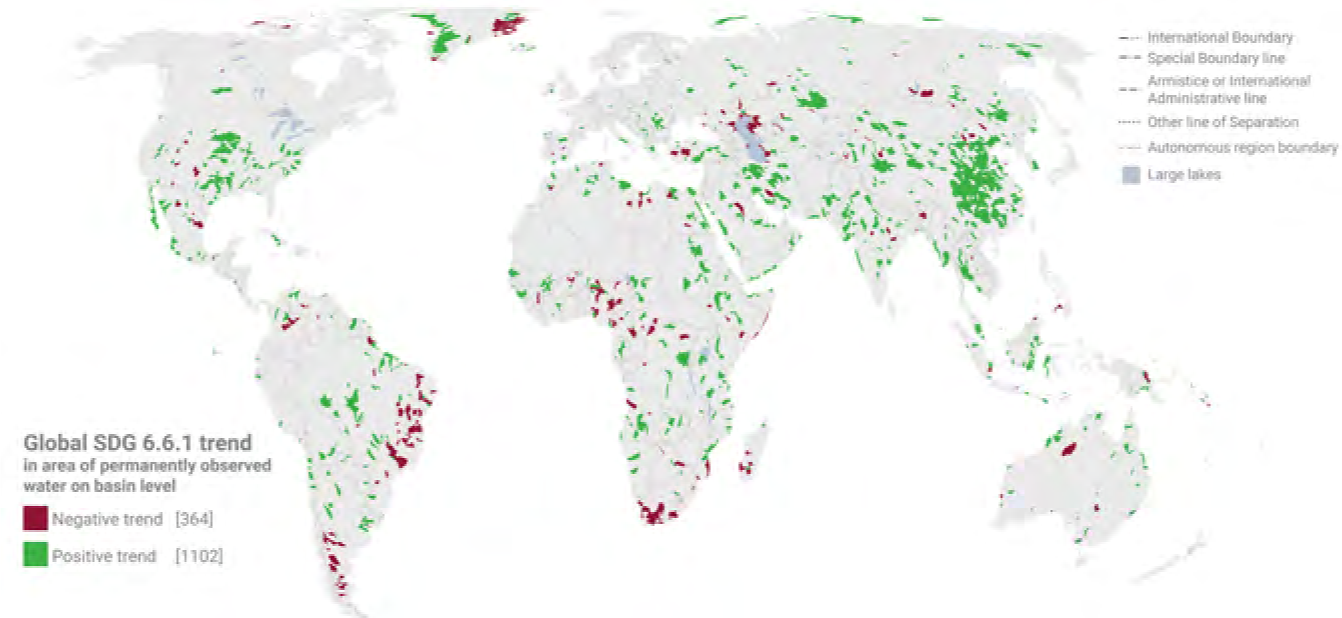


Figure 14: Map showing river basins experiencing a loss or gain in the area of permanently observed water in the current observation period (2017-2021) compared to the baseline reference period (2000-2019)

The global map above (figure 13) shows the locations of basins experiencing a loss or gain in the area of surface water for the most recent 5-year observation period (2017-2021) compared to the long-term baseline reference period (2000-2019). A total of 13 894 basins are observed for surface water analysis.

The focus of permanent water trends is where water loss is occurring. In locations where significant ecosystem loss and degradation has occurred is where the greatest impact is happening. The loss of permanent surface water in 364 river basins is a concerning finding. The causes of this loss, while recognized to be context specific, are largely driven by human development with countries striving to meet food, water, and energy security needs.

Specifically, land use change and unsustainable water use will exacerbate the loss of surface water by altering river flow dynamics and affecting water volume and retention in lakes. An estimated 93.1 million people live in the 364 river basins where permanent water has been receding live.

Compounding these threats further, changes in temperatures and rainfall caused by climate change and experienced as droughts, also contribute to the loss of permanent water, particularly in regions like Northern, Sub-Saharan, and Southern Africa.

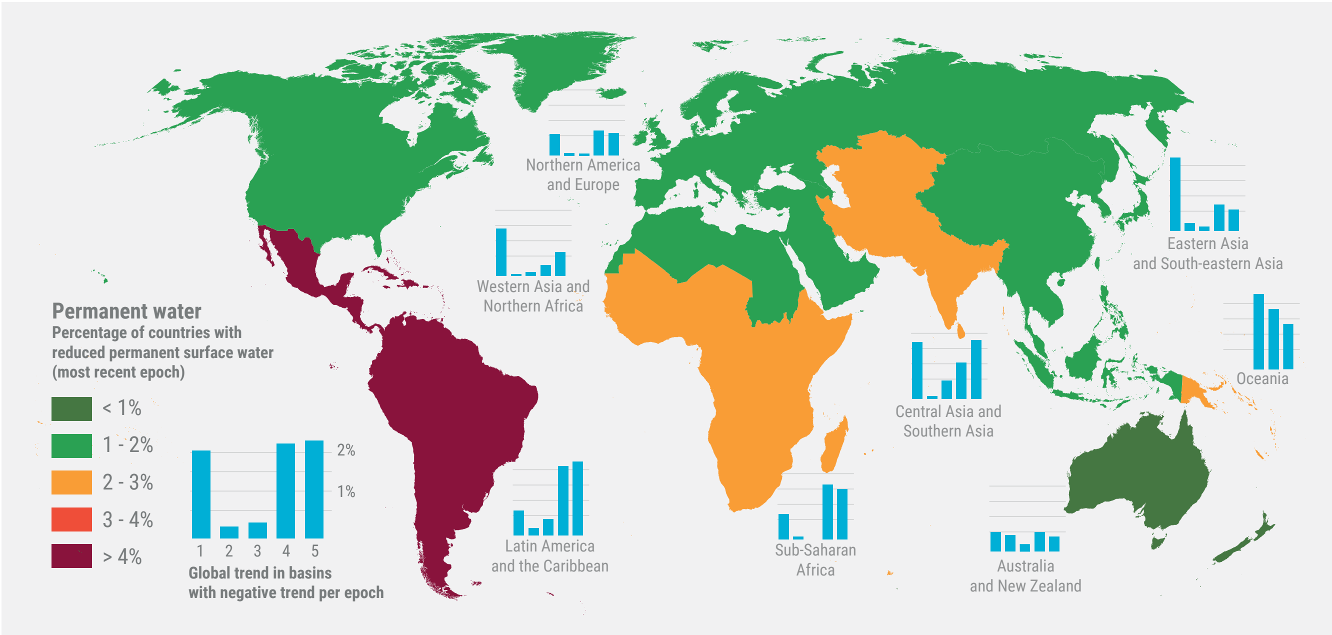


Figure 15: Global map of SDG regions representing fraction of basins over time where permanent water is significantly less than the long-term natural variability

While it's important to focus on where water has been lost, assessment of the full-time series of permanent surface water changes (see Annex 3) shows that there's a global net gain in permanent water. A gain in surface water is generally seen as positive as it indicates good water availability and water security for people. However, the increase in permanent water is partly due to the global reservoir boom since 2000, especially in East and Southeast Asia, and particularly within China.

Within the sub-indicators of SDG 6.6.1, reservoir data are intended to be monitored separately from permanent surface water. It's important to note that a significant number of new reservoirs are not within the global dams and reservoirs database[24] and are therefore being observed within the permanent surface water data.

Reservoirs play a crucial role in ensuring water security by storing water for various purposes like irrigation, drinking water, and hydropower generation and they provide stability in water supply during droughts or fluctuating rainfall patterns. Reservoirs also impact freshwater biodiversity and disconnect river and lake ecosystems. Altering natural flow regimes can disrupt aquatic habitats, affect fish migration patterns, and lead to biodiversity loss. Additionally, reservoirs can trap sediments and nutrients, altering downstream nutrient levels and affecting water quality. Therefore, while reservoirs offer benefits for human water needs, it's vital to carefully consider their potential adverse effects on ecosystem integrity and implement measures to mitigate these impacts.

Sustainable management practices are essential to balance human needs with the preservation of freshwater ecosystems and ensure sustainable social and economic development.

24 Global Dams and Reservoirs Database: https://www.globaldamwatch.org/grand/

Seasonal Water: Global and regional status and trends

Globally, temporary freshwater bodies created by precipitation, snowmelt, and glacial runoff play a vital role in replenishing groundwater and refilling water systems like ponds, reservoirs, and irrigation channels. They support consistent water supply throughout the year and maintain the health of ecosystems by providing fluctuating flows to rivers and wetlands. Alterations to these seasonal water patterns can impact wetlands' ability to buffer severe droughts and heavy rainfall, potentially increasing the risks of flooding and drought and leading to habitat and biodiversity degradation.

