Master Thesis

Analysis of data collection and data evaluation for compliance with SDG 6

Figure 1 SDG 6 icon (UN-Water 2018d, p. 1)

Laura Huber

Student ID 2309000

M. Sc. Environmental Engineering

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Technical University Darmstadt

Department of Civil and Environmental Engineering

Institute IWAR Department Water Supply and Groundwater Protection

Supervised by Prof. Dipl.-Ing. Dr. nat. techn. Wilhelm Urban

Prof. Dr.-Ing. Hussain Al-Towaie

In cooperation with Bettina Rickert, German Environment Agency (UBA)

Executive Summary

In 2016 the Sustainable Development Goals replaced the former Millennium Development Goals, building the new global agenda aiming for sustainable development at all three dimensions of sustainability by 2030. Within the set of global goals SDG 6 is devoted to development in the water and sanitation sector, including not only an improvement of access to drinking water and sanitation but also several other aspects, addressing the entire water cycle in a more comprehensive way as conducted by the MDGs. In order to monitor the development's progress and thereby identify problems in implementation but also well-functioning approaches, new methodologies for monitoring the new SDG 6 indicators had to be developed. Currently, baseline reports on all indicators have been published, on the basis of which a first assessment of the current data availability can be made. The aim of this thesis is to provide an overview of the existing structures and methods for monitoring SDG 6 and to identify current challenges in monitoring as well as possible solutions. In addition, a comparison between the data collected for reporting to the Protocol on Water and Health and the data required for monitoring SDG 6 is conducted in order to find out whether common data use is sensible and already taking place.

The analysis of the existing monitoring activities shows that the greatest challenges causing data gaps are associated with the novelty of most indicators as well as their complexity. There are no conceptual problems concerning the indicators' methodologies but rather challenging conditions that complicate data collection. A key element in increasing data availability within the next years is national capacity-building since national data builds the basis for monitoring the global indicators. In addition, the extent of data sources can be expanded for example by aligning national and regional initiatives with the global goals, enabling common monitoring efforts and thereby reducing the countries' reporting burden. In this context, the Protocol on Water and Health can potentially increase data availability in the pan-European region. The comparison of the SDG 6 indicators and the current reporting template of the Protocol indicates that there are already aspects that require very similar data. However, slight modifications could enhance these overlaps and facilitate the common use of national monitoring capacity and collected data. The comparison of current country reports and the latest JMP progress reports suggests that several Parties of the Protocol do not fully exploit this potential.

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List of abbreviations

ARC	Annual rate of change
BMU	Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit
BOD	Biochemical oxygen demand
CDIAC	Carbon Dioxide Information Analysis Center
COD	Chemical oxygen demand
CRING	Country Reporting on Indicators and Goals
Destatis	Statistisches Bundesamt
DHS	Demographic Health Survey
DSS	Decision Support System
E.coli	*Escherichia Coli*
ECA	United Nations Economic Commission for Africa
ECLAC	Economic Commission for Latin America
ERF	Environmental flow requirements
ESCAP	Economic and Social Commission for Asia and the Pacific
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GEMI	Global Expanded Monitoring Initiative
GEMS/Water program	Global Environmental Monitoring System for Water
GEO	Group on Earth observations Secretariat
GGIM	United Nations Initiative on Global Geospatial Information Management
GLAAS	UN-Water Global Analysis and Assessment of Sanitation and Drinking-water
GRanD	Global Reservoir and Dam geospatial database
GRI	Global Reporting Initiative
HCF	Health-care facilities
HDI	Human Development Index
HydroSheds	Hydrological data and maps based on SHuttle Elevation Derivatives at multiple Scales
IAEG-SDGs	Inter-Agency and Expert Group on Sustainable Development Goal Indicators
IDWSS	International Drinking Water and Sanitation Decade
ILO	International Labor Organization
IMF	International Monetary Fund
IPU	Inter-Parliamentary Union
ISIC	International Standard Industrial Classification
ITC	International Trade Centre
ITU	International Telecommunication Union
IUNC	International Union for Conversation of Nature
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
LSMS	Living Standards Measurement Study
MDG	Millennium Development Goals
MICS	Multiple Indicator Cluster Surveys
MIMEC	Mining, quarrying, manufacturing, electricity, gas, steam and air conditioning supply, constructions
NASA	National Aeronautics and Space Administration
ODA	Official Development Assistance
OECD	Organization for Economic Co-operation and Development

OECD-CRS	Organization for Economic Co-operation and Development - Common Reporting Standards
OECD-DAC	Organization for Economic Co-operation and Development - Development Assistance Committee
OSU	Oregon State University
PPP	Purchasing Power Parity
RBO	International River Basin Organization
SAR	Synthetic Aperture Radar
SDG	Sustainable Development Goals
TrackFin	Tracking financing to sanitation, hygiene and drinking-water
TRWR	Total renewable freshwater resources
TSS	Total Suspended Solids
TWAP	UNEP-GEF Transboundary Waters Assessment Program
TWW	Total freshwater withdrawal
UN	United Nations
UNAIDS	Joint United Nations Program on HIV and AIDS
UNCTAD	United Nations Conference on Trade and Development
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Program
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Program
UNEP-WCMC	United Nations Environment Program - World Conservation Monitoring Centre
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCWA	United Nations Economic and Social Commission for Western Asia
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Fund for Population Activities (today United Nations Population Fund)
UN-GEF	United Nations- Global Environment Facility
UNHCR	United Nations High Commissioner for Refugees
UN-HLPF	United Nations High-level Political Forum on Sustainable Development
UNICEF	United Nations International Children's Emergency Fund (today United Nation Children’s Fund)
UNPD	United Nations Procurement Division
UNSD	United Nations Statistics Division
UWWTD	Urban Waste Water Treatment Directive
VNR	Voluntary National Report
WASAMS	Water and Sanitation Monitoring System
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization
WHO/UNICEF-JMP	WHO/UNICEF-Joint Monitoring Program for Water Supply and Sanitation
WTO	World Trade Organization
WUE	Water Use Efficiency

1. Introduction

1.1 Motivation and goals

In 2015, the proportion of the world population suffering from water scarcity exceeded 40%, an estimated 663 million people used unimproved drinking water resources, 2.4 billion people used unimproved sanitation services, and 946 million people practiced open defecation. This picture emerged after 15 years of implementing the UN Millennium Development Goals (MDGs). The global goals were motivated by the ongoing goal to combat poverty and hunger and the achievement of further development goals like those connected to drinking water and sanitation. These statements demonstrate that global problems were still present at the end of the MDG era in 2015 and that the definition of further global goals was necessary. (UN 2016, p. 6)

The UN Sustainable Development Goals (SDGs) took on this task, and are to be implemented between 2015 and 2030. These new development goals relate to all three areas of sustainability social, ecological and economical and take into account their interconnectedness and interdependence. In addition to the sustainable reduction of poverty and hunger, the 17 goals include development of education, reduction of diseases and inequality. Sustainable economic growth and production and the reduction of unemployment are addressed. In contrast to the SDG's predecessors, ecological issues are now also being given greater focus. Complementary to the issues of drinking water supply, sanitation and water stress, the SDGs imply goals for wastewater treatment, status of surface water and groundwater, IWRM and water ecosystems, which in combination represent the scope of SDG 6. (WHO and UNICEF 2019e, p. 10)

Current progress reports show that the implementation of the individual SDGs is proceeding at different rates. A more detailed analysis of this subject is given in regular progress reports that serve as an UN tool for publishing an assessment of the development's current state and speed, as well as achievements, challenges and problems during the implementation. They are prepared on the basis of data generated within the framework of monitoring. This monitoring framework enables measuring progress through defined indicators and is a prerequisite for achieving the SDGs. On the basis of the monitoring results, policy and decisionmakers can initiate interventions in the form of laws or investments. In addition, further positive effects on the implementation progress of the targets such as raising awareness and encouraging ownership are initiated. It is clear that the necessary interventions can only be tackled if existing deficits are identified within monitoring. Adhering to the SDG's motto of *leaving no one behind* requires monitoring development progress in all parts of society. (UN Water 2017b, p. 7)

The latest SDG progress report however clarifies that big challenges are still ahead. In 2017, 785 million people had no access to basic drinking water services, two out of five people had no opportunity to wash their hands with water at home and 673 million people and thus 9% of the world population practiced open defecation. 2 billion people were affected by a high level of water stress, and in 2030 about 700 million people will be displaced due to intensive water shortage. (UN 2019, p. 9)

The progress report also reveals that there are indicators that only a fraction of countries is currently able to monitor. The appearance of data gaps can be a sign of lacking national monitoring capacity or awareness of the monitoring's importance. The consequences of data gaps, however, can be severe. They can lead to the neglect of parts of the society, mostly the poorest portion, and thereby impede the attempt of reducing inequality and reaching positive development for all. In general, data with inadequate quality or quantity as well as a lack of monitoring capacity can lead to a less efficient or, in the worst case, to a halt in development. (IAEG 2014, p. 4)

The global monitoring process for SDG 6 indicators is undertaken by a number of international agencies, coordinated by the UN-Water-led Integrated Monitoring Initiative. In the course of this thesis, the significance of global monitoring, its process of implementation, the extent to which it presents challenges and problems, and the description of possible solutions will be discussed. The goal is to understand how the monitoring of SDG 6 is conducted in detail and what types of problems and challenges are currently connected to it.

In a second part, the connection between SDG 6 and the Protocol on Water and Health are analyzed. It is a regional instrument which seeks to achieve several targets that overlap with SDG 6 targets. To explore their similarities and especially the opportunity of joint monitoring activities, the current Protocol's reporting cycle's data is analyzed in cooperation with the German Environment Agency (UBA) and then compared to the latest JMP progress report. The aim is to examine whether it is possible that two monitoring systems use the same data and thereby avoid double collection and additional expenditure by national institutions and whether the comparison of national and progress reports indicate that they already do so.

1.2 Structure

This thesis is divided into seven thematic sections. The introduction builds the first chapter. In the second chapter, the development of the Millennium Development Goals is presented, since the SDGs were formed on their basis. The objective of this chapter is to understand the zeitgeist, in which the global goals came into being and what their initial approach was. In addition to their emergence, their content and some of the results of their implementation are briefly discussed.

In the second chapter the transition to the SDGs is then described, and the new global challenges and opportunities that shaped the situation during the period of its definition, are presented. The differences between the MDGs and the SDGs and the extent of the SDGs' complexity are highlighted. The content of the SDGs and a detailed description of SDG 6 conclude the second chapter.

The third chapter is dedicated to monitoring, the core of this thesis. The definition of the term, its purpose and benefits are explained in order to emphasize the monitoring's task and importance in reaching the SDGs. Then the global monitoring at the time of the MDGs is outlined and lessons learned are summarized. The following section describes how the national and global monitoring processes of the SDGs differ from each other and how the monitoring of SDG 6 is conducted in Germany. Since the monitoring of each country is implemented individually at the national level, the focus of this work is global monitoring, which is described in more detail in the following section. The initiatives involved and their methodologies for the individual indicators are explained.

In chapter 4, the content of discussions with monitoring SDG 6 experts are reproduced. The chapter also includes a methodological explanation of the conducted interviews.

Chapter 5 addresses the discussion of problems and challenges in monitoring of SDG 6. After highlighting each indicator's specific data availability, challenging aspects and their possible solutions, a general discussion concludes the chapter. The aim is to provide a comprehensive description of current challenges and problems and their significance in the overarching achievement process of SDG 6.

In addition to the study of challenges in monitoring SDG 6 the Protocol on Water and Health is part of this thesis and addressed in chapter 6. The purpose of this chapter is to find our whether the data used for monitoring the Protocol's targets can be used for SDG 6 monitoring. For this cause the Protocol itself and its connection to SDG 6 are discussed. The data, required for answering the Protocol's reporting template is compared to the data used in SDG 6 monitoring. In this context, the evaluation of country-specific data in cooperation with the German Environment Agency in Berlin is conducted and presented with a focus on data availability. To verify whether the assumed resemblance of required data and also determine whether the monitoring systems already use the same data, the latest data provided by the Parties of the Protocol and the JMP are compared. Since the template has already been modified to be better aligned with the SDG 6 indicators, this comparison also enables an assessment of whether these efforts were successful or could be enhanced by additional modifications.

The last chapter of the thesis comprises a conclusion of the overall attained realizations, provides answers to the questions posed at the outset and an outlook.

2. Basics on MDGs and SDGs

This chapter aims to provide an overview of the history of the Sustainable Development Goals (SDGs) and a detailed understanding of their importance and significance in the global community. To this end, the chapter starts by displaying the historical development of the Millennium Development Goals (MDGs), the direct precursors of the SDGs. The content of the MDGs is described, followed by the results of the water and sanitation-related MDGs. In the following, the transition from MDGs to SDGs including the new challenges and circumstances at the time of initiating the SDGs is outlined. The content of the SDGs and detailed presentation of SDG 6 conclude this chapter.

2.1 Millennium Development Goals

2.1.1 History of the Millennium Development Goals

In 2015 ten percent of the world population, in total 736 million people, lived in extreme poverty which means that they lived on less than $1.90 a day (UN 2019, p. 4). In 2017 821 million people suffered from hunger (UN 2019, p. 5). Both values show the extreme relevance of the two globally occurring problems that contribute to increased mortality rates and reinforce each other. While economic poverty can be the cause of undernourishment or malnutrition, it is precisely this malnutrition, combined with illness and reduced productivity that result in poverty. In the 2019 SDG Report the UN states that less than 10% of disaster-induced deaths are situated in high-income countries and that only 45% of the world population have access to social protection (UN 2019, p. 4, 2019, p. 23).

In the late 1980s people recognized that the human rights, universally approved by the UN as early as 1948, were violated by the persistent occurrence of extreme poverty and hunger. To draw attention to these shortcomings over 1,000 people gathered in 1987 at the Trocadero in Paris, where the Universal Declaration of Human Rights had been signed. Five years later, the General Assembly set the anniversary of this event as the International Day for Eradication of Poverty and a resolution was adopted, describing the fight against poverty and hunger as the main tasks of the UN (UN General Assembly 1992, p. 1). Both the MDGs and the SDGs are based on this basic objective. In order to understand their origins and development, it is necessary to look at the fundamental views on the relationship between the economy, poverty and development theories which have changed and evolved several times over the last century. Until the early 1970s, the models of Kuznets and Solow were considered common views concerning these subjects (Alfredo Saad-Filho 2010, p. 1). Kuznets model poses the thesis that in case development induces growing inequality, this can trigger political instability which in the end forces democratization on political elites and thereby institutional changes which lead to redistribution and a reduction of inequality (Alfredo Saad-Filho 2010, p. 1). Solow's growth model comprises the assumption that poor countries grow faster and eventually converge with the development status of developed countries (Alfredo Saad-Filho 2010, p. 1). Throughout the 1970s, however, it became clear that the gap between rich and poor was widening further and that poverty was by no means declining in the way the models had forecasted. This development also contradicted the assumptions of a decrease in poverty through the "trickle down" effect which assumes that an increase in growth ultimately also benefits the standard of living of the poorest sections of the population (Loewe 2005, p.2).

In 1980, the Washington Consensus was considered as a structural solution for development problems in poor countries (Alfredo Saad-Filho 2010, pp. 3–4). The WC was an economic program of the International Monetary Fund and the World Bank which at its core involves the implementation of a neo-liberal ideology and thus measures such as market opening, deregulation and privatization as well as consolidation of current account and budget balance in developing countries (Alfredo Saad-Filho 2010, p. 7). The state's influence on the economy, and thus on development was dismissed as inefficient and corrupt (Alfredo Saad-Filho 2010, p. 1). It was not until the 1990s that the conviction became firmly established that economic growth could not be the sole driving force behind poverty reduction (Loewe 2005, p.2). Indicators such as education and health were not improved by efforts to promote economic growth (Loewe 2005, p.2). For the first time, the fact that poverty was viewed only from an economic perspective was publicly criticized. In this context, Amartya Sen's capability approach played a decisive role. Sen expanded the definition of poverty from a lack of economic resources to a lack of opportunities (Todaro and Smith 2011, p.16). According to Sen's definition, a distinction between political, socio-cultural, protective, human and economic capabilities clarifies all facets of poverty, since it explicitly describes all aspects that a human being needs to function (Todaro and Smith 2011, p.16).

