6 CLEAN WATER AND SANITATION

Progress on Water-related Ecosystems

Piloting the monitoring methodology and initial findings for SDG indicator 6.6.1

2018

UN WATER

UN environment
United Nations Environment Programme

This report was published by UN Environment on behalf of UN-Water.

Progress on Water-Related Ecosystems,
Piloting the monitoring methodology and initial findings for
SDG indicator 6.6.1, 2018

ISBN No: 978-92-807-3712-7

Job No: DEP/2189/NA

Cover photo: UN Photo/Mark Garten

Progress on Water-related Ecosystems

Piloting the monitoring methodology and initial findings for SDG indicator 6.6.1

2018

UN WATER

Presenting the UN-Water Integrated Monitoring Initiative for SDG 6

Through the UN-Water Integrated Monitoring Initiative for Sustainable Development Goal (SDG) 6, 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.

The Initiative brings together the United Nations organizations that are formally mandated to compile country data on the SDG 6 global indicators, who organize their work within three complementary initiatives:

- **WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP)**[1]

  Building on its 15 years of experience from Millennium Development Goals (MDG) monitoring, the JMP looks after the drinking water, sanitation and hygiene aspects of SDG 6 (targets 6.1 and 6.2).

- **Integrated Monitoring of Water and Sanitation-Related SDG Targets (GEMI)**[2]

  GEMI was established in 2014 to harmonize and expand existing monitoring efforts focused on water, wastewater and ecosystem resources (targets 6.3 to 6.6).

- **UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS)**[3]

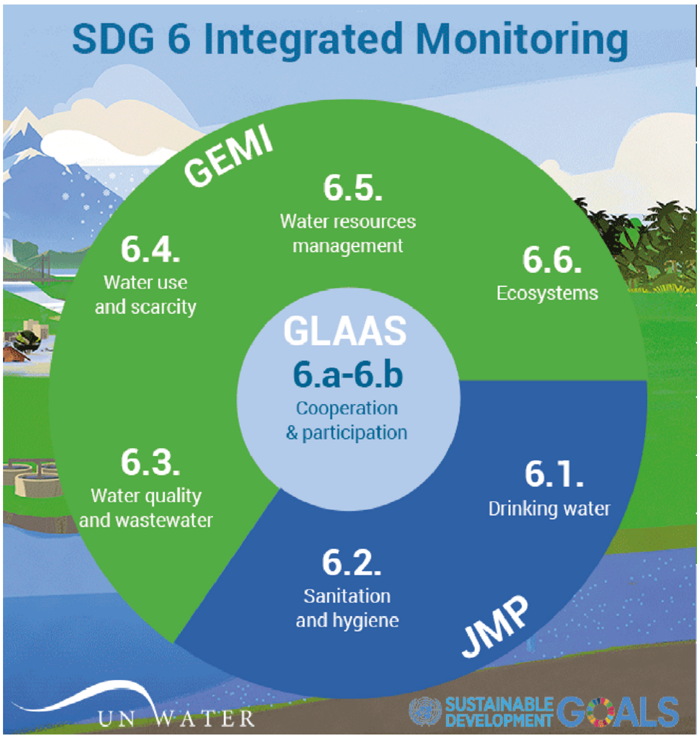
  The means of implementing SDG 6 (targets 6.a and 6.b) fall under the remit of GLAAS, which monitors the inputs and the enabling environment required to sustain and develop water and sanitation systems and services.

The objectives of the Integrated Monitoring Initiative are to:

- Develop methodologies and tools to monitor SDG 6 global indicators
- Raise awareness at the national and global levels about SDG 6 monitoring
- Enhance technical and institutional country capacity for monitoring
- Compile country data and report on global progress towards SDG 6

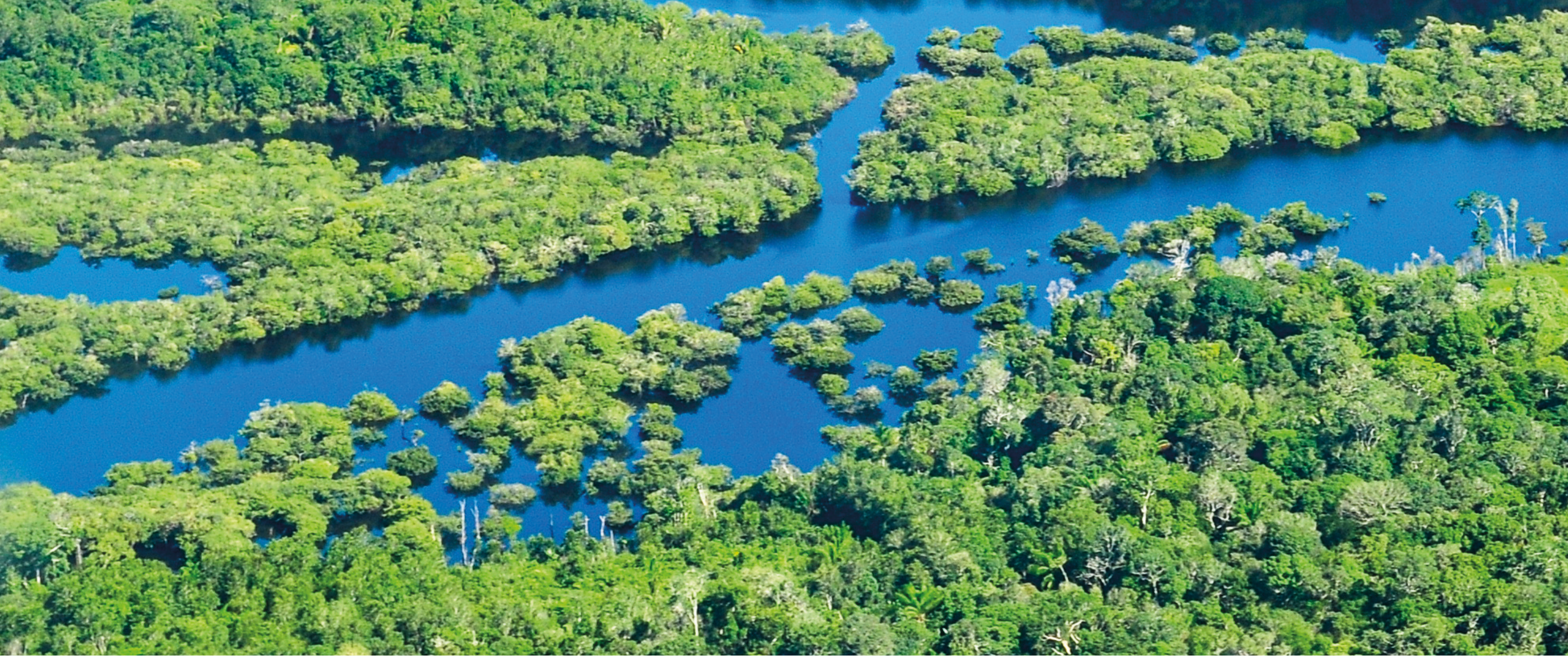
The joint effort around SDG 6 is especially important in terms of the institutional aspects of monitoring, including the integration of data collection and analysis across sectors, regions and administrative levels.

To learn more about water and sanitation in the 2030 Agenda for Sustainable Development, and the Integrated Monitoring Initiative for SDG 6, visit our website: www.sdg6monitoring.org



INDICATORS	CUSTODIANS
6.1.1 Proportion of population using safely managed drinking water services	WHO, UNICEF
6.2.1 Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water	WHO, UNICEF
6.3.1 Proportion of wastewater safely treated	WHO, UN-Habitat, UNSD
6.3.2 Proportion of bodies of water with good ambient water quality	UN Environment
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 implementation (0-100)	UN Environment
6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation	UNESCO, UNECE
6.6.1 Change in the extent of water-related ecosystems over time	UN Environment, Ramsar
6.a.1 Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan	WHO, UN Environment, 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, UN Environment, OECD

[1] http://www.sdg6monitoring.org/about/components/jmp/
[2] http://www.sdg6monitoring.org/about/components/presenting-gemi/
[3] http://www.sdg6monitoring.org/about/components/glaas/



CONTENTS

Aerial view of the Amazon Rainforest near Manaus. Photo: Neil Palmer/CIFOR

FOREWORD

Water is the lifeblood of ecosystems, vital to human health and well-being and a precondition for economic prosperity. That is why it is at the very core of the 2030 Agenda for Sustainable Development. Sustainable Development Goal 6 (SDG 6), the availability and sustainable management of water and sanitation for all, has strong links to all of the other SDGs.

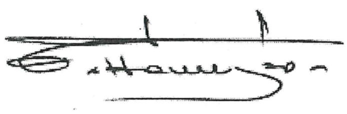
In this series of progress reports under the UN-Water Integrated Monitoring Initiative for SDG 6, we evaluate progress towards this vital goal. The United Nations organizations are working together to help countries monitor water and sanitation across sectors and compile data so that we can report on global progress.

SDG 6 expands the Millennium Development Goal focus on drinking water and basic sanitation to include the management of water and wastewater and ecosystems, across boundaries of all kinds. Bringing these aspects together is an essential first step towards breaking down sector fragmentation and enabling coherent and sustainable management, and hence towards a future where water use is sustainable.

This report is part of a series that track progress towards the various targets set out in SDG 6 using the SDG global indicators. The reports are based on country data, compiled and verified by the responsible United Nations organizations, and sometimes complemented by data from other sources. The main beneficiaries of better data are countries. The 2030 Agenda specifies that global follow-up and review "will be primarily based on national official data sources", so we sorely need stronger national statistical systems. This will involve developing technical and institutional capacity and infrastructure for more effective monitoring.

To review overall progress towards SDG 6 and identify interlinkages and ways to accelerate progress, UN-Water produced the SDG 6 Synthesis Report 2018 on Water and Sanitation. It concluded that the world is not on track to achieve SDG 6 by 2030. This finding was discussed by Member States during the High-level Political Forum on Sustainable Development (HLPF) in July 2018. Delegates sounded the alarm about declining official development aid to the water sector and stressed the need for finance, high-level political support, leadership and enhanced collaboration within and across countries if SDG 6 and its targets are to be met.

To achieve SDG 6, we need to monitor and report progress. This will help decision makers identify and prioritize what, when and where interventions are needed to improve implementation. Information on progress is also essential to ensure accountability and generate political, public and private sector support for investment. The UN-Water Integrated Monitoring Initiative for SDG 6 is an essential element of the United Nations' determination to ensure the availability and sustainable management of water and sanitation for all by 2030.



Gilbert F. Houngbo
UN-Water Chair and President of the International Fund for Agricultural Development

FOREWORD

For many generations, communities living around the Araguaia-Tocantins basin of the Amazon, have depended on goods and services provided by freshwater ecosystems that surround them. However, the rapid loss of wetlands, deforestation and rising pollution are putting this way of life under threat. Investing in protecting and restoring rivers, wetlands, lakes and aquifers is absolutely critical to economic and social well-being.

UN Environment is proud to support a series of reports that assess the world's progress on Sustainable Development Goal 6, which aims to ensure availability and sustainable management of water and sanitation for all. In this report, we report on progress made by countries to protect and restore ecosystems.

The results of this first round of data collection point to significant gaps in our knowledge of how water-related ecosystems are changing over time. This means we don't have enough good quality data to be able to take strategic decisions that ensure both economic growth and the health of water-related ecosystems. Management of water-related ecosystems continues to be guided by short-term considerations. This is doing more harm than good.

The findings highlight some reassuring steps being taken by countries to bridge the data gap such as using satellite-based Earth observations to monitor changes to water-related ecosystems from space. This wealth of information can now compliment national data and be used by decision makers accordingly. At UN Environment, we have launched an exciting partnership with Google, to use sophisticated online tools that can help us truly understand the impact of human activity on global ecosystems.

And finally, the report suggests that high-quality data must be supplemented by investments in national capacity to deliver on priorities. A combination of both will help countries ensure sustainable and healthy water-related ecosystems services and protect freshwater biodiversity.

Erik Solheim
UN Environment Executive Director and
Under-Secretary-General of the United Nations

ACKNOWLEDGEMENTS

UN Environment: Stuart Crane (lead author), Lis Bernhardt, Joakim Harlin, Alain Tchadie, Nisha Midha

This report received review and feedback from several members of the target 6.6 task team including: Chris Dickens from the International Water Management Institute (IWMI), James Dalton from the International Union for the Conservation of Nature (IUCN), Marc Paganini from the European Space Agency (ESA), Maria Rivera from the Ramsar Convention on Wetlands (Ramsar), William Sonntag from the Group on Earth Observations (GEOsec), and Sarah Darrah and Will Simonson from the UN Environment World Conservation Monitoring Center (UNEP-WCMC).

The review and feedback received from the GEMI project team and UN-Water members and partners is gratefully acknowledged.

Financial support was provided by the German Federal Ministry for Economic Cooperation and Development (BMZ), the Dutch Ministry of Infrastructure and Water Management, the Swedish International Development Cooperation Agency (SIDA) and the Swiss Agency for Development and Cooperation (SDC).

EXECUTIVE SUMMARY

Water-related ecosystems provide multiple benefits and services to society and are essential for reaching several Sustainable Development Goals (SDGs). Water-related ecosystems, such as lakes, rivers and vegetated wetlands, are among the world's most biologically diverse environments and provide numerous products and services on which human well-being depends. Although these ecosystems account for only 0.01 per cent of the world's water and cover approximately 0.8 per cent of the Earth's surface, they provide a habitat for almost 10 per cent of the world's known species. In arid environments, springs account for less than 0.01 per cent of the Earth's surface but contain over half the species in these regions. Given that humans and almost every living being require water, water-related ecosystems have significant economic, cultural, aesthetic, recreational and educational value. They help to sustain the global hydrological cycle, carbon cycle and nutrient cycles. They support water security, they provide natural freshwater, regulate flows and extreme conditions, purify water and replenish groundwaters. Services also depend on these ecosystems, which provide water for drinking, agriculture, employment, energy generation, navigation, recreation and tourism. SDG target 6.6 aims to protect and restore water-related ecosystems so that they can continue to benefit society, through halting their degradation and destruction and helping to recover those that are already degraded. Water-related ecosystems underpin and depend on other SDGs, in particular those relating to food and energy production, biodiversity and terrestrial and ocean ecosystems. Progress is therefore needed on all related SDGs to ensure that water-related ecosystems are protected and restored successfully.

Despite the values and benefits of water-related ecosystems, they face considerable pressures to meet short-term socioeconomic development demands. It is alarming to note that most of the world's water-related ecosystems are already degraded and polluted. Over the past 100 years, the world is estimated to have lost half its natural wetlands and with this a significant number of freshwater species. At the same time, artificial water bodies, such as reservoirs, dams and rice paddies, have been increasing in most regions of the world. Although reservoirs have value in helping to provide consistent water supplies to many people, transitioning from a natural ecosystem to an artificial water body can cause ecosystems to become unsustainable. More consideration is needed on this to identify when the negative consequences of such a transition begin to outweigh its benefits. The world's water-related ecosystems continue to be lost as a result of such considerable destruction and unless urgent necessary action is taken to reduce the economic, environmental and social harm that this causes, opportunities for societies to develop sustainably will remain undermined.

Progress on monitoring and reporting indicator 6.6.1 data is slow. The piloting phase for indicator 6.6.1 revealed significant capacity challenges in monitoring and reporting the changes within water-related ecosystems. Satellite-based data have an important role to play in filling data gaps, supporting decision-making and advancing national progress towards achieving target 6.6. Countries recognize that data are needed to inform and catalyse national and subnational action if they are to reverse the ongoing loss and degradation of water-related ecosystems and their services. Thus, the capacity and ability to produce quality data consistently over time is key to measuring changes in water-related ecosystems and will enable countries to identify where such changes are occurring, the extent of the changes and the causes. This is the role that monitoring and reporting on indicator 6.6.1 supports. Countries should significantly upscale in situ monitoring of water quality and quantity, as well as utilize globally available data on the spatial extent of open water bodies and vegetated wetlands generated by satellite-based Earth observations. In situ data have an important role in the monitoring process. Ultimately, countries must actively participate and engage in the monitoring and reporting process, take ownership of monitoring indicator 6.6.1 data and use them to make informed decisions that result in national and local action. To this end, countries would be able to assess and understand the socioeconomic, biological and intrinsic values and the benefits that water-related ecosystem services provide, address impacts on water-related ecosystems resulting from land-use change and prioritize the restoration and protection of source watersheds, such as forests and critical basins, to maintain their ecosystem function and services to society.

This report on global monitoring of water-related ecosystems builds on these key messages, emphasizing the value in monitoring and reporting target 6.6 progress through indicator 6.6.1, while considering the current state and trends of the world's water-related ecosystems. The report presents the first collection of country results that were gathered during the pilot testing of the indicator 6.6.1 methodology, including the use of globally available data from Earth observations, and outlines how the methodology has evolved through its piloting phase, documenting the lessons learned from country outreach activities into an Inter-agency Expert Group on SDGs (IAEG-SDG) Tier II indicator methodology.

1

SDG target 6.6 and indicator 6.6.1

Wetlands in the agriculture landscape near Amsterdam, The Netherlands. Photo: Peter Prokosch

This section introduces Sustainable Development Goal (SDG) target 6.6 and indicator 6.6.1, providing contextual and background information on each.

1.1. Target 6.6

By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.

Water-related ecosystems provide important social and economic benefits in the form of services that support societies, such as providing water for drinking, sanitation and key sectors. To ensure that ecosystem services are sustained, water-related ecosystems must be protected and restored. Target 6.6 aims to achieve this, using the imminent date of 2020 to align with the Aichi Biodiversity Targets of the Convention on Biological Diversity, though it will continue beyond this date to align with the other SDG targets until 2030.

The overarching theme of SDG 6 is to ensure that clean water and sanitation is available for all. Within the people-centred context of this goal, target 6.6 focuses in particular on protecting and restoring water-related ecosystems, so that they can continue to provide sustainable water services to society (Dickens *et al.*, 2017). Within the SDGs, the importance of ecosystems is measured by the services they provide to society.

The inclusion of target 6.6 in the SDGs reflects the growing recognition of the importance of ecosystems for sustainable development.[1] Over the past decade, ecosystems have been increasingly considered in the global development agenda (MEA, 2005; Russi *et al.*, 2013), highlighting that healthy ecosystems are essential to providing services that underpin society (Figure 1). Ecosystem services are specifically defined as the "benefits people obtain from ecosystems" (MEA, 2005). Despite amounting to less than 1 per cent of the Earth's water, water-related ecosystems such as lakes, rivers, wetlands and groundwater are uniquely important for human functioning and well-being, prosperity and the planet (WWF, 2016; UNEP, 2017).

Water-related ecosystems provide critical life support for all human activity and are essential for supporting

KEY FACTS

Water-related ecosystems provide **critical life support** for all human activity and are essential for supporting various types of services.

It is estimated that the world has lost between **54 and 57 per cent** of the extent of its natural wetlands in the last 100 years.

Severe **water scarcity** affects more than **200 river basins** annually, with direct impacts on **2.67 billion people.**

The **loss in natural wetland** is estimated as Africa 42 per cent, Asia 32 per cent, Europe 35 per cent, Latin America and the Caribbean 59 per cent, North America 17 per cent, Oceania 12 per cent.

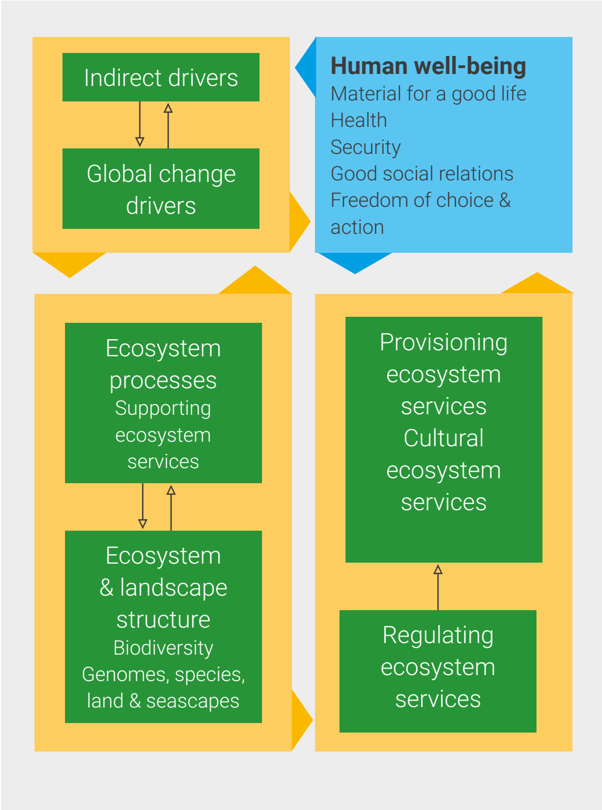
[1] An ecosystem is a dynamic complex of plant, animal and microorganism communities and the non-living environment, interacting as a functional unit which provides several potential benefits to society (MEA, 2005).

various types of services, such as provision services, including water for drinking, agricultural and industrial use, power generation and transport navigation; regulatory services, including maintenance of water quality from natural filtration and water treatment, buffering of flood flows and erosion control; cultural services, including recreation, health benefits and tourism; and supporting services, including nutrient cycling, primary production and ecosystem resilience (MEA, 2005). Most of the United Nations Member States (151 out of 193 countries) share all or part of their water resources with another country, making information sharing and cooperation across borders of utmost importance to prevent tension, conflicts and further degradation of water-related ecosystems (Talaue McManus *et al.*, 2016).

Given the numerous services that water-related ecosystems provide, monitoring and reporting data on water-related ecosystems is key to ensuring their effective governance and will allow for evidence-based decision-making on how to best protect and restore them.