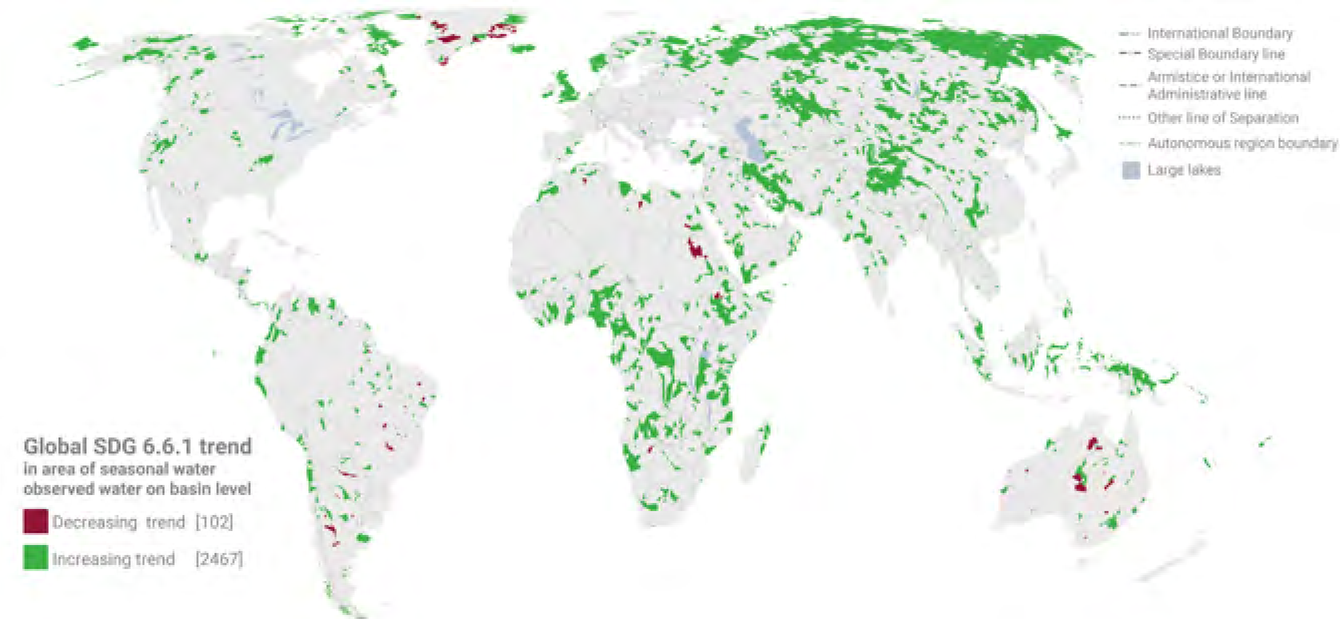


Figure 16: Map showing river basins with increase and decrease in the area of seasonal water in the current observation period (2017-2021) compared to the reference period (2000-2019)

Figure 15 illustrates changes in the area of seasonal water in river basins during the current observation period (2017-2021) compared to the reference period (2000-2019). A total of 13,894 river basins are observed through the surface water analysis. The map shows an overall increasing trend in seasonal surface water, suggesting that climate change is the primary driving force behind these alterations.

Climate change can increase the extent of seasonal surface waters globally through various mechanisms. Increased precipitation, particularly in higher latitudes and certain tropical regions, can lead to more frequent and intense rainfall, expanding the coverage of seasonal lakes, ponds, and wetlands. Additionally, the melting of glaciers and snowpacks due to rising temperatures contributes to river and lake water levels, potentially enlarging seasonal water bodies downstream.

Changes in the distribution and intensity of rainfall, along with alterations in hydrological patterns, can also result in more extensive flooding and the formation of temporary water bodies.

However, the actual impact of climate change on seasonal water dynamics can vary significantly by region due to local factors such as topography, vegetation cover, soil conditions, and human activities like land use changes and water management practices. Adaptive management strategies are essential to ensure water security and ecosystem health in the face of these evolving challenges posed by climate change.

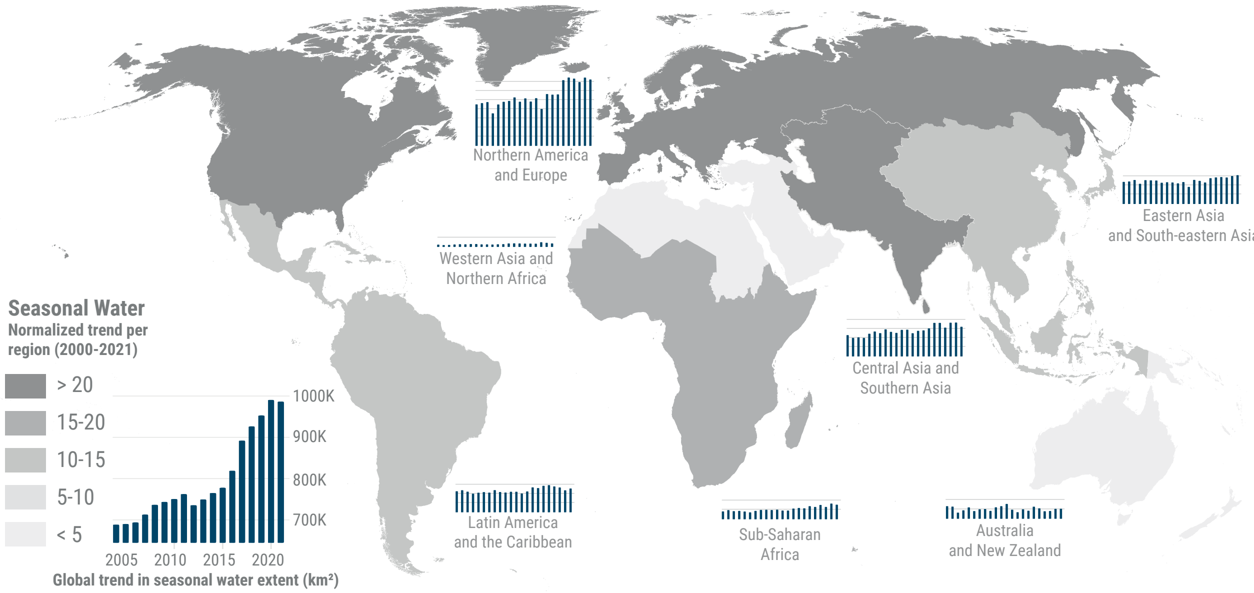


Figure 17: Global map of SDG regions representing fraction of basins over time where seasonal water is significantly less than the long-term natural variability

Lake Water Quality: Global and regional status and trends

Assessment of the ecological state of the world's large lakes involves measuring two key indicators: turbidity, which reflects water clarity, and trophic state, indicating organic matter accumulation. As of 2021, 26 per cent of the world's large lakes are experiencing high to extreme levels of turbidity, while 14 per cent are affected by high to extreme levels of trophic conditions. These adverse effects are particularly pronounced in Northern America and Europe, where most of the world's large lakes are located, accounting for approximately 65 per cent of them. An estimated 192.5 million people live in the 609 river basins where trophic state events have been increasing and an estimated 437 million people live in the 935 river basins where turbidity conditions have worsened.

High turbidity levels can impair water quality by reducing light penetration and disrupting aquatic ecosystems. Elevated levels of organic matter accumulation, indicated by trophic state, can lead to eutrophication, harmful algal blooms, and oxygen depletion, further degrading aquatic habitats.

The global trend in large lake conditions underscores the significant impact of human activities, such as urbanization, agriculture, and industrialization, which contribute to pollution and nutrient runoff into freshwater systems. Addressing these issues requires coordinated efforts to reduce pollution, improve water management practices, and mitigate the impacts of climate change on freshwater ecosystems.

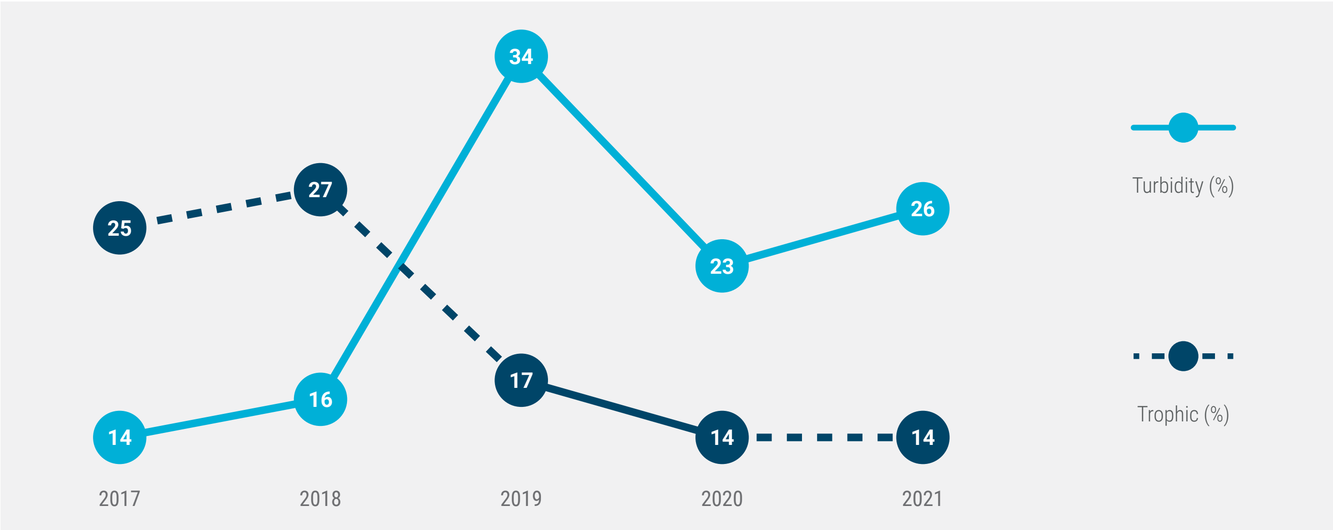


Figure 18: Proportion of large lakes with high turbidity and tropic state conditions when compared to the 2006-2010 baseline