At this time, the Human Development Index, an approach to quantify the different dimensions of human development such as GDP, education and health indicators, was established by the UN (Loewe 2005, p.3). Since the 1990s the Human Development Reports summarize the status quo of the Human Development Index (Loewe 2005, p.3). It is noticeable that throughout the 1990s several UN conferences were held due to poor progress in social and economic development as shown in Table 1 (Loewe 2005, p.3). At that time, the awareness that interdependent socio-economic and ecological problems required international solutions was growing (Loewe 2005, p.3).

Table 1 UN Conferences 1990-2000 (own representation based on Loewe 2005, p.4)

1990	*World Summit on Education for All*	*1994*	*Conference on Small Island Developing States*
1990	*World Summit for Children*	*1995*	*World Summit for Social Development*
1992	*UN Conference on Environment and Development / "Earth Summit"*	*1995*	*4th World Conference on Women*
1993	*2nd World Conference on Human Rights*	*1996*	*2nd UN Conference on Human Settlements/ "Habitat"*
1994	*World Conference on Natural Disaster Reduction*	*1996*	*World Food Summit*
1994	*3rd International Conference on Population and Development*	*2000*	*UN Millennium Summit*

In 1996, the OECD adopted a resolution, setting out the results of the conferences held in the 1990s in the form of common international development goals (Loewe 2005, p.5). These were also largely taken up at the Millennium Summit in 2000 and manifested in the Millennium Declaration (Loewe 2005, p.10). The Millennium Summit was in many ways of special nature. Extraordinary was for example the large number of Heads of State present which underpins the summit's importance (Loewe 2005, p.3). In addition, the resolution of the Millennium Declaration not only established a new common value system, but also concrete targets. The topics reflected in those targets were social development aspects such as human rights, protection of vulnerable groups and poverty reduction, but also governmental development concerning democracy, peace and disarmament. In

addition the MDGs addressed environmental protection, special needs of Africa and strengthening the UN (UN General Assembly 2000, pp. 2–9). The declaration emphasized that besides each country's separate responsibility to their individual societies the UN members had a shared responsibility to globally maintain their core values, especially for protecting the vulnerable and children (UN General Assembly 2000, p. 2). Unlike before, development was no longer understood as pure economic growth. Development was defined in terms of fighting poverty in all its dimensions as mentioned by Sen. In addition, the MDGs represented indicators that were used to measure the success of development and laid down a timeline, terminating in 2015.

In conclusion, starting with a reformulation of the definition of poverty and development between 1970 and 2000, the UN analyzed the globally existing challenges of human development, recognized that only joint efforts could lead to their solution and summarized these findings in concrete and verifiable global goals, called the Millennium Development Goals.

2.1.2 Content of the Millennium Development Goals

The Millenniums Declaration's chapters three and four were the basis for the MDGs which were confirmed again and expanded in 2002 (Loewe 2005, p.10). They include eight goals (as shown in Figure 2), 21 targets and 60 indicators (UNSD 2008, pp. 1–2).

Figure 2 Millennium Development Goals (UN 2015b, p. 1)

Goal 1 includes the three targets *Halving the proportion of people whose income is less than 1$ a day* and *Halving the proportion of people who suffer from hunger*, both between 1990 and 2015, and *Achievement of full and productive employment and decent work for all, including women and young people* (UN General Assembly 2001, p. 56). The indicators serve as measurable success parameters and include, for example, the *Proportion of the population living on less than 1$ a day*, the *Share of the poorest quintile in national consumption* and the *Prevalence of underweight children* (UN General Assembly 2001, p. 56). The rest of the MDG indicators can be found in the Appendix (Appendix A). The mentioned indicators were used to quantify the progress in achieving the respective targets, hence goals. The process of analyzing and assessing progress was conducted as part of the monitoring task further described in chapter 3.2.

2.1.3 Results of Millennium Development Goal 7

The final monitoring report on the MDGs includes, in addition to comments on monitoring, the latest reported status of target achievement in 2015. In the following, the achievements in Goal 7 are presented, since its targets are related to the subjects of SDG 6 and therefore in a way represent the baseline for SDG 6 implementation and monitoring.

Target 7.A: ***Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources*** **(UN 2015c, p. 52)**

Target 7.A has not been reached (UN 2015c, p. 52). Forest deforestation was successfully reduced by 3.1 million hectares/year between 2000 and 2010 compared to the base value of 1990. Nevertheless, the remaining value of 5.2 million hectares/year was still high (UN 2015c, p. 52). In addition, greenhouse gas emissions increased from 21.6 billion of metric tons in 1990 to 33 billion of metric tons in 2012 (UN 2015c, p. 53). Increasing overfishing caused the marine fish stock to fall to a level that put a sustainable yield at risk (UN 2015c, p. 54). In Europe, North America and Oceania, however, overfished stocks were restored. In 2011, it was also noted that over 40% of the world population were exposed to water scarcity and that a rising trend was observed (UN 2015c, p. 54). A positive development was the reduction of ozone-depleting substance consumption between 1986 and 2013 (UN 2015c, p. 54). By only allowing the use of 2% of ozone-depleting substances compared to 1990, the worldwide consumption of these substances was no longer around 200 thousand of metric tons but less than 50 thousand of metric tons in 2013. It was assumed that the ozone layer would recover by the middle of the century (UN 2015c, p. 54). Between 1998 and 2011 the number of countries experiencing water stress increased from 36 to 41 (UN 2015c, p. 55).

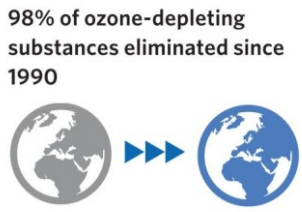


Figure 3 MDG achievements (UN 2015c, p. 7)

Target 7.B: ***Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss*** **(UN 2015c, p. 56)**

Target 7.B has not been reached (UN 2015c, p. 56). Although there was an increase in the proportion of protected terrestrial and marine areas, the proportion of species at increased risk of extinction counterbalanced the proportion of species at improved status (UN 2015c, p. 56).

Target 7.C: ***Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation*** **(UN 2015c, p. 58)**

Target 7.C has partially been reached (UN 2015c, p. 58). The proportion of the population without access to sustainable, safe drinking water was halved between 2000 and 2010 and continued to decline since then (UN 2015c, p. 58). By 2015, 58% of the world population had access to sustainable safe drinking water resources and the *proportion of people using surface water* was more than halved compared to 1990 (UN 2015c, p. 58). However, the target of halving the proportion of the population without access to basic sanitation was missed (UN 2015c, p. 58).

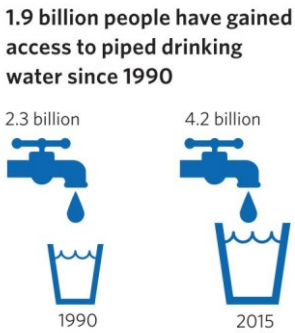


Figure 4 MDG achievements (UN 2015b, S. 7)

Between 2000 and 2015, this share fell from 46% to 32%, a reduction of just under 30% (UN 2015c, p. 58). In the developing regions of Sub-Sahara Africa, Oceania, Southern Asia, South-eastern Asia, Latin America and the Caribbean, the target has been missed (UN 2015c, p. 59). There were strong differences between access to drinking water and sanitation in urban and rural areas, albeit reduced compared to 1990 (UN 2015c, p. 59). In urban areas, 96% of the population had access to improved drinking water resources by 2015 and 82% had access to improved sanitation (UN 2015c, p. 59). In rural areas, on the other hand, only 84% had access to improved drinking water resources and 51% to improved sanitation (UN 2015c, p. 59).

Target 7.D: By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers (UN 2015c, p. 60)

Target 7.D has been reached and even exceeded. Between 2000 and 2014, the living conditions of over 320 million people living in slums improved. Although the proportion of people living in urban slums had decreased, their absolute number had increased. Possible reasons are population growth and urbanization. (UN 2015c, p. 60)

Taking into account the outcomes of all MDG targets, it can be said that enormous changes, positive progress and trends have been initiated and achieved in the MDG validity period. Nevertheless, a large number of targets have not or have only partially been reached. When considering the regional results, no target has been reached by all regions. Particularly striking were the different degrees of target achievement when comparing regions, urban and rural areas and country with different demographic patterns (World Bank and IMF 2016, p. 94). Examples include the differences in the achievement in halving the proportion of people using unimproved drinking water resources across developing regions, the different degrees of achievement in halving poverty rates within different countries in Sub-Sahara Africa, the different degrees of achievement in lowering under-five-old mortality rates in rural and urban areas and the fact that 92% of countries that have not achieved the poverty target were characterized by high fertility rates and strong population growth (World Bank and IMF 2016, p. 94). Ultimately, improved living conditions had reached millions of people through the formation of a joint coalition with common goals and the pooling of financial and institutional resources with the help of the MDG framework (World Bank and IMF 2016, p. 87).

2.2 Sustainable Development Goals

2.2.1 Transitioning from MDGs to SDGs

By 2015, when the MDG-era ended and the SDG-era was to replace it, not only had the prior knowledge of those involved changed, but the global situation also offered new challenges and opportunities. The international connectedness had strongly increased and a multitude of new technologies had emerged and spread much faster than in the year 2000. The increasing effects of climate change and environmental destruction, urbanization, migration, increased inequalities and demographic changes shaped the starting situation of the 2030 Agenda. (World Bank and IMF 2016, p. 88)

New developments in science and technology enabled increased and more cost-effectively access to services and infrastructure. The key was the use of mobile phones and other technologies that improved and quickened money transfer, information sharing and feedback. Low-income countries

had become part of global supply chains due to advanced globalization, which made it possible to increase productivity in these countries, but also offered an opportunity to implement sustainable production schemes. Sustainable solutions were being researched in agriculture and energy production at the time. (UNDP 2016, p. 64)

The ecological situation in 2015 was far less positive, since it was characterized by an increase in natural disasters, environmental degradation and pollution of ecosystems such as forests, water resources and wetlands along with severe consequences for the population (UNDP 2016, pp. 61–62). By contrast, migration, which was already on the rise in 2015, offered an opportunity for sustainable development, as migrants could have shared their newly acquired education and salaries with those left behind and thus contribute to poverty reduction (UNDP 2016, p. 62). The demographic structures that prevailed in 2015 were characterized by the fact that societies in high-income countries were increasingly ageing, while in low-income countries, which high fertility rates, they were predominantly young. In 2015 85% of young people worldwide lived in developing countries (UNDP 2016, p. 62). The SDGs offered the opportunity to build structures that enabled young people to be part of sustainable development (UNDP 2016, p. 62). However, the rapid growth of urban areas, which made investments in water and wastewater projects indispensable, as well as the necessary expansion of low-carbon energy and infrastructure, was contrasted by a decelerating economy (UNDP 2016, p. 64). The great task, the global community was facing in 2015, was to recognize the potential synergy effects of the existing circumstances and simultaneously strive for and promote economic growth and sustainable development (UNDP 2016, p. 4). The vehicle for promoting these ideas and accelerating global development in all its dimensions was the definition of new global goals, called the Sustainable Development Goals.

2.2.2 Content of the Sustainable Development Goals

As with the adoption of the MDGs, several UN conferences were held prior to the adoption of the SDGs to shape and prepare their content. The most important of these were the World Summit on Sustainable Development in South Africa in 2002 and the UN Conference on Sustainable Development Rio20+ in Rio de Janeiro in 2012. The Johannesburg Declaration reaffirmed the UN member's commitment to the Agenda 21 and the Millennium Declaration, hence to both poverty reduction and sustainable development in close multilateral cooperation. In 2012, the resolution *The Future We Want* was published as a result of the conference which, in addition to the implementation of the UN High-level Political Forum on Sustainable Development, set out the decision to develop new global goals (UN General Assembly 2012, p. 1). The General Assembly convened an Open Working Group in 2013 to deal with the development of the SDGs (UN General Assembly 2012, p. 47). Negotiations took place between January and September 2015, culminating in the adoption of the 17 SDGs at the UN Sustainable Development Summit in New York in the form of a new agenda called *Transforming our World: The 2030 Agenda for Sustainable Development* (UNDP 2016, p. 2).

In a sense, it was not until 2015, 33 years after the UN Conference on the Human Environment in Stockholm and 23 years after the Earth Summit in Rio, which also dealt with human and environmental development and their obvious dependence, that a combination of the two agendas took place. The reason for this is the experience gained during the MDG-era which on the one hand revealed the entanglement of both agendas in the implementation process, but also the increasing

effects of climate change and environmental destruction which led the member-states to recognize that only a joint consideration of human and environmental development can potentially result in sustainable development (UNDP 2016, p. 3).

The SDG's targets should be achieved by 2030 and emphasize the involvement of all people in their implementation, including participation and benefit from development progress. The motto *leaving no-one behind* illustrates this fundamental idea of the SDGs. (UNDP 2016, p. 4) The following 17 goals were adopted, containing 169 targets and 232 indicators (UN 2015d, pp. 22–23). The goals are illustrated in Table 2, while the targets and indicators can be viewed online at the UN's implemented SDG Homepage. The link can be found in the Appendix B.

Table 2 Sustainable Development Goals – 17 Goals based on (UN 2015e, p. 18)

Goal 1	*End poverty in all its forms everywhere*
Goal 2	*End hunger, achieve food security and improved nutrition and promote sustainable agriculture*
Goal 3	*Ensure healthy lives and promote well-being for all at all ages*
Goal 4	*Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*
Goal 5	*Achieve gender equality and empower all women and girls*
Goal 6	*Ensure availability and sustainable management of water and sanitation for all*
Goal 7	*Ensure access to affordable, reliable, sustainable and modern energy for all*
Goal 8	*Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all*
Goal 9	*Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*
Goal 10	*Reduce inequality within and among countries*
Goal 11	*Make cities and human settlements inclusive, safe, resilient and sustainable*
Goal 12	*Ensure sustainable consumption and production patterns*
Goal 13	*Take urgent action to combat climate change and its impacts*
Goal 14	*Conserve and sustainably use the oceans, seas and marine resources for sustainable development*
Goal 15	*Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss*
Goal 16	*Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels*
Goal 17	*Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development*

As with the creation of the MDGs, icons were chosen for the SDGs, which are displayed as well as a color wheel in Figure 5. The SDGs are based on the MDGs and take up all MDG targets in a modified form, since one of the basic ideas when creating the SDGs was to achieve unfinished MDG goals. However, since the evaluation of the MDG results showed that a *business as usual approach* would not achieve the desired outcome, an ambitious and much bigger set of goals and indicators was formulated that go beyond those of the MDGs. The fact that the SDGs are addressed to all Member

States is an important key element and at the same time a major difference from the MDGs. The overall goal is that all countries benefit from a joint problem solution under consideration of the environment and common goods. Not only the development of developing countries is to be achieved, but the economies and societies of all Member States are to be changed for the better by achieving the SDGs. The developed countries should focus more on combating environmental degradation, biodiversity loss and climate change, e.g. by promoting renewable energies, while in low-income countries access to new technologies and financing models must be improved in order to accelerate human development. (UNDP 2016, p. 66)

Figure 5 SDG Icons and color wheel (UNECE and WHO Regional Office for Europe 2016, p. 2)

Explicit reference is made to how the follow-up and reviews of the SDGs are to be carried out. The UNDP accomplishes the task of supporting countries in integrating SDGs into national strategies and laws (UNDP 2016, p. 46). The High-level Political Forum on Sustainable Development (HLPF) is the patron of the follow-up and review processes (UNECE and WHO Regional Office for Europe 2019). UNDESA's Division for Sustainable Development Goals is responsible for assessing the implementation of Agenda 2030 and advocacy activities to increase the countries' commitment to and ownership of the SDGs (UN General Assembly 2016, p. 3, 2008, p. 5).