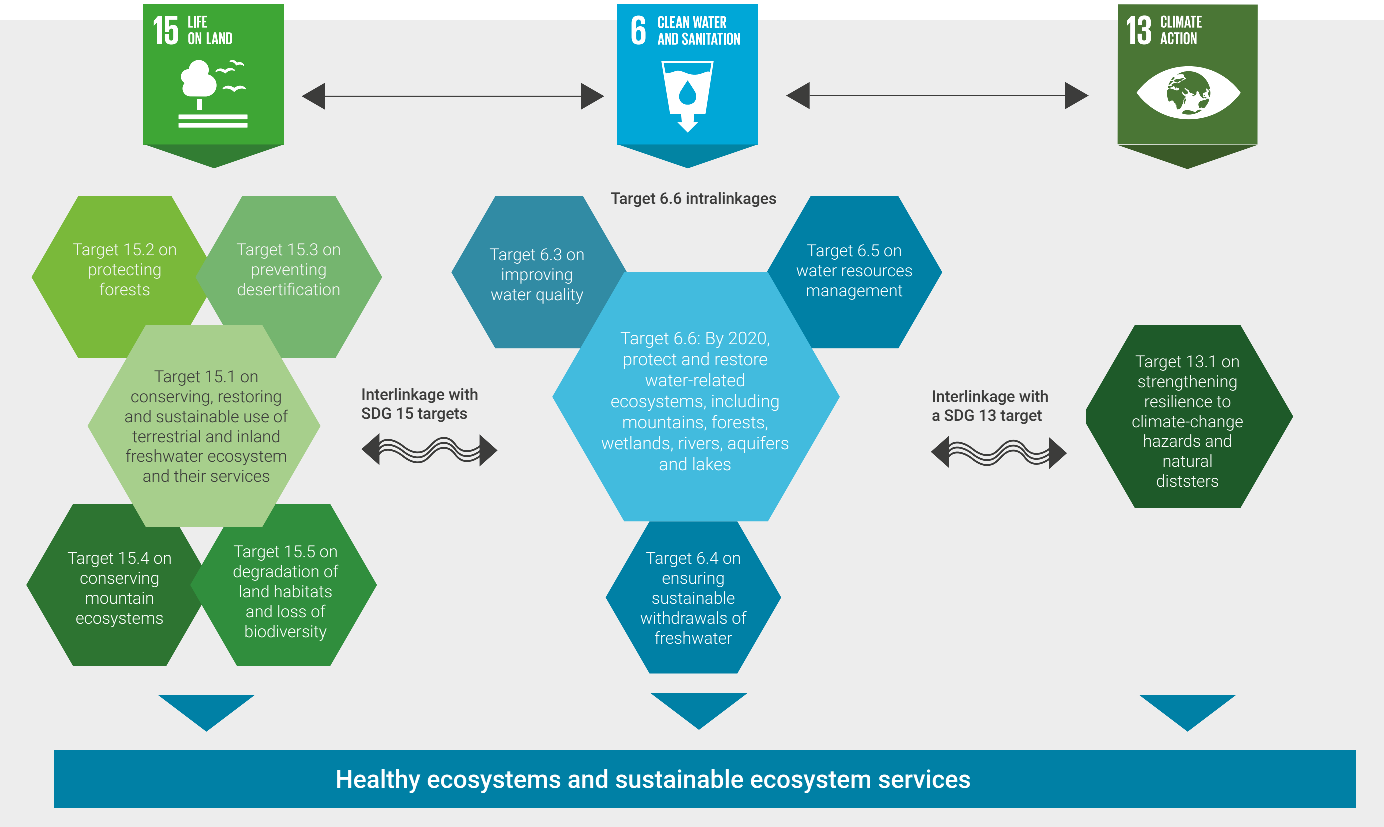
No matter how developed, human society remains fundamentally dependent on services from natural ecosystems. For example, rural communities may live close to ecosystems and thus be immediately dependent on its services for their livelihood. Contrastingly, urban com-

Figure 1: Ecosystems and their relation to society



Source: Adapted from MEA, 2005 by Carpenter et al., 2009.

Figure 2: Intralinkages and interlinkages between SDG target 6.6 and other SDGs



munities may not feel short-term changes and spatial changes in the ecosystem, though this does not mean they are less dependent on ecosystems than rural communities, rather, they are simply often unaware of their dependence (Dickens *et al.*, 2017).

Target 6.6 has close intralinkages with other SDG 6 targets on ecosystems and ecosystem management, including target 6.3 on improving water quality, target 6.4 on ensuring sustainable withdrawals of freshwater and target 6.5 on water resources management. Progress towards these SDG 6 targets can positively impact progress towards target 6.6, which in turn can positively impact the other targets.

More broadly, target 6.6 has strong interlinkages to other environmental SDGs and targets, including SDG 13 on climate change, specifically target 13.1 on strengthening resilience to climate change hazards and natural disasters, and SDG 15 related to life on land, specifically target 15.1 on ensuring the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, target 15.2 on protecting forests, target 15.3 on preventing desertification, target 15.4 on mountain ecosystems and target 15.5 on the degradation of natural habitats and loss of biodiversity (Dickens *et al.*, 2017).

While the target 6.6 language "protect and restore" suggests the need to measure water-related ecosystem management practices, thereby quantifying how much protection and restoration is occurring, this aspect is not monitored under target 6.6. However, integrated water resources management is monitored under target 6.5.

1.2. Indicator 6.6.1

Change in the extent of water-related ecosystems over time

Of the indicators for target 6.6, indicator 6.6.1 specifically enables countries to monitor progress towards achieving the target by tracking **changes in the extent of water-related ecosystems over time**. This indicator requires data to be collected on three components: the **spatial extent** of water-related ecosystems and the **quantity** and **quality** of water within them. These components, collectively termed "extent", provide a comprehensive picture on changes within ecosystems, allowing informed decisions to be made on how to protect and restore them successfully. Further explanation of the terms water-related ecosystems and extent are provided in section 1.4.

In addition to in situ biological data collection, the indicator also enables decision makers to monitor the health of water-related ecosystems, though only at the country level. Indicator 6.6.1 responds to SDG 6 in that it seeks to provide data and information to support the management and protection of water-related ecosystems, so that ecosystem services – especially those related to water and sanitation – continue to be available to society.

1.3. Sub-indicators and data sources

The methodology for monitoring indicator 6.6.1 has evolved over time, having been first conceptualized in 2014 and then developed and tested in a piloting phase until 2017. The monitoring methodology was subsequently revised in early 2018 and approved by the Inter-agency Expert Group on SDG Indicators (IAEG-SDG), which classified the indicator as Tier II in April 2018.[2] The indicator 6.6.1 monitoring methodology is framed around five sub-indicators:

1 – spatial extent of water-related ecosystems (from satellite data)

2 – water quality of lakes and artificial water bodies (from satellite data)

3 – quantity of water (discharge) in rivers and estuaries (in situ data)

4 – water quality imported from SDG Indicator 6.3.2 (in situ data)

5 – quantity of groundwater within aquifers (in situ data)

Ecosystem health monitoring is recommended as an optional component of indicator 6.6.1 at the national level. Two data-collection approaches have been proposed for monitoring these sub-indicators: satellite-based Earth observation data, which countries will validate against their own data sets, thus filling data

[2] At this meeting, the IAEG-SDG also decided to include the national reports to the Ramsar Convention as a separate data stream in the Global SDG Indicators Database for target 6.6. This data stream is not included or discussed in this report.

gaps (for sub-indicators 1 and 2) and from in situ measurements (sub-indicators 3, 4 and 5).

1.4. Defining water-related ecosystems and extent

Indicator 6.6.1 terminology includes the terms water-related ecosystems and extent, which warrant further explanation to ensure a clear understanding of their meanings.

Water-related ecosystems: there are five categories of water-related ecosystems monitored under indicator 6.6.1: vegetated wetlands, rivers and estuaries, lakes, aquifers and artificial water bodies. Each of these water-related ecosystem categories plays a significant role in delivering water-related services. The indicator specifically applies to freshwater ecosystems and does not include saltwater ecosystems,[3] since the objective of SDG 6 is to ensure water and sanitation services are available and sustainably managed for all people. Thus, all water-related ecosystems included in indicator 6.6.1 are freshwater, with the exception of mangroves and estuaries –which are brackish bodies of water – due to their relationship with freshwater ecosystems.

River Ölfusá in southern Iceland is of major importance to the local salmon fishing industry. Photo: Peter Prokosch.

Vegetated wetlands and artificial water bodies are distinct from the other water-related ecosystem categories and therefore require further discussion. Vegetated wetlands, which include swamps, fens, peatlands, marshes and mangroves, have been separated into their own ecosystem category as they are highly important for achieving target 6.6 and also rely on a monitoring methodology (Earth observations) that is different to that used for other open waters. Artificial water bodies include open water bodies created by humans, such as reservoirs, canals, mines and quarries. Although artificial water bodies are not traditional water ecosystems that need to be protected and restored, in some countries, they hold significant amounts of freshwater and are therefore included as a water-related ecosystem category that should be monitored. Given this difference, all data on artificial water bodies will be separated from data on natural water-related ecosystems. Data from Earth observations on the spatial extent of vegetated wetlands and artificial water bodies will not be used to calculate spatial extent values for lakes, rivers and estuaries and will be detailed in a separate report. Separating the data in this manner is particularly important, as it prevents duplicated spatial extent results and allows any losses or gains occurring in natural and artificial water bodies to be accurately reported.

Extent: for indicator 6.6.1, extent does not only cover spatial changes, but has been expanded to capture additional basic parameters that are needed to protect and restore water-related ecosystems. These parameters comprise three components: the spatial extent or surface area of the water-related ecosystem and the quality and quantity of its water. However, not all of these three components are relevant to each water-related ecosystem category (see Table 1).

For example, monitoring water quantity within vegetated wetlands or the spatial extent of aquifers is not an accurate measure of their state and is therefore not included in the indicator's monitoring methodology. Similarly, it is not necessary to monitor the water quantity of lakes and

[3] Saltwater ecosystems, such as coral reefs and coastal waters are covered in SDG 14 and terrestrial ecosystems, including mountains, forests, and drylands are covered in SDG 15.

Table 1: Water-related ecosystem categories and their applicable extent components

		Water-related ecosystems categories				
		Lakes	Rivers and estuaries	Vegetated wetlands	Aquifers	Artificial waterbodies
Extent components	Spatial extent				N/A	
	Quality					
	Quantity	N/A		N/A		N/A

artificial water bodies, since this can be inferred from its spatial extent measurements using Earth observations, which is a more efficient way to measure and reduces the reporting burden on countries.

1.5. Impacts of human activity on water-related ecosystems

Despite the evident value of water-related ecosystems, they are under considerable threat. It is estimated that the world has lost between 54 and 57 per cent of the extent of its natural wetlands in the last 100 years (Davidson, 2014) and that up to one third of rivers in developing countries face severe pathogenic and organic pollution, primarily from a lack of wastewater and agricultural run-off management (UNEP, 2016). There is ample evidence that freshwater resources are vulnerable and could be strongly impacted by climate change, with wide-ranging consequences for human societies and ecosystems, including more erratic rainfall and climatic patterns, leading to droughts and floods (Bates *et al*., 2008).

Human pressures on water-related ecosystem, such as water abstraction and pollution, habitat alterations, flow modifications, fragmentation from dams and other infrastructure, over-exploitation of species and invasions of unfamiliar species (Juffe-Bignoli *et al.*, 2016) continue to grow, jeopardizing critical ecosystems services such as nutrient cycling, primary production, water provisioning, water purification and recreation (DOPA, 2017). The effects of these pressures are increasingly being felt by society. Severe water scarcity is affecting more than 200 river basins annually, with direct impacts on over 2.67 billion people (Matthews, 2016). This loss of water-related ecosystem functionality can lead to increasing water insecurity (Dickens *et al*., 2017) and it is predicted that by 2025, two thirds of people may be affected by severe water stress. It is therefore crucial to identify solutions that will contribute to conserving and preserving water-related ecosystems (Matthews, 2016). Effective regular global monitoring of water-related ecosystems to improve the relationship between human and freshwater ecosystems can help to identify and implement sustainable solutions.

1.6. Observed changes in freshwater availability, ecosystems and species

At present, there is insufficient data to generate an accurate global assessment and understanding of changes in water-related ecosystems. Data on indicator 6.6 should fill this data gap over time, with global and nationally derived in situ measurements, providing countries with the information needed to protect and restore water-related ecosystems.

It is possible to draw on available literature to obtain an indication of the extent of change and factors driving change. For instance, the National Aeronautics and Space Administration (NASA) has recently published evidence on how freshwater availability is changing worldwide, observed by the Gravity Recovery and Climate Experiment (GRACE) satellites during 2002–2016. The 14-year study concludes that the drivers of change are natural inter-annual variability, unsustainable groundwater consumption, climate change or combinations thereof. Several of the trends that NASA observed lacked thorough investigation and attribution, including massive changes in northwestern China and the Okavango Delta. Most trends observed were found to be consistent with climate model predictions. This "observation-based assessment of how the world's water landscape is responding to human impacts and climate variations provides a blueprint for evaluating and predicting emerging threats to water and food security" (Rodell *et al.*, 2018).

The extent of natural wetland is known to have decreased worldwide by approximately 50 per cent (Davidson *et al.*, 2014). At a regional scale for the period 1970–2015, this loss in natural wetland extent is estimated as follows: Africa 42 per cent, Asia 32 per cent, Europe 35 per cent, Latin America and the Caribbean 59 per cent, North America 17 per cent and Oceania 12 per cent (UNEP-WCMC, 2016).

While natural wetlands are decreasing, artificial water bodies, such as reservoirs and rice paddies are increasing (300,000 km^2 from 1970 to 2014 for rice cultivation and 106,000 km^2 from 1970 to 2010 for reservoirs) (IRRI, 2017; Lehner *et al.*, 2011), with at least 3,700 major dams planned or under construction in emerging economies countries during 2014 (Zarfl *et al.*, 2014).

The spatial extent of open water bodies is also changing. Between 1984 and 2015, permanent surface water disappeared from an area of almost 90,000 km^2 (Pekel *et al.*, 2016), though new permanent bodies of surface water covering 184,000 km^2 formed elsewhere. All continental regions show a net increase in permanent water, except Oceania, which has a fractional net loss (1 per cent). Much of the increase is from reservoir filling, though climate change is also a factor. These data are further discussed and assessed in section 4.4.

BOX 1

Business case for monitoring SDG indicator 6.6.1

Water-related ecosystems are important as they provide social and economic benefits to human well-being. Their degradation and/or destruction have direct impacts on water availability and other important services, including water supply, energy and food production, transportation, biodiversity, flood control and recreation. Water-related ecosystems are increasingly facing serious pressures, which are affecting their ability to provide ecosystem services. These pressures include pollution and over-extraction due to socioeconomic development, which are worsened by the impacts of climate change. The diversity and complexity of freshwater ecosystems makes it difficult for countries to know how to manage them. The challenges largely revolve around balancing the need for short-term socioeconomic development, which often puts extra pressures on ecosystems, and the need to protect and restore ecosystems to support more long-term, sustainable development.

Monitoring target 6.6 progress using indicator 6.6.1 can provide the necessary data for countries to take action to protect and restore these valuable ecosystems. Countries should use the indicator 6.6.1 data to help them better understand the values and benefits of the various services that water-related ecosystem provide for society; better assess the long-term implications of land-use change; and prioritize their restoration and protection initiatives, particularly source watersheds such as forests, core connective pathways for species movements and sediment delivery and critical basins. These actions would help to sustainably maintain the high-value benefits of services.

Countries can learn from and be encouraged by the results of existing global, regional and national initiatives that can support countries aiming to protect and restore water-related ecosystems. For example, the Framework for Freshwater Ecosystem Management (UNEP, 2017), the European Water Framework Directive and the South-East Queensland Ecosystem Services Framework in Australia are good examples of legislative frameworks and guidance on protecting and restoring water-related ecosystems. The UN Environment Framework for Freshwater Ecosystem Management (2017) in particular presents a holistic management framework to guide country-level action in sustainably managing freshwater ecosystems. It is also supports national and international goals related to freshwater ecosystems, such as relevant Aichi Biodiversity Targets.

For more information on the UN Environment Framework for Freshwater Management, see https://www.unenvironment.org/resources/publication/framework-freshwater-ecosystem-management

Changes in populations of freshwater species also indicate the extent to which water-related ecosystems are being lost. For example, despite providing 10 per cent of habitats for all living species, the Living Planet Index estimates that the abundance of populations[4] monitored in freshwater ecosystems declined by 81 per cent on average between 1970 and 2012 (WWF, 2016).

The decline of natural freshwater ecosystems, fisheries and species around the world is partly due to the development of artificial water storage systems, which change natural ecosystems in countless ways. The dam wall of such systems prevents the movement of species and changes flows and habitats upstream and downstream of the dam, which not only affects quantities, but qualities and temperatures (Liermann *et al.*, 2012; World Commission on Dams, 2000). Reservoirs act as sediment traps, changing the sediment flows downstream, which contributes to sinking deltas and loss of nutrients to floodplains (Syvitski *et al.,* 2009; Vörösmarty *et al.*, 2003). Artificial water bodies are also often sources of invasive species, which are introduced to replace native species that have either been lost or diminished due to the extreme changes caused to the natural ecosystems (Hermoso *et al.*, 2011). Although further data are required, available literature provides information on changes in freshwater availability, loss of natural wetland extent, increases in reservoirs and dams, changes in spatial extent of open water and the loss of freshwater species, indicating the current state of water-related ecosystems and the trends occurring within them.

1.7. Protecting freshwater ecosystems

An important part of target 6.6 is protecting water-related ecosystems (including mountains, forests, wetlands, rivers, aquifers and lakes). Through compiling information on the extent, quality and quantity of water-related ecosystems, indicator 6.6.1 is a first step to improving the data needed to understand current levels of protection of water-related resources. There are many mechanisms at different scales used to protect water-related resources which differ between regions and countries. Protected areas are one such mechanism used to protect ecosystems worldwide and contribute to the implementation of many SDG targets (UNEP-WCMC/IUCN, 2016). Protected area networks have, however, historically been established for terrestrial conservation and a specific focus on coverage and management of water-related ecosystems in their own right is often missing (Watson *et al.*, 2014; Herbert *et al.*, 2010). Although indicator 15.1.2 measures protection of freshwater Key Biodiversity Areas to "ensure conservation, restoration and sustainable use of freshwater ecosystems", there is currently no established indicator to track progress towards the protection of all inland water systems.

In the context of SDG 6, protected areas provide more than one fifth of total continental run-off (Harrison *et al.*, 2016). Protecting freshwater resources through protected areas directly provides all or a significant proportion of drinking water to 33 of the world's largest cities, including New York, Sydney and Tokyo (Dudley *et al.*, 2003). Protected areas can safeguard water-related ecosystems and contribute directly to target 6.6, and other SDG 6 targets, such as providing safe drinking water (6.1), contributing to better ambient water quality (6.3.2) and reducing stress on water resources (6.4.2). In addition, protected areas that cross country borders – known as transboundary protected areas – may encourage international cooperation to adequately manage water resources (6.5) (Vasilijević *et al.*, 2015).

Increasing human population size, particularly in cities, means that protected areas will play an ever-important role in providing high-quality freshwater to downstream populations. However, estimates of the extent of protected ecosystem areas provide a very limited understanding of management effectiveness and ecosystem conditions. Monitoring the extent of surface water and vegetated wetlands under indicator 6.6.1 and measuring water quality and quantity can build a more complete picture of protection and threat levels in all water-related ecosystems worldwide. Improved spatial data can be used to analyse threat levels both inside and outside protected areas. Decision makers can use this information to reduce threats to human water security and biodiversity within current protected area networks and consider the creation of new protected areas to safeguard freshwater resources and biodiversity at the catchment level. While protection within protected areas is important, protecting ecosystems outside of protected areas is extremely important, as most water-related ecosystems are within these areas. Careful management of ecosystems in unprotected areas to balance their use and protection is necessary to ensure long-term sustainability of the entire ecosystem.

[4] Data from more than 3,300 populations of over 880 freshwater species were included in the WWF Living Planet Index assessment.

2

Piloting the indicator 6.6.1 monitoring methodology and initial results

Napo river, Yasuni National Park, Ecuador. Photo: Peter Prokosch

As a result of the ambitious 2030 Agenda, for the first time, United Nations Member States have been asked to monitor and report data on changes in the extent of their water-related ecosystems. As these data become available, countries will be able to make more informed decisions on protecting and restoring their water-related ecosystems. In the spirit of the 2030 Agenda "to leave no one behind", the indicator methodology intends to incorporate the different starting points from which countries begin to monitor indicator 6.6.1 data.

KEY FACTS

Of the **193 countries** invited to provide data on their water-related ecosystems, **40 countries** submitted data addressing **at least one sub-indicator** for indicator 6.6.1.

Progress on reporting indicator 6.6.1 data is low – only **20 per cent** of United Nations Member States have provided the information.

Satellite data on national extent of open water bodies was collected for **188 United Nations Member States**.

Globally, groundwater provides about **98 per cent** of all unfrozen freshwater.

2.1. Methodology development and testing

As the custodian agency for indicator 6.6.1, UN Environment led the process to develop and test the indicator 6.6.1 monitoring methodology under a UN-Water SDG 6 monitoring initiative. The purpose of developing a monitoring methodology was to provide a coherent guide as to what, when, where and how to monitor globally comparable and nationally relevant parameters of water-related ecosystems.

To support the methodology development process, an SDG target 6.6 task team was established that comprised organizations, institutions and secretariats with institutional expertise in water-related ecosystems. For indicator 6.6.1 this included: UN Environment, the United Nations World Water Assessment Programme, the Ramsar Convention Secretariat, the Convention on Biological Diversity Secretariat, the International Union for the Conservation of Nature, the World Resources Institute, RTI International, the United Nations University Institute for Water Environment and Health, the European Space Agency, the International Water Management Institute and the Group on Earth Observations (GEO) Secretariat.

The indicator 6.6.1 monitoring methodology underwent a country consultation exercise (proof of concept) in five countries during 2016.[5] A broad range of water experts and national statistical offices were consulted on the methodology's technical feasibility and usefulness for policymaking, leading to the development of institutional implementation models and capacity requirements.[6] During the proof of concept consultation exercise, countries were positive about the methodology's scope and

[5] The five proof of concept countries consulted were Jordan, the Netherlands, Peru, Senegal and Uganda.

[6] Review of draft monitoring methodologies for SDG 6 global indicators – Summary of feedback and responses – 6.6.1. Available at: https://static1.squarespace.com/static/57fddec6725e25594e4847bb/t/58d3de8ae4fcb51bf3abba67/1490280081344/Summary+of+feedback+and+responses+%E2%80%93+6+6+1_2017-02-05.pdf

value, indicating that they would develop the necessary capacity to implement it. All comments were considered and approved comments were incorporated into a revised methodology document (UN-Water, 2017).

2.2. Country outreach and support

To maximize outreach and implementation of the methodology in preparation for a global data drive in 2017, capacity-building tools were rolled out worldwide through webinars on SDG 6, followed by a series of indicator 6.6.1 technical training webinars and several training workshops in eight countries. The methodology was translated into the six United Nations languages and a help desk of international freshwater experts was established to allow countries to engage directly with UN Environment and ask technical or process-oriented questions regarding the indicator. Table 2 outlines the details of the country outreach support that UN Environment provided to countries to help strengthen capacity and knowledge for monitoring and reporting indicator 6.6.1 data.

2.3. Indicator 6.6.1 data submitted to UN Environment in 2017

All United Nations Member States were requested to report indicator 6.6.1 data to UN Environment in 2017 on the water-related ecosystems that they deemed significant within their country. The global communication was sent out to SDG 6 (Integrated Monitoring of Water and Sanitation-Related SDG Targets Initiative – GEMI) focal points in countries or to relevant water and environment focal points where SDG 6 focal points were not identified.