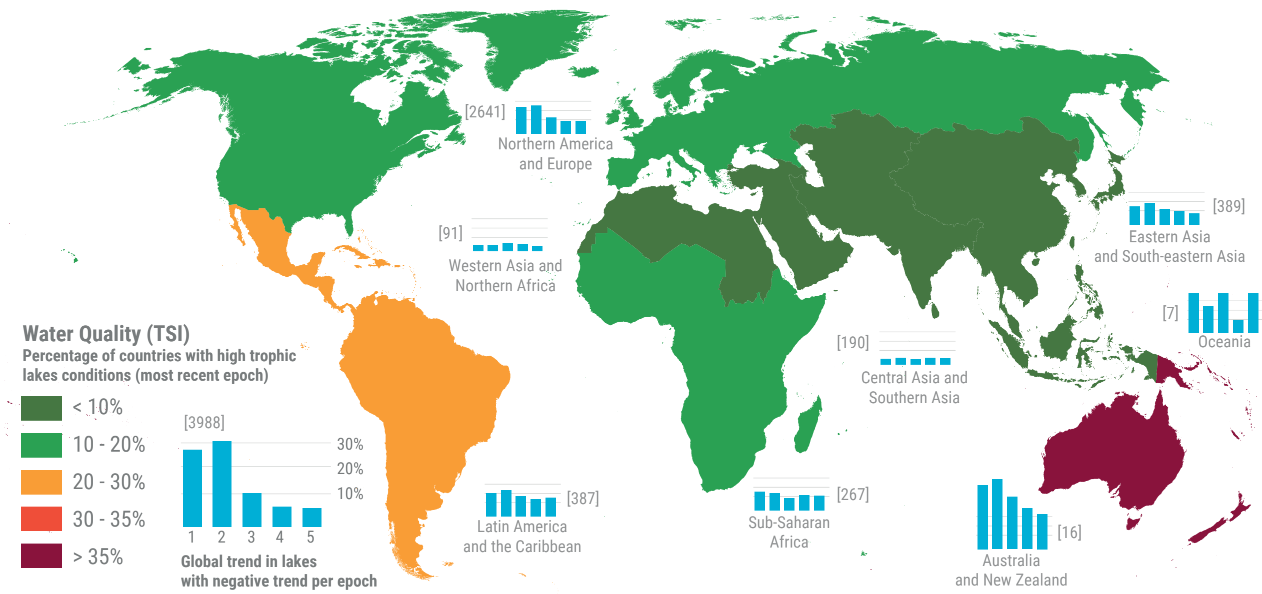


Figure 19: Proportion of large lakes with high changes in tropic state conditions globally (top) and regionally when compared to the 2006-2010 baseline

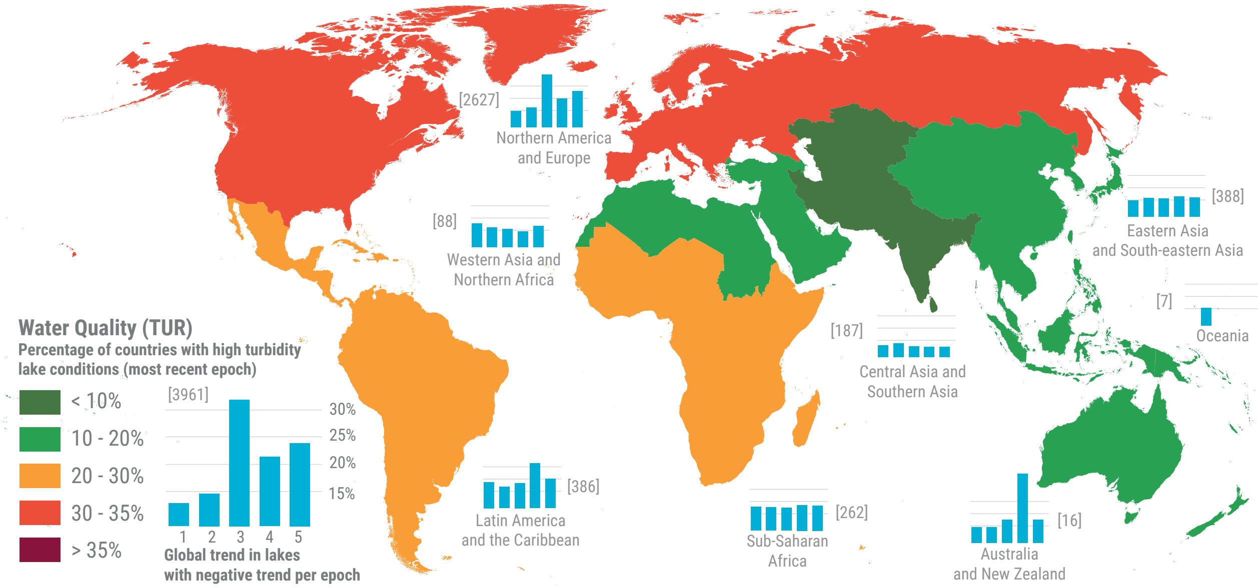


Figure 20: Proportion of large lakes with high changes in turbidity conditions globally (top) and regionally when compared to the 2006-2010 baseline

At the regional level, the changes in lakes affected by turbidity and trophic state vary across different parts of the world. In Northern America and Europe, there has been a notable increase in lakes affected by turbidity, with a 16 per cent increase since 2017. This trend is also observed in Australia and New Zealand, with a 6 per cent increase, followed by Latin America and the Caribbean, with a 3 per cent increase since 2017. However, Central and Southern Asia, as well as Western Asia and Northern Africa, have shown improvements in turbidity conditions.

Regarding the trophic state of lakes, the most significant improvements have been observed in Australia and New Zealand, with a remarkable 31 per cent decrease since 2017. Northern America and Europe have also seen notable improvements, with a 15 per cent decrease since 2017. On the other hand, Central Asia and Southern Asia are experiencing deteriorating conditions in terms of trophic state.

These regional variations highlight the complex interplay of factors influencing the ecological health of large lakes, including land use changes, pollution levels, climate variability, and management practices. Effective regional strategies and interventions are essential to address these challenges and ensure the long-term sustainability of freshwater ecosystems.

Weather events such as heavy rain and hurricanes can indeed contribute to erosion and landslides, leading to an increase in suspended particles in rivers and lakes. However, it's essential to recognize that human activities play a significant role in degrading water quality, particularly through processes like eutrophication.

Eutrophication, which was once a natural process of nutrient enrichment in water, is now primarily driven by human actions. Activities such as land clearance for agriculture, urban runoff, urbanization, and industrialization lead to increased nutrient discharges into water bodies. When rain or irrigation washes nutrients from sources like animal waste, fertilizers, industrial waste, and sewage into lakes and rivers, it can promote excessive growth of algae and aquatic plants.

This overgrowth, often referred to as algal blooms or dense floating plant mats, can have several negative impacts on water bodies. It can alter the hydrology of lakes, reduce water quality, and harm both human health and ecosystem health. For example, algal blooms can produce toxins and deplete oxygen levels in water, leading to fish kills and posing risks to human health by contaminating drinking water and increasing the likelihood of waterborne diseases like cholera and typhoid.

Addressing eutrophication and its associated impacts requires comprehensive management approaches that aim to reduce nutrient inputs into water bodies, improve land use practices, and implement effective wastewater treatment and pollution control measures.

By addressing these human-driven factors, we can work towards safeguarding water quality and protecting the health of freshwater ecosystems and the communities that depend on them.

Mangroves - global and regional status and trends

The world has lost 5 250 km2 of mangrove area, a net decrease of 34 per cent since 1996. The decline underscores the significant loss of these critical ecosystems worldwide.

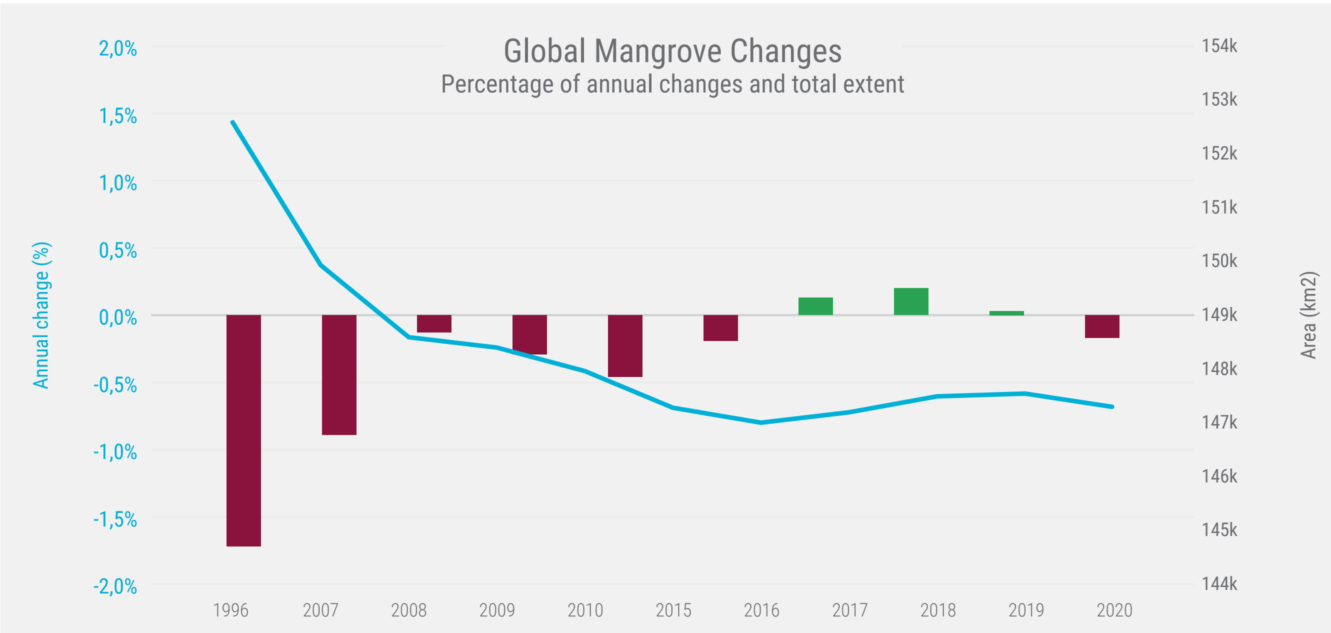


Figure 21: Graph showing global changes in area of mangrove cover since 1996 to 2020, both extent (line) as well as annual net-change compared to the 1996 baseline (bars) (Global Mangrove Watch, v3.0)

Historically widespread across the tropical and subtropical shorelines of the world, mangroves have been experiencing declines comparable to those of inland natural forests. Mangroves serve as natural filters, capturing pollutants, sediments, and nutrients from runoff, thus preserving the quality of nearby freshwater resources and shielding them from contamination. Additionally, their dense root systems play a crucial role in reducing saltwater intrusion into freshwater aquifers, which is vital for communities reliant on groundwater. By stabilizing shorelines and mitigating erosion, mangroves contribute to maintaining water clarity and preventing soil loss. Their presence helps preserve the integrity of coastal ecosystems and habitats, supporting diverse aquatic species essential for ecosystem health and human livelihoods. Furthermore, mangroves play a pivotal role in climate change mitigation by sequestering carbon dioxide from the atmosphere. This function helps combat climate change impacts, ensuring the availability and quality of freshwater resources in the face of increasing water scarcity and quality challenges.