With regard to monitoring, the relevance of regular national reports is emphasized (UN General Assembly 2016, p. 2). They serve to show the status of current progress and can provide information on necessary interventions in the form of laws and investments (UN General Assembly 2015, p. 31). Their accessibility should provide the public and decision-makers with the insight of lessons learned (UNECE and WHO Regional Office for Europe 2019, p. 8). In addition, the voluntary national reviews (VNR), including data that go beyond the SDG indicators' scope, serve as a basis for the reports of the HLPF (UNECE and WHO Regional Office for Europe 2019, p. 8). Public feedback and hearings are also part of the follow-up process and should serve to build trust between citizens and state institutions (UNDP 2016, p. 73). The concrete tasks and responsibilities in monitoring SDG 6 are discussed in detail in chapter 3.4.

The implementation of the SDGs requires not only the initiative of governments and civilians but also the involvement of the private sector (UN General Assembly 2015, p. 10). For this cause, the Global Reporting Initiative (GRI), in cooperation with the UN Global Compact and the World Business Council for Sustainable Development, has published the so-called SDG Compass to facilitate the implementation of SDGs at the corporate level (GRI, UN Global Compact, wbcsd, p. 5). The SDG Compass explains five steps to help companies align their strategies with SDGs to achieve the greatest possible success in achieving them (GRI, UN Global Compact, wbcsd, p. 5).

Differences between SDGs and MDGs

Each country is encouraged to identify and address its national problem areas, in addition to finding common solutions to global problems. Against this background, it only makes sense for each country to formulate its own national targets in order to reflect their specific problems and priorities (UNDP 2016, p. 4). Such national targets have the potential to become part of political agendas or national movements and are thus brought closer to citizens (UNDP 2016, pp. 6–7). The advantage of this approach is that citizens are enabled to relate to the objectives, to initiate rethinking in society and to facilitate legislative changes in favor of achieving sustainable development and thereby emphasize local ownership (UNDP 2016, p. 53).

Another point in which the SDGs differ from the MDGs is their creation. While the MDGs were formulated as part of the Millennium Declaration by UN experts, the process of SDG preparation was much more complex, involving the views and participation of a variety of people (World Bank and IMF 2016, p. 100). The goals were founded in cooperation with stakeholders who reflected the views of 193 governments, 7 million people who participated in a UN online survey, the UN High Level Panel of Eminent Persons, the Open Working Group of the UN General Assembly on SDGs and the Intergovernmental Committee of Experts on Sustainable Development Financing (World Bank and IMF 2016, p. 100).

The number of SDGs indicates that the scope of the SDGs also greatly differs from that of the MDGs. Clear objectives are set for the three overarching themes of economy, ecology and social affairs, as well as governance and implementation objectives. Their interdependencies and synergy effects are highly emphasized, so that the agenda as a whole has a more integrated character than the MDGs had (UNDP 2016, p. 60).

Overall, the SDGs represent an advancement of the MDGs, including a larger number of concrete topics and their dependencies, and aims to achieve an all-encompassing and above all sustainable development. Concerning environmental topics, the SDGs directly address significantly more aspects than the MDGs, including broader scope of water and sanitation (SDG 6) in terms of environmental aspects, climate action (SDG 13), marine life (SDG 14) and terrestrial life (SDG 15) and a variety of other aspects as parts of other goals such as target 11.5 on environmental disasters and 11.6 on air pollution and waste management. Over 40 targets and over 50 indicators are somehow connected to environmental aspects. In comparison, the MDGs devoted only four targets and ten indicators to environmental matters.

2.2.3 Detailed description of Sustainable Development Goal 6

In the context of this thesis SDG 6 will be discussed in more detail. It consists of 8 targets and 11 indicators (IAEG 2019, pp. 16–18). The targets cover the areas of access to drinking water, access to sanitation and hygiene, improved water quality, more efficient use of water, IWRM, protection of water ecosystems, expansion of cooperation and the participation of local communities. The goal's targets and indicators can be found in Table 3.

Figure 6 SDG 6 icon (UNECE, WHO Regional Office for Europe 2016, p. 2)

Table 3 SDG 6 targets and indicators based on (IAEG-SDG 2019a, pp. 16–18)

SDG 6 Target	*SDG 6 Indicator*
6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all	*6.1.1 Proportion of population using safely managed drinking water services*
6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	*6.2.1a Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water* *6.2.1b Proportion of population with a handwashing facility with soap and water available on premises*
6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	*6.3.1 Proportion of wastewater safely treated* *6.3.2 Proportion of bodies of water with good ambient water quality*
6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	*6.4.1 Change in water-use efficiency over time* *6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources*
6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate	*6.5.1 Degree of integrated water resources management implementation (0-100)* *6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation*
6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	*6.6.1 Change in the extent of water-related ecosystems over time*
6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies	*6.a.1 Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan*
6.b Support and strengthen the participation of local communities in improving water and sanitation management	*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*

As already mentioned, the SDG 6 targets cover a range of different topics. In most cases, their formulations conceal a large number of requirements which will be examined in more detail below.

Target 6.1: By 2030, achieve universal and equitable access to safe and affordable drinking water for all (UN Water 2017c, p. 8)

In order to understand the scope of this target, it is useful to examine its wording in detail. Universal access means that in addition to private households, schools, health-care facilities and workplaces should also be included. *Equitable* emphasizes that everyone has the same right to access and that inequalities should be reduced. *Safe drinking water* is water that is not contaminated by pathogens and toxic chemicals, while *drinking water* comprises water used for drinking but also several other domestic activities such as food preparation and personal hygiene. The claim of affordability refers to the fact that the price for this access should not be an obstacle for anyone. The last wording for all explicitly implies all people of every gender, age and physical condition. (UN Water 2017c, p. 8)

The indicator introduced for this purpose refers to the *proportion of the population using safely managed drinking water services*, which are defined as *improved sources that are accessible on premises, available when needed and free from fecal and priority chemical contamination*n (UN Water 2017c, p. 9).

Target 6.2: By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations (UN Water 2017c, p. 11)

In addition to equitable access, adequacy is required in this target, which in this case means that the accessible sanitation includes a hygienic separation of excreta and its disposal, treatment, reuse or transport. *Access to sanitation and hygiene* is understood as access to facilities and services that enable the *management and disposal of urine and faece*s and implies conditions such as washing hands, food hygiene and menstrual hygiene to prevent disease spreading. (UN Water 2017c, p. 11)

Another important requirement of this target is ending open defecation. This refers to the direct depositing of excreta in nature, which leads either to direct entry into waterbodies or soil and represents a major health risk. Addressing special needs of women and children consist in facilitating the procurement of water, mostly through them, and a dignified management of menstrual hygiene, whether in school, hospital, workplace or detention center. Special needs of people in vulnerable conditions should also be considered, for example in refugee camps, at mass gatherings or during pilgrimages. The target's indicator addresses the proportion of people using safely managed sanitation services. *Safely managed sanitation services* are defined as *improved sanitation facilities at the household level that are not shared with other households and where excreta are treated and disposed*. Examples for improved sanitation are flush or pour-flush toilets to sewerage systems, septic tanks, latrines, composting toilets or improved pit latrines. The indicator for ensuring hygiene is the *proportion of people using sanitation services including a hand-washing facility with soap and water*. (UN Water 2017c, p. 11)

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally (UN Water 2017c, p. 14)

Target 3 deals with reducing pollution of water resources to improve water quality and protecting both ecosystems and human health from the negative effects triggered by pollution. It addresses chemical and untreated wastewater pollution, while promoting reuse and recycling of water. The two related indicators refer to the *percentage of safely treated wastewater* including domestic and industrial wastewater, and the *proportion of waterbodies with good water quality*. The waterbodies addressed by the indicator's methodology are rivers, lakes and groundwater bodies (UN Water 2017c, p. 14)

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity (UN Water 2017c, p. 18)

Target 4 is dedicated to increasing water use efficiency in order to counteract water scarcity. This means gaining a decoupling of the height of water use and production of any economic sector in order to reduce the dependence of economy and economic growth on water use. The sectors concerned are agriculture, mining, quarrying, manufacturing, energy supply, water collection, treatment and distribution. Sustainable water abstraction is understood as abstraction in a way that does not sustainably impair the resource, such as preventing overuse of a groundwater body and thus avoiding associated groundwater subsidence. In addition to groundwater resources, this target also includes surface waters and glaciers. Water scarcity is defined here in two ways. Firstly, as physical scarcity, which is spoken of when more than 75% of the available water resources are abstracted. Secondly, it is defined as economic scarcity which already sets in as soon as malnutrition exists, although less than 25% of the water resources have been abstracted. The two selected indicators are the *level of water stress* and the *change in water use efficiency over time*. (UN Water 2017c, p. 18)

6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate (UN Water 2017c, p. 24)

Target 5 refers to three conventions or plans: the Johannesburg Plan of Implementation (2002), the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) (1992) and the Convention on the Law of the Non-navigational Uses of International Water-courses (1997). IWRM is the concept of managing water resources and land in a way that simultaneously enables social and economic development whilst ensuring the sustainability of vital ecosystems, which is defined as being integrated. In order to achieve this target, it is essential to act and promote cooperation at all levels involved, i.e. national, local and river basin levels. Since catchment areas of rivers or groundwater bodies often cross borders, management across national borders is inevitable in several cases. The first indicator for monitoring this target is the *degree of IWRM implementation* on a scale from 0 to 100 by assessing progress concerning the four aspects of IWRM *enabling environment, institutions and participation, management instruments and financing*. (UN Water 2017c, pp. 23–24)

The second indicator provides information about the *percentage of transboundary basin area with an operational arrangement for water cooperation*, meaning any convention, treaty or agreement between two or more countries that implies rules for a common management of transboundary basin areas, including regular communication, data exchange and common targets or plans. (UN Water 2017c, p. 25)

6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes (UN Water 2017c, p. 28)

Target 6 refers to the Aichi Biodiversity Targets and calls for protection against the destruction of water-related ecosystems and the restoration of already degraded systems. The ecosystems named in the target's definition are mountains, forests, wetlands, surface waterbodies and aquifers, while its indicator *change in the extent of water-related ecosystems over time* referring to spatial extent, water quantity and quality includes surface waterbodies and aquifers. The thought behind the indicator is that change within eco-systems may lead to restriction of their functioning and thus a decrease in their ability to provide the services necessary for society. (UN Water 2017c, p. 28)

6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies (UN Water 2017c)

Target 6.a addresses the importance of increasing international financial support as well as the reinforcement of skills and competences in developing countries in the technologies and technology fields mentioned in the target's definition. The indicator for this target is the *amount of official development assistance (ODA) that is part of a government-coordinated spending plan* and refers to ODA that is specifically targeted at water- and sanitation-related projects. The indicator measures the amount of ODA in this area that donors provide in alignment with the national government's water and sanitation policies and plans. In addition it highlights a donor's investment in water- and sanitation-related support without the government's knowledge. (UN Water 2017c, p. 31)

6.b Support and strengthen the participation of local communities in improving water and sanitation management (UN Water 2017c, p. 34)

To ensure long-term sustainability, local ownership through involvement of local communities plays a key role. For this reason, Target 6.b explicitly calls for contribution of local communities to decision-making and planning concerning water and sanitation programs. The indicator monitors the *percentage of a country's local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management*. Administrative units are defined as *non-overlapping districts, municipalities and communes*. (UN Water 2017c, p. 34)

Links between SDG 6 and other SDGs

Although this thesis deals primarily with SDG 6 and its monitoring, it should be noted that the achievement of SDG 6 is closely linked to the achievement of other SDGs (UN Water 2017c, p. 36). In order to explain this fact in more detail, it is helpful to consider the goal's influence on other SDGs.

Water plays an important role in the environment and hence life under water (SDG 14) and life on land (SDG 15), since a large number of different ecosystems depend on it. The absence of water or its necessary quality or quantity can lead to the destruction of these ecosystems and thus impede their productivity. The water cycle, however, also plays a role in climate change (SDG 13) and associated extreme events such as floods and draughts. An example of how the enrichment of SDG 6 can increase climate resilience of countries is the use of water-saving technologies, e.g. in agriculture.

Drinking water is a crucial requirement for human health (SDG 3), as are sanitation and hygiene. In addition, it is indispensable in food production and thus has a direct impact on the issues of hunger (SDG 2), and poverty (SDG 1). Access to drinking water and sanitation in schools is also of great importance (SDG 4). The health and well-being of pupils and teachers have an effect on their educational outcomes and, in addition, their sensitivity for the importance of clean drinking water, handling of sanitation and hygiene. By pointing out the special role of women in water procurement and dignified conditions in relation to menstrual hygiene, SDG 6 also has an impact on addressing inequalities (SDG 5/SDG 10). These inequalities can be reduced within SDG 6 by providing access to water and sanitation for everyone, regardless of gender, age and physical condition. The challenges of enhancing clean energy (SDG 7), increasing urbanization (SDG 11), sustainable production and consumption (SDG 9/SDG 12), all include water and wastewater relevant topics, since water has a high value in many production processes and thus, results in wastewater needs adequate treatment. (UN-Water 2016b, pp. 16–18)

Energy production is highly dependent on water, growing cities require functioning water resources and intact supply systems, and sustainable production is trying to achieve a decrease of products' water footprints. Especially in the agricultural sector, water and thus the concerns of SDG 6 are decisive. The sector employs 30% of the world's working population and is the main driver of development in developing countries. People working in the energy sector, food or water industry are also directly dependent on water (SDG 8). SDG 16 can benefit from the effects of shared waterbodies between countries and their internal need for cooperation, whereas managing transboundary water resources and combating water stress across boundaries enhances partnerships and thus has benefits on achieving SDG 17. (UN-Water 2016b, p. 25)

These brief remarks already show that SDG 6 is related to each of the other SDGs and that only a joint achievement of all goals is sustainable. SDG 6 connects goals from all three sustainability dimensions as. The environment offers water and other ecosystem services, relevant to the economy, while the economy has to ensure sustainable water use, control the pollution of the resources and is responsible for finances used in favor of the environment and thereby interlinks economic and environmental topics. The connection between societal and environmental aspects through SDG 6 works in a similar way. The society is in need for water resources and other ecosystem services, in return it has to use them in a sustainable way, limit pollution and enhance education and legislation to promote environmental incentives. Societal topics such as health, education and political stability, which are dependent on the content of SDG 6, are requisite conditions for many economical aspects, while only a functioning economy allows for public water services, employment and poverty reduction which are all beneficial to society. Figure 7 emphasizes that achieving SDG 6 can have tremendous positive effects on achieving other SDGs. (UN-Water 2016b, pp. 28–30)

Figure 7 SDG 6' effects on other SDG's (UN Water 2018c, p. 130)

3. Monitoring

Chapter 3 deals with a definition of monitoring and its value in the context of the SDGs. It includes a distinctive look at national, regional and global monitoring processes and then details the methodologies for monitoring SDG 6 by presenting the involved UN agencies, data sources and calculation methods. After giving an aggregated overview the chapter is concluded by a presentation of Germany's approach to monitoring SDG 6.

3.1 Basics on monitoring

> *72. We commit to engaging in systematic follow-up and review of the implementation of this Agenda over the next 15 years. A robust, voluntary, effective, participatory, transparent and integrated follow-up and review framework will make a vital contribution to implementation and will help countries to maximize and track progress in implementing this Agenda in order to ensure that no one is left behind. (UN General Assembly 2015)*

The final chapter of the resolution *Transforming our world: the 2030 Agenda for Sustainable Development* begins with this commitment which calls for a follow-up and review of the implementation process of the global goals. It continues to describe principles for these purposes and differentiates between global, regional and national efforts. Before going into detail, the terms monitoring, follow-up and review have to be defined and the purpose and benefits of monitoring have to be outlined.