Table 2: Country outreach and support provided to countries

Proof of concept testing	Held between April and November 2016, the draft indicator 6.6.1 monitoring methodology was piloted with other SDG 6 methodologies in Jordan, the Netherlands, Peru, Senegal and Uganda. The objective was to collect feedback on its technical feasibility, usefulness for policymaking, institutional models for implementation and capacity requirements. The feedback collected from this exercise helped to improve the methodology and inform the global data drive process in 2017.
Technical webinars	A series of technical webinars in the six United Nations languages was organized for countries to understand practical requirements. The recorded webinars are available on the SDG 6 monitoring[7] website.
Country visits	Support was provided to eight countries through training workshops (Bangladesh, Cambodia, Cameroon, Fiji, Jamaica, Nepal, Peru and Zambia) and country facilitators were engaged in 62 countries to collect indicator 6.6.1 data with the national focal points in their respective countries.
Workshops and conferences	• UN-Water, Global workshop for integrated monitoring of Sustainable Development Goal 6 on water and sanitation, The Hague, the Netherlands, November 2017. Presentations on indicator 6.6.1 and "market stalls" (75 countries) • Africa Regional Environmental Statistics workshop, Nairobi, Kenya (8 countries) • United Nations Global Geospatial Information Management, SDG Expert Group Meeting, Mexico City, Mexico (15 countries) • Cap-Net annual retreat and planning meeting, Montevideo, Uruguay (10 countries) • Consultative Meeting on the Implementation Framework for the Environmental Dimension of the 2030 Agenda in the Arab Region, Cairo, Egypt, September 2017 (12 countries) • Centre for Environment and Development for the Arab Region and Europe (CEDARE), Regional Meeting on the 3rd Arab State of the Water Report, Cairo, Egypt, November 2017 (13 Countries) • Mapping Water Bodies from Space (MWBS) 2018 Conference, Rome, Italy, March 2018 (Earth observation community)

[7] http://www.sdg6monitoring.org/indicators/target-66/indicators661/.

Leningradskaya River, Northern Taimyr. Photo: Peter Prokosch

Of the 193 countries invited to provide data on their water-related ecosystems, 40 countries submitted data addressing at least one sub-indicator for indicator 6.6.1. For this first data-collection process, countries were requested to report sub-indicator data on the following aspects of water-related ecosystems: spatial extent, quantity and quality of vegetated wetlands, lakes, rivers and groundwaters.

Table 3 shows the limited spread of data that countries reported.

Most of the data reported were from 2015 onwards. Sixteen countries reported data on basins covering more than 75 per cent of the surface area of their country, two countries submitted data for basins that cover between 25 and 75 per cent and eight countries submitted data for basins that cover less than 25 per cent.

Progress on reporting indicator 6.6.1 data is low, with only 20 per cent of United Nations Member States providing the information.

Table 3: Number of countries reporting against sub-indicators and water body type

Sub-indicator	Number of reporting countries	Water body type	Number of reporting countries
Extent	33	Vegetated wetlands	22
		Open water body	32
		River	18
Quantity	29	Open water body	20
		River	25
		Groundwater	14
Quality	32	Open water body	22
		River	32
		Groundwater	26

Countries that reported data include those from Europe (15 countries), sub-Saharan Africa (12 countries), Northern Africa and Western Asia (four countries), Latin America and the Caribbean (three countries), Eastern and Southern Asia (four countries) and Oceania (two countries).

Global and regional aggregate analysis could not be carried out using these limited country-derived data, as the number of countries providing data was below the minimum 30 per cent regional threshold (UNEP, 2016).

Prior to data submissions, UN Environment carried out quality assurance processes to help countries better understand their data and correct any erroneous information. However, the data that countries submitted varied greatly in quality: of the 40 countries that reported data, 11 country submissions contained significant data errors and could not be quality assured.

The limited number of countries that submitted data (20 per cent of Member States) and the high variability in its quality is an indication of the challenges that countries faced in reporting indicator 6.6.1 data and points to a lack of political will to report.

The indicator 6.6.1 data set that was submitted to UN Environment and reported to the United Nations Statistics Division (UNSD) as SDG data is shown in Annex 1. Nationally submitted data that could not be quality assured was not submitted to UNSD.

To help fill the indicator data gap, globally available satellite-based data on national spatial extent of open water bodies was collected for 188 United Nations Member States. The full data set is shown in Annex 2 and discussed in section 4 of this report.

2.4. Challenges and opportunities observed from country reporting

Indicator 6.6.1 data reported by countries in 2017, coupled with the indicator methodology piloting and country outreach highlighted several challenges and opportunities in monitoring the core parameters of water-related ecosystems.

2.4.1 Limited data on water quantities, particularly river flow data

The quantity of water in ecosystems is the amount of water contained in rivers – measured as streamflow – together with the water stored in lakes, reservoirs and beneath the ground. Water quantity is the defining issue of most water-related ecosystems. Reductions in quantities through withdrawals of water diminish the size of ecosystems (i.e. a lake gets smaller, a river shrinks, groundwater becomes out of reach), thus reducing the

BOX 2

Country highlights

Throughout the data collection process for indicator 6.6.1 in 2017, several countries demonstrated their commitment to monitoring and reporting indicator 6.6.1 data for the first time. Fiji and South Africa are two examples of many country highlights.

Fiji

Freshwater data are often spread across many institutions and ministries, which was the case in Fiji. The government therefore organized a two-day workshop, bringing together representatives from several ministries and institutions working on water-related issues to discuss how the country could best collect and share water-related data. The participants were trained on the methodologies for monitoring water-related ecosystems and water quality. Fiji subsequently submitted good quality data on its water quantity and quality in rivers, open water bodies and groundwaters.

South Africa

South Africa committed to contributing to the 2017 indicator 6.6.1 data drive and submitted data for almost all of the indicator's components. With 22 basin districts reported, data were provided on spatial extent, quantity and quality of water and vegetated wetlands. South Africa took the opportunity afforded by the SDG data drive to align its National Wetland Policy and Water Quality Master Plan with the SDGs. The country also included indicator 6.6.1 monitoring in their new wetland management policy.

amount of services that ecosystems can provide to society. Reduced water levels also change water-related habitats, which result in changes to biodiversity and ecosystem services provided. The flow of water in a river is best represented by data collected from a flow measurement station, with long-term data (more than 50 years) being ideal.

Only 29 countries reported data on monitoring changes in the volume or quantity of water, with just 24 countries reporting data on river flow volumes and 14 on groundwater volumes (see section 2.4.2 on groundwater data). The quality of the country-derived data was extremely varied and difficult to complete quality assurances. In many cases, the data required follow-up and further communication with the countries concerned. The use of global data sets was explored, such as the Global Runoff Database, which despite containing a large amount of historical data was incomplete, as it lacked recent data. It is not evident whether countries had river flow data and were unwilling to report them or simply lacked the capacity and flow data monitoring stations. This resulted in poor reporting on water quantity.

2.4.2 Lack of groundwater data

Groundwater provides about 98 per cent of all unfrozen freshwater worldwide (Jimenez-Cisneros, 2015), making it a vital water supply for people and nature worldwide. Changes in groundwater recharge (due to climate change and land use) and anthropogenic removals from the water body (groundwater abstraction) mean that groundwater volumes are continually changing. Groundwater supplies are difficult to measure, since aquifers containing groundwater have not been adequately mapped and/or characterized in large parts of the world.

Countries were requested to report data on the spatial extent, flow (quantity, volume, depth) and quality of their groundwater. Fourteen countries reported the quantity of groundwater in aquifers and 25 countries reported on the quality of groundwater in aquifers (the latter reporting is data imported from indicator 6.3.2 monitoring on ambient water quality). No countries reported on the spatial extent of groundwater. The limited number of countries reporting these data is likely due to a lack of available data, the challenging nature of monitoring groundwater aquifers effectively and the required capacity and technology to complete this task. The depth to the water table below the surface is traditionally monitored using boreholes. However, placing boreholes is often a difficult task, as these are expensive to construct and may not always adequately represent the total groundwater situation for an area. Currently no global data set is available to help monitor and report on groundwater, though modelled estimates indicate that global withdrawals were approximately 900 km^3/a in 2010, providing approximately 36 per cent of drinking water supplies, 42 per cent of water in irrigation systems for agriculture and 24 per cent of water supplies in the industrial sector (IAH, 2017). The indicator 6.6.1 monitoring methodology has since been revised in the light of these difficulties to prioritize monitoring the depth to the water table within an aquifer as a proxy for measuring an aquifer's groundwater volume.

2.4.3 Setting a relevant and comparable monitoring and reporting scale

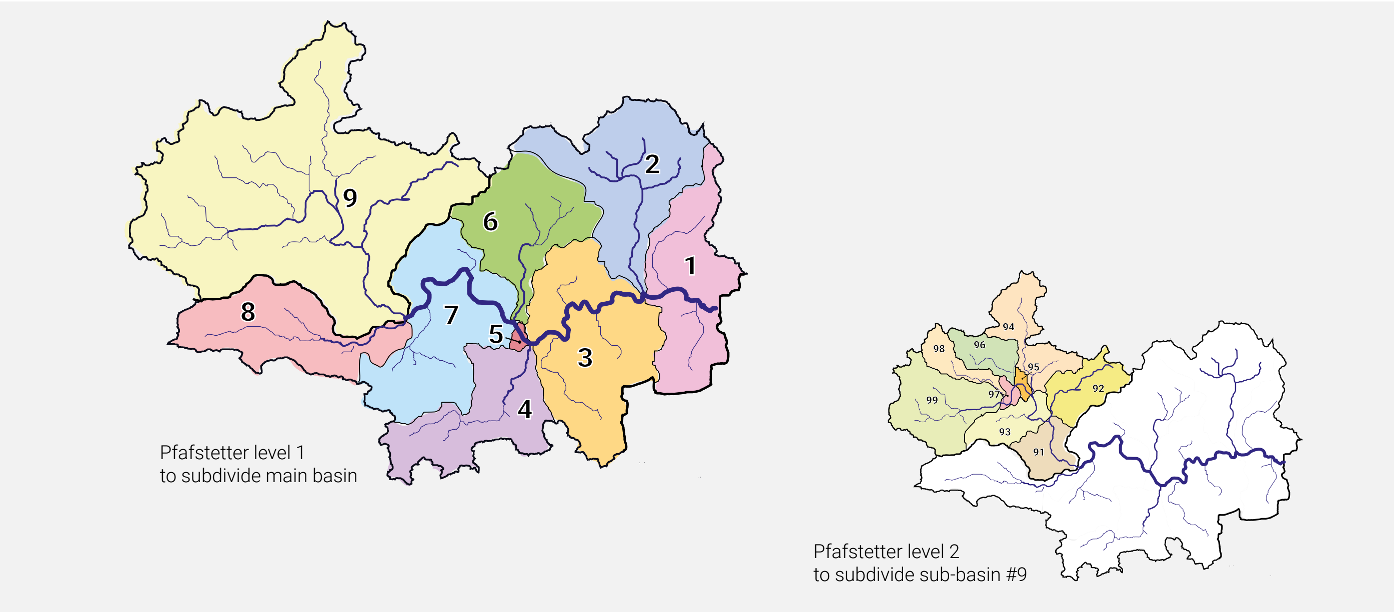
When UN Environment requested indicator 6.6.1 data from countries in 2017, it was clearly communicated that countries should decide which water-related ecosystems to report, identifying the River Basin Reporting District that contained the water bodies. This approach was adopted to encourage countries to decide which water-related ecosystems were important for their country and which data to provide. However, the result was that many countries reported only on a limited number of basins for which they held data.

The indicator 6.6.1 monitoring methodology has since been revised to include a global set of basins that will facilitate data provision at a national and subnational level, while also allowing data from different indicators to be compared (for example indicators 6.3.2, 6.5.1 and 6.6.1). To generate data at a subnational level, the revised indicator 6.6.1 methodology is applied to the WWF HydroBASINS (Lehner and Grill, 2013) data set. This data set identifies the primary watershed boundaries for each country, which are based on elevations. These main basins are then further divided into sub-basins by separating any main channels and tributaries (Figure 3). Where a hydrobasin crosses any national boundaries (transboundary basin), only the proportion of water within each national boundary is reported.

2.4.4 Reference period

Countries were requested to indicate the reference period of the data they provided for each parameter and water-related ecosystem type. Data reference periods were found to vary considerably across different parameters for the same ecosystem type, presenting a challenge in generating percentage change analyses

Figure 3: Subnational basins and sub-basins approach adopted by the HydroBASINS data set



Source: Adapted from Lehner, 2013.

and global comparisons. This challenge can partly be overcome by using Earth observation data, whereby a consistent set of data with a long time series is available for all countries, allowing a common and comparable baseline to be set. The indicator 6.6.1 monitoring methodology was revised following this approach: for instance, to calculate a percentage change of national spatial extent of lakes, rivers and estuaries, a time series of data from 2001 to 2015 is available and can be used to set a baseline period, against which change in extent can be measured. As discussed further in section 5.2 of this report, the revised methodology uses 2001–2005 as the five-year baseline period. Averaging all Earth observations annually and over a five-year period accounts for seasonal and climactic fluctuations in water-related ecosystems.

2.4.5 Ecosystem health

To fully document target 6.6, it is essential to monitor how the health of water-related ecosystems is changing. Although it was included in the initial draft monitoring methodology, ecosystem health is no longer included as a formal sub-indicator for indicator 6.6.1, as monitoring this is context-specific, which means the most appropriate methodologies will be based on local ecological conditions. While the original indicator 6.6.1 methodology sought to overcome this by normalizing all data to represent the percentage change from natural ecosystems, it was anticipated that few countries would be able to do this. Consequently, ecosystem health data were not requested to be reported in 2017.

2.5. Using indicator 6.6.1 data to achieve SDG 6 at the national level

Monitoring and reporting consistent and good quality data on indicator 6.6.1 at the water body and basin level is essential for enabling good national and subnational decision-making on water-related ecosystems and underpins national progress towards SDG 6. With water-related ecosystems providing services for many competing demands, knowing if and why changes in the extent of water-related ecosystems are occurring can be valuable information for water managers and ensure that these services continue to be provided. For example, pursuing national policies that protect and restore critical source watersheds can be considered a cost-effective and long-term investment that has multiple direct and indirect benefits across sectors and society.

To support progress towards SDG 6 at the national level, the following measures must be applied to indicator 6.6.1 data:

- Collect indicator 6.6.1 data at the water body and basin levels. These are natural hydrological spatial areas that contain specific and sometimes unique water-related ecosystems and are, as such, good physical areas upon which to make decisions.

- Collect as much sub-indicator data as possible for as many water body types that exist within a basin. Data on spatial extent, quantity and quality for of the various water body types that may exist in a basin (such as rivers, lakes, wetlands and groundwaters) provide a comprehensive picture on the state of basins and water bodies, as well as any changes. It is important to recognize the links between these aspects, including the drivers generating changes (for example land-use change, abstraction and regulation, climate change etc.).

- Make use of indicator 6.6.1 data for local water resources and ecosystem management, encouraging the development of a national policy that protects and restores water-related ecosystems.

2.6. Key lessons learned from piloting the methodology and the global data drive

The limited quantity and quality of indicator 6.6.1 data submitted by countries during the 2017 data drive, together with qualitative feedback obtained from the UN Environment help desk and engagement with countries, allows the following conclusions to be drawn from the methodology piloting phase:

- There is a lack of data on vegetated wetlands and river flows with no recent global data sets available that could otherwise be used to support countries with SDG indicator 6.6.1 monitoring and reporting. Where in situ country-derived data exist and were reported, they typically represented only some aspects of the indicator and a portion of a country's total water-related ecosystems.

- The technical and institutional capacity to report indicator 6.6.1 data is often lacking. Many countries reported to the UN Environment help desk that they had received the methodology but were unsure when they could generate such data. There is a need for increased technical knowledge and human capacity to implement the methodology. Several countries requested financial support to collect data.

- Linked to the above conclusion, the nature of indicator 6.6.1 – which spans both water and environmental domains – often required data to be collected from several institutions. It was difficult to identify a single focal person that had the requisite responsibility and authority to coordinate the identification and collection of data from ministries and institutions.

- Some countries lacked the political will to monitor and report on a Tier III indicator,[8] with some noting the high reporting burden associated with reporting on so many SDG indicators. This may have led countries to report only on Tier I and Tier II indicators and/or indicators identified as a country priority for the country.

- Many countries declined or were reluctant to report indicator 6.6.1 data as they either had long-standing national water monitoring processes in place and/or were already engaged with regional monitoring processes (such as the EU Water Framework Directive or African Union African Ministers' Council on Water (AU AMCOW)) and consequently felt it would duplicate their reporting.

[8] The indicator 6.6.1 methodology has since been revised and reclassified by IAEG-SDG (in April 2018) as a Tier II indicator.

3

Refining the indicator 6.6.1 monitoring methodology following the piloting phase

A family ride upstream on the Amazon River, Brazil. Photo: Neil Palmer/CIAT

3.1. Methodology reclassification

In the seventh meeting of IAEG-SDG held on 9–12 April 2018 in Vienna, Austria, the indicator 6.6.1 methodology submitted by UN Environment to IAEG-SDG was approved and reclassified as a Tier II indicator. IAEG-SDG members decided that UN Environment will be responsible for the internationally comparable methodology, along with the national data and regional and global aggregations generated for indicator 6.6.1. They also decided that the Ramsar Convention Secretariat will have a separate reporting line in the Global SDG Indicators Database hosted by UNSD with national reporting from the Ramsar Convention, based on Ramsar definitions and requirements. The two separate lines reporting to the Global SDG Indicators Database for indicator 6.6.1 will have a clear delineation of the type of data in each stream. Each co-custodian will be responsible for its respective reporting line and will jointly contribute to target 6.6 progress.

The 2030 Agenda is a country-led and country-owned process and the approved methodology for indicator 6.6.1 embraces this approach, placing responsibility on countries to monitor and report data. However, the progressive indicator 6.6.1 methodology encourages the use of globally available environmental data to enhance country-derived data, filling data gaps and enabling countries to make progress more rapidly towards achieving target 6.6. This same approach has been adopted for other SDG indicator methodologies, such as indicator 15.3.1.

In applying a progressive monitoring approach, countries can utilize global and national data to report on indicator 6.6.1. As regards the global data, this is easily and readily available for countries to validate, thus complying with the 2030 Agenda. While it is beneficial to capture data on all aspects of the indicator, this may not be immediately feasible for all countries to achieve. Progressive monitoring over time can therefore encourage different levels of ambition among countries. For that reason, the indicator is framed around two levels: level 1 data are generated globally (but validated locally) and provide a foundation of data for all countries and level 2 data are generated by countries to build on this foundation.

Indicator 6.6.1 has five sub-indicators. The pilot testing in 2017 revealed that countries currently lack capacity to monitor all five sub-indicators. Thus, level 1 data utilizes data that are already globally available to establish a foundation which countries can strengthen as they de-

KEY FACTS

Satellite imagery can determine new or lost water bodies, helping to locate where new artificial bodies are formed and where natural bodies are lost.

In April 2018, the **indicator 6.6.1** monitoring methodology was approved and reclassified as a **Tier II indicator.**

Approximately **90 percent of springs and seeps** are not identifiable by satellite imagery.

Countries report their data to UNSD **every five years.**

velop the capacity and ability to report on level 2 data. All globally available data will be shared with national statistical offices and other relevant authorities for countries to validate, thus ensuring that water-related ecosystems are represented accurately. Since these global data are derived from Earth observations, some countries may have and return their own Earth observations of even higher resolution and accuracy which will then be used.

Level 1 data include two sub-indicators based on globally available data from Earth observations which countries will validate against their own methodologies and data sets:

- **Sub-indicator 1 – spatial extent of water-related ecosystems**
- **Sub-indicator 2 – water quality of lakes and artificial water bodies**

Level 2 data are additional data informing progress on target 6.6 collected by countries. These data may already be available and reported under existing monitoring mechanisms. Countries are encouraged to consolidate these data to better understand the state of their freshwater ecosystems and decide which actions to take. Level 2 data include the following three sub-indicators:

- **Sub-indicator 3 – quantity of water (discharge) in rivers and estuaries**
- **Sub-indicator 4 – water quality imported from indicator 6.3.2**
- **Sub-indicator 5 – quantity of groundwater within aquifers**

Utilizing satellite-based Earth observations to support countries in monitoring and reporting sub-indicators 1 and 2 of indicator 6.6.1 (on the spatial extent of water-related ecosystems and water quality of lakes and artificial water bodies, respectively) has clear benefits in terms of the frequency, coverage and accuracy of data that can be produced. Earth observations can generate at least seven images per year (though often many more) at a pixel resolution of up to 10 metres, which was improved from a 30-metre pixel resolution in 2016. In addition, there is a database of Earth observation images that dates back to the year 2000. With this data, a baseline period can be established (2001–2005) for countries, which can be used alongside the Earth observation data to determine seasonal and inter-annual changes.

A progressive monitoring approach is beneficial as it prioritizes components of the indicator that have widely available high-quality data, reducing the reporting burden on countries and allowing them to focus monitoring efforts on validating level 1 data and generating level 2 data. These focused monitoring efforts will be supported by increased capacity-building, technological advancements and improved data sharing among the international community.

To fully document target 6.6, it is essential to monitor how the health of water-related ecosystems is changing. To reduce the monitoring burden on countries, it is now recommended that countries only use the sub-indicator data (spatial extent, quality and quantity) to determine ecosystem health. Countries with the capacity to monitor ecosystem health directly using bio-indicators and other response variables will be able to report directly using these data in the future. Currently countries are not required to report on ecosystem health as part of SDG reporting, as the reporting system for this has not yet been implemented. However, as implementing the SDGs takes place at the country level, local use of ecosystem health data for local ecosystem management should be regarded as an important priority and continue even without global SDG reporting.

3.2. Indicator 6.6.1 limitations

This methodology mobilizes the collection of widely available Earth observation data on spatial extent and some water quality parameters that will be validated by countries. In many countries, tools and training will be necessary to build capacity to validate data. The data itself are presented as easy-to-understand images and numbers. However, the methodologies used to generate these data are technical in nature and some countries may wish to gain a better understanding of these. The methodology employs internationally recognized methods, from expert communities – such as the GEO and international space agencies – to derive statistically comprehensive and technologically advanced Earth observation data sets for sub-indicators 1 and 2.

Sub-indicator 1 measures the spatial extent of water-related ecosystems. Two distinct methodological approaches are required to distinguish and generate spatial extent data on open water bodies and specifically on vegetated wetlands. The data generated on open water bodies are separated into lakes, rivers and estuaries and artificial water bodies. The resulting data sets

The Great Kemeri Bog, in Latvia. Knolls, pools, hollows and small lakes are all characteristic features of moss bogs. Photo: Runa S. Lindebjerg

obtained from Earth observations on the spatial extent of vegetated wetlands and artificial water bodies are excluded from the calculation of spatial extent values for lakes, rivers and estuaries to prevent duplicated spatial extent estimations. Data on artificial water bodies are also separated from data on natural water bodies. Satellite imagery can determine new and lost water bodies, thus helping to locate where new artificial water bodies are formed and where natural water bodies are lost. This requires the collection of in situ data to validate where new water bodies are being formed.