Given the multifaceted benefits provided by mangroves, their preservation and restoration are paramount for safeguarding both marine and freshwater ecosystems, as well as supporting sustainable human development in coastal regions. Efforts to conserve and manage mangrove ecosystems must be prioritized to mitigate further loss and ensure their continued contribution to global freshwater resources and biodiversity conservation.

The data revealing that approximately 70 per cent of mangrove-holding nations have experienced a net reduction in mangrove areas underscores the widespread decline of these crucial ecosystems. This trend is particularly pronounced in regions such as Eastern and South-Eastern Asia, Western Asia and Northern Africa, and Australia and New Zealand. Almost half (47 per cent) of the losses globally 1996-2020 occurred in Southeast Asia, which holds a third (33 per cent) of the world's mangrove areas.

Human activities are identified as the primary drivers behind this reduction, with land transformation for aquaculture and agriculture being significant contributors. The expansion of aquaculture and agricultural activities often leads to the clearing of mangrove forests to create space for shrimp farms, rice paddies, or other agricultural ventures. Similarly, urban development encroaches upon mangrove habitats, further accelerating their loss. While urbanization and exploration activities also play a role, their impact is relatively smaller compared to land transformation for agriculture and aquaculture. Nevertheless, these activities contribute to the cumulative pressure on mangrove ecosystems, exacerbating their decline.

Addressing the loss of mangroves requires comprehensive conservation and management strategies that prioritize protection of these valuable ecosystems. Efforts to mitigate the impacts of aquaculture expansion, agricultural expansion, urbanization, and other human activities must be integrated into land-use planning and environmental policies to ensure the sustainable management of mangrove habitats. Additionally, promoting awareness and engaging local communities in mangrove conservation initiatives are essential for fostering long-term stewardship and preserving these critical ecosystems for future generations.

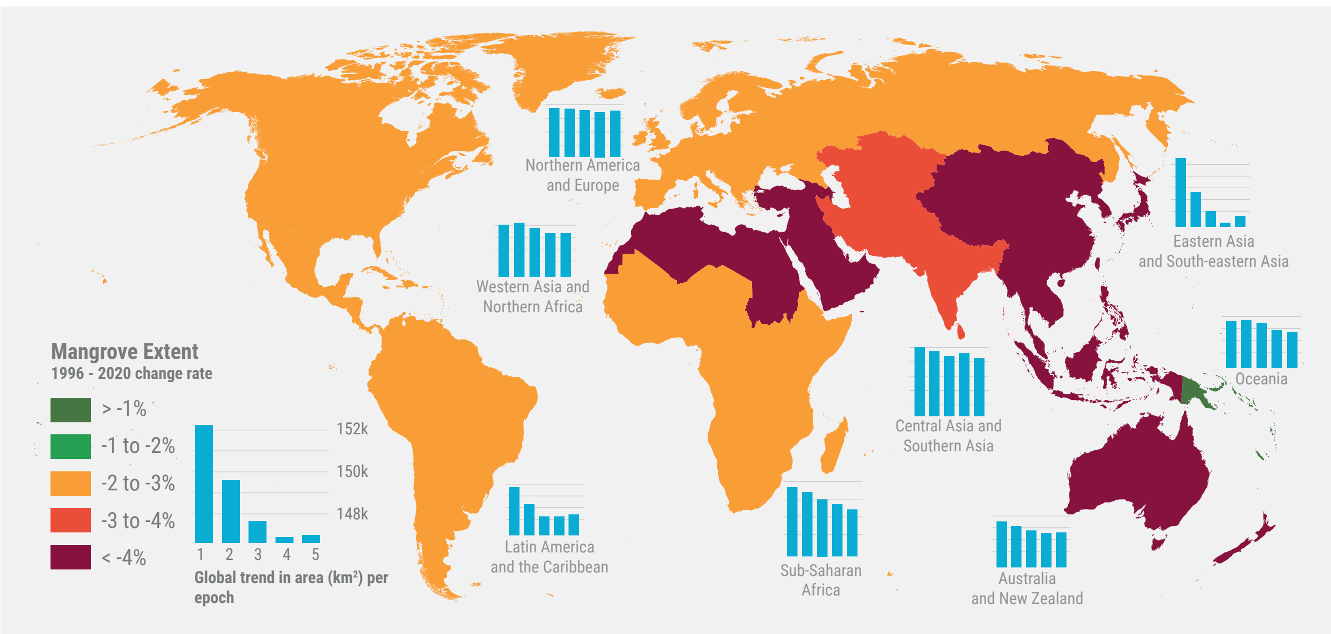


Figure 22: Global map of mangrove extent per SDG region since 1996 to 2020

The recent stabilization and even slight increase in mangrove area in some regions, coupled with a general trend of less mangrove loss in the last decade, offer hope amid the ongoing challenges facing these ecosystems. The shift from predominantly large negative annual change rates in the 1990s and early 2000s to more balanced or even positive rates today indicates a potential reversal or at least a slowdown in the decline of mangrove forests in some regions.

The recent stabilization and even slight increase in mangrove area in some regions, coupled with a general trend of less mangrove loss in the last decade, offer hope amid the ongoing challenges facing these ecosystems. The shift from predominantly large negative annual change rates in the 1990s and early 2000s to more balanced or even positive rates today indicates a potential reversal or at least a slowdown in the decline of mangrove forests in some regions.

This positive development suggests that conservation efforts, awareness campaigns, and policy interventions may be starting to yield results in certain regions. However, continued vigilance and concerted action are necessary to ensure the long-term sustainability and resilience of mangrove ecosystems worldwide. Addressing the root causes of mangrove loss requires multifaceted approaches that combine conservation efforts, sustainable land-use practices, and climate change mitigation strategies. By addressing both direct human impacts and underlying environmental stressors, we can work towards safeguarding these vital ecosystems for future generations.

There is growing international awareness of the value of mangroves, a part terrestrial and part marine ecosystem in tidal zones along tropical coastlines. Maps from the Global Mangrove Watch (Bunting *et al.* 2022) – the evidence base informing the Global Mangrove Alliance (GMA) – provide comprehensive detail and temporal coverage and have been selected as the official mangrove dataset by UNEP for reporting on SDG 6.6.1, and these data from Global Mangrove Watch maps are integrated and presented on the Freshwater Ecosystem Explorer. The latest data shows there are 147 000 km^2 of mangroves remaining worldwide, an area about the size of Bangladesh, and that the rate of mangrove loss is declining. While the SDG 6.6.1 data shows a net loss of 5 250 km^2 of mangroves to date, the State of the World's Mangroves 2022 report estimates that 8 183 km^2 of mangroves can be considered restorable globally. Restoring half of these mangroves would build habitat that generates over 25 billion commercially important fish and shellfish every year and continue to support 4.1 million small-scale fishers and countless communities that rely on mangroves for their livelihoods (Wetlands International 2022).

Data on these super-ecosystems has surged since the launch of the Global Mangrove Watch (in 2011), and the publications on the State of the World's Mangroves reports by the Global Mangrove Alliance in 2021 (Spalding *et al.* 2021) and 2022 (Wetlands International 2022). The 2022 report highlights that preventing just 1 per cent of mangrove loss results in two hundred million tons of carbon locked away, and that the restoration of lost mangroves since 1996 could safeguard carbon in soil and above-ground biomass equivalent to 1.27 gigatons of carbon dioxide – equating to over 520 million barrels of oil, or the annual emissions of 49 million cars in the United States. In addition, mangroves are estimated to prevent more than $65 billion in property damage from storms and reduce flood risk to some 15 million people every year. The Global Mangrove Alliance recently launched a Mangrove Restoration Tracker Tool[25] which invites mangrove practitioners to record and track their restoration projects while ensuring best practice towards sustainable long-living mangroves globally.

25 https://www.mangrovealliance.org/news/new-the-mangrove-restoration-tracker-tool/

Summary of global and regional data analysis for SDG indicator 6.6.1

This report provides a comprehensive overview of the global status and trends related to Sustainable Development Goal (SDG) indicator 6.6.1, which focuses on tracking changes to freshwater ecosystems. Here are the key findings:

Global Trend and Policy Implications:

- The percentage of countries with one of more degraded freshwater ecosystem type fluctuates since 2000, indicating a lack of steady progress.
- Currently, half of all countries have one or more sub-indicators in a state of degradation, signalling the urgent need for accelerated action to protect freshwater systems.
- Various drivers of freshwater changes exist, including climate change, land use modifications, pollution, water extraction, and lack of effective governance of ecosystems and river basins.
- Effective policies tailored to specific country contexts and responsive to the causes of freshwater changes are essential.
- To achieve this, it is important for environmental authorities to be able to communicate the value of ecosystems to meet various socioeconomic development objectives, including water supply, water treatment, climate mitigation, and resilience to floods and droughts. Applying frameworks such as integrated water resources management (SDG 6.5.1) and the Water-Energy-Food-Ecosystems Nexus supports these objectives.

Regional Differences:

- Significant variations exist across regions in terms of countries with degraded freshwater ecosystems for indicator 6.6.1.
- Central and Southeast Asia have the highest percentage of countries with one of more freshwater ecosystem type in a state of degradation, while Oceania shows positive trends.
- Regional challenges underscore the need for tailored solutions based on climate variability, geography, and socio-economic development priorities.

River Flow Trends:

- Changes in river flow, influenced by climate change and land use, impact freshwater biodiversity and ecosystem health globally.
- The number of river basins experiencing decreased flows has increased significantly since 2000.