3.1.1 Definitions

Monitoring is an ongoing process that aims to provide a project's stakeholders or management with information on progress or stagnation in the achievement of its goals (UNDP 2009, p. 59). In case of the SDGs the process consists of data collection on specified indicators, representing key parameters of the respective target, which involves measuring values for those indicators (UN Water 2017b, p. 7). Each target, as part of a goal, requires at least one indicator (UN Water 2017b, p. 7). A comparison between the current value and a baseline value indicates, whether there is progress over time and thereby identifies functioning or poor strategies, successes and problems in implementing a certain target (UN Water 2017b, p. 7). Hence, monitoring requires the definition of indicators and the development of methodologies, describing the process of monitoring (UN Water 2017b, p. 7). The outcome is information on the current and prior state of progress and always a picture of the current situation within the process of achieving a certain target (UN Water 2017b, p. 7).

Evaluating the identified progress is related to as follow-up and review and involves analyzing the causes and challenges leading up to it. Good practices can be established and the gained knowledge can be shared between the involved parties. Follow-up and review enable the assessment of the information gained in the monitoring process. (UN Water 2017b, p. 8)

The difference between the processes monitoring and follow-up and review is that the former is dedicated to measuring progress while the latter is designed to evaluating it. Since follow-up and review depend on monitoring and only measuring the current situation alone are not as useful for further action, they are conducted in combination and build an indispensable role in achieving the SDGs. (UN Water 2017b, p. 7)

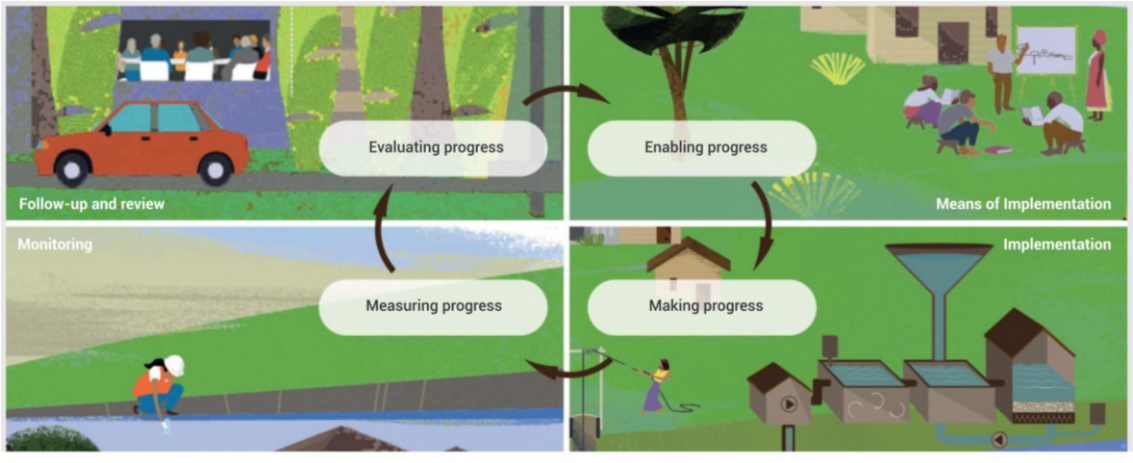


Figure 8 Cycle of processes that enable progress towards sustainable development (UN Water 2017b, p. 7)

The information generated by the follow-up and review process is used within the means of implementation that enables progress as depicted in Figure 8. Those means of implementation are considered as all kinds of financial and human resources, administrative and legal institutions, policies and legal frameworks that help to create an enabling environment. By providing the means of implementation concrete implementation actions can follow which lead to progress towards achieving the SDGs. (UN Water 2017b, p. 7)

3.1.2 Purpose and benefits

The monitoring process of the SDGs is intended to fulfil several purposes. One purpose is to enhance accountability to the population and within the international system (UNECE and WHO Regional Office for Europe 2019, p. 10). The success of implementation of the SDGs becomes measurable and each country can thus be held liable by its citizens or other countries if the set targets are not achieved. The concepts of transparency and accountability are often mentioned in the context of good governance (UN Water 2018c, p. 125). The OECD guidelines state that the two components are the basis of good governance (UN Water 2018b, p. 17). The aim is to provide the citizens with the information they need to understand the state's activities and to make non-compliance with the defined goals visible by creating transparency and accountability. By publishing monitoring reports and making the development more transparent to everyone in combination with public hearings, trust can be built between government and citizen (UNDP 2016, p. 73).

In addition to accountability, monitoring should contribute to improving cooperation between and within countries. Best practices can be identified in the monitoring process and thus benefitting the transfer to and adoption by other countries. In this sense, monitoring reports represent a common learning and exchange platform. Countries can learn from each other and achieve greater success more quickly. (UN General Assembly 2015, p. 31)

Another important goal of monitoring is the possibility of identifying emerging problems in the development progress and thereby using existing resources as efficiently as possible (UN General Assembly 2015, p. 31). Through monitoring, challenges within the implementation process of specific targets can be uncovered such as the neglect of certain parts of the population or rising trends in disease outbreaks and thus be addressed in a targeted manner (UN General Assembly 2015, pp. 31–32). The identification of data is a way of determining which part of the population may not be

covered by statistics or by development policy (UN 2016, p. 50). This can improve data collection and thus provide a more comprehensive picture of a country's current development situation.

In this context, the allocation of financial resources and enabling environment have to be mentioned (UN 2015a, p. 58). A detailed description of the status quo and current problems forms the basis for policy and decisionmakers with regard to the allocation of funds and adapting of policies (UN Water 2017b, p. 27). By continuously monitoring the progress of implementation, a data pool that serves as a basis for decision-making in the distribution of available funds and hence triggers the establishment of development policies and interventions (UN 2015c, p. 10). Since collecting national data builds the basis of monitoring processes and is meant to be a country-led process, the participating countries are encouraged to take ownership through monitoring processes (UN 2015a, p. 58).

Overall, monitoring can fulfil multiple tasks with the aim to maximize development success and accelerate the development process. Incomplete or deficient monitoring, on the other hand, can lead to shortcomings and decisions that are detrimental to development success.

3.2 Monitoring of the Millennium Development Goals

3.2.1 Monitoring of the Millennium Development Goals

In the last chapter of the Millennium Declaration the General Assembly is assigned with the review of the progress made in implementation of the declaration’s provisions on a regular basis (UN General Assembly 2000, p. 9). The Secretary-General is asked to publish regular reports for the General Assembly (UN General Assembly 2000, p. 9). The data needed for these causes was analyzed and summarized in reports by the United Nations Inter-Agency and Expert Group on MDG indicators (IAEG-MDG 2013, p. 2). In short, the agency is referred to as IAEG-MDG and included members of international agencies, regional organizations and national statistical offices (IAEG-MDG 2013, p. 2). In addition, the UN Secretary-General appointed UNDP to be responsible for country-level monitoring. (UNDP 2016, p. 46)

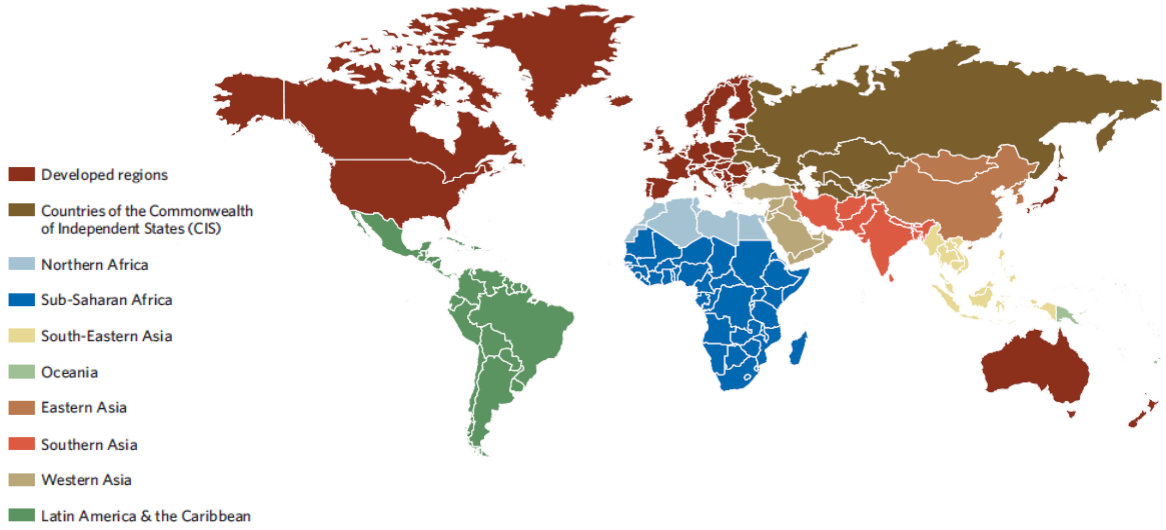


Figure 9 Regional groupings in 2005 (UN 2005, p. 43)

Before going into more detail on the collection and use of data, it should be noted that the countries to be examined were grouped together in defined ways that are still referred to in the SDG context. In order to provide a clear picture of the status of the global development trend the countries were divided into regions and sub-regions on the basis of the UN geographical divisions (UN 2015c, p. 70).

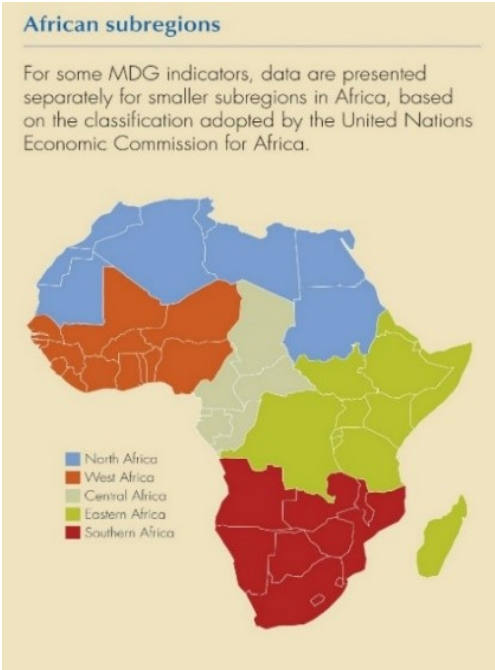


Figure 10 African subregions (UN 2012, p. 67)

Figure 9 shows the regional groupings in 2005 consisting of ten regions namely *developed regions, the countries of the Commonwealth of Independent States (CIS), Northern Africa, Sub Saharan-Africa, South-Eastern Africa, Oceania, Eastern Asia, Southern Asia, Western Asia and Latin America and the Caribbean* (UN 2005, p. 43). Since 2011 the regional groupings changed tackling the former region *Countries of the Commonwealth of Independent States* (CIS) (UN 2005, p. 43). A part of the region was put into the new group *Caucasus and Central Asia* while the rest became a part of the region *developed regions* (UN 2005, p. 43). In 2012, a further division was made in the data analysis of the African regions (UN 2012, p. 67). The so-called sub-regions of Africa are presented in Figure 11.

The actual process of monitoring was based on the defined indicators of the MDGs and their temporal frames baseline (UN 2015c, p. 70). Most of the targets were set for the 2015 deadline, while all targets were based on the status quo of 1990 as a baseline (UN 2015c, p. 70). Progress was therefore measured as changes to the situation in 1990 (UN 2015c, p. 70). The methods used for computation, interpretation and specifications of data sources and data collection can still be found today on the IAEG-MDG website, operated by the United Nations Statistics Division. The approach is target-specifically stored under the tab metadata but also on a specially created Wiki homepage in the form of a manual for monitoring the MDGs.

The monitoring of Target 7.C is exemplarily shown in the following. As mentioned above, the monitoring was based on the indicator of the respective target. The target is defined as *halving, by 2015, the* p*roportion of people without sustainable access to safe drinking water and basic sanitation*. In this case, two indicators were designed to monitor the target. Indicator 7.8 was defined as the *proportion of population using an improved drinking water source*. The definition implies the classification improved of the used facility, which mainly refers to protection from contamination such as fecal matter. Facilities that were classified as improved are *piped water into dwelling, plot or yard, public taps, boreholes or tube wells, protected dug wells, protected springs, rainwater collection and bottled water*, provided that a secondary improved water source was available. The water in question is water used for drinking, food preparation and basic hygiene purposes. To calculate the indicator for urban and rural areas, data on the amount of people using improved drinking water sources and the total amount of the population was needed. The former value was divided by the latter and multiplied by 100 to generate the percentage. The data was collected through censuses and household surveys conducted by national governments at national and sub-national levels conducted by national governments. The survey formats typically used were Demographic Health

Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS), since they included questions on access to drinking water. In order to fill data gaps, administrative data was used, such as data on coverage though the number of piped households. However, they often did not include facilities that were built by NGOs, and did not differentiate between operational and non-functional facilities. The WHO/UNICEF Joint Monitoring Program for Water Supply and Sanitation was responsible for monitoring this target and collected data from country offices, the internet, national statistics offices and the International Household Survey Network. The collected data was validated based on factors such as national representativeness, sampling size and disaggregation by urban, rural and type of drinking water source. In 2008 and 2012 the JMP revised the categorization of facility to enable a more distinctive characterization of the level of access. Regional and global estimates were calculated by using population-weighted averages from national estimates, if a minimum of 50% of the relevant population was covered by the available data. (UNSD 2012, p. 1)

As mentioned above, the IAEG-MDG was responsible for the supervision and collection of the data acquired in this way (UN 2015c, p. 70). The actual calculation or generation of the data was carried out by a large number of institutions and organizations such as the JMP as shown in Table 4 (UN 2015c, p. 72).

Table 4 Contributing agencies (UN 2015c, p. 72)

1 ERADICATE EXTREME POVERTY AND HUNGER	2 ACHIEVE UNIVERSAL PRIMARY EDUCATION	3 PROMOTE GENDER EQUALITY AND EMPOWER WOMEN	4 REDUCE CHILD MORTALITY	5 IMPROVE MATERNAL HEALTH	6 COMBAT HIV/AIDS, MALARIA AND OTHER DISEASES	7 ENSURE ENVIRONMENTAL SUSTAINABILITY	8 A GLOBAL PARTNERSHIP FOR DEVELOPMENT
Target 1.A World Bank UN **Target 1.B** ILO **Target 1.C** FAO UNIFEC Additional UNHCR	**Target 2.A** UNESCO	**Target 3.A** ILO IPU UNESCO UN	**Target 4.A** UNICEF United Nations Population Division World Bank WHO	**Target 5.A** UNFPA UNICEF United Nations Population Division World Bank **Target 5.B** UNFPA UNICEF United Nations Population Division	**Target 6.A** UNAIDS UNICEF WHO **Target 6.B** UNAIDS WHO **Target 6.C** UNICEF WHO	**Target 7.A** CDIAC FAO UNEP UNFCCC **Target 7.B** IUCN UNEP-WCMC **Target 7.C** UNICEF WHO **Target 7.D** UN-Habitat	**Target 8.A** ITC UNCTAD WTO **Target 8.B** OECD **Target 8.C** OECD **Target 8.D** World Bank **Target 8.E** WHO **Target 8.F** ITU

Results were regularly published in the form of MDG reports by UN-DESA in collaboration with numerous other organizations (IMF, World Bank, OECD, Global Monitoring Reporting of the IMF/World Bank, UNDP) (Manning 2009, p. 25). The last annual MDG monitoring report from 2015 takes stock of the monitoring success of previous years. In addition to the basic procedure already explained, it also points out which data have proved to be particularly valuable, which improvements have been made over the years and which problems have arisen (UN 2015c, p. 10). Data collected at local level are identified as particularly valuable as they allow monitoring local progress and assessment of local development plans (UN 2015c, p. 10).

3.2.2 Lessons learned from monitoring and implementing the Millennium Development Goals

Great challenges, illustrated in the MDG results, are a lack of data in general and timely data in particular which can lead to distorted results (UN 2015c, p. 11, 2015c, p. 12). Especially the emphasis on the strong differences within regions and between urban and rural areas suggested that only differentiated data can present a correct picture of reality (UN 2015b, S. 10). This is why data collected at local level were identified as particularly valuable as they allow monitoring local progress and assessment of local development plans (UN 2015b, S. 10).