Sub-indicator 2 only measures two water quality variables (chlorophyll-a as an indicator of nutrient enrichment and total suspended solids (TSS) as an indicator of poor land-use management in the basin), though it is recognized that measurements of multiple parameters are needed to determine good water quality. However, these globally available data can indicate potential hotspots of pollution or human disturbance, allowing countries to undertake more local assessments of water quality. As part of level 2 monitoring, in situ water quality data can be used to improve understanding about the situation in a basin (the data being imported directly from the SDG 6.3.2 results), though these data are also limited by the number of variables that are monitored. Countries should exercise wisdom in assessing these data, as in many local situations severe water pollution may be caused by substances that are not included in the SDG monitoring, which could lead to spurious conclusions on the overall water quality situation. Thus, data describing these additional variables should override the conclusions drawn from the SDG indicators. Such situations should be clearly indicated as part of SDG data submissions and more importantly, should be incorporated into local water quality assessments.

Global data sets of river flow or discharge are poor and have generally deteriorated in the past decades. The global community is encouraged to begin adding to the presently sparse collection of data to develop a new global data set that can be used to support indicator 6.6.1 reporting.

Monitoring groundwater data remains difficult. The early version of the indicator 6.6.1 methodology proposed to measure the actual volume of water contained within aquifers, but in the interest of simplicity, this has been altered to measure the depth to the groundwater table only, which is now the proxy for groundwater volume.

This methodology concentrates on wetlands of significant size and may miss small, ephemeral groundwater dependent ecosystems such as seeps and springs. However, it should be recognized that in desert regions, these small water-related ecosystems can be particularly critical water resources. Ground surveys have shown that approximately 90 per cent of springs and seeps are not identifiable from satellite imagery.

While the target 6.6 language "protect and restore" suggests the need to measure water-related ecosystem management practices to quantify how much protection and restoration is occurring, this management aspect is not monitored as part of the target. In view of this, the indicator may require additional refinement in future to ensure that data are collected on the scope, scale and effectiveness of different protection and restoration measures.

At present, indicator 6.6.1 does not require ecosystem health to be directly monitored, as the information can be determined primarily through monitoring biological indicators. Given that all of the sub-indicators under indicator 6.6.1 are drivers of ecosystem conditions, any deterioration to these is expected to result in a corresponding deterioration of an ecosystem's biological component. This method requires countries to collect biological data in order to develop an improved understanding of ecosystems' conditions and facilitate better management practices. As such, there will be a procedure to submit these data in the future as part of SDG reporting.

Indicator 6.6.1 has been designed to generate data that supports decision-making aimed at protecting and restoring water-related ecosystems. While it is expected that countries use the data to actively make such decisions, these actions are not currently being measured. The data generated should be considered alongside other data, such as land-use change, to enable decision makers to protect and restore these ecosystems.

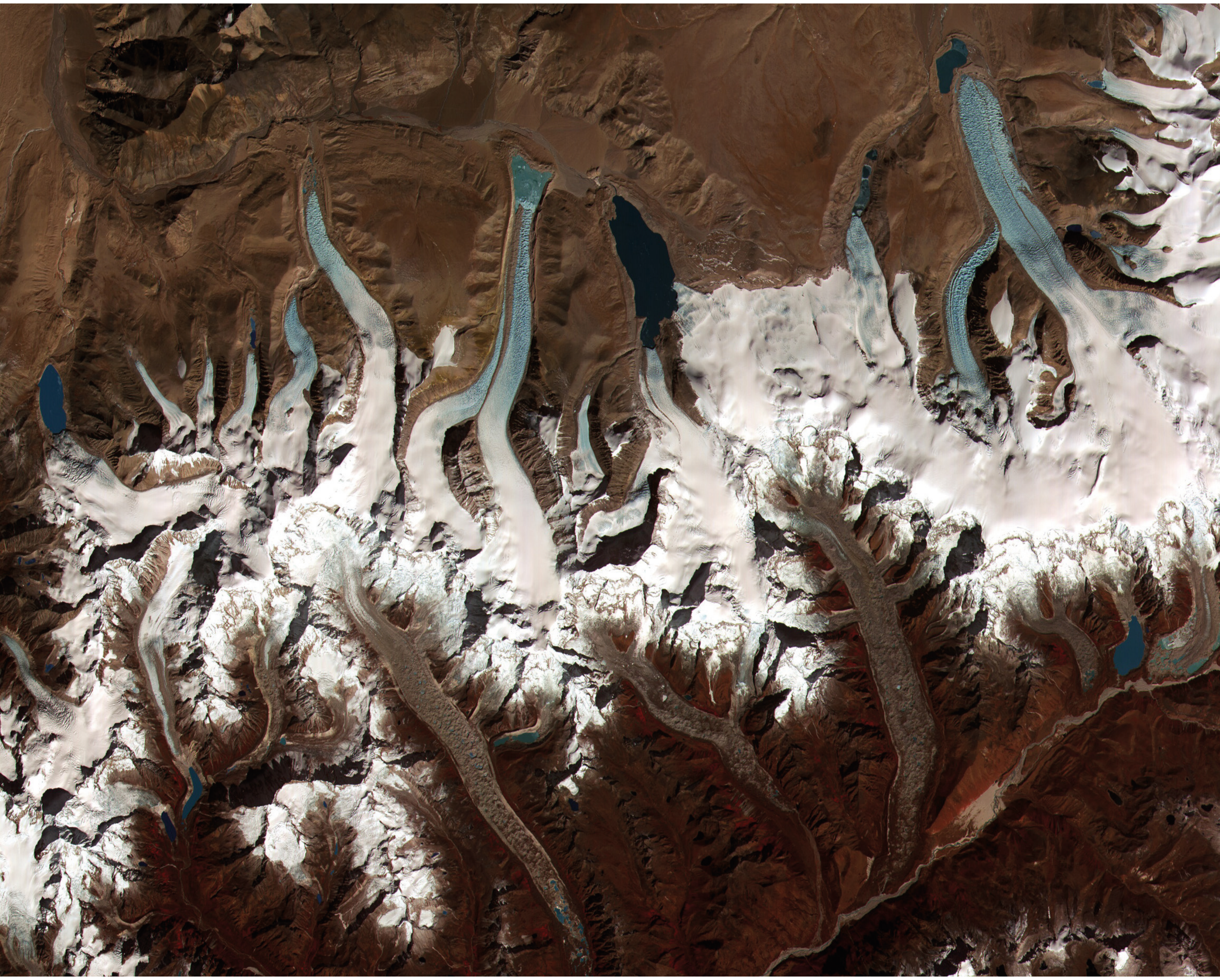
3.3. Reporting cycles and key calendar milestones for indicator 6.6.1

The data for sub-indicators 1 and 2 are available annually. For sub-indicators 3, 4 and 5 data are already available from some countries, though national authorities should aim to strengthen their monitoring and reporting efforts in order to expand data availability for these three sub-indicators.

Data collection for all sub-indicators was included in the 2017 data drive to countries, which are still being validated. In addition, national spatial extent data for 188 countries using Earth observations have been collected from 2001 to 2015 to support sub-indicator 1. Countries report their data to UNSD for all five sub-indicators every five years following national data drives. The last data drive occurred in 2017 and the next two drives are planned for 2022 and 2027. Annual estimations can be made available for countries using their data, though there is a risk that releasing this information will highlight short-term changes, which is not the objective of the SDGs.

4

Using satellite-based Earth observation data to support monitoring and reporting of indicator 6.6.1



Glacial lakes from retreating glaciers. Photo: NASA/Creative Commons

The pilot data collection for indicator 6.6.1 conducted by UN Environment in 2017 found that most countries have little to no information on the extent of their water-related ecosystems and for the countries that do have data, the collection frequency, adherence to international definitions and quality of the data varied greatly. As such, the most efficient and statistically robust way to monitor water-related ecosystems worldwide is using available satellite data. The indicator 6.6.1 monitoring methodology was therefore revised to include such data in response to the global data gap. This methodology revision was accepted by Member States in the IAEG-SDG, which subsequently voted to upgrade indicator 6.6.1 to a Tier II status in April 2018.

4.1. The potential of satellite-based data to measure the spatial extent of open water bodies, vegetated wetlands and reservoirs

The spatial extent of open water bodies (lakes, rivers and estuaries), vegetated wetlands and artificial water bodies (reservoirs) can all be monitored using satellite data, which are accurate and have broad coverage. Satellites generate Earth observations by capturing images and wavelengths of light from different land covers across the globe – such as snow, bare rock, vegetation and water – as they circle the Earth. For any one location on Earth, thousands of images can be combined to classify an area and show any changes in its land cover over time. Advanced computing technology can be programmed to digest these images and split the Earth into different land cover pixels. One example of a land cover pixel type is open water, which is defined as any area of surface water unobstructed by aquatic vegetation. Thus, changes in the spatial extent of open water locations over a long period can be determined, including where new water bodies (e.g. reservoirs) are formed or where water bodies are lost.

The 2001–2015 data set (referred to as the spatial extent open water data set) primarily includes open water surfaces for all months of a given year, though accounts for any seasonal and climactic fluctuations of water (such as lakes and rivers which freeze for part of the year and seasonal waters). From 2016 to 2030, higher spatial and temporal resolution satellite imagery will be used, capturing more

KEY FACTS

Most countries have **little to no information** on the extent of their water-related ecosystems.

In 2017, UN Environment and its partners created **188 country data sets on spatial extent of water,** which were shared with national statistical offices for validation.

Central Asia has seen a **7 per cent decrease** in the extent of open water.

Afghanistan, Iran and Iraq **lost 54 per cent, 56 per cent and 34 per cent of** their permanent surface water area since 1984.

images and allowing water bodies to be delineated at a resolution of 10–20 metres. In addition, a mixed satellite approach using optical and radar satellites will allow surface waters to be mapped in permanently cloudy areas.

To distinguish one water-related ecosystem type from another, the data generated on open water are processed to distinguish lakes, rivers and estuaries from artificial water bodies. Vegetated wetlands are identified through detecting the physical properties of wetland areas (e.g. soil moisture and vegetation water content) and referring to other geospatial data sets related to the topography of the area, hydrography of the watershed and its drainage network and soil types.

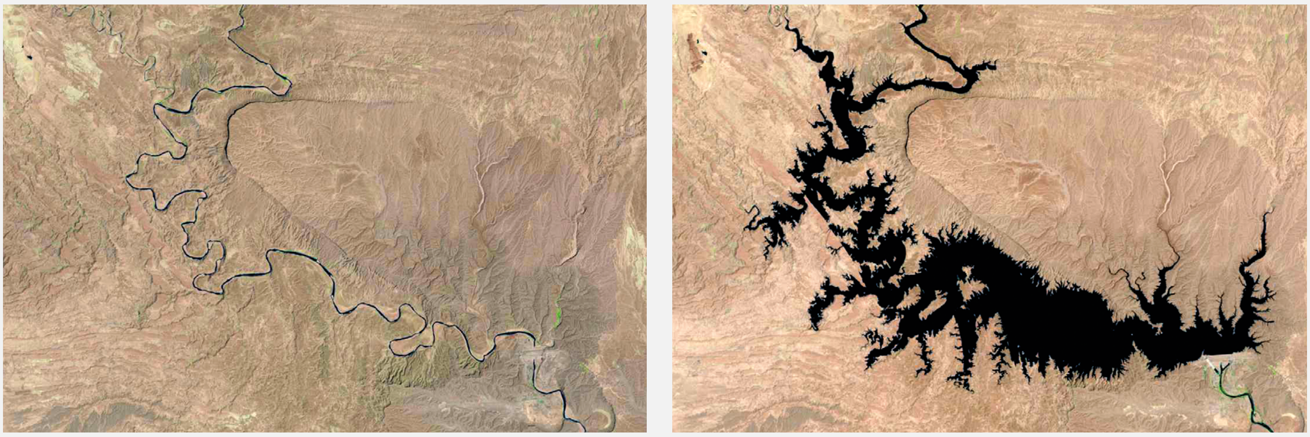
Thus, global data sets can be generated on the spatial extent of open water (lakes, rivers and estuaries), the spatial extent of artificial water bodies (reservoirs) and the spatial extent of vegetated wetlands. These data sets can be generated annually and analysed every five years to determine changes in spatial extent against a baseline period.

The following satellite images (Figure 4) were taken before and after a dam was constructed on the Karkheh River in Iran (Islamic Republic of).

The change in the spatial extent of this water body can be clearly observed and monitored.

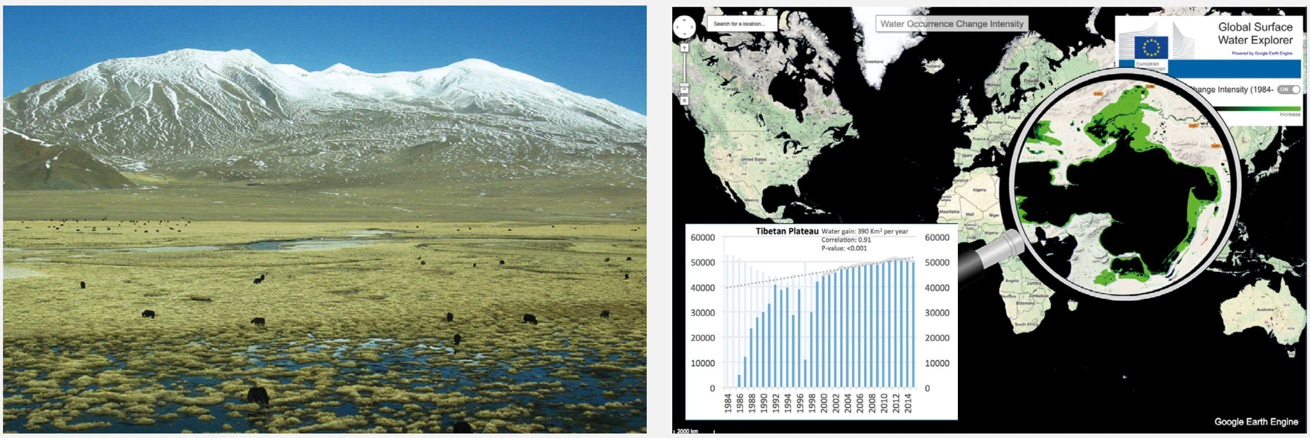
In the following example (Figure 5), the data generated from satellite imagery, as shown in the graph, indicate that water levels have increased in the Tibetan Plateau since 1984.

Figure 4: Satellite images of Karkheh River, Iran



Source: United State Geological Survey (USGS)/NASA.

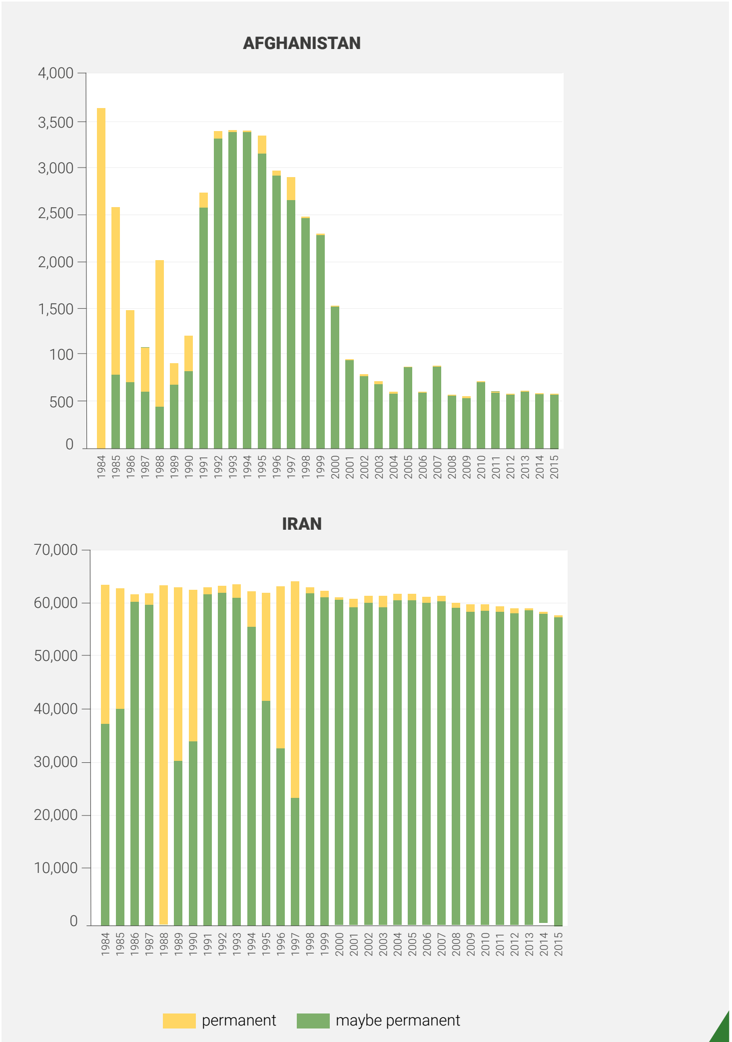
Figure 5: Image of the Tibetan Plateau and graph showing water gain in the area from 1984 to 2014



Source: European Commission Joint Research Centre (JRC).

Changes in open water extent can be tracked over time and the numerical data can be generated from the images. For example, in Figure 6, the data show that open surface water in Afghanistan and Iran has decreased since the 1980s.

Figure 6: Annual changes in the spatial extent of open water bodies in Afghanistan and Iran



Afghanistan and Iran have less permanent surface water area than they had in the 1980s.

Note: Y axis is per km^2, X axis is the time period (from 1985 to 2014).

Source: JRC.

4.2. Sub-indicator data on national spatial extent of open water

Satellite-based Earth observation data were used to support the first data-collection process for indicator 6.6.1 in 2017 to fill data gaps on monitoring the spatial extent of open water bodies. The open water spatial extent (30-metre resolution) data were generated for the entire globe from 2001 to 2015 by the European Commission Joint Research Centre (JRC) and Google Earth Engine. In 2017, UN Environment collaborated with these partners to generate the data which were processed and packaged into 188 country data sets and shared with national statistical offices for validation. Each country data set comprised of annual national spatial extents from 2001 to 2015, percentage change statistics based on five-year averages and graphical depictions of the data.

Data are generated annually (available to countries if required) and every five years countries will be requested to validate percentage changes in the extent of their water-related ecosystems and provide their nationally derived data. From these statistics, UN Environment produces regional, subregional and global aggregations and is currently producing time series for basins, sub-basins and local administrative boundaries for all United Nations Member States. In 2018, additional data for new and lost water bodies, as well as seasonal data will be produced, which will help countries to better understand and manage water bodies. All data are updated annually and are available from the UN Environment data dissemination platform.

UN Environment is working with partners to generate global data products on vegetated wetlands and water quality (using changes in TSS and chlorophyll-a as a proxy for water quality) to be available in 2019. The national open water extent data are available online for all United Nations Member States.[9]

[9] These data are available for United Nations Member States at https://environmentlive.unep.org/mapviewer

To illustrate the percentage change (gain or loss) in national open water extent from the baseline year period (2001–2005), the following world maps show countries that have a percentage gain (in blue and generally resulting from the construction of artificial reservoirs) and countries that have seen a percentage loss (in orange).

It is important to note that the data set obtained in 2017 on the spatial extent of open water bodies, as illustrated in Figures 7 and 8, represents all open water and therefore captures data on natural and artificial water bodies. Grouping artificial and natural water bodies together is potentially misleading, since many countries are experiencing a loss of natural water-related ecosystems and a gain in artificial water bodies. As such, the new global data set on spatial extent, generated in early 2019, will separate data on artificial and natural water bodies, which will be illustrated and reported separately.