Permanent Surface Water Trends:

- The construction of reservoirs contributes to the global net-gain in permanent water, mainly in certain regions like North America, Europe, and Asia.
- However, significant declines in permanent water are observed in some river basins, with implications for biodiversity and socio-economic development.

Seasonal Water Patterns:

- Climate change is driving alterations in seasonal surface water patterns, with potential impacts on ecosystems and water supply.
- Local factors such as topography and human activities also influence seasonal water dynamics.

Lake Water Quality:

- Human activities, such as land clearance and urbanization, significantly affect water quality, leading to eutrophication and harmful algal blooms.
- Weather events can exacerbate water quality degradation, highlighting the need for sustainable water management practices.

Mangrove Status and Trends:

- Mangroves play a crucial role in maintaining freshwater resources and biodiversity.
- While mangrove loss has occurred globally, the largest decreases were recorded in Southeast Asia 1996-2007.
- Recent data indicate that the net rate of deforestation has levelled off in the last decade.
- Human activities, particularly conversion for aquaculture and agriculture, are the primary drivers of mangrove loss.

Overall, the findings underscore the interconnectedness of environmental changes and the urgent need for targeted policies and management strategies to protect freshwater ecosystems and ensure sustainable development.

Special Focus on Sectoral Interlinkage between Freshwater Ecosystems and Biodiversity

Biodiversity in freshwater ecosystems

The importance of freshwater ecosystems cannot be overstated. They are not only biodiversity hotspots but also essential for sustaining life on Earth.
Despite covering only 1 per cent of the planet's surface (WWF 2020), freshwater ecosystems host an astonishing 140 000 species (UN-Water 2020; Van der Sleen 2021), including nearly half of all known fish species. Furthermore, these ecosystems provide vital services that support biodiversity and human well-being. Unfortunately, freshwater ecosystems face severe threats, making them the most endangered ecosystems globally. Since 1970, global freshwater species populations have plummeted by 83 per cent (WWF 2020), with a quarter of freshwater fish species now facing extinction (Fennessy 2018). Inland wetlands have shrunk by 60 per cent since the last century (Fennessy *et al.* 2018), and one in five water basins is experiencing rapid changes in size (UN Water 2021).

A multitude of factors contribute to the decline of freshwater biodiversity. Changes in streamflow patterns due to water exploitation, dams, and stream diversion disrupt habitats. Pollution from urbanization, industry, agriculture, and transportation further degrades water quality. Overfishing, climate change, and invasive species exacerbate the problem (IUCN 2023). Urbanization and agricultural expansion are rapidly encroaching on wetlands impacting migratory species (UN Environment Programme 2023a), (UN Environment Programme 2023b) and (UN Environment Programme 2023c), while industrial waste and agricultural runoff pollute rivers and lakes.

Hydropower dams fragment rivers, disrupting connectivity and harming biodiversity. This loss of connectivity is particularly threatening in biodiversity hotspots like the Amazon, Congo, and Mekong River basins[26, 27].

Looking ahead, it's crucial to prioritize sustainable water management practices on a global scale. Addressing the multi-sectoral drivers of freshwater biodiversity loss, such as agriculture and industry, requires integrated approaches. Protecting and restoring freshwater ecosystems necessitates accurate data on their status, including water quality and trends in droughts and floods, to inform effective interventions.

Safeguarding freshwater ecosystems is paramount for preserving biodiversity and ensuring the well-being of both nature and humanity. Adopting sustainable water management practices and implementing targeted conservation efforts are essential steps toward reversing the alarming trends of freshwater biodiversity loss.

Global policy frameworks aiming to boost freshwater biodiversity restoration and protection action

Policies aimed at boosting freshwater biodiversity restoration and protection action are crucial for achieving global biodiversity and sustainability goals. Two key frameworks, the Kunming-Montreal Global Biodiversity Framework (GBF) and Sustainable Development Goal 6 (SDG-6), provide guidance and targets for such efforts.

The GBF, adopted during COP15 of the Convention on Biological Diversity (CBD), sets ambitious goals for protecting and restoring ecosystems, halting species extinction, and promoting sustainable use of biodiversity. Several targets within the GBF directly or indirectly relate to freshwater biodiversity, including those focused on ecosystem restoration, reduction of invasive species, pollution control, and enhancing blue spaces. By establishing action-oriented targets for 2030, the GBF provides a roadmap for prioritizing freshwater biodiversity conservation efforts on a global scale.

26 Suman Jumani *et al.* (2020) Environ. Res. Lett. **15** 123009 https://iopscience.iop.org/article/10.1088/1748-9326/abcb37/meta

27 Winemiller, K. O. *et al.* (2016) Balancing hydropower and biodiversity in the Amazon, Congo, and Mekong. Science 351,128-129 (2016). DOI:10.1126/science.aac7082

SDG-6, on the other hand, specifically addresses the need for safe drinking water and sanitation for all. Target 6.6 within SDG-6 is particularly relevant for freshwater biodiversity, aiming to protect and restore water-related ecosystems by 2020. Indicator 6.6.1 tracks progress toward this target by monitoring changes in various freshwater factors, including surface-water trends, permanent water trends, seasonal water trends, reservoir water trends, water quality trends, mangrove trends, and vegetated wetland trends. By focusing on these indicators, policymakers can assess the state of freshwater ecosystems and prioritize conservation and restoration efforts accordingly.

Overall, integrating freshwater biodiversity restoration and protection actions into global frameworks like the GBF and SDG-6 is essential for achieving sustainable development and biodiversity conservation goals. By aligning policies with these frameworks and leveraging the indicators they provide, governments and stakeholders can work together to safeguard the health and resilience of freshwater ecosystems for current and future generations.

Freshwater in the Global Biodiversity Framework

The Kunming-Montreal Global Biodiversity Framework (GBF) represents a significant milestone in global efforts to address biodiversity loss and achieve sustainability. Adopted during COP15 of the Convention on Biological Diversity (CBD) in 2022, the GBF outlines ambitious goals to be achieved by 2050, with action-oriented targets set for 2030.

Key objectives of the GBF include protecting and restoring ecosystems, preventing the extinction of threatened species, conserving genetic diversity, promoting sustainable use of biodiversity, and ensuring equitable distribution of benefits. These goals are essential for maintaining the health of ecosystems and biodiversity worldwide.

Many of the targets established by the GBF are directly or indirectly related to freshwater ecosystems. For instance, targets focusing on the restoration and conservation of ecosystems aim to improve the health and resilience of freshwater habitats. Additionally, efforts to reduce invasive alien species and pollution are crucial for maintaining the integrity of freshwater ecosystems. Enhancing blue spaces, such as rivers, lakes, and wetlands, contributes to the conservation and restoration of freshwater biodiversity.

By integrating freshwater-related targets into the GBF, policymakers recognize the importance of these ecosystems for biodiversity conservation and sustainable development. Through collaborative action and implementation of targeted strategies, the GBF aims to address the growing threats facing freshwater biodiversity and ensure the long-term health and resilience of these vital ecosystems.

Reversing biodiversity loss trends in freshwater ecosystems requires implementing and upscaling sustainable water management practices globally through an integrated approach. Given that the drivers of freshwater biodiversity loss are multi-sectoral, the effectiveness of biodiversity policies and actions would be higher when addressing activities performed by sectors such as agriculture or industry.

Planning protection and restoration policies and actions requires data. Information indicating the status of freshwater ecosystems, such as water quality, and drought or flooding trends, allows identification of the main threats and vulnerable areas, and the design of effective interventions.

How SDG indicator 6.6.1 data can support National Biodiversity Strategies and Action Plans

Indicator 6.6.1 can provide valuable support to countries in updating and implementing their National Biodiversity Strategies and Action Plans (NBSAPs) by offering comprehensive data on the status and trends of freshwater ecosystems:

Understanding Biodiversity Conditions: The data provided by Indicator 6.6.1 offers insights into the conditions of freshwater ecosystems, including river flow, water quantity, quality, and the extent of wetlands and mangroves. This information helps countries assess the state of freshwater biodiversity within their territories and identify areas of concern.

Informing Strategic Planning: By utilizing the data from Indicator 6.6.1, countries can better prioritize and plan their biodiversity conservation and restoration efforts. They can identify hotspots of biodiversity decline or degradation and allocate resources accordingly to address the most urgent needs.

Tracking Progress: The availability of data on freshwater ecosystems allows countries to track their progress towards achieving biodiversity conservation goals outlined in their NBSAPs. They can monitor changes in freshwater biodiversity over time and evaluate the effectiveness of their conservation and restoration actions.

Reporting to CBD: Parties to the Convention on Biological Diversity (CBD) are required to submit national reports on their progress towards biodiversity conservation. The data from Indicator 6.6.1 can support countries in preparing these reports by providing evidence-based information on the status of freshwater biodiversity within their territories.

Accessing Data: The Freshwater Explorer platform associated with Indicator 6.6.1 offers an accessible way for countries to access and analyse freshwater ecosystem data. This platform enables Member States to visualize trends, identify priority areas for intervention, and assess the impact of national interventions at the river basin level.

Overall, Indicator 6.6.1 serves as a valuable tool for countries in enhancing their understanding of freshwater biodiversity and formulating evidence-based strategies and actions to conserve and restore these vital ecosystems as part of their NBSAPs.

Using SDG 6.6.1 indicator data to support monitoring under the GBF

The integration of Earth Observation data collected for SDG indicator 6.6.1 into the monitoring of the Global Biodiversity Framework (GBF) offers valuable opportunities for enhancing biodiversity conservation efforts. By leveraging this complementary data, policymakers and stakeholders can gain insights into the status and trends of freshwater ecosystems, facilitating more informed decision-making and targeted interventions.

The information provided by SDG indicator 6.6.1, which includes data on water surface area, quantity, and quality, can be particularly useful for monitoring GBF-related objectives and actions. By disaggregating the data into different ecosystems, such as rivers, lakes, wetlands, and mangroves, Member States can track specific biodiversity indicators and assess the effectiveness of conservation and restoration measures.