The problem of data gaps, is that they can impede an appropriate response and decision-making by governments and thus slow down improvement and development in these areas (UN 2015c, p. 11). The World Bank has found this to be the case with poverty monitoring in half of the countries where data was collected, mostly to the detriment of the poorest, whose situation was not included in the data (UN 2015c, p. 11). One of the causes of data gaps was the fact that less than half of the UN countries had a civil registration system with national coverage (UN 2015b, S. 11). Hence, improving data availability was a big challenge in monitoring. To address the problem of data gaps, investments were made in statistical and administrative systems and capacity, which, as mentioned above, have increased the availability and quality of data (UNDP 2016, pp. 46–47). Locally collected data and disaggregated data contributed to filling data and thus counteracting the neglect of vulnerable groups (UNDP 2016, p. 50). In Tanzania, for example, the survey of disaggregated data helped to measure local progress and identify inequalities (UNDP 2016, p. 50). For both community-based and disaggregated data collection, specially adapted indicators were needed to provide the desired data, such as indicators covering sex, age, ethnicity, linguistic group, income or other characteristics (UNDP 2016, p. 50). This approach proved its worth in reducing data gaps and enabling decision makers to address inequalities directly through the necessary interventions and laws (UNDP 2016, p. 50). In order to carry out such local monitoring, local capacities were needed which was still a problem in many countries in 2015 (UNDP 2016, p. 50). Figure 11 shows the amount of data available from different sources in five-year intervals (IAEG 2014, p. 12). The trend is increasing, but always below 70% (IAEG 2014, p. 12). The last period however only includes data for a four-year interval which is why the percentage value is lower than the previous value (IAEG 2014, p. 12).

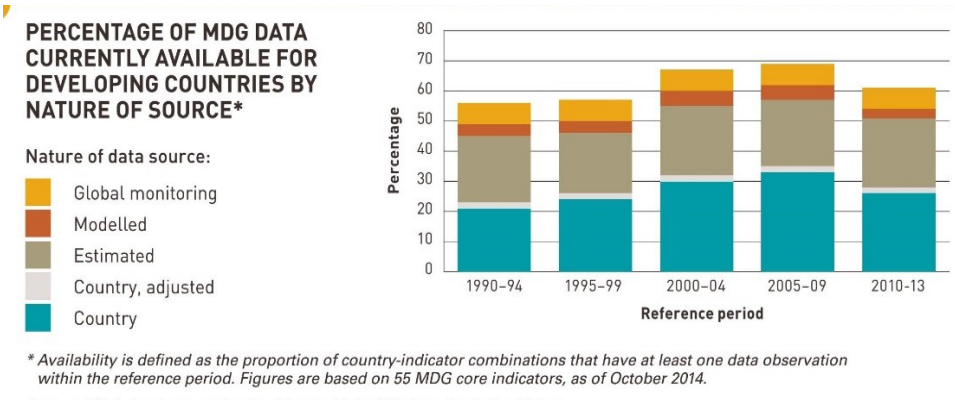


Figure 11 MDG Data development 1990-2013 (IAEG 2014, S. 12)

Figure 12 displays the increase of MDG indicator data over time. The share of countries in developing regions that provided between 16 and 22 data points for an indicator series rose from 0% to 70% between 2003 and 2014. (IAEG 2014, p. 13)

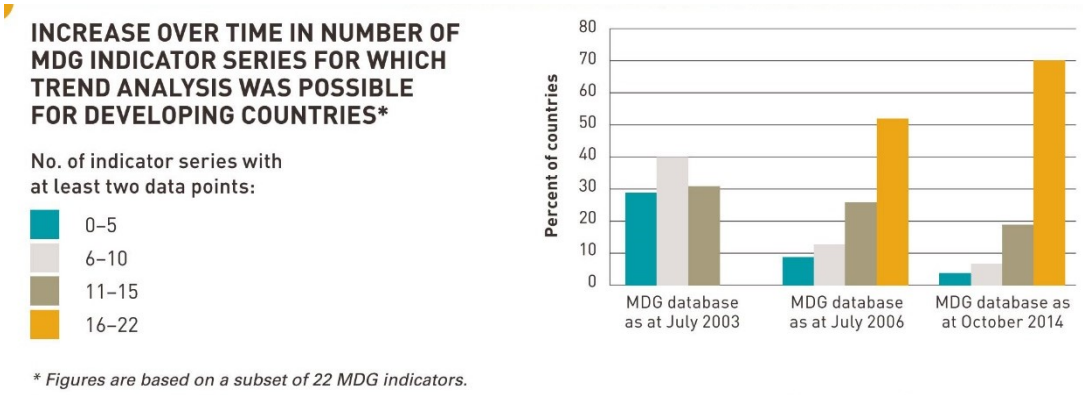


Figure 12 Number of MDG indicator series with trend analysis for developing countries (IAEG 2014, p. 13)

The improvements that have occurred in monitoring between 2000 and 2015 include a significant increase in the number of surveys and the capacity of national statistical systems (UN 2015c, p. 11). This development is reflected in the increase of data points for the indicators transmitted. The level of detail has also increased considerably over this period, as can be seen, for example, from the fact that considerably more Latin American countries collect data on indigenous peoples (UN 2015c, p. 11). This development led to a significant rise in the births of indigenous women who were supervised by health care personnel, as the data revealed a previous maladministration in this area and interventions were thus initiated to combat it (UN 2015b, S. 11). In a larger UN study, precisely this issue was examined. The number of developing countries including a minimum of two data points for 16 of indicators increased thirtyfold from originally four countries to 129 countries within 10 years (UNDP 2016, pp. 46–47).

In addition, consistency of local and national surveys, had to be resolved by collecting national and sub-national data individually and using different indicators (UNDP 2016, p. 50). The evaluation in the form of regular national development reports proved to be very positive (UNDP 2016, p. 50). It provided an opportunity for countries to control and reflect on themselves and to pay attention to MDG progress as it became part of the public debate (UNDP 2016, p. 50). In addition, local actors and advocates had insight into what is already working and where inequalities remained (UNDP 2016, p. 50). There have been small improvements in the two to three-year delay between the collection and evaluation or publication of the data, which was still considered a problem (UN 2015c, p. 12). SMS, mobile phone based communication systems and the internet played a role here (UN 2015c, p. 12). UNICEF has enabled real-time data collection and sharing in the health sector by introducing various technologies, e.g. in Liberia, Guinea and Sierra Leone (UN 2015b, S. 12). An example of this type of new unconventional data source is tracking people after they have left disease hotspots, which was used in West Africa to predict Ebola epidemics. In Indonesia, a mobile phone technology called iMonitor has been developed that allows HIV-infected and vulnerable people to share information on prevention, treatment and evaluation of treatment services received (UNDP 2016, p. 48). Although new technology enabled a significantly accelerated transfer of data, it could also disadvantage people who, for financial or other reasons, did not have access to these technologies (UN 2015b, S. 13).

Overall the fact that the MDG framework included concrete indicators applicable to all member states facilitated the monitoring process and entailed several advantages as the IAEG-members outlined in their Lessons Learned Report in 2013 (IAEG-MDG 2013, p. 3). Since every member state was obligated to provide data on their progress, monitoring capacity was expended and the indicators were optimized. Data availability and comparability improved both on the national and global level (IAEG-MDG 2013, p. 3). At the global level partnerships between national and international statistical systems were formed and deviating national and international data series could be identified and interpreted (IAEG-MDG 2013, p. 3). Lessons learned in monitoring but also implementation of global goals in general were taken into account when transitioning from the MDG- to the SDG-era.

3.3 Monitoring the Sustainable Development Goals

The monitoring, conducted by UN agencies by using national data for producing national, regional and global estimates for global indicators, is referred to as global monitoring. Aside that regional and national monitoring is carried out by using national or regional indicators that reflect prioritized targets or aspects thereof specifically tailored to the nations or regions situation. Those three dimensions of monitoring are illustrated within this chapter.

3.3.1 Global monitoring

The last chapter of the Agenda 2030 is devoted to follow-up and review. It sets out a number of principles for its implementation, which are similar to the monitoring objectives mentioned above. The monitoring is to be implemented voluntarily and, on a country-led basis. National data are to be used as the basis for the global reviews. The monitoring should serve to present the status of the implementation of the goals and targets and, in doing so, to observe their context and interlinkages. It should also help to identify successes, failures, challenges and gaps and thus help countries to provide information for policy choices. The presentation of best practices, improvement of coordination and effectiveness in the international community is also promoted. The agenda's resolution demands the monitoring to be as *transparent, accessible and inclusive for all, people-centered, gender-sensitive, respecting human rights and with special attention to the poorest and most vulnerable people*. (UN General Assembly 2015, p. 31)

Furthermore, the monitoring should use existing platforms and infrastructure to prevent duplication and take into account national circumstances, capacities and priorities. In the course of time, the process will be adapted to changing conditions and new methodologies will be developed with the aim of relieving national administrations. The required data should be collected nationally and be of high quality and reliability, up-to-date and disaggregated according to a variety of categories, depending on national background. To this end, existing capacities in developing countries will be expanded, including their data systems and evaluation processes. The monitoring processes are to be supported by UN institutions and other multilateral institutions. (UN General Assembly 2015, p. 31)

At the global level, the High-Political Forum, meeting every four years, has the patronage over the follow-up and review processes (UN General Assembly 2015, p. 34). One of its tasks is the dissemination of successes and lessons learned with the aim of giving the member countries suggestions for follow-up (UN General Assembly 2015, p. 33). The HLPF should also continuously support and recall development progress and its relevance. To carry out these tasks, HLPF receives

an annual report prepared by the Secretary General in cooperation with UN institutions (UN General Assembly 2015, p. 33). The information it contains is produced by national statistical offices and on a regional basis (UN General Assembly 2015, p. 33). In addition, the HLPF is to be provided with the Global Sustainable Development Report, which is intended to support political decisions and contribute to the work of the Science-policy Interface, which was established in 2013 and aims to bring science's findings on land degradation, drought and desertification into legislation by promoting dialogue between scientists and legislators (UN General Assembly 2015, p. 34).

The President of the Economic and Social Council discusses the objectives, methodology and frequency of global reports and their relationship to progress. The HLPF should conduct regular reviews involving all UN members, UN entities, the public and the private sector. This also includes thematic reviews, such as its 2018 thematic report on SDG 6. Financing and other funding should be included in the review and follow-up process as described in the Addis Ababa Action Agenda. (UN General Assembly 2015, p. 34)

At the Addis Ababa Conference 2015 heads of state and representatives met to work out a global framework for financing development after 2015 (UN 2015a, p. 1). The last chapter of the outcome-document deals with data, monitoring and follow-up (UN 2015a, p. 58). The chapter emphasized the importance of disaggregated data that it should be of high quality and that it is an important basis for decision makers (UN 2015a, p. 58). Due to the high relevance of the statistical and administrative systems necessary for data collection and analysis, support for these systems and improvement of data quality and specification were sought (UN 2015a, p. 59). Furthermore, it is described that effective follow-up requires the involvement of all “relevant ministries, local authorities, national parliaments, central banks, stakeholders, development banks, civil society, academia and the private sector” (UN 2015a, p. 60). The document ends with the commitment to hold a regular Economic and Social Council Forum on financing for development follow-up (UN 2015a, p. 61). The resolution stipulates that in addition to global indicators and national indicators and baselines have to be produced by the Member States (UN 2015a, p. 61).

The results of the monitoring and review processes are reported in form of regular progress reports. Developing the global indicators framework was a task that the IAEG-SDG was responsible for (UN 2016, p. 50). Since it is composed out of members by every state’s national Statistical Office, this was a country-led process (UN Water 2017b, p. 3). UN agencies such as UN Water and many other stakeholders, were consulted within the process but after all the countries had the final say. The final indicators were adopted by the Statistical Commission and then adopted by the Economic and Social Council and the General Assembly (UNECE and WHO Regional Office for Europe 2019, p. 10). The definition of the global indicators was chosen with the intention of being as relevant as possible for as many Member States as possible (Huber 11/8/2019). The numerous differences in the infrastructure and development stages of the 193 Member States make it clear that not every indicator is highly useful for every Member State (Huber 11/8/2019).

In order to be able to present the national priorities and circumstances in more detail in monitoring, the development of national indicators was also called for (UN General Assembly 2015, p. 32).

However, to assess the current development status and maturity of the global indicators with regard to their methodologies and data availability, they are categorized into one of three tiers (UN Water 2017b, p. 10):

- Tier I indicators are those which are already fully developed, i.e. for which both established methodologies and regular data generation exist from most of the countries (UN Water 2017b, p. 10).
- Tier II indicators have complete methodologies but no regularly generated data (UN Water 2017b, p. 10).
- Tier III indicators have methodologies that are under development (UN Water 2017b, p. 10).

The goal is to further develop the 2017 implemented indicator framework so that all indicators reach Tier I or at least Tier II (UN Water 2017b, p. 10). The first revision of the framework is planned for 2020 (UN Water 2017b, p. 10).

The primary goals of global monitoring are the creation of a clear picture of progress towards achieving national goals and the countries understanding of their own national sectors. For the JMP, the aim is to create comparability between countries, allowing them to place themselves in a global context and to support meeting regional and global goals. In addition, the temporal development of the achievement of objectives is recorded. For reaching this comparability, the monitoring process requires the use of the same definitions, parameters and indicators. The results of the global monitoring are usually used by multinational and international actors such as NGOs for orientation and to allocate resources. This can be seen in the current increase in investment and support in on-site sanitation and other new SDG 6 indicators. (Huber 10/2/2019)

3.3.2 Regional monitoring

Five UN regional commissions connect the global UN processes and the regional implementation processes (UN Economic and Social Council 2019, p. 3). In detail these are the United Nations Economic Commission for Europe (UNECE), the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), the Economic Commission for Latin America (ECLAC), the United Nations Economic Commission for Africa (ECA) and the United Nations Economic and Social Commission for Western Asia (UNESCWA) (UN Economic and Social Council 2019, 3 ff). In addition to supporting implementation, international knowledge sharing and cooperation, the RCs also contribute to follow-up and review by providing regional data to the HLPF (UN Economic and Social Council 2019, 3). Monitoring on a regional and sub-regional level can potentially improve peer-learning though knowledge exchange, sharing best practices and cooperation of commissions and organizations (UN General Assembly 2015, p. 33). Reviews at regional level should help identify best practices and create a space for discussion of common goals, as well as providing suggestions for regional legislation (UN General Assembly 2015, p. 33).

3.3.3 National Monitoring

The national monitoring refers to the data collection processes for global monitoring but also for estimating national indicators as part of national development strategies. By producing regular national reports present development progress, identify regional and global problems and include civil society, the private sector, and other stakeholders. The data generated and collected at the

national level build the basis for regional and global monitoring. At the national level, these values have a signal function for global monitoring and can influence the focus of national activities and investments. The implementation of a national development agenda and its monitoring, however, is more important to national decision-makers, since it captures nationally prioritized problems. (UN General Assembly 2015, p. 33)

In contrast to global monitoring, national monitoring requires much higher resolution, detailed and granular data, does not aim at comparability and may differ from global monitoring in its approach and indicators. With regard to the importance of monitoring, Johnston also clearly distinguishes between national and global monitoring of data users. The results of national monitoring are therefore used by national decision makers and investors for annual budgets, strategic and investment plans. (Huber 10/2/2019)

3.4 Global Monitoring of SDG 6

The national monitoring processes of SDG 6 are highly dependent on national characteristics such as development state, existing institutions, programs, capacity and existence of water-ecosystems. Covering every country's national monitoring exceed the scope of this work. Thus, the following chapter and descriptions of monitoring and its indwelling challenges and problems focus on global monitoring. However, the Integrated Monitoring Initiative gives advice on how national monitoring in general should be structured.