Figure 7: Global map showing countries that have a percentage gain in their national open water extent

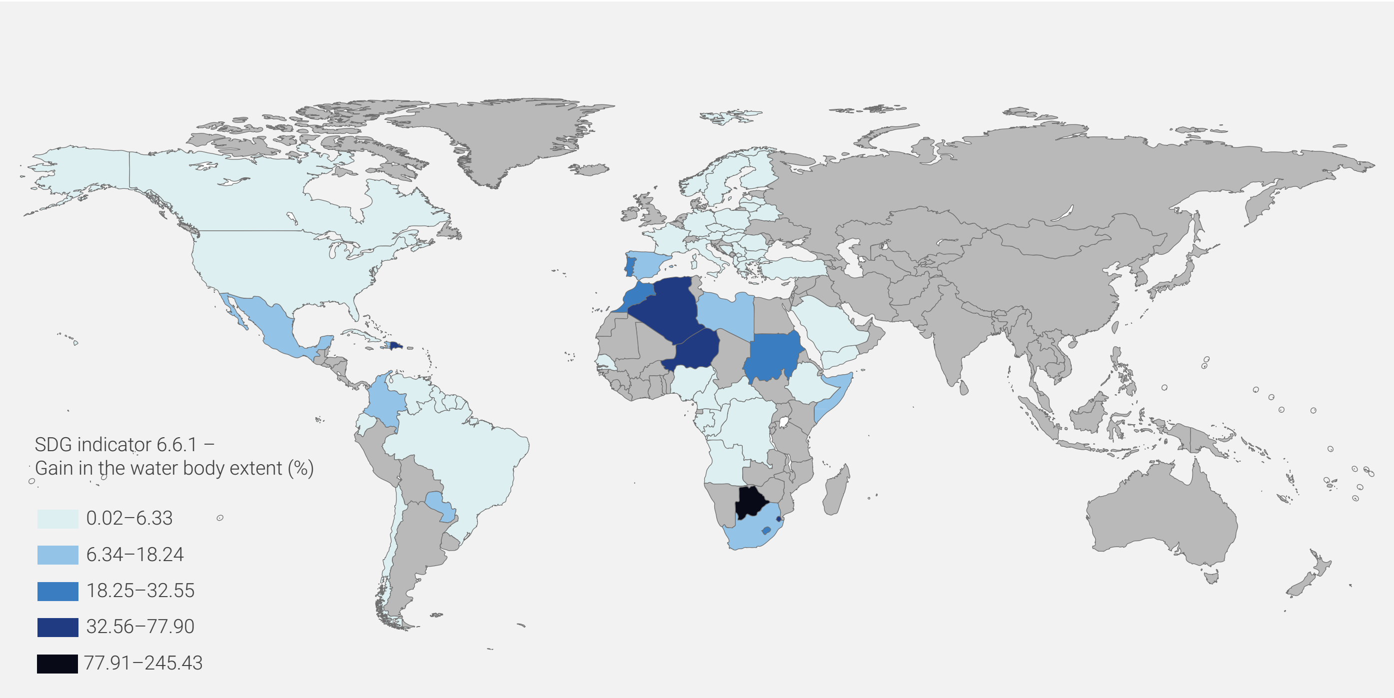
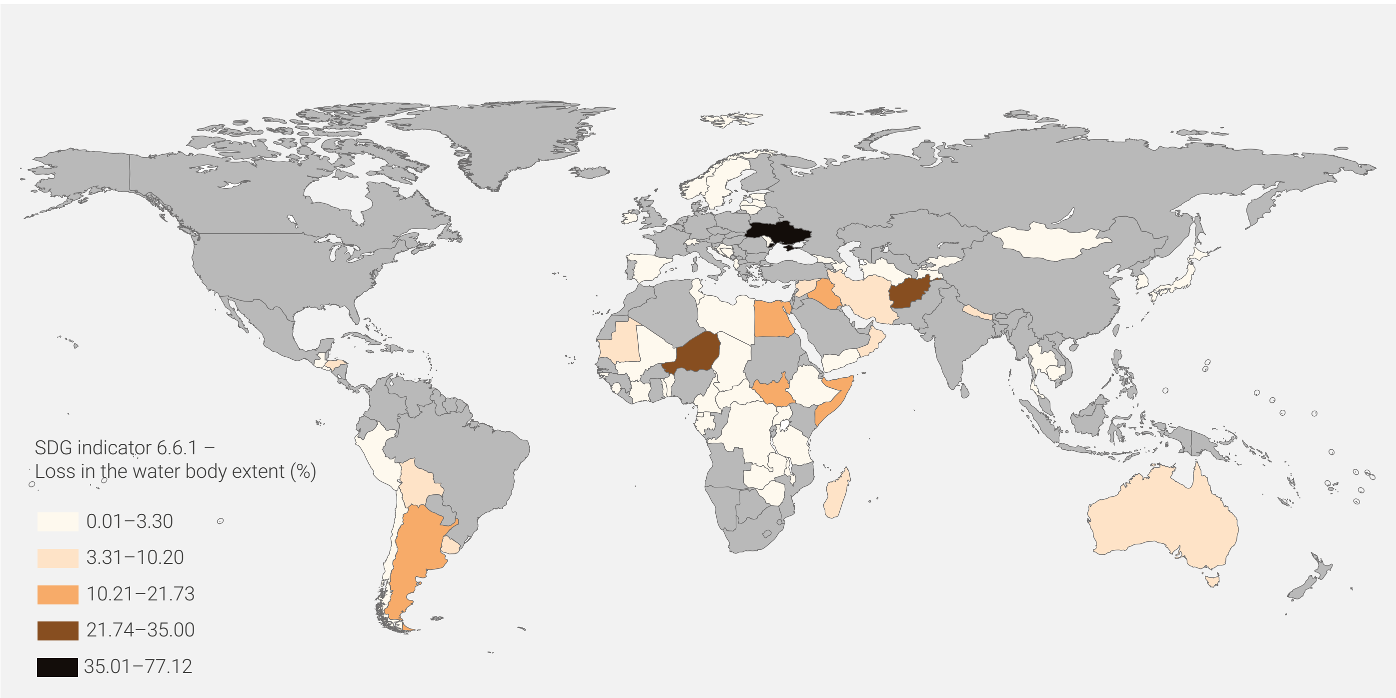


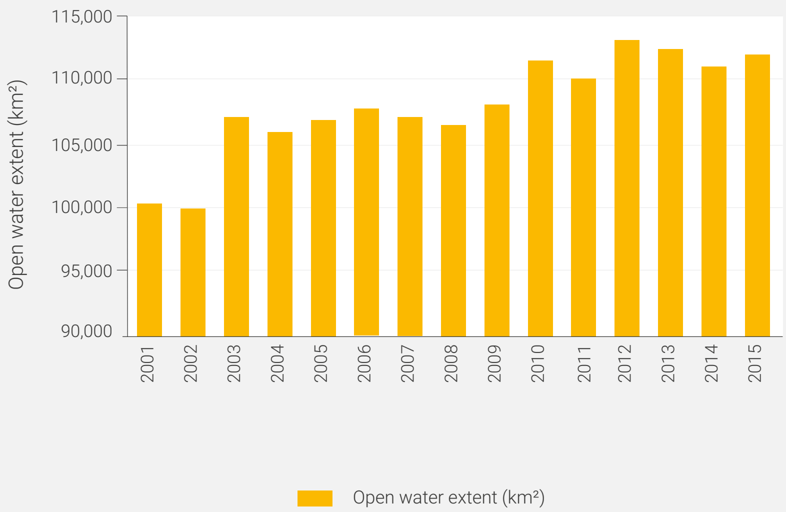
Figure 8: Global map showing countries that have a percentage loss in their national open water extent

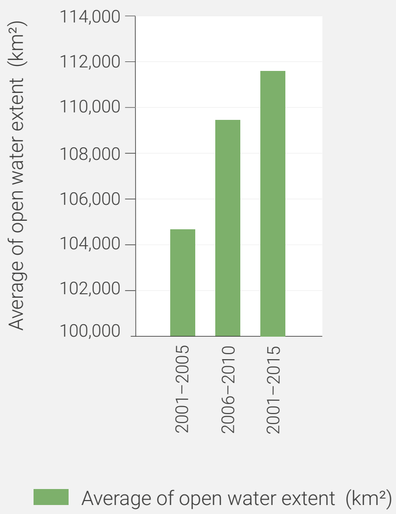


4.3. Example spatial extent data provided to countries

The following tables (Figure 9) are an example of the data on spatial extent of open water that UN Environment sent to United Nations Member States. From the annual data series obtained from the JRC, it was possible to establish a baseline period (2001–2005) from which change could then be measured over five-year periods. For the following example, the spatial extent of water is shown to be increasing and is likely to be the result of significant construction of dams and reservoirs.

Figure 9: Example data set on the spatial extent of open water bodies provided to Member States



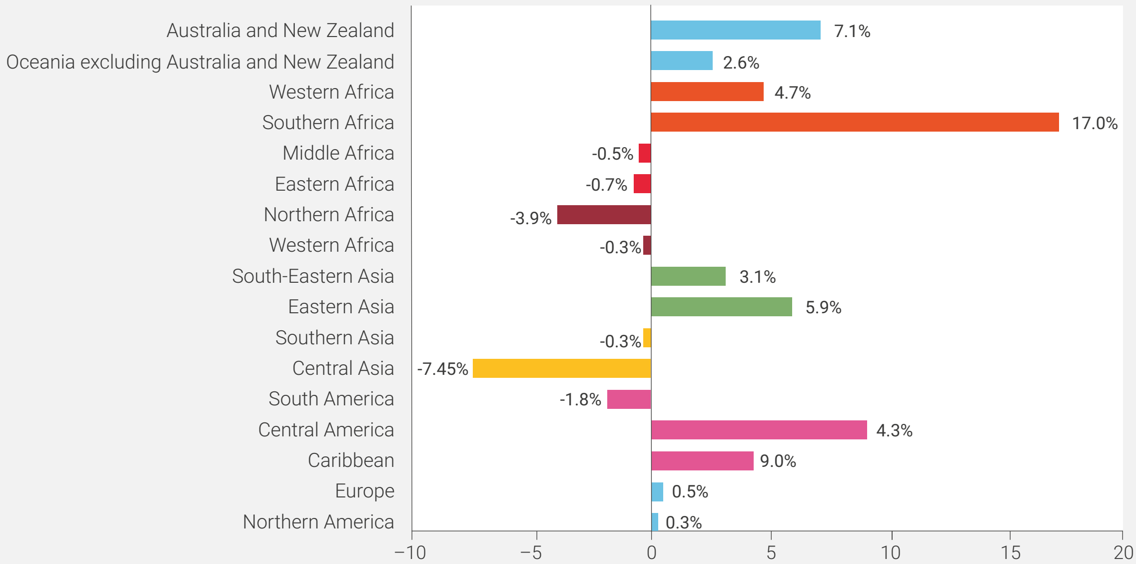


	Year range	5-year average of open water extent (km²)	% change from baseline	Gain or loss
Baseline	2001–2005	104,093.79		
	2006–2010	108,234.16	-3.98	Gain
	2011–2015	111,859.06	-7.46	Gain

Note: The data includes annual trends in open water extent in km² and changes between the five-year average and baseline period.

As previously mentioned, a new global data set measuring the spatial extent of open water bodies intends to separate data on natural and artificial water bodies. This will be reported to countries as separate data so that countries can track loss and/or gain in both types of water bodies.

Figure 10: Open water regional average trends from 2001 to 2015 showing percentage loss and gain



Source: Pekel et al., 2016.

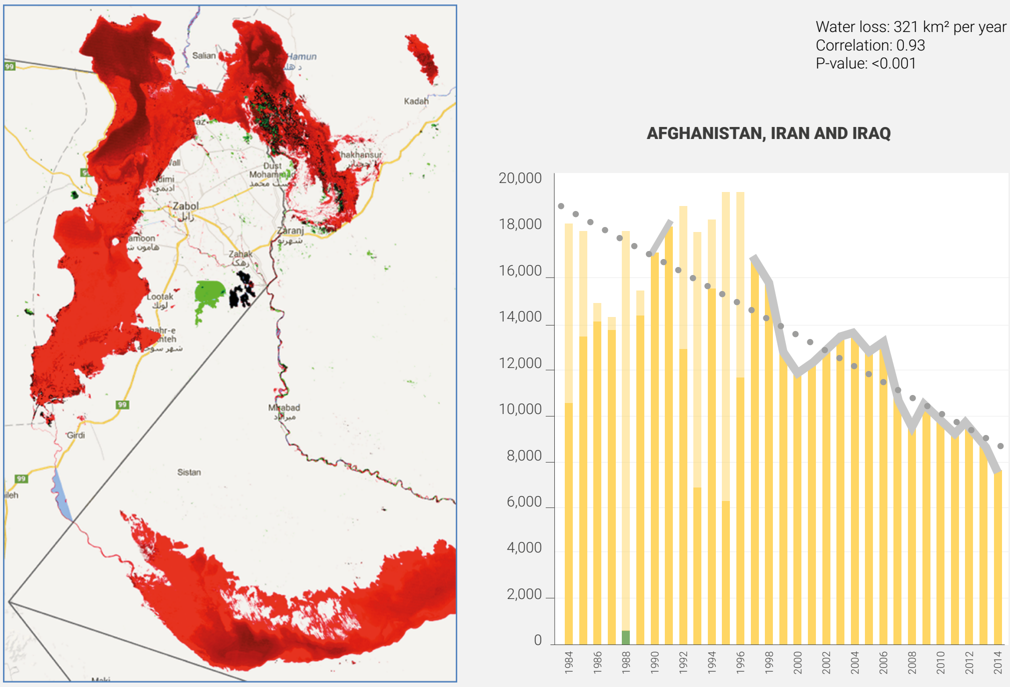
4.4. Analysis of the spatial extent of open water data set

By aggregating national data on the spatial extent of open water at a regional level, it is possible to observe regional trends. Figure 10 shows the percentage loss or gain in the extent of all open water (including lakes and reservoirs) per region from 2001 to 2015. As previously noted in section 2, there has been a 54 per cent loss of the extent of natural wetlands worldwide (Davidson, 2014) and dam and reservoir construction has been steadily increasing in many countries (Zarfl *et al.*, 2014). This is resulting in an overall increase in observable spatial extent of open water in the regional analysis. However, there are also examples of decreasing spatial extent of open water in some regions. Central Asia, for example, has seen a 7 per cent decrease in the extent of open water. This is likely due to significant over abstraction, as total water withdrawals increased in the region by 229 per cent in just five years from 2001 to 2005 (FAO AQUASTAT).

Aggregating national spatial extent data into a regional trend analysis may be best interpreted to show where dams and reservoirs have been increasingly constructed. Subregional and national data must be closely analysed to understand country specific changes in the spatial extent of open water. In Western Asia, the data showed a 0.3 per cent loss of surface water in the region from 2000 to 2015. However, analysing the subregional level data, shows that Afghanistan, Iran and Iraq have lost 54 per cent, 56 per cent and 34 per cent of their permanent surface water area since 1984 (Figure 11) (Pekel *et al.*, 2016). Such a degree of change in the extent of open water has significant implications for people, agriculture and ecosystem services at the local level that are not captured in regional analysis.

Although there is value in observing surface water extent, it does not provide a full picture of the situation. The services provided through water-related ecosystems depend on the location of the ecosystem and its composition, for example, whether water bodies are natural or artificial. The regional trend data show that surface water extent increased in many regions from 2001 to 2015, most likely due to the construction of new reservoirs, climate change and flood irrigation (Pekel *et al.*, 2016). The loss in natural wetlands may be due to the increasing construction of artificial wetlands or use of land for other purposes, such as agriculture.

Figure 11: Open water extent from 1984 to 2015 in Afghanistan, Iran and Iraq



Note: The map shows the change in open water in Afghanistan and Iran. The graph shows the trend of open water loss from 1984 to 2015 in square kilometres for all three countries.
Source: Pekel et al., 2016.

4.5 The potential of satellite-based Earth observations to monitor the spatial extent of vegetated wetlands

Satellite-based Earth observation data also have a huge role to play in supporting the monitoring and reporting of sub-indicator data on vegetated wetlands. Space agencies and the GEO are working to produce a satellite ready analysis of wetlands, which is expected to be available by 2022. This methodology concentrates on wetlands of significant size and may miss small, temporary groundwater dependent ecosystems.

The following case study is included to demonstrate the potential for satellite-based Earth observations in monitoring wetlands.

The Satellite-based Wetland Observation Service (SWOS) project,[10] funded under the European Union Horizon 2020 Programme, has used Earth observation data to generate mapping products and indicators of wetlands. Among the indicator tools that have been developed and made available through the GEOclassifier toolbox are those that support indicator 6.6.1 monitoring. Baseline information developed for sub-indicator 6.6.1.a (change in the spatial extent of surface water-related ecosystems) has been used at the national level in Albania. Using Landsat 8 satellite images and other data sets, the methodology follows three steps: (1) mapping potential wetland areas; (2) mapping wetland habitats within these; and (3) indicator computation.

[10] Further information available at: http://swos-service.eu/.

Table 4: Spatial extent of surface water-related ecosystems in Albania in 2015

Total area of natural coastal wetlands	263 km²
Total area of natural inland wetlands	772 km²
Total area of constructed wetlands	273 km²
Total area of open water bodies	430 km²
Total area of open river bodies	426 km²
Total area of vegetated wetlands	307 km²

4.5.1 Potential wetlands mapping

This step identified areas where water-related ecosystems were highly likely to exist. The assessment was based on surface water dynamics maps (using the Landsat 8 2015 time series) as well as hydrological and topographic indices. A Global Urban Footprint data set was then used to produce a mask of built-up areas,[11] from which a map of potential wetland areas with different probability categories was developed. As a final step, information on all land use and land cover (LULC) classes was integrated to generate a map of functional area for wetlands and water-related ecosystems (Figure 13), representing the surface area that could influence and impact wetland ecosystem functions and services.

4.5.2 LULC and wetland habitat mapping

After creating the LULC map, the SWOS GEOclassifier software was used to segment and classify the same Landsat 8 time series images into LULC data. The final product of this step (Figure 13) represents the location and delineation of "effective" wetland and water-related ecosystems, in this case based on the Corine Land Cover (CLC)-Ramsar definitions developed for use under GEO-Wetlands.

4.5.3 Indicators computation

Based on the LULC map, indicator tools were used to classify all water-related ecosystems according to the definitions used in the original indicator 6.6.1 step-by-step methodology, namely vegetated wetlands, open water bodies and river water bodies (Figure 14). This extent map was used to derive relevant statistics in order to assess and monitor sub-indicator 6.6.1.a (Table 4). While this demonstrates the development of the baseline picture, applying this methodology to multi-annual time series data would provide a country with monitoring information, which could be further analysed at the river basin level.

"Space agencies and the GEO are working to produce a satellite ready analysis of wetlands, which is expected to be available by 2022. This methodology concentrates on wetlands of significant size and may miss small, temporary groundwater dependent ecosystems."

[11] In general, land conversions to built-up areas are considered irreversible and the probability of finding functional wetland habitats in these areas is very low.

Figure 12: Potential wetlands in Albania mapped using the SWOS approach (combining surface water dynamics with topographic and hydrological indices)

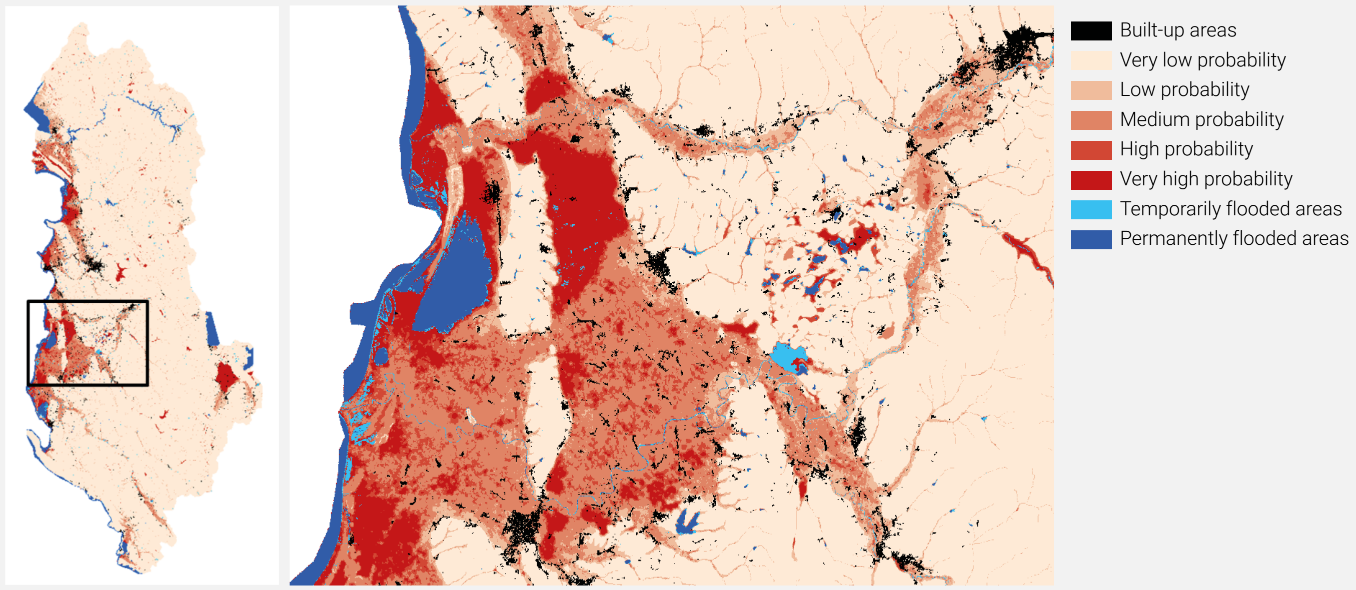


Figure 13: Identification of "effective" wetlands within the potential wetlands layer, using a LULC classification based on the CLC-Ramsar definitions

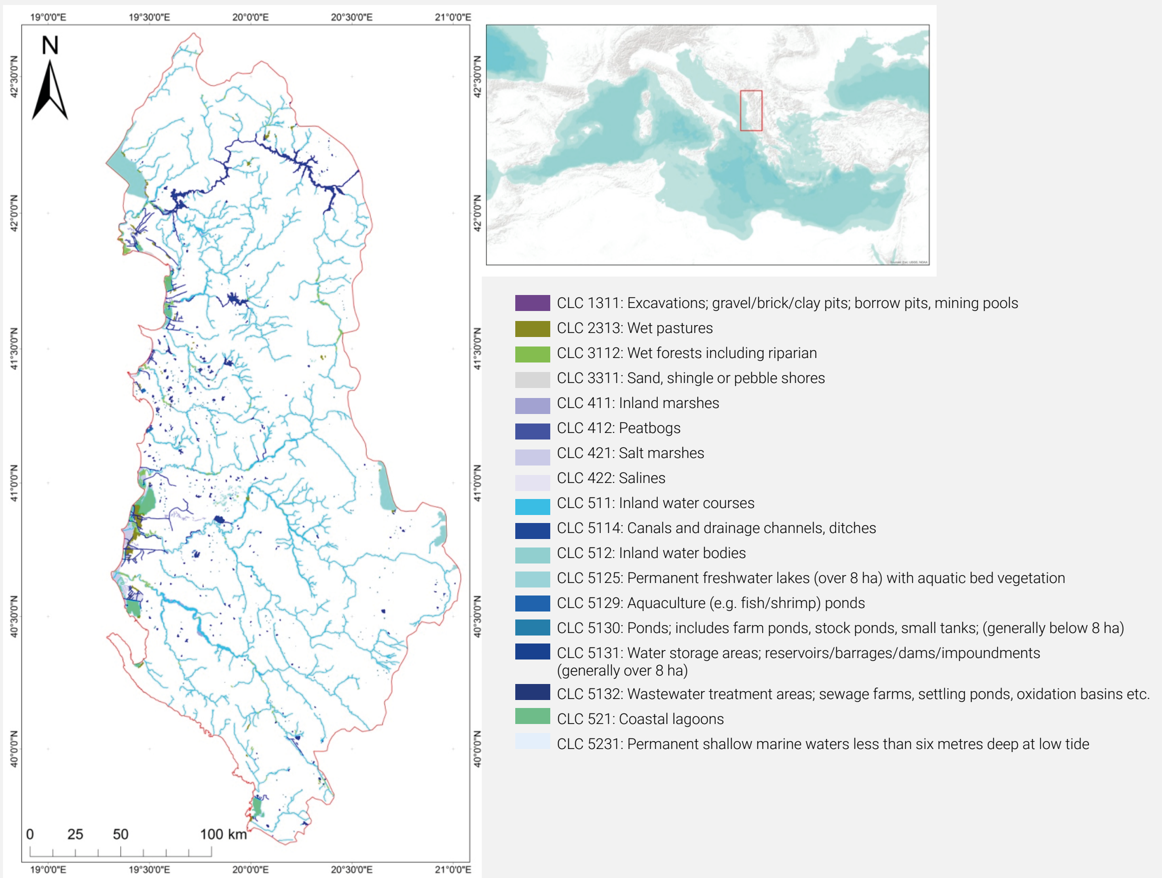
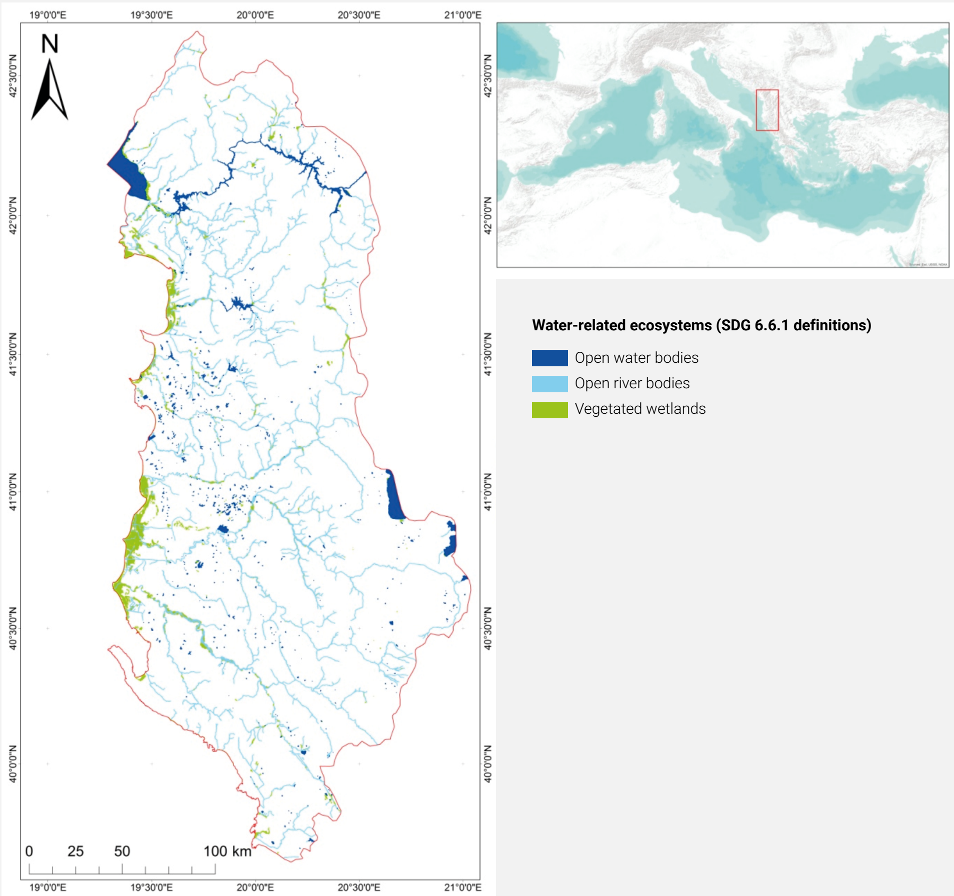


Figure 14: Water-related ecosystems mapped according to the SDG 6.6.1 definitions



5

Conclusion

Water-related ecosystems are among the world's most biologically diverse environments and provide many products and services on which human well-being depends. Due to their enormous social, economic, biological and educational value, SDG target 6.6 was established, specifically to protect and restore freshwater ecosystems. Not only does target 6.6 underpin progress made towards SDG 6, it also underpins progress towards many other SDGs and targets. Ecosystem services, such as those provided by water-related ecosystems, form the very foundations of our society. Without these life supporting services, society collapses.