For example, SDG 6.6.1 data on changes to minimum river flows can inform freshwater biodiversity interventions on restoring streams and rivers. Similarly, information on lake pollution levels can help prioritize areas for pollution control measures, while data on mangroves and wetlands can guide efforts to protect and restore these critical habitats.

By utilizing the available SDG 6.6.1 Earth Observation data, Member States can monitor their progress towards achieving GBF goals and targets related to freshwater biodiversity protection and restoration. This data-driven approach enables more effective allocation of resources and facilitates evidence-based policymaking for sustainable management of freshwater ecosystems. Overall, integrating SDG 6.6.1 data into monitoring of GBF goals and targets enhances the synergies between global sustainability initiatives and strengthens efforts to conserve and restore freshwater biodiversity.

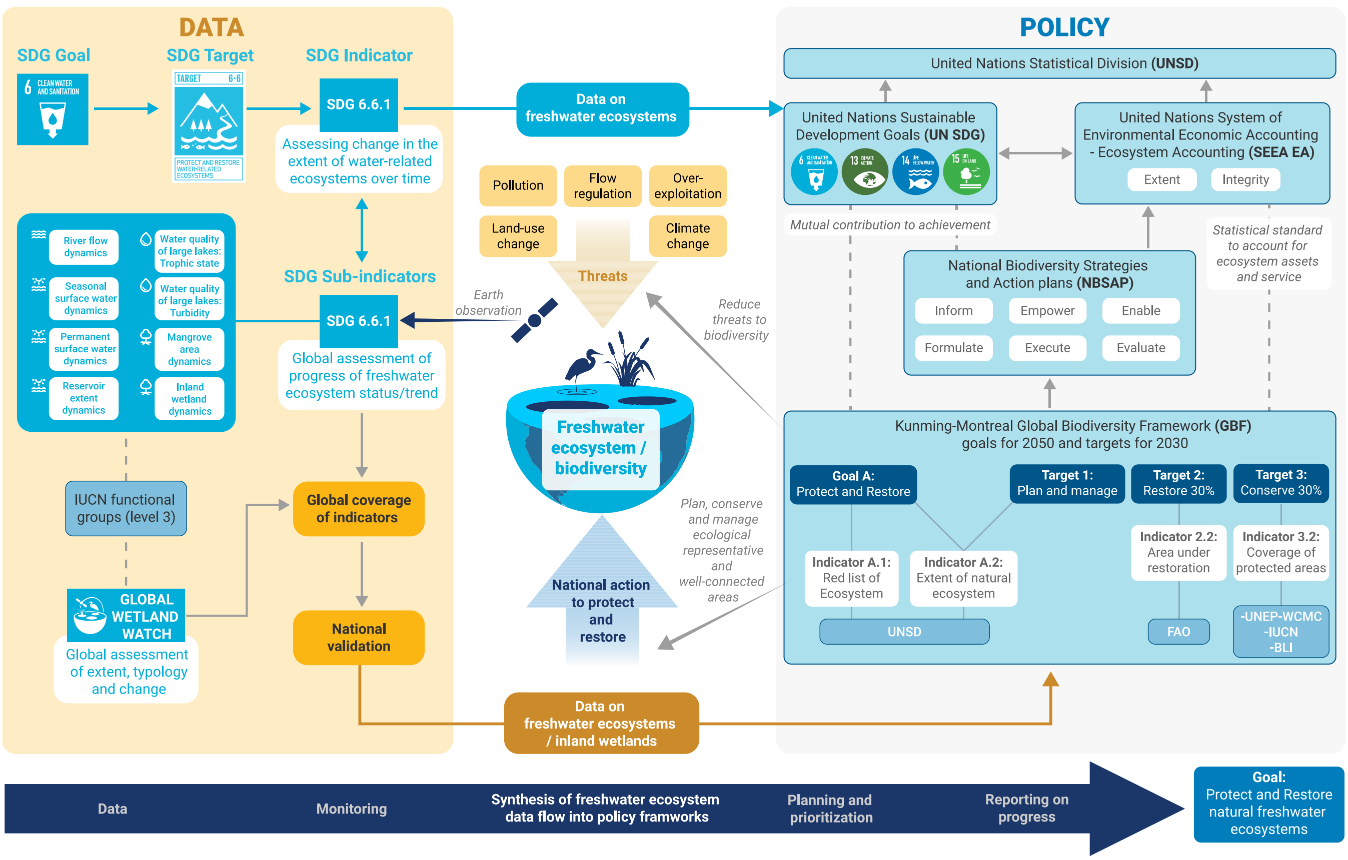


Figure 23: Graphic showing interlinkage between SDG indicator 6.6.1 sub-indicators and how they can support monitoring under the Global Biodiversity Framework and Ecosystems accounts as well as NBSAPs

Data reported through indicator 6.6.1 may serve as direct input and/or complementary sources of freshwater ecosystem information that is useful within several areas of the GBF monitoring framework, with particular relevance for monitoring inland waters within GBF indicators. The following Goals, Targets and Indicators may benefit from SDG 6.6.1 water data:

GOAL A, TARGET 1

Headline Indicator A1: Red list of ecosystems. The Red List of Ecosystems ***assesses the relative risk of ecosystem collapse of an ecosystem type*** and tracks change over time based on change in the risk category of each ecosystem. The Red List of Ecosystems is the global standard for assessing risk of ecosystem collapse and biodiversity loss to all marine, freshwater, and terrestrial ecosystems. Red List of Ecosystems assessments collate standardized knowledge, maps and data about ecosystems, and apply quantitative criteria to estimate relative risks of ecosystem collapse to identify threatened ecosystems. The five criteria are: (A) change in ecosystem area; (B) restricted ecosystem distribution; (C) change in the abiotic environment (for example hydrological processes); (D) change in biotic processes and components (for example species interactions); and (E) the probability of collapse estimated using dynamic ecosystem models (where such models are available).

Headline indicator A2: Extent of natural ecosystems. The indicator, at the national level, is defined as ***the extent of natural and semi-natural ecosystems as a proportion of total area of the country*** at a particular point in time, expressed as a percentage. The concepts, definitions and classification used are based on the SEEA Ecosystem Accounting and the International Union for the Conservation of Nature's Global Ecosystem Typology (IUCN GET 2020).

TARGET 2

Headline indicator 2.1: Area under restoration. Ensure that by 2030 at least 30 per cent of areas of degraded terrestrial, inland water, and marine and coastal ecosystems are under effective restoration, in order to enhance biodiversity and ecosystem functions and services, ecological integrity and connectivity.

TARGET 3

Headline indicator 3.1: Coverage of protected areas and other effective area-based conservation measures. Ensure and enable that by 2030 at least 30 per cent of terrestrial and inland water areas, and of marine and coastal areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures, recognizing indigenous and traditional territories, where applicable, and integrated into wider landscapes, seascapes and the ocean, while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognizing and respecting the rights of indigenous peoples and local communities, including over their traditional territories.

Component Indicators: Indicators such as the Protected Connected (Protconn) Index, River Fragmentation Index, and continuous global database of mangrove forest cover help assess ecosystem connectivity, protection, and restoration efforts.

Complementary Indicators: These indicators, such as trends in mangrove extent and the Wetland Extent Trends Index, provide additional information on the status of specific ecosystems like mangroves and wetlands, contributing to the overall goal of protecting and restoring ecosystems. Similarly, the Ecosystem Intactness Index, which provides insights into the status and trends of ecosystems and species abundance.

Next Steps for SDG Target 6.6 and Indicator 6.6.1

New river flow data was added to the SDG 6.6.1 metadata and used in the global and regional analysis of this report. While this new global data series has been approved by the Inter-Agency Expert Group for SDGs, these data will be shared with countries for approval during the next global round of data validation starting in 2026.

New data are also anticipated on inland wetlands by the end of 2025 and will be ready for global dissemination and approval by countries during the next data round.

The new initiative of measuring wetland extent led by DHI, Global Wetlands Watch, will directly benefit SDG indicator 6.6.1 and form part of the new data series published on UNEP's Freshwater Ecosystem Explorer. The wetlands data will provide global maps and statistics on the extent of different types of wetlands that are changing over time.

The next global monitoring round for SDG indicator 6.6.1 will start in 2026.

Useful Reports, Resources and Global Initiatives

Several global initiatives are underway, or have recently launched, that are highly relevant for countries wanting to improve and increase the protection and restoration of freshwater ecosystems. These include:

Decade on Ecosystem Restoration[28:] The UN Decade on Ecosystem Restoration is a rallying call for the protection and revival of ecosystems all around the world, for the benefit of people and nature. It aims to halt the degradation of ecosystems and restore them to achieve global goals. Only with healthy ecosystems can we enhance people's livelihoods, counteract climate change, and stop the collapse of biodiversity. The UN Decade runs from 2021 through 2030, which is also the deadline for the Sustainable Development Goals and the timeline scientists have identified as the last chance to prevent catastrophic climate change. The United Nations General Assembly has proclaimed the UN Decade following a proposal for action by over 70 countries from all latitudes.

Freshwater Challenge[29]: The Freshwater Challenge (FWC) is a country-led initiative that aims to support, integrate and accelerate the restoration of 300 000 km of degraded rivers and 350 million hectares of degraded wetlands by 2030, as well as conserve intact freshwater ecosystems. Forty-six countries have joined the Freshwater Challenge so far. The Challenge aims to substantiate, integrate and accelerate targeted interventions for rivers and wetlands, connecting these with national plans and strategies.

It will increase the overall investment into the restoration and conservation of freshwater ecosystems and substantially increase the social and economic returns on those investments.

Global Wetland Watch[30]: The Global Wetland Watch is a new initiative with the aim of filling this critical global data gap led by DHI, the UNEP-DHI Centre on Water and Environment and UNEP. This new wetland information system will generate high-resolution maps and statistics that detail near real-time changes to different wetland ecosystems across the globe. The system will make this information readily available at national and ecosystem scales down to a 10-metre resolution. The data and information generated by the Global Wetlands Watch will support country commitments and ambitions towards national targets of the 2030 Agenda for Sustainable Development, the Global Biodiversity Framework and other multilateral environmental agreements.