As mentioned above the global indicators were developed by the IAEG-SDG in cooperation with several other institutions that are experts in the respective field. Concerning SDG 6 UN Water is one of the main organizations involved in the process. Aside the indicators, the monitoring framework comprises methodologies for each indicator. The following sub chapter is dedicated to detail these for SDG 6. In the course of defining the SDG 6 indicators several stakeholders such as UN-Water, the Sustainable Development Solutions Network (SDSN), the WHO/UNICEF Joint Monitoring Program and the open working group proposed indicators. In the end the open working groups proposal was implemented. The coordination of monitoring processes for SDG 6 is carried out within the Integrated Monitoring Initiative for SDG 6 launched by UN Water in 2016. (Huber 11/8/2019)

There is a difference between the official and the actual benefits of global monitoring which depends on the country's level of development and is caused by the compromises made in indicator definition in order to please all countries. In principle, the indicators should help countries to monitor their development process and draw conclusions from it. However, since the indicators chosen represent the lowest common denominator of the needs of the more than 200 countries, it can be assumed that they will actually be used mainly to illustrate global progress and to benefit the discussion in high level processes. In addition, their results are also interesting for donors and NGOs and offer countries the opportunity to compare themselves with, for example, their neighbors. In the national context, the 11 indicators usually represent only a fraction of the national indicators examined. For this reason, UN Water is trying to find a balance between the global indicators and the issues that are relevant for the country and approaches that are adapted to their policy making. In order to facilitate international comparison, basic parameters must be adhered to, but the custodian agencies are also endeavoring to establish monitoring structures that are of national use. Since the Member States differ greatly in their monitoring efforts to date, the 11 indicators have a different national

significance. In countries where only a few monitoring programs on water and sanitation exist to date, they are the initial committee and have increased interest and awareness in this area. The fact that global monitoring is mandatory therefore also helps to motivate countries that have made little effort in this area. (Huber 11/8/2019)

3.4.1 Integrated Monitoring Initiative

The initiative's goals are to help countries with implementing global monitoring processes for SDG 6 through giving them methodologies and tools, raising awareness about the relevance of monitoring, building technical and institutional capacities, gathering country data and publish them in form of progress reports (UN Water 2017b, p. 13). Together with UN Water, the initiative forms a framework for the cooperation of all custodian agencies involved and coordinates their work (UN Water 2017b, p. 12). The data produced is published by UN Water (UN Water 2017b, p. 12). The three initiatives for monitoring SDG 6 are the WHO/UNICEF Joint Monitoring Program for Water Supply, Sanitation and Hygiene (JMP), the Global Expanded Monitoring Initiative (GEMI) and the UN-Water Global Analysis and Assessment of Sanitation and Drinking Water (GLAAS) cooperation and thereby enhance global monitoring efforts (UN Water 2017b, p. 13).

Figure 13 illustrates which custodian agency is responsible for monitoring which target. The collaboration among UN agencies in form of the three initiatives within the IMI is supposed to facilitate support cross-sectoral cooperation and thereby enhance global monitoring efforts (UN Water 2017b, p. 13).

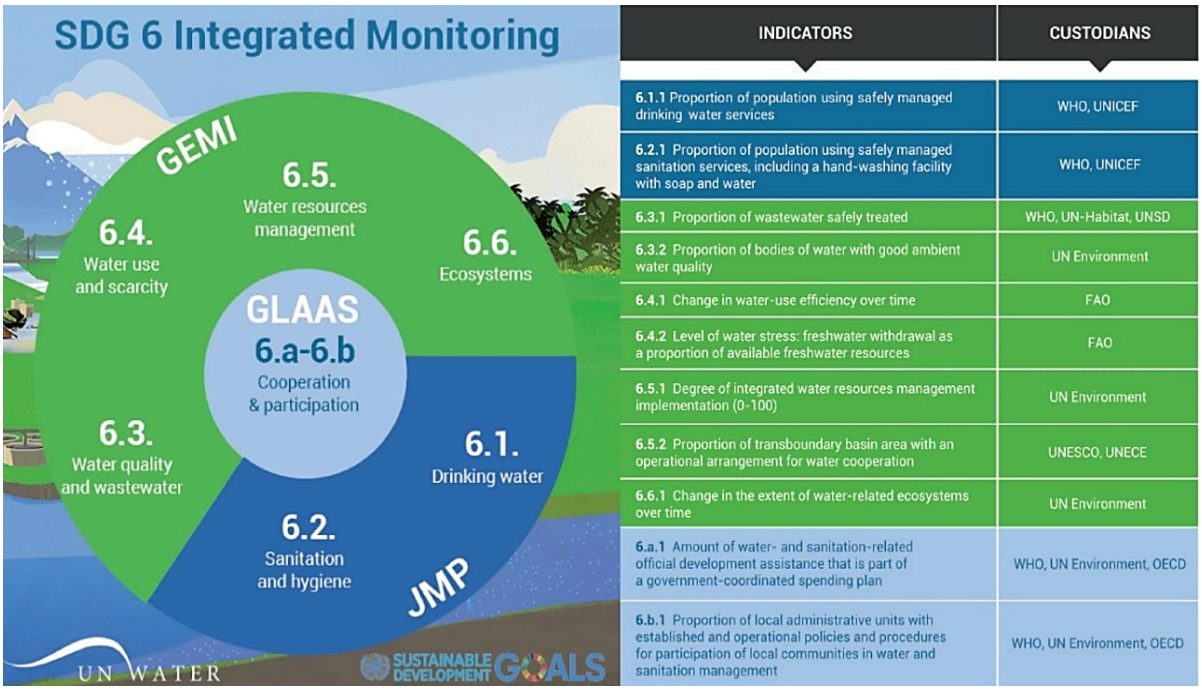


Figure 13 Custodian agencies (UN Water 2017b, p. 13)

The IMI provides an integrated monitoring guide containing monitoring methodologies and tools, an outline of rationale for monitoring and the use of data. The guide offers recommendations for the implementation of monitoring on a national level and raises awareness about SDG 6 monitoring. An important component of the guide is the recommendation of building on existing national efforts so every country starts according to its capacities and resources and advances the monitoring process

from there and using similar standards and definitions within and across countries facilitates monitoring. It is also the IMI's objective to enhance technical and institutional capacity for monitoring on the national level and conduct the data compilation and reporting for the global progress. (UN Water 2017b, p. 3)

The audience addressed by this guide consists of people responsible for measurement, data collection and analysis, i.e. technical staff in line ministries, national statistical offices, subnational governments, utilities, academia, private sector and civil society groups. The guide itself is composed of three separate reports with different objectives covering good practices for country monitoring systems, targets and global indicators and step-by-step methodologies for SDG 6 global indicators. It was developed by technical staff within UN agencies that are responsible for national data collection. The process of developing the guide started in 2014 and contributed to the IAEG-SDG process. In 2016 a draft was delivered and tested in five countries. Those five countries and an open expert group evaluated the guide, reported on lessons learned and gave feedback that led to a revision and expansion of the guide (UN Water 2017b, pp. 4–5).

The IMI's work in SDG monitoring is special as it is multi-layered, well organized and integrated. The IAEG has already cited IMI's coordination performance as a positive example for orientation towards other SDGs. Regarding this coordination, the IMI is structured as a project in which he acts as project leader. The project is currently financed by funds from Germany, Sweden, Switzerland and the Netherlands. The project team consists of representatives of the responsible UN agencies. Internal coordination meetings, a steering committee and a strategic advisory group form part of the project structure and work. In addition to joint agreements on methodologies and data collection, the IMI also develops joint products such as the newly implemented SDG 6 data portal and the synthesis reports. The regular exchange of information enables the synergies between the various indicator managers to be exploited to the full. However, technical discussions do not take place regularly but rather in connection with the development of synthesis reports. Since the first phase of work served to develop the methodologies and the baseline reports, no major changes and further developments are to be expected in this sense. (Huber 11/8/2019)

Responsibilities and roles

The responsibilities and roles in the SDG 6 monitoring process are defined nationally, regionally and globally. At the national level, the national statistical systems are responsible for monitoring and usually consist of national statistical authorities, line ministries and other national institutions, depending on the country. The role of the countries is to collect data and transmit it to the global custodian agency. It is at the discretion of each country which data and metadata are transmitted and published, whereby at least one national aggregate per indicator is required. Data that goes beyond the indicator's scope can be published in voluntary national reports. At the regional level, mechanisms are to be created to promote the transfer of data and metadata and capacity building. (UN Water 2017b, pp. 12–13)

Global monitoring lies in the hands of the appointed custodian agencies, which are either UN agencies or international organizations. Their task is to collect and verify country data. This also includes the creation of international standards and methodologies for monitoring, calculating estimates for missing data and adapting data. In addition, the custodians are expected to strengthen national monitoring and reporting capacities. Usually, the monitoring of the SDG 6 indicators is only

one part of the issues monitored by the agencies. Following the data analysis, custodians submit these as well as the determined regional and global aggregates to the UNSD, which publishes them on the SDG database and summarizes them in annual progress reports to inform the HLPF responsible for the follow-up and review. The organization and coordination of the custodian agency takes place under the auspices of the IMI under the direction of UN Water. (UN Water 2017b, p. 13)

Monitoring process

The monitoring process includes institutional and technical components. The institutional component mainly consists of the means of implementation required for monitoring. They include the formation of political support and institutional capacity, but also the alignment with national structures and the improvement of cross-sectoral collaboration which the IMI is globally responsible for. The countries are encouraged to appoint a national focal point for SDG 6 who take over the national coordination of the monitoring process and an intersectoral team. To support countries in this task, the IMI provides institutional guidelines, webinars and a help desk and organizes workshops. At the technical level, the custodian agencies are responsible for the implementation of indicator methodologies, which can vary greatly depending on the indicator, data source and involved stakeholders. The countries should share their data and metadata about the global indicators with the custodians, while the national focal point will be informed about data requests. The phased implementation of the SDG 6 monitoring framework officially started in 2015 with a baseline process that aimed to identify a global baseline for the SDG 6 indicators. In 2018 the HLPF conducted an in-depth review of SDG 6 which also drew from national voluntary reports on this subject. Since 2019 and until 2022, the goal is to reach global coverage and build national ownership of the monitoring process. The following phase between 2023 and 2026, is devoted to integrating and mainstreaming the monitoring efforts. The final phase lasting until 2030 is focused on consolidating and sustaining the monitoring process. (UN Water 2017b, p. 17)

The four phases of the IMI's approach are illustrated in the following figure.

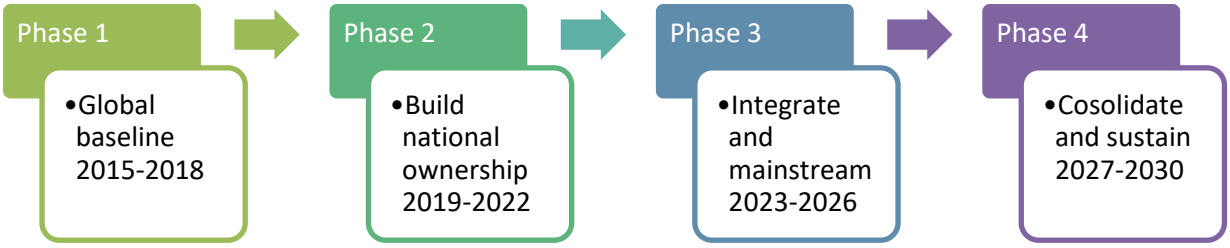


Figure 14 Phased approach to reach the IMI's goals based on (UN-Water 2019g)

The results of the first phase are the development of methodologies and capacity-building mechanisms, upgrading all indicators to Tier I or Tier II, identification of national focal points and raising awareness for SDG 6 monitoring in 95 countries. In addition, the IMI managed to collect global data for all indicators, hosted global workshop, published a synthesis report in 2018 and only recently launched a data portal for SDG 6. (UN-Water 2019i)

The currently conducted phase two focuses on enhancing data availability, supporting national capacity-building in monitoring and therefor also institutional and intersectoral cooperation. According to the UN Water's timeline for this phase, 2019 was devoted to refine methodologies and

initiate capacity-building, while in 2020 the latter will be continued and complemented by the second global data drive. The collected data will be analyzed and put into progress reports. (UN-Water 2019h)

Data flow

The data flow between the various parties involved in the global monitoring process of SDG 6 is illustrated in the following Figure 15. The central national statistical system is supported by the private sector, academia and civil society organizations and consists, as mentioned above, of the national statistical office, line ministries and other institutions. The countries additionally come together at regional organizations and provide data for the custodian agencies, which support the national systems in a variety of ways. The data and metadata of the countries end up in the country data lab. The custodians forward national, regional and global aggregates to UNSD. (UN Water 2017b, p. 12)

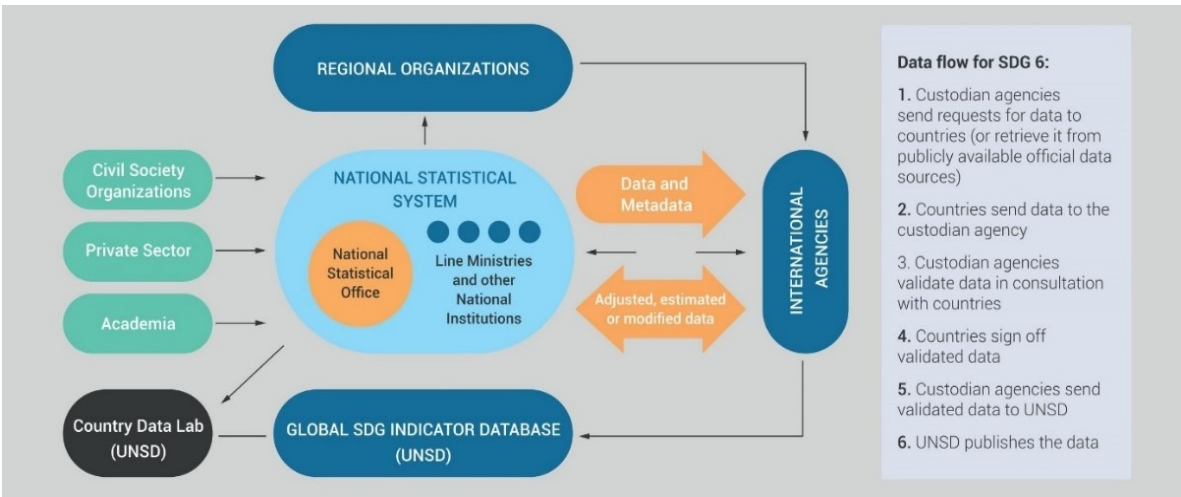


Figure 15 Dataflow within global monitoring (UN Water 2017b, p. 12)

Data portal

A new development in global monitoring is the launch of a new database and tool for visualization and analysis of all SDG 6 monitoring data called the UN-Water SDG 6 data portal. It was launched by the various custodian agencies and other key social, economic and environmental parameters in 2018. The published data is available for everyone and provides the options of downloading maps, charts, tables and country and regional fact sheets. The data sets can be interactively visualized and combined. The objective of the data portal is to track progress towards SDG 6, enable this advanced form of assessment and analysis, raise awareness for WASH, encourage monitoring and reporting and build one joint access point to all water and sanitation data within the UN system. Although linked to the Global SDG Indicators Database the SDG 6 data portal goes beyond its scope and additionally offers information on each SDG 6 indicator and the mentioned interactive tools. Further details on each specific indicator, metadata and qualitative analysis of its progress can be found at indicator-specific databases. This database is mainly dedicated to help stakeholders from different sectors to have an overview, see the sectors interlinkages, identify data gaps and learn about good practices and make sound decisions. The portal can be found under **http://sdg6data.org/**. It offers a

guided tour, when visited for the first time. UN-Water also hosted open webinars in October 2019 to explain and show the main functionalities of the portal that will be available shortly.

When looking at the monitoring structures, it becomes clear that global monitoring is based on national data. This means that national data must be collected or generated and made available for SDG 6 monitoring. In the context of SDG 6 monitoring, however, national monitoring is to be understood as the review of other nationally selected indicators that go beyond the global SDG 6 indicators.