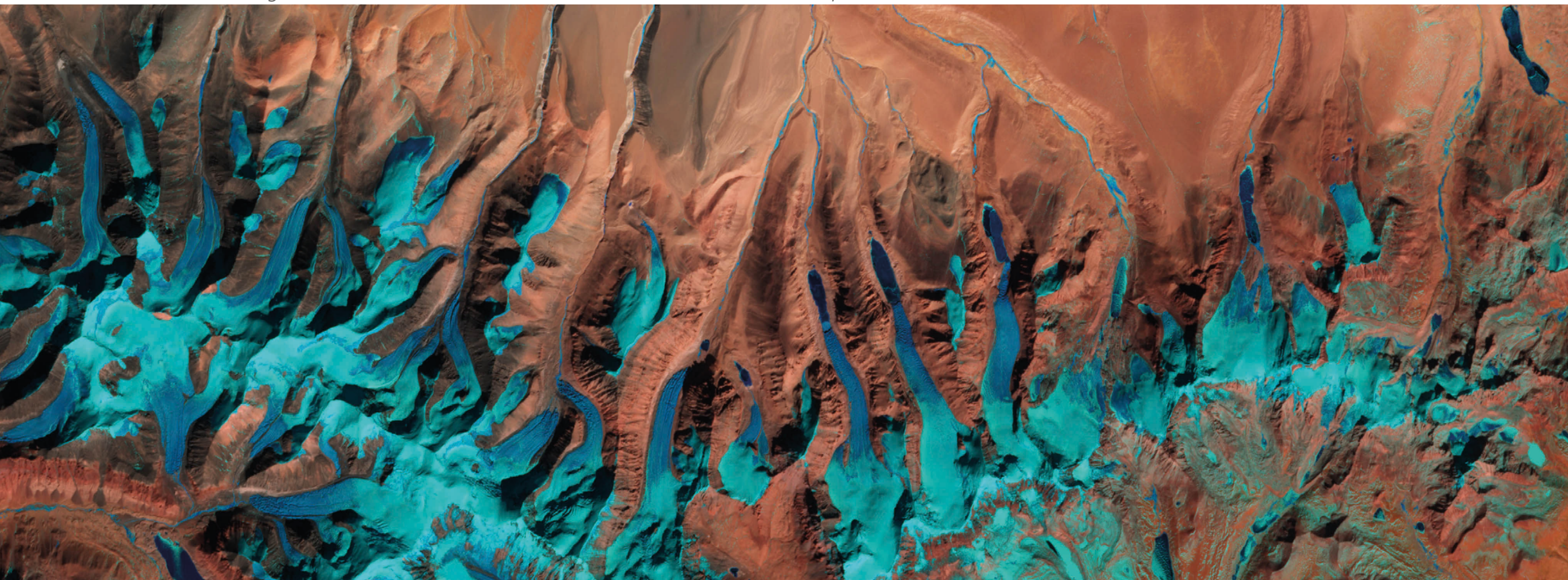
Despite the value and role that water-related ecosystems have and serve around the world, they are under considerable threat from human activity, largely due to land conversion and the increasing shift from natural to artificial water bodies. Countries must act to change this situation. Monitoring target 6.6 progress using indicator 6.6.1 can provide the necessary data for countries to protect and restore these valuable ecosystems.

Most countries need to strengthen monitoring of their water-related ecosystems and develop the requisite technical, institutional and financial capacity to carry out good quality monitoring. Countries should use globally available data, such as Earth observations, to understand the spatial extent to which their water-related ecosystems are changing. Such data provides countries with a foundation to which they can add national data on water quality and water flows or discharges.

Countries should also use the data to help them better understand the values and benefits that water-related ecosystem services provide across sectors and society, better assess the long-term implications of land-use change and ultimately prioritize their restoration and protection initiatives, particularly for source watersheds such as forests and critical basins.

"Despite the value and role that water-related ecosystems have and serve around the world, they are under considerable threat from human activity, largely due to land conversion and the increasing shift from natural to artificial water bodies. Countries must act to change this situation."

Southern-central edge of the Tibetan Plateau near the border with western Nepal and the Indian state of Sikkim. Photo: ESA/Creative Commons



References

Bates, B. C., Kundzewicz, Z. W., Wu, S. and Palutikof, J. P. (eds.) 2008. Climate Change and Water. Technical Paper, Intergovernmental Panel on Climate Change (IPCC). Geneva, Switzerland, IPCC Secretariat.

Davidson, N. C. 2014. How much wetland has the world lost? Long-term and recent trends in global wetland area. Marine and Freshwater Research, Vol. 65, No. 10, pp. 934–941. doi.org/10.1071/MF14173

Davidson N. C., Fluet-Chouinard, E. and Finlayson, C. M. 2018. Global extent and distribution of wetlands: trends and issues. Marine and Freshwater Research, Vol. 69, No. 4. doi.org/10.1071/MF17019

Dickens, C., Rebelo, L-M. and Nhamo, L. 2017. Guideline and indicators for Target 6.6 of the SDGs: "Change in the extent of water-related ecosystems over time". International Water Management Institute. Consultative Group on International Agricultural Research (CGIAR) Research Program on Water, Land and Ecosystems (WLE).

DOPA (Digital Observatory for Protected Areas). 2017. Inland surface water and inland surface water change, DOPA Factsheet G.2. European Commission. http://dopa.jrc.ec.europa.eu/sites/default/files/DOPA%20Factsheet%20G2%20Inland%20Surface%20Water_0.pdf

Dudley, N. and Stolton, S. 2003. Running Pure: The importance of forest protected areas to drinking water. World Bank/World Wide Fund for Nature (WWF) Alliance for Forest Conservation and Sustainable Use. http://wwf.panda.org/?8443/Running-Pure-The-importance-of-forest-protected-areas-to-drinking-water

EPA (US Environmental Protection Agency). 2012. Identifying and protecting healthy watersheds: concepts, assessments and management approaches. Washington DC, USA, US EPA, 841-B-11-002.

FAO (United Nations Food and Agriculture Organization). AQUASTAT, http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en

Harrison, I. J., Green, P. A., Farrell, T. A., Juffe-Bignoli, D., Sáenz, L., and Vörösmarty, C. J. 2016. Protected areas and freshwater provisioning: a global assessment of freshwater provision, threats and management strategies to support human water security. Aquatic Conservation: Marine and Freshwater Ecosystems. doi.org/10.1002/aqc.2652

Herbert, M. E., McIntyre, P. B., Doran, P. J., Allan, J. D. and Abell, R. 2010. Terrestrial reserve networks do not adequately represent aquatic ecosystems. *Conservation Biology*, Vol. 24, No. 4, pp. 1002–1011.

Hermoso, V., Clavero, M., Blanco-Garrido, F. and Prenda J. 2011. Invasive species and habitat degradation in Iberian streams: an analysis of their role in freshwater fish diversity loss. *Ecological Applications*, Vol. 21, No.1, pp. 175–188.

IAH (International Association of Hydrogeologists). 2017. Strategic Overview Series, Ecosystem Conservation and Groundwater. https://iah.org/wp-content/uploads/2016/04/IAH-SOS-Ecosystem-Conservation-Groundwater-9-Mar-2016.pdf

IAH. 2017. The UN-SDGs for 2030 Essential Indicators for Groundwater. https://iah.org/wp-content/uploads/2017/04/IAH-Groundwater-SDG-6-Mar-2017.pdf

IRRI (International Rice Research Institute). 2017. IRRI World Rice Statistics. http://ricestat.irri.org:8080/wrsv3/entrypoint.htm

Jimenez-Cisneros, B. 2015. Responding to the challenges of water security: the Eighth Phase of the International Hydrological Programme, 2014–2021. Hydrological Sciences and Water Security: Past, Present and Future (Proceedings of the 11th Kovacs Colloquium, Paris, France, June 2014). IAHS Publ. 366. doi.org/10.5194/piahs-366-10-2015. https://www.proc-iahs.net/366/10/2015/piahs-366-10-2015.pdf

Juffe-Bignoli, D., Harrison, I, Butchart, S. H. M., Flitcroft, R., Hermoso, V., Jonas, H., Lukasiewicz, A., Thieme, M., Turak, E., Bingham, H., Dalton, J., Darwall, W., Deguignet, M., Dudley, N., Gardner, R., Higgins, J., Kumar, R., Linke, S., Milton, G. R., Pittock, J., Smith, K. G. and van Soesbergen, A. 2016. Achieving Aichi Biodiversity Target 11 to improve the performance of protected areas and conserve freshwater biodiversity. *Aquatic Conservation: Marine and Freshwater Ecosystems*, Vol. 26, No. S1, pp. 133–151. doi.org/10.1002/aqc.2638

Kløve, B., Ala-aho, P., Bertrand, G., Boukalova, Z., Ertürk, A., Goldscheider, N., Ilmonen, J., Karakaya, N., Kupfersberger, H., Kvœrner, J., Lundberg, A., Mileusnić, M., Moszczynska, A., Muotka, T., Preda, E., Rossi, P., Siergieiev, D., Šimek, J., Wachniew, P., Angheluta, V. and Widerlund, A. 2011. Groundwater Dependent Ecosystems. Part I: hydrogeological status and trends. *Environmental Science & Policy*, Vol. 14, No. 7, pp. 770–781.

Kløve, B., Allan, A., Bertrand, G., Druzynska, E., Ertürk, A., Goldscheider, N., Henry, S., Karakaya, N., Karjalainen, T. P., Koundouri, P., Kupfersberger, H., Kvœrner, J., Lundberg, A., Muotka, T., Preda, E., Pulido-Velazquez, M. and Schipper, P. 2011. Groundwater Dependent Ecosystems. Part II: ecosystem services and management under risk of climate change and land-use intensification. *Environmental Science & Policy*, Vol. 14, No. 8, pp. 770–793.

Kreamer, D. Stevens, L. E. and Ledbetter, J. D. 2015. Groundwater Dependent Ecosystems – Science, challenges and policy directions. Groundwater, New York, USA, Nova Science Publishers, pp. 205–230.

Lehner, B., Liermann, C. R., Revenga, C., Vörösmarty, C., Fekete, B., Crouzet, P., Döll, P., Endejan, M., Frenken, K., Magome, J., Nilsson, C., Robertson, J. C., Rödel, R., Sindorf, N. and Wisser, D. 2011. High-resolution mapping of the world's reservoirs and dams for sustainable river-flow management. *Frontiers in Ecology and the Environment*, Vol. 9, No. 9, pp. 494–502.

Lehner, B. and Grill, G. 2013. Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems. *Hydrological Processes*, Vol. 27, No. 15, pp. 2171–2186.

Liermann, C. R., Nilsson, C., Robertson, J. and Ng, R. Y. 2012. Implications of Dam Obstruction for Global Freshwater Fish Diversity. *BioScience*, Vol. 62, No. 6, pp. 539–548.

Matthews, N. 2016. People and fresh water ecosystems: pressures, responses and resilience. *Aquatic Procedia*, Vol. 6, pp. 99–105. doi.org/10.1016/j.aqpro.2016.06.012

MEA (Millennium Ecosystem Assessment). 2005. Ecosystems and Human Well-being: Synthesis. Washington DC, USA, Island Press. Available at: https://millenniumassessment.org/documents/document.356.aspx.pdf

Pekel, J-F., Cottam, A., Gorelick, N., and Belward, A. S. 2016. High-resolution mapping of global surface water and its long-term changes. *Nature*, Vol. 540, pp. 418–422. doi.org/10.1038/nature20584

Ramsar Convention Secretariat. 2010. *Managing Groundwater: Guidelines for the management of groundwater to maintain wetland ecological character*. Ramsar handbooks for the wise use of wetlands, Vol. 11. Gland, Switzerland, Ramsar Convention Secretariat. https://ramsar.org/sites/default/files/documents

Rodell, M., Famiglietti, J. S., Wiese, D. N., Reager, J. T., Beaudoing, H. K., Landerer, F. W. and Lo, M-H. 2018. Emerging trends in global freshwater availability. *Nature*, Vol. 557, pp. 651–659. doi.org/10.1038/s41586-018-0123-1

Russi, D., ten Brink, P., Farmer, A., Badura, T., Coates, D., Förster, J., Kumar, R. and Davidson, N. 2013. The Economics of Ecosystems and Biodiversity for Water and Wetlands. London and Brussels, Institute for European and Environmental Policy (IEEP), Gland, Switzerland. Ramsar Secretariat. http://doc.teebweb.org/wp-content/uploads/2013/04/TEEB_WaterWetlands_Report_2013.pdf

Syvitski, J. P. M. *et al*. 2009. Sinking deltas due to human activities. *Nature Geoscience*, Vol. 2, pp. 681–686.

Talaue McManus, L., Mahon, R., Aureli, A., Barbiére, J., Bertule, M., Bigagli, E., Bjørnsen, P., Combal, B., Dumont, A., Fanning, L., Fischer, A., Glennie, P., Grimes, S., Heileman, S, Lacroix, P., Lagod, M., Nakamura, M., Nijsten, G-J., Rast, W. and Sherbinin, A. 2016. Transboundary Water Systems - Status and Trends: Crosscutting Analysis. Nairobi, Kenya, UN Environment. http://www.geftwap.org/publications/volume-6-crosscutting-technical-report-high-res

UNEP (UN Environment). 2016. A Snapshot of the World's Water Quality: Towards a global assessment. Nairobi, Kenya, UN Environment. http://wedocs.unep.org/bitstream/handle/20.500.11822/19524/UNEP_WWQA_report_03052016.pdf?sequence=1&isAllowed=y

UNEP. 2017. A Framework for Freshwater Ecosystem Management. Volume 1: Overview and guide for implementation. http://wedocs.unep.org/bitstream/handle/20.500.11822/22243/Framework_Freshwater_Ecosystem_Mgt_vol1.pdf?sequence=1&isAllowed=y

UNEP. 2017. A Framework for Freshwater Ecosystem Management. Volume 2: Technical guide for classification and target-setting. http://wedocs.unep.org/bitstream/handle/20.500.11822/22242/Framework_Freshwater_Ecosystem_Mgt_vol2.pdf?sequence=1&isAllowed=y

UNEP-WCMC (UN Environment World Conservation Monitoring Centre)/IUCN (International Union for Conservation of Nature). 2016. Protected Planet Report 2016. Cambridge, UK/Gland, Switzerland, UNEP-WCMC/IUCN.

UN-Water. 2017. *Outcomes of methodology revision process*, 2nd Steering Committee Meeting. Geneva, Switzerland, 8–9 February 2017. http://sdg6monitoring.org/s/Outcomes-of-methodology-revision-process_2017-02-08.pdf

Vasilijević, M., Zunckel, K., McKinney, M., Erg, B., Schoon, M. and Rosen Michel, T. 2015. *Transboundary Conservation: A systematic and integrated approach*. Best Practice Protected Area Guidelines, Series No. 23, Gland, Switzerland, IUCN. doi.org/10.2305/IUCN.CH.2015.PAG.23.en

Vörösmarty, C. J., Meybeck, M., Fekete, B., Sharma, K. Green, P. and Syvitski, J. P. M. 2003. Anthropogenic sediment retention: major global impact from registered river impoundments. *Global and Planetary Change*, Vol. 39, Nos. 1–2, p. 169. doi.org/10.1016/S0921-8181(03)00023-7

Watson, J. E. M., Dudley, N., Segan, D. B. and Hockings, M. 2014. The performance and potential of protected areas. *Nature*, Vol. 515, pp. 67–73.

Wetland Extent Trends Index. 2018.

World Commission on Dams. 2000. *Dams and development: A new framework for decision-making*. London, UK/Sterling, USA, Earthscan Publications Ltd. https://internationalrivers.org/sites/default/files/attached-files/world_commission_on_dams_final_report.pdf

WRI (World Resources Institute). 2005. Millennium Ecosystem Assessment. *Ecosystems and human well-being: wetlands and water synthesis*. Washington DC, USA, WRI. https://millenniumassessment.org/documents/document.358.aspx.pdf

WWF (World Wide Fund for Nature). 2016. Living Planet Report 2016: Risk and resilience in a new era. https://c402277.ssl.cf1.rackcdn.com/publications/964/files/original/lpr_living_planet_report_2016.pdf?1477582118&_ga=1.148678772.2122160181.1464121326

Zarfl, C., Lumsdon A. E., Berlekamp J., Tydecks, L. and Tockner, K. 2014. A global boom in hydropower dam construction. *Aquatic Sciences*, Vol. 77, No. 1, p. 161–170. doi.org/10.1007/s00027-014-0377-0

Annex 1 Nationally derived (in situ) data for indicator 6.6.1 collected in 2017

Country code	Assess-ment period extent	Extent of wetlands	Extent of open water bodies	Extent of rivers	Total extent	Assessment period quan-tity	Quantity of open water bodies	Quantity of rivers	Quantity of groundwater	Total quantity	Assessment period water quality	Quality of open water bodies	Quality of river	Quality of groundwater	Percentage of water bodies with good quality
Fiji	N/A	N/A	N/A	N/A	N/A	2012-2016	320241.3	83468314.81	0.016981	83788556.13	2014-2016	100.00	100.00	100.00	100.00
Marshall Islands	2017-2017	N/A	0.0428	N/A	0.0428	2001-2017	118861.93	0	0.02869342	0.14755535	2016-2017	100.00	N/A	100.00	100.00
Andorra	2016-2016	4.5159	1.6611	467.2092	473.3862	2016-2016	N/A	11.8	N/A	11.8	2016-2016	N/A	100,00	75.00	92.86
Austria	2010-2015	955.4	1034	83851	85840.4	2011-2015	19502.4	78384	80955	178841.4	2013-2015	91.94	80.12	94.57	80.44
Benin	1984-1999	59051	323	119685	179059	1984-1999	N/A	4.13216E+17	N/A	4.13216E+17	1999-2002	N/A	N/A	N/A	N/A
Botswana	2003-2016	12910.1	2.69	208286.9	221199.69	N/A	N/A	N/A	N/A	N/A	N/A	94.44	94.74	7.69	50.00
Burundi	1985-2005	117993	2756.97	N/A	120749.97	1973-2016	1487304.85	11466.33192	N/A	1498771.182	2014-2017	N/A	N/A	N/A	N/A
Estonia	2010-2013	4030.481549	1958.377	93698.2	99687.05835	2009-2013	12160.59439	3962.273143	N/A	16122.86753	2010-2013	100.00	100.00	N/A	100.00
Finland	2012-2012	32650	28826	0	61476	1990-2000	808585.4265	3.4848E+12	N/A	3.4848E+12	2006-2012	80.82	64.09	76.35	76.06
Macedo-nia	1961-2009	N/A	176.8	1095	1271.8	1961-2009	5000	N/A	N/A	5000	2010-2016	N/A	12.50	N/A	8.70
Malaysia	2016-2016	3591.7499	1928.895	N/A	5520.6449	1970-2010	69650900000	4.59935E+11	N/A	5.29586E+11	2016-2016	3.36	40.74	99.49	39.74
Jamaica	1968-2017	134.78529	164.78757	N/A	299.57286	1972-2017	N/A	0.000091223	N/A	0.000091223	2014-2016	N/A	92.08	N/A	92.08
Japan	N/A	N/A	N/A	N/A	N/A	2011-2015	64605	2.14429E+12	2065	2.14429E+12	2012-2015	75.00	30.00	0.00	37.50
Kenya	N/A	N/A	75729.56	306091	381820.56	N/A	N/A	N/A	N/A	N/A	2011-2016	N/A	30.52	42.18	35.50
Latvia	2010-2012	1660	95.6	N/A	1755.6	2014-2016	950	24509	343.7	25802.7	2010-2016	52.90	72.44	100.00	64.41
Lebanon	1990-2017	6255	7	27.25	6289.25	1931-2016	N/A	37906272000	786	37906272786	1990-2017		50%	100%	50%
Morocco	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18340	N/A	18340	N/A	85.94	71.28	76.27	76.96
Nether-lands	2015-2015	573.4	3054.2	N/A	3627.6	N/A	N/A	N/A	N/A	N/A	2009-2014	53.22	47.15	86.96	52.22
Peru	N/A	83.5	15.7	N/A	99.2	N/A	N/A	N/A	N/A	N/A	2014-2016	N/A	36.84	N/A	36.84
Poland	2012-2016	1109.88	2331.35	763.22	4204.45	2015-2015	N/A	1.67248E+12	N/A	1.67248E+12	2010-2012	38.51	30.64	85.71	33.71
Romania	2016-2016	3156.8	2320.47	N/A	5477.27	2016-2016	475.348	N/A	9600	10075.348	2016-2016	62.61	57.37	83.69	61.37
Slovania	2011-2016	351.245042	38.76	82.64	472.645042	2014-2015	N/A	36026	N/A	36026	2014-2016	9.09	80.43	90.48	75.81
South Africa	2014-2016	56227.81167	2090.909808	136.577695	58455.29917	2014-2016	2095.977	5637504894	N/A	5637506990	2014-2016	62.50	37.05	N/A	46.92
Sudan	2017-2018	N/A	6.6	11246		2017-2018	952000000	84000000000	1.2E+13	178875969.8	2017-2018		100.00	97.25	35.29