National wetland inventories support mechanism[31]: Data and information on the extent and condition of wetlands, and their changes over time are critical to inform the actions of governments and other actors to protect and sustainably use wetlands. Accordingly, the development of national wetland inventories (NWIs)is an important mechanism in providing a foundation for wetland assessment and monitoring as well as planning and decision support.

28 https://www.decadeonrestoration.org/

29 https://www.freshwaterchallenge.org

30 https://www.globalwetlandwatch.org/

31 See Convention on Wetlands Standing Committee (SC63) Document 10 'Urgent challenges to the wise use of wetlands to receive enhanced attention: Update on wetland inventories'

This is recognized as a priority area in the Convention on Wetlands Strategic Plan 2016-2024. Paragraph 49 of Resolution XIV.6 encourages Parties to strengthen their efforts to complete their national wetland inventories and to report on wetland extent, also to report on SDG Indicator 6.6.1. It requests the Secretariat to continue working with Contracting Parties to actively support these efforts. Hence, the Secretariat has developed a new approach to address the national wetland inventory through five workstreams, among them capacity-building including training courses and training materials.

National reporting on wetland extent for Indicator 6.6.1 to the Convention on Wetlands

National reporting on wetland extent

The Interagency Expert Group on SDGs in 2017 appointed the Convention on Wetlands as co-custodian with UNEP of Indicator 6.6.1 of the Sustainable Development Goals (SDGs) on change in the extent of water- related ecosystems over time. This represents two complementary reporting lines to the global SDG database hosted by the UN Statistic Division. In contrast to UNEP's method to produce data that relies on global databases, the Convention on Wetlands' approach is to aggregate data as reported by Contracting Parties, based on nationally led processes such as National Wetland Inventories.

Contracting Parties report wetland extent through their national reporting to the Convention on Wetlands. This reporting is based on the wetland definition in the Convention (Article 1.1) and the adopted classification of wetland type. The Ramsar Classification System for Wetland Types, adopted at COP4 in 1990, and amended at COP6 in 1996 (Resolution VI.5) and at COP7 in 1999 (Resolution VII.11) has value as a basic internationally applicable habitat description for sites designated for the Ramsar List of Wetlands of International Importance.

The national reporting form includes a section dedicated to Indicator 6.6.1 and wetland extent that requests Contracting Parties to report at the level of inland/coastal and marine and human-made wetlands, as per the three major categories of the Ramsar Classification System. The minimum information that should be provided is the total area of wetlands for each of these three categories. If the information is available, Contracting Parties are invited to indicate the percentage of change in the extent of wetlands over the last three years, or by default, if the period of data covers more than three years, to provide the available information, while indicating the period of the change. Further guidance is provided in the national reporting form, as well as in the online toolkit for National Wetlands Inventories that was published on the Convention website in 2020.

In 2022, 77 Contracting Parties provided a value in square kilometres on wetland extent in their National Reports submitted to COP14. This represents 61 per cent of the 127 National Reports submitted to COP14. Out of these 77 Countries, 63 of them indicated a precise figure on wetland extent, while 14 Parties preferred to refer to an estimation ('more than x km2'). The reporting rate on wetland extent was higher than in 2018 for COP13 (only 51 Parties then provided precise figures on wetland extent) but remains limited. As per national wetland inventory, 56 Contracting Parties reported that they had a completed a national wetland inventory, which represents only a third of all Contracting Parties to the Convention.

Support mechanism to Contracting Parties

To support Parties in providing updated and consolidated figures on wetland extent, the Secretariat is developing a new support mechanism for Contracting Parties for completion of national wetland inventories. This includes the development of additional guidance to support Parties on designing and implementing robust data management protocols to increase data quality, consistency, and interoperability of data.

In parallel, the Secretariat continues to improve the national reporting form and to investigate Contracting Parties' challenges, constraints, and expectations and needs and constraints regarding NWI thanks to direct exchanges with Parties, discussions with partners and donors, and the use of NWI information that Parties will report through their National Reports to COP15.

A three-year programme consisting of annual training courses and associated training materials in the three official languages of the Convention is also being developed. Three training modules will be organized between 2024 and 2026. This will be closely aligned with the development of additional guidance on national wetland inventory.

Box 1: National reporting on wetland extent for Indicator 6.6.1 to the Convention on Wetlands

Other Online Tools and Training resources

Several tools and training resources on water management are also freely available online including:

IWRM for climate resilience launched on 13 March 2024.

New edition of the online course on Integrated Drought Management: Monitoring and Early Warning launched on 22 February 2024.

Sustainable lake management launched on 6 January 2024.

Water Pollution Management in Achieving SDG Target 6.3 launched in June 2023. See trailer video here.

Nature-based Solutions for Disaster and Climate Resilience hosted on the SDG Academy/edX platform.

The Ecosystem Approach and Systems Thinking (5 September 2023).

Resilient rivers: Watershed-based management of forests, freshwater, and inland fisheries (FAO, March 2023).

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Annexes

Annex 1: Statistical method of calculating and aggregating sub-indicator status and trends

For all sub-indicators, except inland wetlands, temporal information is available so the changes over time can be analysed. Since freshwater ecosystems are intrinsically dynamic, a long-time series of annual data is used to identify changes which differ significantly for the longer-term mean. For the sub-indicators on river flow, permanent water, and reservoirs, changes are measured across 5-year intervals relative to a 20-year baseline 2000-2019. Annual metrics such as annual minimum and maximum values are used as input to reduce any cyclical patterns in the seasonal hydrological processes that could violate the statistical requirements of independence in observations. River basins are used as the underlying spatial area, which can be aggregated to regional and global scales.

Changes are calculated for the current five-year assessment period (2017-2021) and also each preceding five-year period enabling data comparison at periodic intervals since 2000 (that is2000–2004, 2005–2009, 2010–2014 and 2015–2019). The resulting distributions of the delta values are analysed to identify cut-off points for basins lying within an expected “normal” versus those who have experienced a significant change. First, all delta values within + 1.5 standard deviations from the global mean were considered to fall within the nominal range of deviations. For all countries/basins where the delta value were larger than + 1.5 standard deviations from the global mean, a U-test was used to determine if the variability observed in the 5-year period could be considered different from what would be expected when compared to the baseline period (2000-2019). In the cases where the null hypothesis H0 of the U-test (that is the distributions of both populations are identical) failed, the countries/basins were classified as either high positive or high negative change.

Changes in mangrove area are also calculated using Equation 1 but with single year data rather than 5-year medians, and in which case β is the national spatial extent of mangroves for the baseline year (that is 1996) and γ is the national spatial extent for any subsequent year, including the reporting period (2020). This means that a positive delta (Δ) represents a gain in mangrove extent and a negative value represents a loss in extent.

For water quality, a five-year baseline from 2006 to 2010 has been established for two parameters: Turbidity and Trophic State. This baseline serves as a reference to identify lakes that have experienced a degradation in environmental conditions by measuring annual deviations from recent years (2017-2021) relative to the baseline. The assessment considers lakes of various sizes and categorizes the degree of change into four levels: low, medium, high, and extreme on a monthly basis. A lake is categorized as adversely affected if the combined occurrences of high and extreme changes outweigh those of low and medium changes. For turbidity, this rule is applied to the average lake conditions across the year, but for trophic state, which is more event- based, a lake is considered adversely affected if the rule applies for any month within a given year. A country or basin’s lake water quality status is labelled as “bad” if over 20 per cent of its lakes are affected, based on these criteria.

Annex 2: What are Global Hydrological Models?

Global Hydrological Models (GHM) are computational tools that simulate the water cycle and its components, such as precipitation, evaporation, runoff, and groundwater flow. These models are essential for understanding the distribution and movement of water on Earth, predicting water availability, managing water resources, and assessing risks related to floods and droughts. When it comes to predicting long-term variability in river flows at the global level, hydrological models play a crucial role but face several challenges and limitations which can be attributed to several factors related to the inherent characteristics of these models, the analysis scale, and the complex nature of hydrological responses to climate and human activities. In this way, GHMs simplify complex hydrological processes to make global-scale simulation feasible. This simplification includes the parameterization of processes like precipitation-runoff relationships, evapotranspiration, and soil moisture dynamics, which might not capture the full range of natural variability and change, especially under extreme conditions or changing climates as well as those stemming from human activities (cf. water withdrawals, land use changes, and dam operations).