National data collection for SDG 6

For the national monitoring process, impressions and lessons from the pilot phase were recorded. The inception workshops conducted served to identify already existing monitoring structures, to compare them with the implications of the 2030 agenda, to clarify roles and responsibilities, and to appoint technical teams and their members and institutions as their leaders. In addition, a national focal point and an intersectoral monitoring team had to be appointed, the relationship between the teams clarified and a baseline plan for the global indicators developed. (UN Water 2017b, p. 18)

The National Statistical Office is usually the authority on official statistical data. The national focal point acts as process coordinator and connects the national and global monitoring process. The technical teams for each indicator including their leaders are responsible for bringing different stakeholders together in order to gather data sources. For each team, at least one institution has been designated to be responsible. The tasks of these teams are the collection of data, the evaluation of this data, the review of the methodologies, the implementation of processes that enable the consolidation of the data and the discussion of additional indicators at national level. If necessary, they can obtain additional support from the custodian agency. The structure of the national monitoring system is shown in Figure 16. (UN Water 2017b, p. 19)

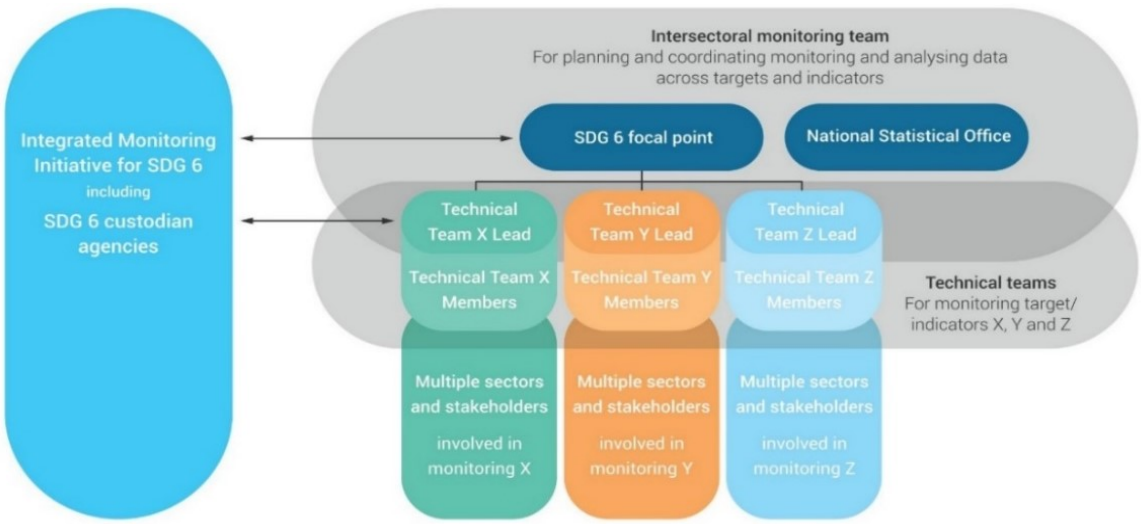


Figure 16 Organization of national stakeholders (UN Water 2017b, p. 19)

At the end of the pilot phase, workshops were held in which results and experiences were exchanged and a plan was drawn up for the further reporting cycles (UN Water 2017b, p. 18). One of the results

is that data availability in general was already very high in most of the countries, but their organizational structure is partly uncoordinated and data are distributed across different ministries and institutions (UN Water 2017b, p. 20). The topics of data collection, storage and analysis should function in a more coordinated way in the future (UN Water 2017b, p. 20). A further finding is that complete data sets do not necessarily have to be collected, since in many countries indicators are already being collected by other reporting mechanisms such as for example the Organization for Economic Cooperation and Development (OECD)/Eurostat questionnaire (6.3.1, 6.4.2) follow-up on the commitments of the African Ministers' Council on Water (AMCOW) and the Arab Ministerial Water Council (several SDG 6 global indicators), the European Union Water Framework Directive (6.3.2, 6.6.1) and the reporting under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (6.5.2), and the Ramsar Convention (6.6.1) (UN Water 2017b, p. 20).

In addition, four success factors were identified that constitute a successful monitoring system. These include policy support education, a focus on data use, links with national processes and structures, and the inclusion of stakeholders. Political support at all levels is so important because it facilitates the sharing of data between sectors and is essential for financial support for monitoring. To build this support, the benefits and importance of monitoring have to be highlighted. The relationship between national and global monitoring has to be explained and the national extent of possible achievement have to be gauged. In addition, existing national structures must be strengthened. The second success factor focusing on data usage addresses the link between monitoring and policy process. The data is therefore to be applied directly to the development of policies and plans. The ministry responsible for the implementation of the targets should also be responsible for monitoring the associated indicator, as these processes reinforce each other. In addition, data, lessons learned and good practices should be shared between countries and stakeholders within countries in order to increase efficiency and to allow for cross-sectoral data analysis. A high availability of data as well as a standardized, transparent and comprehensive analysis tool is indispensable. The data can be used to raise awareness among politicians, stakeholders and the public. Existing data gaps should be identified to prioritize water and wastewater policies and investments. The third factor relates to the integration of monitoring to existing national systems in all relevant sectors, the legislative development process, institutional frameworks and the statistical authority. The process should be fixed in the state budget as well as in work plans. The last success factor is the involvement of stakeholders at all sectors and governance levels and to define roles and responsibilities. (UN Water 2017b, pp. 20–22)

The test phase revealed that resources must be made available for monitoring both financial and human. The aspects to be considered are staff time, technical support and capacity building for the new indicators. Technical support that can be of use to countries is, for example, access to data from water and wastewater utilities, universities and NGOs, but also citizen science groups. Complementary data or sampling points can increase the temporary and spatial resolution of the data. Opportunities to receive additional financial support include bilateral donors, and development banks, infrastructure investments or business communities that can thus fulfill their social responsibilities. In addition, financial benefits from synergies between monitoring SDG 6 and other SDGs can be achieved by extending surveys to query multiple indicators or sharing data such as health data and Earth observation. (UN Water 2017b, pp. 22–23)

Analytical tools and frameworks already identified and used in the test phase are e.g. (UN Water 2017b, p. 25):

- System of Environmental-Economic Accounting (SEEA)
- Integrated water resource management (IWRM)
- The Driving forces, Pressures, State, Impact, Responses framework (DPSIR) used by the European Environment Agency and the European Union Water Framework Directive
- SDG Policy Support System (SDG PSS) developed by the United Nations University
- Methodology by the United Nations Economic and Social Commission for Asia and the Pacific for mapping and assessing interlinkages across the 2030 Agenda
- Water risks and management assessment tools by the business community

Ultimately, the collected data and analysis should be made available to the stakeholders in an appropriate form. The needs of politicians, for example, are synthesis reports in which trends, risks and opportunities are highlighted, scientists are more interested in metadata, while decision makers in the public and private sectors benefit from detailed and disaggregated data. To inform the public it is recommended to work with key messages. The data should also be available online. (UN Water 2017b, p. 26)

3.4.2 The Joint Monitoring Program

History

The WHO/UNICEF Joint Monitoring Program for Water Supply, Sanitation and Hygiene (JMP) was established in 1990 as a result of the consolidation of the WHO's and the UNICEF'S monitoring activities concerning the topics drinking water and sanitation (Bartram et al. 2014, p. 8141). The JMP's objectives are the tracking of global, regional and national progress concerning access to drinking water and sanitation in order to accelerate their achievement and to this end the development progress (WHO and UNICEF 1992, p. 1). Before joining forces, the WHO und UNICEF separately carried the responsibility for monitoring drinking water and sanitation. The decade between 1981 and 1990 was designated as the International Drinking Water and Sanitation Decade (IDWSS) by the UN, as the result of the UN Water Conference at Mar Del Plata in 1977 (Bartram et al. 2014, p. 8141). Throughout the 1980s the WHO gathered data on water and sanitation coverage within their DEMOS monitoring system, which was part of the IDWSS review process (WHO and UNICEF 1992, p. 3). The review revealed the insufficient character of the water and sanitation sector management which led to the call for enhancing development in the sector during the 1990s and enhanced monitoring efforts in several conferences, including the New Delhi Conference, the World Summit for Children and the International Conference on Water and the Environment (WHO and UNICEF 1992, pp. 4–5). Moreover, the General Assembly decided to review the progress within the drinking water and sanitation sector at its 50th session in 1995 (WHO and UNICEF 1992, p. 3)

The WHO recognized the urgency of improving monitoring especially at country level and extending the monitoring's purpose from a mere passive representation of the status quo to a tool that promotes sectoral development. In order to do so the monitoring had to implement indicators and enhance both monitoring frequency and capacity at all levels. Launching the JMP in 1990 was the WHO's and UNICEF's attempt to satisfy these demands. The three core indicators *coverage*, *management* and *funding* were established and incorporated in a computer monitoring program

called WASAMS (Water and Sanitation Monitoring System). *Coverage* concerned the share of population having access to drinking water and sanitation in form of systems like household water, sewerage connections, hand-pumps and improved pit latrines. The indicator *management* quantified a community's financial input into operation, maintenance and management. The last indicator *funding* was established to quantify the investments in the sector and displays which part of them were made in low-cost technologies. The WASAMS was categorized as a decision support system (DSS) which is a strategic and policy information management system that seeks to support decision makers. (WHO and UNICEF 1992, pp. 6–7)

In addition to WASAMS, the JMP held regional monitoring workshops, interministerial meetings, and defined realistic sector goals, effective frameworks and national monitoring units (NMU). Because the original monitoring process consisted of using WASAMS for data analysis on country level, in order to provide baseline values, the JMP suggested monitoring initiatives on community level prospectively. In late 1990 70 out of the 130 countries receiving a questionnaire assessed their sector status with the data they collected in WASAMS and sent a baseline report. (WHO and UNICEF 1992, p. 2)

The data collection built on already existing systems at country level as censuses, household surveys and government administration networks with reporting routines. However, in 1997 the two agencies decided to improve their approach for estimating coverage by replacing government-provided data with data gathered directly through censuses and nationally-representative household-surveys. The motivation for this change was financial saving and more importantly more realistic and accurate coverage estimates. (Bartram et al. 2014, p. 8141)

Monitoring SDG target 6.1

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all	*6.1.1 Proportion of population using safely managed drinking water services*

First of all, the JMP does not calculate and report on national estimates, if national data does not represent a minimum of 50% of a country's relevant population (WHO and UNICEF 2019d, p. 81). As mentioned in the general methodology, the data sources are household surveys, institutional records and in this case licensed service providers. The database for monitoring SDG 6.1 is managed by the JMP (UN Water 2017c, p. 9). The analysis of the data is carried out by WHO and UNICEF. The following points have to be considered.

Universal access for all: The term *access for all* includes institutional settings and public spaces, which is why access in schools and health-care facilities is monitored by the JMP as well as in households. Nevertheless, it is not part of the target's indicator but of the JMP's additional monitoring work. (UN Water 2017c, p. 8)

Accessibility: *Accessibility*, however, is part of the indicator's scope and monitored through travel time for water collection and the location of the water source that are usually asked for in national household surveys and censuses. Apart from data from household surveys and censuses, available sector data on household connections or maximum distance to water sources can be used. (WHO and UNICEF 2017a, p. 10)

Equitability: In order to identify inequalities, the data on WASH should be disaggregated by individual characteristics like sex, age and disability, ethnicity, race, religion, migratory status. If possible, the JMP provides wealth quintiles for rural and urban areas, depending on the given data. Just as the universality of access, this part of the target is not specifically mentioned in the indicator. (UN Water 2017c, p. 8)

Safety: The indicator 6.1.1 measures *drinking water quality* in order to monitor the safety of water. The majority of Member States already have adjusted their national standards to the WHO Guidelines for Drinking Water Quality (WHO and UNICEF 2017c, p. 38). The globally used indicator for that is Escherichia Coli (*E.coli*). To guarantee water safety, the JMP recommends establishing a risk management approach such as a Water Safety Plan (WSP) (WHO and UNICEF 2017c, p. 43). Since the minority of countries have data on the share of people whose drinking water supplies are managed under a WSP, the globally used indicator is *E.coli* which indicates faecal contamination (WHO and UNICEF 2017c, p. 38). Another option of assessing the microbiological quality is measuring thermotolerant coliforms (WHO and UNICEF 2017a, pp. 10–11). For additionally monitoring chemical quality the parameters arsenic and fluoride are usually used as indicator parameters due to their natural appearance and their potentially severe health consequences (WHO and UNICEF 2017a, p. 11). For some countries another opportunity is the indicator residual chlorine which is useful when dealing with chlorinated water supplies (WHO and UNICEF 2017c, p. 38). The data on this aspect is usually available at national authorities, if it isn't, household surveys are a possible approach to collect the data (WHO and UNICEF 2017a, p. 11). In some cases, sector data do not include the parameters *E.coli*, arsenic and fluoride, mainly cover the urban sector and formal systems like piped systems or report compliance with several parameters as a combined indicator and not with each parameter on its own (WHO and UNICEF 2017c, p. 40). For this cause UNICEF's MICS program and JMP developed a cost-effective approach to test water quality within household surveys by using membrane filtration and dehydrated growth plates (WHO and UNICEF 2017c, pp. 39–40). The field teams test water from the point of collection and consumption to identify change in quality between them (WHO and UNICEF 2017c, pp. 39–40). Since data on water quality at the point of delivery or collection is more common than at the point of consumption, the JMP uses this data to monitor safely managed drinking water (WHO and UNICEF 2017c, p. 41).

Affordability: To monitor *affordability* the JMP and the World Bank developed the approach of comparing the amount of money used for gaining access to water to a household's entire consumption. However it is not part of the target's indicator, hence not reflected in the estimate for safely managed drinking services. (UN Water 2017c, p. 8)

Source of drinking water and availability: The source of drinking water that is monitored, is the household's *primary source*. Nevertheless, many households use more than one source of drinking water. Knowledge of these secondary sources can provide data on the *availability* of drinking water, when the use of this source is connected to problems with the primary source. Due to scarcity of data on secondary sources, the JMP uses data on *primary sources*. To measure availability the JMP uses household surveys or censuses that include questions about *availability*. Possible questions concern problems within the past week or month or whether drinking water is available at the day of the survey. If this data is not provided, the JMP draws on sectoral data such as service hours from utilities or regulators. However, these data sources mainly cover piped water supply systems. (WHO and UNICEF 2017c, p. 33)

Safely managed drinking water services: As mentioned before, the final indicator *safely managed drinking water services* is monitored through data on the type of water source and the sub-indicator *water quality* and a minimum of one of the two sub-indicators *accessibility* and *availability* for at least half of a country's population (WHO and UNICEF 2019d, p. 83). The is therefore produced by identifying household using an *improved source that is accessible on the premises, available when needed and free from contamination* (WHO and UNICEF 2019d, p. 16). This approach means only the criteria with the lowest percentage determines the height of the estimate, since it is decisive on the proportion of households, fulfilling all criteria (WHO and UNICEF 2017a, p. 16). The following figure illustrated the determination of the final estimates for all service levels.