Country code	Assess-ment period extent	Extent of wetlands	Extent of open water bodies	Extent of rivers	Total extent	Assessment period quan-tity	Quantity of open water bodies	Quantity of rivers	Quantity of groundwater	Total quantity	Assessment period water quality	Quality of open water bodies	Quality of river	Quality of groundwater	Percentage of water bodies with good quality
Switzer-land	2004-2007	N/A	2023	41477	43500	2007-2015	232240	1403.4	N/A	233643.4	2015-2015	N/A	100.00	N/A	100.00
Sweden	2010-2015	N/A	31857.10682	N/A	31857.10682	N/A	N/A	N/A	N/A	N/A	2010-2015	48.85	31.77	97.70	45.13
Tanzania	2014-2016	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2014-2016	N/A	N/A	N/A	N/A
Data below this line is not quality assured and available on UNSD database															
Chile	N/A	N/A	1046.5	N/A	1046.5	N/A	172980.84	#VALUE!	N/A	#VALUE!	2014-2017	50.00	50.00	100.00	66.67
Hungary	1981-2010	N/A	1179.4	464.64	1644.04	1981-2010	3111.150447	1899442827	N/A	1899445938	2009-2012	41,77	53,60	81,98	57,66
Lesotho	2016-2017	412.828	1867	30355	32634.828	2016-2017	1956	4553625600	316.224	4553627872	2016-2017	N/A	33,33	N/A	16,67
Lithuania	N/A	17472	934	N/A	18406	N/A	N/A	26312.6	3.72112	26316.32112	2010-2013	74,69	41,12	100,00	55,39
Madgas-car	1993-2017	N/A	800.35	349246	350046.35	1993-2017	1600.7	134267673600	58704000	134326379201	1945-2017	94.59	94.12	81.58	90.91
Namibia	2009-2010	400	281.2	N/A	681.2	2008-2016	725.3	4530	363	5618.3	2008-2016	60.00	85.71	100.00	78.57
Rep. of Korea	2016-2016	135	1137.627582	1500.469636	2773.097218	2012-2014	22086.4	724.53	12891.4	35702.33	2015-2016	N/A	82.61	96.01	87.29
South Sudan	2010-2012	65000	55000	75000	195000	2010-2012	924	1218	N/A	2142	2010-2012	100.00	100.00	100.00	100.00
Tunisia	2010-2015	N/A	496.1393201	N/A	496.1393201	2010-2015	N/A	85.61643836	N/A	85.61643836	2010-2015	N/A	N/A	N/A	N/A
United Arab Emirates	2005-2016	N/A	N/A	N/A	N/A	2005-2016	N/A	N/A	4740000	4740000	2005-2016	N/A	N/A	66.67	66.67
Uganda	2005-2017	4736	36756	N/A	41492	2005-2017	1359.1	N/A	N/A	1359.1	2012-2015	100.00	100.00	66.67	90.91

Annex 2 Data reported on national spatial extent of open water bodies

Country	Year	km²	% Change from baseline	Gain or loss
AFGHANISTAN	2001–2005	763.25	n/a	Baseline reference
	2006–2010	643.77	15.65	Loss
	2011–2015	580.46	23.95	Loss
ALBANIA	2001–2005	507.2	n/a	Baseline reference
	2006–2010	504.89	0.46	Loss
	2011–2015	518.5	-2.18	Gain
ALGERIA	2001–2005	237.09	n/a	Baseline reference
	2006–2010	383.18	-61.62	Gain
	2011–2015	421.77	-77.9	Gain
ANDORRA	2001–2005	0.64	n/a	Baseline reference
	2006–2010	0.65	-1.59	Gain
	2011–2015	0.62	3.25	Loss
ANGOLA	2001–2005	892.89	n/a	Baseline reference
	2006–2010	937.98	-5.05	Gain
	2011–2015	913.35	-2.29	Gain
ANTIGUA AND BARBUDA	2001–2005	34.24	n/a	Baseline reference
	2006–2010	34.39	-0.44	Gain
	2011–2015	33.53	2.08	Loss
ARGENTINA	2001–2005	33,959.14	n/a	Baseline reference
	2006–2010	29,474.34	13.21	Loss
	2011–2015	27,897.89	21.73	Loss
ARMENIA	2001–2005	1,314.19	n/a	Baseline reference
	2006–2010	1,328.61	-1.10	Gain
	2011–2015	1,333.45	-1.47	Gain
AUSTRALIA	2001–2005	13,054.65	n/a	Baseline reference
	2006–2010	12,266.36	6.038384	Loss
	2011–2015	14,511.39	-11.15881	Gain
AUSTRIA	2001–2005	631.59	n/a	Baseline reference
	2006–2010	632.98	-0.22	Gain
	2011–2015	633.49	-0.3	Gain
AZERBAIJAN	2001–2005	72,219.98	n/a	Baseline reference
	2006–2010	72,209.73	0.01	Loss
	2011–2015	72,059.04	0.22	Loss
BAHAMAS	2001–2005	995.40	n/a	Baseline reference
	2006–2010	1,003.94	-0.86	Gain
	2011–2015	1,076.81	-8.18	Gain
BAHRAIN	2001–2005	54.69	n/a	Baseline reference
	2006–2010	52.95	3.18	Loss
	2011–2015	52.38	4.22	Loss
BANGLADESH	2001–2005	4,566.61	n/a	Baseline reference
	2006–2010	4,651.78	-1.87	Gain
	2011–2015	4,681.36	-2.51	Gain

Country	Year	km²	% Change from baseline	Gain or loss
BARBADOS	2001–2005	0.23	n/a	Baseline reference
	2006–2010	0.24	-8.67	Gain
	2011–2015	0.2	9.82	Loss
BELARUS	2001–2005	1,784.35	n/a	Baseline reference
	2006–2010	1,802.13	-1	Gain
	2011–2015	1,804.6	-1.14	Gain
BELGIUM	2001–2005	153.49	n/a	Baseline reference
	2006–2010	155.99	-1.63	Gain
	2011–2015	157.95	-2.9	Gain
BELIZE	2001–2005	278.43	n/a	Baseline reference
	2006–2010	287.16	-3.14	Gain
	2011–2015	281.48	-1.1	Gain
BENIN	2001–2005	121.97	n/a	Baseline reference
	2006–2010	120.57	1.14	Loss
	2011–2015	119.81	1.77	Loss
BHUTAN	2001–2005	76.65	n/a	Baseline reference
	2006–2010	76.11	0.71	Loss
	2011–2015	75.43	1.59	Loss
BOLIVIA (PLURINATIONAL STATE OF)	2001–2005	12,711.55	n/a	Baseline reference
	2006–2010	11,414.63	10.2	Loss
	2011–2015	12,019.8	5.44	Loss
BOSNIA AND HERZEGOVINA	2001–2005	199.24	n/a	Baseline reference
	2006–2010	194.37	2.44	Loss
	2011–2015	197.82	0.71	Loss
BOTSWANA	2001–2005	111.07	n/a	Baseline reference
	2006–2010	161.38	-45.3	Gain
	2011–2015	383.65	-245.43	Gain
BRAZIL	2001–2005	102,782.9	n/a	Baseline reference
	2006–2010	105,730.5	-2.87	Gain
	2011–2015	104,863.5	-2.02	Gain
BRUNEI DARUSSALAM	2001–2005	61.98	n/a	Baseline reference
	2006–2010	62.73	-1.21	Gain
	2011–2015	62.37	-0.62	Gain
BULGARIA	2001–2005	1,021.04	n/a	Baseline reference
	2006–2010	1,034.77	-1.34	Gain
	2011–2015	1,028.15	-0.7	Gain
BURKINA FASO	2001–2005	326.93	n/a	Baseline reference
	2006–2010	346.1	-5.86	Gain
	2011–2015	370.06	-13.19	Gain
BURUNDI	2001–2005	1,953.71	n/a	Baseline reference
	2006–2010	1,951.87	0.09	Loss
	2011–2015	1,955.15	-0.07	Gain
CAMBODIA	2001–2005	3,542.78	n/a	Baseline reference
	2006–2010	3,613.56	-2	Gain
	2011–2015	3,431.14	3.15	Loss
CAMEROON	2001–2005	1,907.26	n/a	Baseline reference
	2006–2010	1,922.72	-0.81	Gain
	2011–2015	1,875.94	1.64	Loss

Country	Year	km²	% Change from baseline	Gain or loss
CANADA	2001–2005	695,683.8	n/a	Baseline reference
	2006–2010	696,434.3	-0.11	Gain
	2011–2015	698,030.3	-0.34	Gain
CAPE VERDE	2001-2005	281.76	n/a	Baseline reference
	2006–2010	281.15	0.22	Loss
	2011–2015	280.67	0.39	Loss
CENTRAL AFRICAN REPUBLIC	2001–2005	434.4	n/a	Baseline reference
	2006–2010	438.14	-0.86	Gain
	2011–2015	431.46	0.68	Loss
CHAD	2001–2005	1,372.7	n/a	Baseline reference
	2006–2010	1,317.14	4.05	Loss
	2011–2015	1,360.09	0.92	Loss
CHILE	2001–2005	12,185.22	n/a	Baseline reference
	2006–2010	12,218.59	-0.27	Gain
	2011–2015	12,106.65	0.64	Loss
CHINA	2001–2005	104,093.8	n/a	Baseline reference
	2006–2010	108,234.2	-3.98	Gain
	2011–2015	111,859.1	-7.46	Gain
COLOMBIA	2001–2005	9,024.63	n/a	Baseline reference
	2006-2010	9,986.02	-10.65	Gain
	2011–2015	9,438.51	-4.59	Gain
COMOROS	2001–2005	6.05	n/a	Baseline reference
	2006–2010	5.91	2.31	Loss
	2011–2015	5.61	7.28	Loss
CONGO	2001–2005	1,659.36	n/a	Baseline reference
	2006-2010	1,701.19	-2.52	Gain
	2011–2015	1,675.35	-0.96	Gain
COSTA RICA	2001–2005	176.36	n/a	Baseline reference
	2006–2010	174.49	1.06	Loss
	2011–2015	170.38	3.39	Loss
COTE D'IVOIRE	2001–2005	1847.4	n/a	Baseline reference
	2006–2010	1,845.07	0.13	Loss
	2011–2015	1,812.46	1.89	Loss
CROATIA	2001–2005	630.53	n/a	Baseline reference
	2006–2010	624.53	0.95	Loss
	2011–2015	630.15	0.06	Loss
CUBA	2001–2005	2,442.13	n/a	Baseline reference
	2006–2010	2,529.29	-3.57	Gain
	2011–2015	2,543.54	-4.15	Gain
CYPRUS	2001–2005	12.15	n/a	Baseline reference
	2006–2010	10.04	17.38	Loss
	2011–2015	13.37	-10.04	Gain
CZECHIA	2001–2005	493.91	n/a	Baseline reference
	2006–2010	503.97	-2.04	Gain
	2011–2015	503.7	-1.98	Gain
DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA	2001–2005	1,581.81	n/a	Baseline reference
	2006–2010	1,694.37	-7.12	Gain
	2011–2015	1,672.69	-5.75	Gain

Country	Year	km²	% Change from baseline	Gain or loss
DEMOCRATIC REPUBLIC OF THE CONGO	2001–2005	36,048.93	n/a	Baseline reference
	2006–2010	36,207.22	-0.44	Gain
	2011–2015	35,865.05	0.51	Loss
DENMARK	2001–2005	2,388.22	n/a	Baseline reference
	2006–2010	2,400.56	-0.52	Gain
	2011–2015	2,416.52	-1.18	Gain
DJIBOUTI	2001–2005	158.75	n/a	Baseline reference
	2006–2010	150.44	5.23	Loss
	2011–2015	151.31	4.69	Loss
DOMINICA	2001–2005	0.39	n/a	Baseline reference
	2006–2010	0.36	8.15	Loss
	2011–2015	0.32	17.41	Loss
DOMINICAN REPUBLIC	2001–2005	320.19	n/a	Baseline reference
	2006–2010	423.64	-32.31	Gain
	2011–2015	478.49	-49.44	Gain
ECUADOR	2001–2005	2,060.7	n/a	Baseline reference
	2006–2010	2,131.8	-3.45	Gain
	2011–2015	2,121.1	-2.93	Gain
EGYPT	2001–2005	7,451.97	n/a	Baseline reference
	2006–2010	6,816.88	8.52	Loss
	2011–2015	6,376.32	14.43	Loss
EL SALVADOR	2001–2005	347.3	n/a	Baseline reference
	2006–2010	350.02	-0.78	Gain
	2011–2015	340.07	2.08	Loss
EQUATORIAL GUINEA	2001–2005	113.57	n/a	Baseline reference
	2006–2010	111.66	1.68	Loss
	2011–2015	112.82	0.65	Loss
ERITREA	2001–2005	31.43	n/a	Baseline reference
	2006–2010	36.12	-14.92	Gain
	2011–2015	47.54	-51.25	Gain
ESTONIA	2001–2005	2,069.32	n/a	Baseline reference
	2006-2010	2,067.59	0.08	Loss
	2011–2015	2,063.14	0.3	Loss
ESWATINI	2001–2005	36.22	n/a	Baseline reference
	2006–2010	46.59	-28.6	Gain
	2011–2015	56.17	-55.07	Gain
ETHIOPIA	2001–2005	6,726.04	n/a	Baseline reference
	2006–2010	6,703.06	0.34	Loss
	2011–2015	6,896.89	-2.54	Gain
FIJI	2001–2005	522.72	n/a	Baseline reference
	2006–2010	522.42	0.06	Loss
	2011–2015	525.88	-0.6	Gain
FINLAND	2001–2005	29,900.6	n/a	Baseline reference
	2006–2010	29,851.53	0.16	Loss
	2011–2015	30,116.2	-0.72	Gain
FRANCE	2001–2005	3,613.38	n/a	Baseline reference
	2006–2010	3,674.01	-1.68	Gain
	2011–2015	3,689.84	-2.12	Gain

Country	Year	km²	% Change from baseline	Gain or loss
GABON	2001–2005	2,139.43	n/a	Baseline reference
	2006–2010	2,171.92	-1.52	Gain
	2011–2015	2,133.65	0.27	Loss
GAMBIA	2001–2005	742.16	n/a	Baseline reference
	2006–2010	740.79	0.18	Loss
	2011–2015	742.35	-0.03	Gain
GEORGIA	2001–2005	309.55	n/a	Baseline reference
	2006–2010	305.99	1.15	Loss
	2011–2015	308.25	0.42	Loss
GERMANY	2001–2005	3,701.73	n/a	Baseline reference
	2006–2010	3,761.5	-1.61	Gain
	2011–2015	3,838.09	-3.68	Gain
GHANA	2001–2005	5,563.8	n/a	Baseline reference
	2006–2010	5,755.28	-3.44	Gain
	2011–2015	6,064.95	-9.01	Gain
GREECE	2001–2005	2,820.19	n/a	Baseline reference
	2006–2010	2,831.9	-0.42	Gain
	2011–2015	2,903.25	-2.95	Gain
GRENADA	2001–2005	1.25	n/a	Baseline reference
	2006–2010	1.42	-13.3	Gain
	2011–2015	1.33	-5.78	Gain
GUATEMALA	2001-2005	1,160.19	n/a	Baseline reference
	2006–2010	1,159.29	0.08	Loss
	2011–2015	1,153.56	0.57	Loss
GUINEA	2001–2005	147.2	n/a	Baseline reference
	2006–2010	159.4	-8.29	Gain
	2011–2015	169.02	-14.82	Gain
GUINEA-BISSAU	2001–2005	56.79	n/a	Baseline reference
	2006–2010	57.78	-1.75	Gain
	2011–2015	55.38	2.47	Loss
GUYANA	2001–2005	1,389.44	n/a	Baseline reference
	2006–2010	1,413.39	-1.72	Gain
	2011–2015	1,421.28	-2.29	Gain
HAITI	2001–2005	182.68	n/a	Baseline reference
	2006–2010	200.14	-9.56	Gain
	2011–2015	212.19	-16.15	Gain
HONDURAS	2001–2005	837.79	n/a	Baseline reference
	2006–2010	845.09	-0.87	Gain
	2011–2015	836.29	0.18	Loss
HUNGARY	2001–2005	1,113.46	n/a	Baseline reference
	2006–2010	1,134.1	-1.85	Gain
	2011–2015	1,144.91	-2.82	Gain
ICELAND	2001–2005	2,672.98	n/a	Baseline reference
	2006–2010	2,676.19	-0.12	Gain
	2011–2015	2,677.91	-0.18	Gain
INDIA	2001–2005	14,797.1	n/a	Baseline reference
	2006–2010	16,222.46	-9.63	Gain
	2011–2015	16,686.13	-12.77	Gain

Country	Year	km²	% Change from baseline	Gain or loss
INDONESIA	2001–2005	30,760.68	n/a	Baseline reference
	2006–2010	31,321.41	-1.82	Gain
	2011–2015	30,901.51	-0.46	Gain
IRAN (ISLAMIC REPUBLIC OF)	2001–2005	60,428.63	n/a	Baseline reference
	2006–2010	59,525.79	1.49	Loss
	2011–2015	57,712.02	4.5	Loss
IRAQ	2001–2005	4,941.63	n/a	Baseline reference
	2006–2010	4,590.04	7.11	Loss
	2011–2015	4,210.86	14.79	Loss
IRELAND	2001–2005	1,534.65	n/a	Baseline reference
	2006–2010	1,527.61	0.46	Loss
	2011–2015	1,528.32	0.41	Loss
ISRAEL	2001–2005	460.98	n/a	Baseline reference
	2006–2010	460.32	0.14	Loss
	2011–2015	457.46	0.76	Loss
ITALY	2001–2005	3,551.16	n/a	Baseline reference
	2006–2010	3,612.9	-1.74	Gain
	2011–2015	3,627.02	-2.14	Gain
JAMAICA	2001–2005	21.11	n/a	Baseline reference
	2006–2010	20.69	2	Loss
	2011–2015	19.83	6.07	Loss
JAPAN	2001–2005	7,913.86	n/a	Baseline reference
	2006–2010	7,929.71	-0.2	Gain
	2011–2015	7,910.77	0.04	Loss
JORDAN	2001–2005	446.51	n/a	Baseline reference
	2006–2010	452.62	-1.37	Gain
	2011–2015	446.72	-0.05	Gain
KYRGYZSTAN	2001–2005	7,303.95	n/a	Baseline reference
	2006–2010	7,267.61	0.5	Loss
	2011–2015	7,249.77	0.74	Loss
LAO PEOPLE'S DEMOCRATIC REPUBLIC	2001–2005	1,311.11	n/a	Baseline reference
	2006–2010	1,407.77	-7.37	Gain
	2011–2015	1,656.4	-26.34	Gain
LATVIA	2001–2005	962.19	n/a	Baseline reference
	2006–2010	960.02	0.23	Loss
	2011–2015	964.65	-0.26	Gain
LEBANON	2001–2005	18.16	n/a	Baseline reference
	2006–2010	17.99	0.89	Loss
	2011–2015	17.53	3.45	Loss
LESOTHO	2001–2005	44.2	n/a	Baseline reference
	2006–2010	53.63	-21.35	Gain
	2011–2015	49.4	-11.76	Gain
LIBERIA	2001–2005	191.92	n/a	Baseline reference
	2006–2010	198.02	-3.18	Gain
	2011–2015	197.99	-3.16	Gain
LIBYA	2001–2005	60.4	n/a	Baseline reference
	2006–2010	64.55	-6.87	Gain
	2011–2015	59.64	1.25	Loss

Country	Year	km²	% Change from baseline	Gain or loss
LIECHTENSTEIN	2001–2005	0.59	n/a	Baseline reference
	2006–2010	0.59	0.22	Loss
	2011–2015	0.57	4.54	Loss
LITHUANIA	2001–2005	916.28	n/a	Baseline reference
	2006–2010	913.73	0.28	Loss
	2011–2015	916.78	-0.05	Gain
LUXEMBOURG	2001–2005	5.29	n/a	Baseline reference
	2006–2010	5.32	-0.56	Gain
	2011–2015	5.31	-0.41	Gain
MADAGASCAR	2001–2005	2,662.98	n/a	Baseline reference
	2006–2010	2,657.77	0.2	Loss
	2011–2015	2,542.55	4.52	Loss
MALAWI	2001–2005	24,007.75	n/a	Baseline reference
	2006–2010	24,016.01	-0.03	Gain
	2011–2015	23,757.17	1.04	Loss
MALAYSIA	2001–2005	3,531.28	n/a	Baseline reference
	2006–2010	3,626.66	-2.7	Gain
	2011–2015	3,907.33	-10.65	Gain
MALDIVES	2001–2005	17.36	n/a	Baseline reference
	2006–2010	16.72	3.74	Loss
	2011–2015	16.72	3.7	Loss
MALI	2001–2005	1,530.71	n/a	Baseline reference
	2006–2010	1,504.04	1.74	Loss
	2011–2015	1,493.27	2.45	Loss
MALTA	2001–2005	2.37	n/a	Baseline reference
	2006–2010	1.78	24.67	Loss
	2011–2015	2.8	-18.24	Gain
MARSHALL ISLANDS	2001–2005	23.46	n/a	Baseline reference
	2006–2010	23.48	-0.11	Gain
	2011–2015	19.83	15.44	Loss
MAURITANIA	2001–2005	165.68	n/a	Baseline reference
	2006–2010	157.01	5.24	Loss
	2011–2015	152.75	7.81	Loss
MAURITIUS	2001–2005	17.55	n/a	Baseline reference
	2006–2010	18.51	-5.47	Gain
	2011–2015	16.28	7.26	Loss
MEXICO	2001–2005	9,374.35	n/a	Baseline reference
	2006–2010	10,500.88	-12.02	Gain
	2011–2015	10,345.59	-10.36	Gain
MICRONESIA (FEDERATED STATES OF)	2001–2005	4.18	n/a	Baseline reference
	2006–2010	4.05	3.06	Loss
	2011–2015	4.16	0.47	Loss
MONGOLIA	2001–2005	14,258.74	n/a	Baseline reference
	2006–2010	13,947.25	2.18	Loss
	2011–2015	14,021.39	1.66	Loss
MONTENEGRO	2001–2005	265.63	n/a	Baseline reference
	2006–2010	263.23	0.9	Gain
	2011–2015	262.52	1.17	Gain