Annex 3: List of Graphs

GRAPHS: GLOBAL AND REGIONAL ANNUAL TRENDS

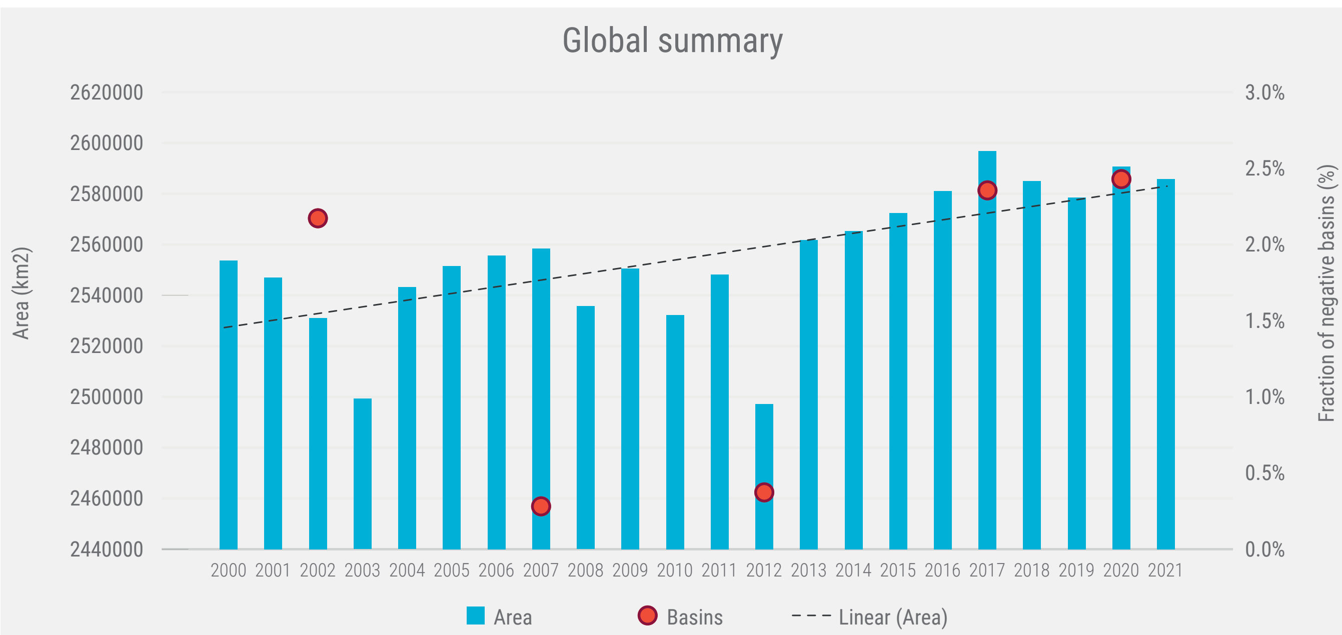

Figure A.3.1: Global annual time-series graph of permanent surface water area

Figure A.3.2: Global and regional annual time-series graph of seasonal surface water area

Figure A.3.3: Global and regional annual time-series graph of reservoir minimum area

Figure A.3.4: Global and regional annual time-series graph of permanent surface water area

Figure A.3.5: Global and regional annual time-series graph of water quality

Figure A.3.6: Global and regional annual time-series graph of mangrove extent

Learn more about progress towards SDG 6

Sustainable Development Goal (SDG) 6 expands the Millennium Development Goal (MDG) focus on drinking water and basic sanitation to include the more holistic management of water, wastewater and ecosystem resources, acknowledging the importance of an enabling environment. Bringing these aspects together is an initial step towards addressing sector fragmentation and enabling coherent and sustainable management. It is also a major step towards a sustainable water future.

Monitoring progress towards SDG 6 is key to achieving this SDG. High-quality data help policymakers and decision makers at all levels of government to identify challenges and opportunities, to set priorities for more effective and efficient implementation, to communicate progress and ensure accountability, and to generate political, public and private sector support for further investment.

The 2030 Agenda for Sustainable Development specifies that global follow-up and review shall primarily be based on national official data sources. The data are compiled and validated by the United Nations custodian agencies, who contact country focal points every two to three years with requests for new data, while also providing capacity-building support. The last global "data drive" took place in 2023, resulting in status updates on seven of the global indicators for SDG 6 (please see below). These reports provide a detailed analysis of current status, historical progress and acceleration needs regarding the SDG 6 targets.

To enable a comprehensive assessment and analysis of overall progress towards SDG 6, it is essential to bring together data on all the SDG 6 global indicators and other key social, economic and environmental parameters. This is exactly what the SDG 6 Data Portal does, enabling global, regional and national actors in various sectors to see the bigger picture, thus helping them make decisions that contribute to all SDGs. UN-Water also publishes synthesized reporting on overall progress towards SDG 6 on a regular basis.

Summary Brief: Mid-term status of SDG 6 global indicators and acceleration needs

Based on latest available data on all SDG 6 global indicators. Published by UN-Water through the UN-Water Integrated Monitoring Initiative for SDG 6.

Progress on household drinking water, sanitation and hygiene 2000–2022: special focus on gender

Based on latest available data on SDG indicators 6.1.1 and 6.2.1. Published by World Health Organization (WHO) and United Nations Children's Fund (UNICEF).

https://www.unwater.org/publications/who/unicef-joint-monitoring-program-update-report-2023

Progress on the proportion of domestic and industrial wastewater flows safely treated – Mid-term status of SDG Indicator 6.3.1 and acceleration needs, with a special focus on climate change, wastewater reuse and health

Based on latest available data on SDG indicator 6.3.1. Published by WHO and United Nations Human Settlements Programme (UN-Habitat) on behalf of UN-Water.

https://www.unwater.org/publications/progress-wastewater-treatment-2024-update

Progress on ambient water quality: Mid-term status of sdg indicator 6.3.2 and acceleration needs, with a special focus on health

Based on latest available data on SDG indicator 6.3.2. Published by United Nations Environment Programme (UNEP) on behalf of UN-Water.

Progress on change in water-use efficiency. Mid-term status of sdg indicator 6.4.1 and acceleration needs, with special focus on food security and climate change

Based on latest available data on SDG indicator 6.4.1. Published by Food and Agriculture Organization of the United Nations (FAO) on behalf of UN-Water.

Progress on the level of water stress. Mid-term status of the sdg indicator 6.4.2 and acceleration needs, with special focus on food security and climate change

Based on latest available data on SDG indicator 6.4.2. Published by FAO and UN-Water.

Progress on implementation of Integrated Water Resources Management. Mid-term status of SDG indicator 6.5.1 and acceleration needs, with a special focus on climate change

Based on latest available data on SDG indicator 6.5.1. Published by UNEP and UN-Water.

Progress on transboundary water cooperation. Mid-term status of SDG Indicator 6.5.2, with a special focus on climate change – 2024

Based on latest available data on SDG indicator 6.5.2. Published by United Nations Economic Commission for Europe (UNECE) and United Nations Educational, Scientific and Cultural Organization (UNESCO) on behalf of UN-Water.

Progress on water-related ecosystems. Mid-term status of sdg indicator 6.6.1 and acceleration needs, with a special focus on biodiversity

Based on latest available data on SDG indicator 6.6.1. Published by UNEP on behalf of UN-Water.

Strong systems and sound investments: evidence on and key insights into accelerating progress on sanitation, drinking-water and hygiene.

The UN-Water global analysis and assessment of sanitation and drinking-water (GLAAS) 2022 report

https://www.unwater.org/publications/un-water-glaas-2022-strong-systems-and-sound-investments-evidence-and-key-insights

Based on latest available data on SDG indicators 6.a.1 and 6.b.1. Published by WHO through the UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS) on behalf of UN-Water.

UN-Water reports and other relevant publications

UN-Water coordinates the efforts of United Nations entities and international organizations working on water and sanitation issues. UN-Water publications draw on the experience and expertise of UN-Water's Members and Partners.

United Nations System-Wide Strategy for Water and Sanitation

The United Nations system-wide strategy for water provides a system-wide approach for the United Nations to work collaboratively on water and sanitation. In September 2023, Member States adopted General Assembly resolution 77/334, which requested the Secretary-General to present a United Nations system-wide water and sanitation strategy in consultation with Member States before the end of the seventy-eighth session. The strategy has been developed by UN-Water under the leadership of the UN-Water Chair, as requested by the Secretary-General, and will be launched in July 2024.

Blueprint for Acceleration: Sustainable Development Goal 6 Synthesis Report on Water and Sanitation 2023

The report, written by the UN-Water family of Members and Partners, is a concise guide to delivering concrete results – offering actionable policy recommendations directed towards senior decision-makers in Member States, other stakeholders, and the United Nations System to get the world on track to achieve SDG 6 by 2030. It was released ahead of the discussions of Member States and relevant stakeholders at the 2023 High-level Political Forum on Sustainable Development (HLPF), which includes a Special Event focused on SDG 6 and the Water Action Agenda.

United Nations World Water Development Report

The United Nations World Water Development Report is UN-Water's flagship report on water and sanitation issues, focusing on a different theme each year. The report is published by UNESCO on behalf of UN-Water, and its production is coordinated by the UNESCO World Water Assessment Programme.

SDG 6 Progress Update – 9 reports, by SDG 6 global indicator

This series of reports provides an in-depth update and analysis of progress towards the different SDG 6 targets and identifies priority areas for acceleration. *Progress on household drinking water, sanitation and hygiene, Progress on wastewater treatment, Progress on ambient water quality, Progress on water-use efficiency, Progress on level of water stress, Progress on integrated water resources management, Progress on transboundary water cooperation, Progress on water-related ecosystems and Progress on international cooperation and local participation*. The reports, produced by the responsible custodian agencies, present the latest available country, region and global data on the SDG 6 global indicators, and are published every two to three years.

Progress reports of the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP)

The JMP is affiliated with UN-Water and is responsible for global monitoring of progress towards SDG 6 targets for universal access to safe and affordable drinking-water and adequate and equitable sanitation and hygiene services. Every 2 years, the JMP releases updated estimates and progress reports for WASH in households (as part of the progress reporting on SDG 6, see above), schools and health care facilities.

UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS)

The GLAAS report is produced by WHO on behalf of UN-Water. It provides a global update on the policy frameworks, institutional arrangements, human resource base, and international and national finance streams in support of water and sanitation. It is a substantive input into the activities of Sanitation and Water for All as well as the progress reporting on SDG 6. The next report will be published in 2025.

UN-Water Country Acceleration Case Studies

To accelerate the achievement of SDG 6 targets as part of the SDG 6 Global Acceleration Framework, UN-Water releases SDG 6 Country Acceleration Case Studies to explore countries' pathways to achieving accelerated progress on SDG 6 at the national level. Since 2022, six case studies have been released from Costa Rica, Pakistan. Senegal, Brazil, Ghana and Singapore. Three new are planned to be released in July 2024 from Cambodia, Czechia and Jordan.

Policy and Analytical Briefs

UN-Water's Policy Briefs provide short and informative policy guidance on the most pressing freshwater-related issues that draw upon the combined expertise of the United Nations system. Analytical Briefs provide an analysis of emerging issues and may serve as basis for further research, discussion and future policy guidance.

UN-Water Planned Publications

- UN-Water Policy Brief on Transboundary Waters Cooperation – update

More information: https://www.unwater.org/unwater-publications/

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