Country	Year	km^2	% Change from baseline	Gain or loss
MOROCCO	2001–2005	504.92	n/a	Baseline reference
	2006–2010	578.46	-14.56	Gain
	2011–2015	630.89	-24.95	Gain
MOZAMBIQUE	2001–2005	11,543.89	n/a	Baseline reference
	2006–2010	11,592.5	-0.42	Gain
	2011–2015	11,620.37	-0.66	Gain
MYANMAR	2001–2005	6,024.55	n/a	Baseline reference
	2006–2010	6,461.94	-7.26	Gain
	2011–2015	6,533.38	-8.45	Gain
NAMIBIA	2001–2005	213.51	n/a	Baseline reference
	2006–2010	250.46	-17.31	Gain
	2011–2015	289.8	-35.73	Gain
NEPAL	2001–2005	210.99	n/a	Baseline reference
	2006–2010	202.24	4.15	Loss
	2011–2015	203.4	3.6	Loss
NETHERLANDS	2001–2005	1,002.36	n/a	Baseline reference
	2006–2010	1,024.72	-2.23	Gain
	2011–2015	1,042.49	-4	Gain
NEW ZEALAND	2001–2005	7,089.56	n/a	Baseline reference
	2006–2010	7,038.51	0.72	Loss
	2011–2015	7,072	0.25	Loss
NICARAGUA	2001–2005	9,729.29	n/a	Baseline reference
	2006–2010	9,730.83	-0.02	Gain
	2011–2015	9,761.65	-0.33	Gain
NIGER	2001–2005	219.59	n/a	Baseline reference
	2006–2010	146.95	33.08	Loss
	2011–2015	326.06	-48.48	Gain
NIGERIA	2001–2005	4,015.9	n/a	Baseline reference
	2006–2010	4,108.84	-2.31	Gain
	2011–2015	4,212.87	-4.9	Gain
NORWAY	2001–2005	17,527.47	n/a	Baseline reference
	2006–2010	17,404.53	0.7	Loss
	2011–2015	17,590.13	-0.36	Gain
OMAN	2001–2005	246.37	n/a	Baseline reference
	2006–2010	250.48	-1.67	Gain
	2011–2015	235.96	4.23	Loss
PAKISTAN	2001–2005	1,883.7	n/a	Baseline reference
	2006–2010	2,148.55	-14.06	Gain
	2011–2015	2,468.87	-31.06	Gain
PALAU	2001–2005	1.89	n/a	Baseline reference
	2006–2010	1.86	1.58	Loss
	2011–2015	1.91	-1.11	Gain
PANAMA	2001–2005	730.92	n/a	Baseline reference
	2006–2010	741.93	-1.51	Gain
	2011–2015	729.8	0.15	Loss
PAPUA NEW GUINEA	2001–2005	5,110.85	n/a	Baseline reference
	2006–2010	5,369.22	-5.06	Gain
	2011–2015	5,280.96	-3.33	Gain

Country	Year	km²	% Change from baseline	Gain or loss
PARAGUAY	2001–2005	3,177.13	n/a	Baseline reference
	2006–2010	3,220.54	-1.37	Gain
	2011–2015	3,407.61	-7.25	Gain
PERU	2001–2005	12,833.42	n/a	Baseline reference
	2006–2010	12,677.84	1.21	Loss
	2011–2015	12,763.17	0.55	Loss
PHILIPPINES	2001–2005	5,980.01	n/a	Baseline reference
	2006–2010	6,101.38	-2.03	Gain
	2011–2015	6,102.27	-2.04	Gain
POLAND	2001–2005	3,517.49	n/a	Baseline reference
	2006–2010	3,534.82	-0.49	Gain
	2011–2015	3,552.05	-0.98	Gain
PORTUGAL	2001–2005	635.34	n/a	Baseline reference
	2006–2010	750.04	-18.05	Gain
	2011–2015	773.56	-21.75	Gain
QATAR	2001–2005	160.05	n/a	Baseline reference
	2006–2010	161.9	-1.16	Gain
	2011–2015	166.06	-3.76	Gain
REPUBLIC OF KOREA	2001–2005	1,807.22	n/a	Baseline reference
	2006–2010	1,805.08	0.12	Loss
	2011–2015	1,820.02	-0.71	Gain
REPUBLIC OF MOLDOVA	2001–2005	293.97	n/a	Baseline reference
	2006–2010	296.91	-1	Gain
	2011–2015	290.05	1.33	Loss
ROMANIA	2001–2005	2,401.81	n/a	Baseline reference
	2006–2010	2,460.38	-2.44	Gain
	2011–2015	2,419.15	-0.72	Gain
RWANDA	2001–2005	1,491.79	n/a	Baseline reference
	2006–2010	1,493.65	-0.12	Gain
	2011–2015	1,505.15	-0.9	Gain
SAINT KITTS AND NEVIS	2001–2005	1.72	n/a	Baseline reference
	2006–2010	1.83	-6.85	Gain
	2011–2015	1.68	2	Loss
SAINT LUCIA	2001–2005	0.4	n/a	Baseline reference
	2006–2010	0.41	-0.64	Gain
	2011–2015	0.36	9.89	Loss
SAINT VINCENT AND THE GRENADINES	2001–2005	1.96	n/a	Baseline reference
	2006–2010	2	-2.45	Gain
	2011–2015	1.74	11.3	Loss
SAMOA	2001–2005	5.14	n/a	Baseline reference
	2006–2010	5.23	-1.77	Gain
	2011–2015	5.17	-0.64	Gain
SAUDI ARABIA	2001–2005	1,428.02	n/a	Baseline reference
	2006–2010	1,464.72	-2.57	Gain
	2011–2015	1,481.16	-3.72	Gain
SENEGAL	2001–2005	1,259.58	n/a	Baseline reference
	2006–2010	1,264.3	-0.37	Gain
	2011–2015	1,269.66	-0.8	Gain

Country	Year	km²	% Change from baseline	Gain or loss
SERBIA	2001–2005	557.4	n/a	Baseline reference
	2006–2010	557.91	-0.09	Gain
	2011–2015	566.21	-1.58	Gain
SEYCHELLES	2001–2005	5.96	n/a	Baseline reference
	2006–2010	5.91	0.86	Loss
	2011–2015	5.85	1.81	Loss
SIERRA LEONE	2001–2005	156.54	n/a	Baseline reference
	2006–2010	149.09	4.76	Loss
	2011–2015	155.9	0.4	Loss
SINGAPORE	2001–2005	39.84	n/a	Baseline reference
	2006–2010	40.27	-1.1	Gain
	2011–2015	36.98	7.17	Loss
SLOVAKIA	2001–2005	264.68	n/a	Baseline reference
	2006–2010	267.36	-1.01	Gain
	2011–2015	265.91	-0.47	Gain
SLOVENIA	2001–2005	39.65	n/a	Baseline reference
	2006–2010	40.71	-2.68	Gain
	2011–2015	42.13	-6.27	Gain
SOLOMON ISLANDS	2001–2005	304.63	n/a	Baseline reference
	2006–2010	302.41	0.73	Loss
	2011–2015	309.67	-1.65	Gain
SOMALIA	2001–2005	68.57	n/a	Baseline reference
	2006–2010	80.07	-16.77	Gain
	2011–2015	56.6	17.45	Loss
SOUTH AFRICA	2001–2005	3,179.68	n/a	Baseline reference
	2006–2010	3,362.03	-5.73	Gain
	2011–2015	3,415.37	-7.41	Gain
SOUTH SUDAN	2001–2005	730.66	n/a	Baseline reference
	2006–2010	661.44	9.47	Loss
	2011–2015	594.4	18.65	Loss
SPAIN	2001–2005	2,969.76	n/a	Baseline reference
	2006–2010	2,922.73	1.58	Loss
	2011–2015	3,222.98	-8.53	Gain
SRI LANKA	2001–2005	964.44	n/a	Baseline reference
	2006–2010	993.05	-2.97	Gain
	2011–2015	1,025.46	-6.33	Gain
SUDAN	2001–2005	1,185.85	n/a	Baseline reference
	2006–2010	1,340.84	-13.07	Gain
	2011–2015	1,571.87	-32.55	Gain
SURINAME	2001–2005	1,786.72	n/a	Baseline reference
	2006–2010	1,870.58	-4.69	Gain
	2011–2015	1,866.88	-4.49	Gain
SWEDEN	2001–2005	35,579.8	n/a	Baseline reference
	2006–2010	35,420.46	0.45	Loss
	2011–2015	35,683.82	-0.29	Gain
SWITZERLAND	2001–2005	1,368.26	n/a	Baseline reference
	2006–2010	1,368.07	0.01	Loss
	2011–2015	1,367.29	0.07	Loss

Country	Year	km²	% Change from baseline	Gain or loss
SYRIAN ARAB REPUBLIC	2001–2005	1,054.21	n/a	Baseline reference
SYRIAN ARAB REPUBLIC	2006–2010	1,041.1	1.24	Loss
SYRIAN ARAB REPUBLIC	2011–2015	1,009.77	4.22	Loss
TAJIKISTAN	2001–2005	1,557.99	n/a	Baseline reference
TAJIKISTAN	2006–2010	1,546.5	0.74	Loss
TAJIKISTAN	2011–2015	1,540.07	1.15	Loss
THAILAND	2001–2005	5,491.28	n/a	Baseline reference
THAILAND	2006–2010	5,644.09	-2.78	Gain
THAILAND	2011–2015	5,434.41	1.04	Loss
TIMOR-LESTE	2001–2005	11.82	n/a	Baseline reference
TIMOR-LESTE	2006–2010	11.38	3.75	Loss
TIMOR-LESTE	2011–2015	10.25	13.28	Loss
TOGO	2001–2005	103.23	n/a	Baseline reference
TOGO	2006–2010	100.91	2.25	Loss
TOGO	2011–2015	101.73	1.46	Loss
TONGA	2001–2005	15.6	n/a	Baseline reference
TONGA	2006–2010	15.64	-0.24	Gain
TONGA	2011–2015	15.74	-0.92	Gain
TRINIDAD AND TOBAGO	2001–2005	13.28	n/a	Baseline reference
TRINIDAD AND TOBAGO	2006–2010	13.36	-0.6	Gain
TRINIDAD AND TOBAGO	2011–2015	12.85	3.3	Loss
TUNISIA	2001–2005	304.96	n/a	Baseline reference
TUNISIA	2006–2010	308.25	-1.08	Gain
TUNISIA	2011–2015	304.32	0.21	Same
TURKEY	2001–2005	11,352.8	n/a	Baseline reference
TURKEY	2006–2010	11,427.33	-0.66	Gain
TURKEY	2011–2015	11,993.4	-5.64	Gain
TURKMENISTAN	2001–2005	86,899.14	n/a	Baseline reference
TURKMENISTAN	2006–2010	86,835.01	0.07	Loss
TURKMENISTAN	2011–2015	86,383.38	0.59	Loss
TUVALU	2001–2005	11.65	n/a	Baseline reference
TUVALU	2006–2010	11.37	2.4	Loss
TUVALU	2011–2015	12	-3.05	Gain
UGANDA	2001–2005	36,480.14	n/a	Baseline reference
UGANDA	2006–2010	36,339.11	0.39	Loss
UGANDA	2011–2015	36,212.66	0.73	Loss
UKRAINE	2001–2005	172,197.8	n/a	Baseline reference
UKRAINE	2006–2010	105,284.5	38.86	Loss
UKRAINE	2011–2015	39,392.34	77.12	Loss
UNITED ARAB EMIRATES	2001–2005	169.96	n/a	Baseline reference
UNITED ARAB EMIRATES	2006–2010	160.91	5.33	Loss
UNITED ARAB EMIRATES	2011–2015	162.39	4.45	Loss
UNITED REPUBLIC OF TANZANIA	2001–2005	56,289.62	n/a	Baseline reference
UNITED REPUBLIC OF TANZANIA	2006–2010	55,836.76	0.8	Loss
UNITED REPUBLIC OF TANZANIA	2011–2015	55,582.32	1.26	Loss
UNITED STATES OF AMERICA	2001–2005	154,193	n/a	Baseline reference
UNITED STATES OF AMERICA	2006–2010	154,428.2	-0.15	Gain
UNITED STATES OF AMERICA	2011–2015	154,786.3	-0.38	Gain

Country	Year	km²	% Change from baseline	Gain or loss
URUGUAY	2001–2005	3,955.81	n/a	Baseline reference
	2006–2010	3,823.19	3.35	Loss
	2011–2015	3,973.67	-0.45	Gain
UZBEKISTAN	2001–2005	16,774.24	n/a	Baseline reference
	2006–2010	11,543.14	31.19	Gain
	2011–2015	9,345.05	44.29	Gain
VANUATU	2001–2005	65.14	n/a	Baseline reference
	2006–2010	65.65	-0.78	Gain
	2011–2015	65.67	-0.82	Gain
VENEZUELA (BOLIVARIAN REPUBLIC OF)	2001–2005	10,046.89	n/a	Baseline reference
	2006–2010	10,556.36	-5.07	Gain
	2011–2015	10,397.65	-3.49	Gain
VIET NAM	2001–2005	5,025.75	n/a	Baseline reference
	2006–2010	5,477.38	-8.99	Gain
	2011–2015	5,614.44	-11.71	Gain
YEMEN	2001–2005	921.75	n/a	Baseline reference
	2006–2010	928.32	-0.71	Gain
	2011–2015	917.3	0.48	Loss
ZAMBIA	2001–2005	12,126.97	n/a	Baseline reference
	2006–2010	11,907.52	1.81	Loss
	2011–2015	11,941.07	1.53	Loss
ZIMBABWE	2001–2005	3,498	n/a	Baseline reference
	2006–2010	3,453.75	1.27	Loss
	2011–2015	3,489.35	0.25	Loss

Boxes, figures and tables

LEARN MORE ABOUT PROGRESS TOWARDS SDG 6

6 CLEAN WATER AND SANITATION

SDG 6 expands the 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.

The monitoring of progress towards SDG 6 is a means to making this happen. High-quality data help policy- 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.

In 2016–2018, following the adoption of the global indicator framework, the UN-Water Integrated Monitoring Initiative focused on establishing the global baseline for all SDG 6 global indicators, which is essential for effective follow-up and review of progress towards SDG 6. Below is an overview of the resultant indicator reports produced in 2017–2018. UN-Water has also produced the SDG 6 Synthesis Report 2018 on Water and Sanitation, which, building on baseline data, addresses the cross-cutting nature of water and sanitation and the many interlinkages within SDG 6 and across the 2030 Agenda, and discusses ways to accelerate progress towards SDG 6.

Progress on Drinking Water, Sanitation and Hygiene – 2017 Update and SDG Baselines (including data on SDG indicators 6.1.1 and 6.2.1) By WHO and UNICEF	One of the most important uses of water is for drinking and hygiene purposes. A safely managed sanitation chain is essential to protecting the health of individuals and communities and the environment. By monitoring use of drinking water and sanitation services, policy- and decision makers can find out who has access to safe water and a toilet with handwashing facilities at home, and who requires it. Learn more about the baseline situation for SDG indicators 6.1.1 and 6.2.1 here: http://www.unwater.org/publication_categories/whounicef-joint-monitoring-programme-for-water-supply-sanitation-hygiene-jmp/.
Progress on Safe Treatment and Use of Wastewater – Piloting the monitoring methodology and initial findings for SDG indicator 6.3.1 By WHO and UN-Habitat on behalf of UN-Water	Leaking latrines and raw wastewater can spread disease and provide a breeding ground for mosquitoes, as well as pollute groundwater and surface water. Learn more about wastewater monitoring and initial status findings here: http://www.unwater.org/publications/progress-on-wastewater-treatment-631.
Progress on Ambient Water Quality – Piloting the monitoring methodology and initial findings for SDG indicator 6.3.2 By UN Environment on behalf of UN-Water	Good ambient water quality ensures the continued availability of important freshwater ecosystem services and does not negatively affect human health. Untreated wastewater from domestic sources, industry and agriculture can be detrimental to ambient water quality. Regular monitoring of freshwaters allows for the timely response to potential sources of pollution and enables stricter enforcement of laws and discharge permits. Learn more about water quality monitoring and initial status findings here: http://www.unwater.org/publications/progress-on-ambient-water-quality-632.
Progress on Water-Use Efficiency – Global baseline for SDG indicator 6.4.1 By FAO on behalf of UN-Water	Freshwater is used by all sectors of society, with agriculture being the biggest user overall. The global indicator on water-use efficiency tracks to what extent a country's economic growth is dependent on the use of water resources, and enables policy- and decision makers to target interventions at sectors with high water use and low levels of improved efficiency over time. Learn more about the baseline situation for SDG indicator 6.4.1 here: http://www.unwater.org/publications/progress-on-water-use-efficiency-641.

Progress on Level of Water Stress – Global baseline for SDG indicator 6.4.2 By FAO on behalf of UN-Water	A high level of water stress can have negative effects on economic development, increasing competition and potential conflict among users. This calls for effective supply and demand management policies. Securing environmental water requirements is essential to maintaining ecosystem health and resilience. Learn more about the baseline situation for SDG indicator 6.4.2 here: http://www.unwater.org/publications/progress-on-level-of-water-stress-642.
Progress on Integrated Water Resources Management – Global baseline for SDG indicator 6.5.1 By UN Environment on behalf of UN-Water	Integrated water resources management (IWRM) is about balancing the water requirements of society, the economy and the environment. The monitoring of 6.5.1 calls for a participatory approach in which representatives from different sectors and regions are brought together to discuss and validate the questionnaire responses, paving the way for coordination and collaboration beyond monitoring. Learn more about the baseline situation for SDG indicator 6.5.1 here: http://www.unwater.org/publications/progress-on-integrated-water-resources-management-651.
Progress on Transboundary Water Cooperation – Global baseline for SDG indicator 6.5.2 By UNECE and UNESCO on behalf of UN-Water	Most of the world's water resources are shared between countries; where the development and management of water resources has an impact across transboundary basins, cooperation is required. Specific agreements or other arrangements between co-riparian countries are a precondition to ensuring sustainable cooperation. SDG indicator 6.5.2 measures cooperation on both transboundary river and lake basins, and transboundary aquifers. Learn more about the baseline situation for SDG indicator 6.5.2 here: http://www.unwater.org/publications/progress-on-transboundary-water-cooperation-652.
Progress on Water-related Ecosystems – Piloting the monitoring methodology and initial findings for SDG indicator 6.6.1 By UN Environment on behalf of UN-Water	Ecosystems replenish and purify water resources and need to be protected to safeguard human and environmental resilience. Ecosystem monitoring, including that of ecosystem health, highlights the need to protect and conserve ecosystems and enables policy- and decision makers to set de facto management objectives. Learn more about ecosystem monitoring and initial status findings here: http://www.unwater.org/publications/progress-on-water-related-ecosystems-661.
UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS) 2017 report – Financing universal water, sanitation and hygiene under the Sustainable Development Goals (including data on SDG indicators 6.a.1 and 6.b.1) By WHO on behalf of UN-Water	Human and financial resources are needed to implement SDG 6, and international cooperation is essential to making it happen. Defining the procedures for local communities to participate in water and sanitation planning, policy, law and management is vital to ensuring that the needs of everyone in the community are met, and to ensuring the long-term sustainability of water and sanitation solutions. Learn more about the monitoring of international cooperation and stakeholder participation here: http://www.unwater.org/publication_categories/glaas/.
SDG 6 Synthesis Report 2018 on Water and Sanitation By UN-Water	This first synthesis report on SDG 6 seeks to inform discussions among Member States during the High-level Political Forum on Sustainable Development in July 2018. It is an in-depth review and includes data on the global baseline status of SDG 6, the current situation and trends at the global and regional levels, and what more needs to be done to achieve this goal by 2030. Read the report here: http://www.unwater.org/publication_categories/sdg-6-synthesis-report-2018-on-water-and-sanitation/.

UN-WATER REPORTS

UN WATER

UN-Water coordinates the efforts of United Nations entities and international organizations working on water and sanitation issues. By doing so, UN-Water seeks to increase the effectiveness of the support provided to Member States in their efforts towards achieving international agreements on water and sanitation. UN-Water publications draw on the experience and expertise of UN-Water's Members and Partners.

PERIODIC REPORTS

Sustainable Development Goal 6 Synthesis Report 2018 on Water and Sanitation

The SDG 6 Synthesis Report 2018 on Water and Sanitation was published in June 2018 ahead of the High-level Political Forum on Sustainable Development, where Member States reviewed SDG 6 in depth. Representing a joint position from the United Nations family, the report offers guidance to understanding global progress on SDG 6 and its interdependencies with other goals and targets. It also provides insight into how countries can plan and act to ensure that no one is left behind when implementing the 2030 Agenda for Sustainable Development.

Sustainable Development Goal 6 Indicator Reports

This series of reports shows the progress towards targets set out in SDG 6 using the SDG global indicators. The reports are based on country data, compiled and verified by the United Nations organizations serving as custodians of each indicator. The reports show progress on drinking water, sanitation and hygiene (WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene for targets 6.1 and 6.2), wastewater treatment and ambient water quality (UN Environment, UN-Habitat and WHO for target 6.3), water-use efficiency and level of water stress (FAO for target 6.4), integrated water resources management and transboundary water cooperation (UN Environment, UNECE and UNESCO for target 6.5), ecosystems (UN Environment for target 6.6) and means for implementing SDG 6 (UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water for targets 6.a and 6.b).

World Water Development Report

This annual report, published by UNESCO on behalf of UN-Water, represents the coherent and integrated response of the United Nations system to freshwater-related issues and emerging challenges. The theme of the report is harmonized with the theme of World Water Day (22 March) and changes annually.

Policy and Analytical Briefs

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

UN-WATER PLANNED PUBLICATIONS 2018

- Update of UN-Water Policy Brief on Water and Climate Change
- UN-Water Policy Brief on the Water Conventions
- UN-Water Analytical Brief on Water Efficiency

More information on UN-Water Reports at www.unwater.org/publications

Ecosystems replenish and purify water resources and need to be protected to safeguard human and environmental resilience. Ecosystem monitoring, including that of ecosystem health, highlights the need to protect and conserve ecosystems and enables policy- and decision makers to set de facto management objectives. In this report, you can learn more about water-related ecosystem monitoring and initial status findings.

This report is part of a series that track progress towards the various targets set out in SDG 6 using the SDG global indicators. To learn more about water and sanitation in the 2030 Agenda for Sustainable Development, and the Integrated Monitoring Initiative for SDG 6, visit our website: www.sdg6monitoring.org

UN WATER

UN environment

United Nations
Environment Programme