Figure 17 Elements of safely managed drinking water service (WHO/UNICEF JMP 2019, p. 48)

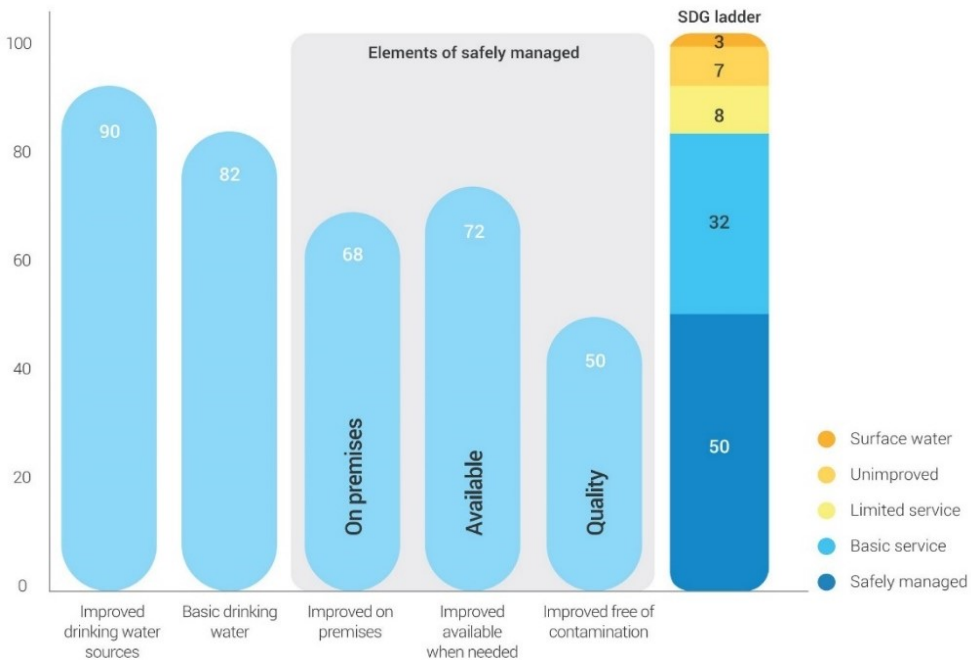


Figure 18 Estimation of service levels for indicator 6.1.1 (UN Water 2017b p.16)

Monitoring SDG target 6.2

6.2 By 2030, achieve access to adequate and	*6.2.1 Proportion of population using safely*

equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	*managed sanitation services* *6.2.2 including a hand-washing facility with soap and water*

The indicator consists of two aspects that have to be considered separately. The first aspect is the use of *safely managed sanitation services*, the second of using *hand-washing facilities with soap and water*.

Access for all: The term access is used in the same way as it is the case in target 6.1. Aside households, the described quality of access should be achieved in other settings such schools and health-care facilities. (UN Water 2017c, p. 11)

Adequacy and equity: Adequate access is further specified by the indicators. In case of sanitation, safely managed services should be achieved, including an improved facility that is not shared and ensuring safe disposal and treatment of excreta or wastewater respectively. Adequate hygiene services are defined by the indicator 6.2.2 as basic services that provide a hand-washing facility with both soap and water. Equity, however, is not specifically addressed within the indicators. (UN Water 2017c, p. 11)

Ending open defecation: Lowering the proportion of population practicing open defecation and eventually ending it is achieved through increasing access to safely managed sanitation services. The JMP monitors the proportion of population practicing open defecation. It is not directly mentioned in the indicator 6.2.1 but throughout its estimation data on the amount of people without an improved sanitation facility is gathered and can be used for addition calculations for the aspect of open defecation. (UN Water 2017c, p. 11)

Special attention to the needs of women and girls and those in vulnerable situations: The special needs of women and girls are for example their use of a safe and lockable facility that is not shared which is especially important when conducting menstrual hygiene. The second part of the sentence addresses lowering inequalities and improving the living conditions of people in most desperate situation. Both elements are not directly measured within the scope of the indicators. The JMP measures inequalities by using wealth quintiles and the described service ladders. In this context it progress report from 2017 that was designated to focus on inequalities. (UN Water 2017c, p. 11)

Indicator 6.2.1

Safely managed sanitation services: Safely managed sanitation services are defined as *improved facilities which are not shared and where the excreta are safely disposed in situ or transported and treated off-site* (WHO and UNICEF 2017a, p. 11). Types of *improved facilities* are listed in Table 5. In addition to that there are different processes of treatment that are categorized as *safely managed*.

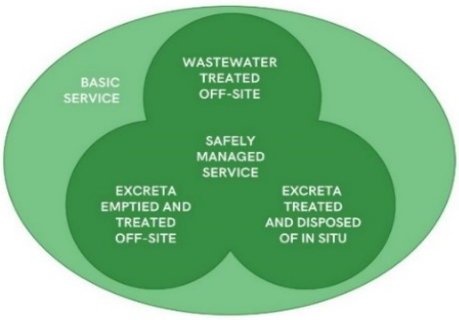


Figure 19 Elements of safely managed (WHO/UNICEF JMP 2019 p. 62)

Table 5 JMP classification of facility types based on (WHO and UNICEF 2017a, p. 9)

	Drinking water	***Sanitation***
Unimproved facilities	*Non-piped supplies* • *Unprotected wells and springs*	*On-site sanitation* • *Pit latrines without slabs* • *Hanging latrines* • *Bucket latrines*
Improved facilities	*Piped supplies* • *Tap water in the dwelling, yard or plot* • *Public standposts* *Non-piped supplies* • *Boreholes/Tubewells* • *Protected wells and springs* • *Rainwater* • *Packaged water (bottled water and sachet water)* • *Delivered water (tanker trucks and small carts)*	*Networked sanitation* • *Flush and pour flush toilets connected to sewers* *On-site sanitation* • *Flush and pour flush toilets or latrines connected to septic tanks or pits* • *Ventilated improved pit latrines* • *Pit latrines with slabs* • *Composting toilets (twin pit latrines and container-based systems*
No facilities	*Surface water*	*Open defecation*

Figure 20 presents a variety of possible treatment option for wastewater and faecal sludge. Within the JMP's approach the treatment is categorized as *safely managed*, when conducting at least secondary treatment or higher for wastewater and at least dewatering and/or stabilizing faecal sludge which are highlighted in the figure with red frames (WHO and UN-Habitat 2018, p. 26).

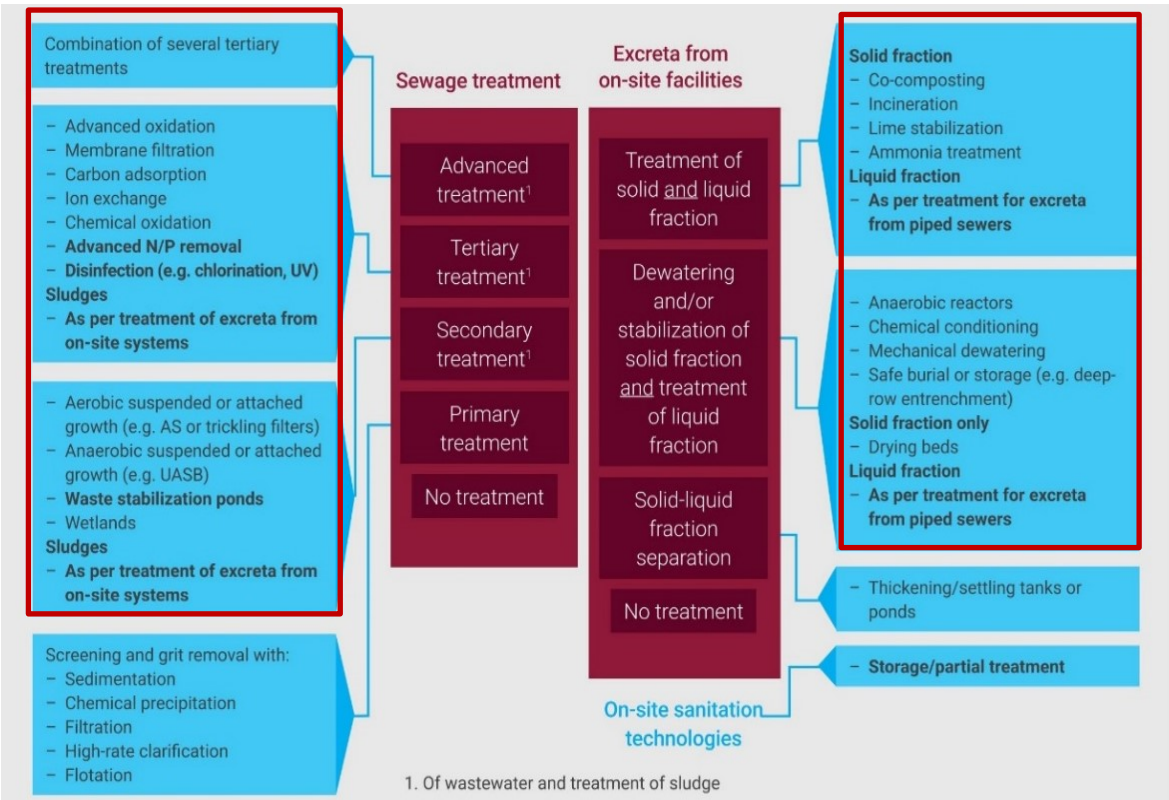


Figure 20 Description of treatment types (WHO and UN-Habitat 2018, p. 27)

In order to monitor this indicator firstly the type of facility and the aspect of sharing has to be measured. The JMP then calculates estimates for the three treatment and disposal options as proportion of people having *basic services*. The sum of these three percentages builds the *proportion of people having access to safely managed sanitation services*. (WHO and UNICEF 2017a, p. 17)

Improved facilities: Data on the *proportion of population using improved facilities* is gathered through household surveys. The results are data points for rural and urban areas which each get straightened with linear regression. The combination of those two lines allows calculation national estimates. Th estimates are used to populate the sanitation service ladder. (WHO and UNICEF 2017a, p. 17)

Not shared: The definition of being *not shared* rises from the demand of human rights and is meant to provide privacy and dignity. The information is also collected through household surveys. (WHO and UNICEF 2017a, p. 17)

Excreta treated and disposed in situ: This definition applies to facilities such as composting toilets that do not need to be emptied but provide a treatment and disposal at the point of use. The data on this facility type is usually obtained in household surveys. (WHO and UNICEF 2017a, pp. 11–12)

Excreta emptied and treated off-site: Facilities that need to be emptied such as pit latrines or septic tanks require a safe treatment that is carried out off-site within a treatment facility. Therefor data on the use of those facilities and their emptying should be drawn from household surveys while data on the treatment should be drawn from the facility operators. (WHO and UNICEF 2017a, pp. 11–12)

Wastewater treated off-site: All sewered systems generate wastewater that has to be treated off-site. To monitor the volume of wastewater treated off-site the JMP uses sector data on the number of sewage connections. A disadvantage of this approach is that sector data primarily covers urban information and that treatment information is only provided by service providers. Moreover, data on containment and transport is very scarce. (WHO and UNICEF 2017a, p. 12)

Indicator 6.2.2

Hand washing facilities with soap and water: The information on hand washing facilities and availability of water and soap is covered by observation of handwashing or at least the facilities within the household surveys. MICS and DHS survey formats contain a standard module asking if the person conducting the survey can see the space, in which residents commonly wash their hands. If both water and soap is available at the facility, the *basic service* level is achieved. Additionally, the JMP estimates what proportion of people use *limited* or *no services*. To classify as *limited service*, the facility is available on the premises but does not provide soap and water. If the facility is not located on the premises, the household is classified as having *no service*. (WHO and UNICEF 2017a, p. 18)

The JMP's Methodology for indicators 6.1.1 and 6.2.1/6.2.2

Since the monitoring of these indicators resemble each other concerning their methodology, the following paragraphs relate to both of them. The JMP developed an overall monitoring methodology that involves data sources, data compilation, classification with the help of service ladders and producing national, regional and global estimates.

Data sources

Besides household surveys and national censuses, the JMP also uses administrative data and other data such as data from international or sectoral sources (WHO and UNICEF 2017a, pp. 6–7). Figure 21 illustrates the number of data sources used for the 2015 and the 2017 progress report. It shows a general increase in data sources and especially in the amount of administrative data sources.

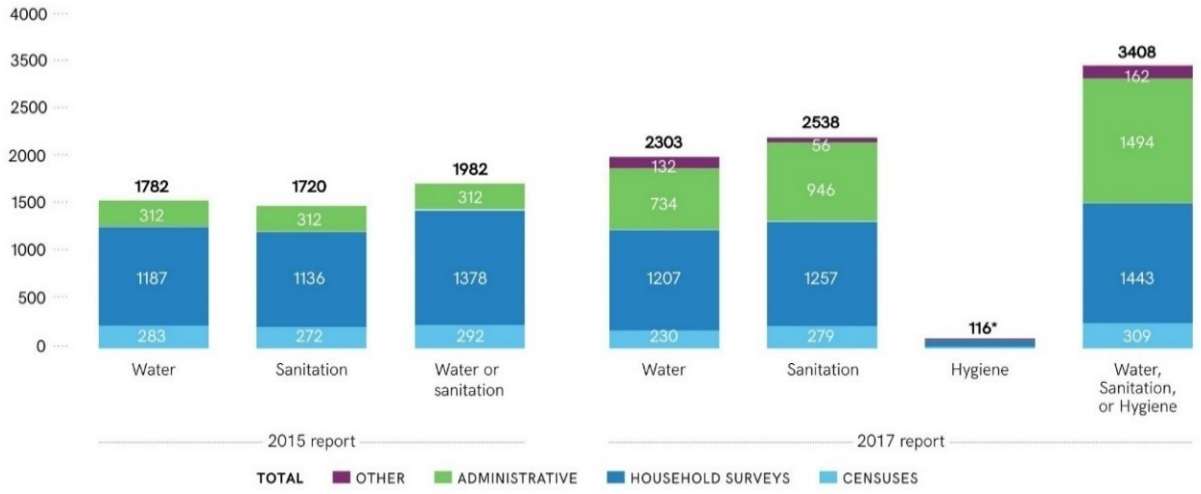


Figure 21 Number of data sources used in the JMP progress reports in 2015 and 2017 (WHO and UNICEF 2017b, p. 51)

The data source national censuses are typically conducted every ten years and collect data on a country's whole population by using interviews or questionnaires (Bartram et al. 2014, p. 8143). Household surveys are undertaken at shorter intervals in over 100 countries by their national statistical offices (Bartram et al. 2014, p. 8146). The JMP collaborates with other international survey programs such as the Demographic and Health Survey program (DHS), Living Standard Measurement Study (LSMS) and the Multiple Indicator Cluster Survey program (MICS) (Bartram et al. 2014, p. 8141). MICS was developed by the UNICEF in the 1990s as a response to the World Summit for Children and comprises about a multitude of indicators assess the progress on a several of topics like health, education, children's protection and since 2015 the SDGs (Bartram et al. 2014, p. 8141). DHS surveys use different kinds of questionnaires to collect data. One of them is a household questionnaire and comprises information on household characteristics such as for example sanitation, drinking water, household wealth, hand washing, birth registration and education (NSO and ICF 2019, pp. 7–15). LSMS was implemented in the early 1980s and provides data on household as for example labor, enterprises, migration, subjective poverty, durable goods and type of water source (inStat 2005, p. 1).

In order to conduct a survey each country is divided into Primary Sampling Units of equal population . (Bartram et al. 2014, p. 8144) In each PSU the households are counted and randomized before 10 to 35 households get selected (Bartram et al. 2014, p. 8144). When there is no raw data available the JMP uses survey or census reports produced by national statistical offices. If those are not available either, the JMP uses data from national government agencies after reviewing their consistency (WHO and UNICEF 2017a, p. 7). Combined with data collected by non-governmental agencies this source classifies as administrative dataset. Water and sanitation databases and reports of regulators are examples (WHO/UNICEF JMP 2017, p. 7). The fourth type of dataset includes every other dataset for

example data from international initiatives and studies by research institutes (WHO and UNICEF 2017a, p. 7). The JMP only uses datasets that cover at least 20% of the relevant population (WHO and UNICEF 2017a, p. 7). In 2017 out of 3653 available datasets, 2871 were used for the calculation of national, regional and global estimates on 26 indicators related to water, sanitation and hygiene (WHO and UNICEF 2017a, p. 6).

The process is composed of five steps. First of all, the available national datasets have to be identified through JMP staff members. They review the available data from national statistical offices, relevant ministries and regulators as well as other global and regional databases. In addition, regional and country offices of UNICEF and WHO are instructed to identify new household surveys, administrative datasets and censuses. UNIFEC also operates an internal system called CRING (Country Reporting on Indicators and Goals) which is used for data submission and thus constitutes another way of data identification. (WHO and UNICEF 2017a, pp. 6–7)

Data compilation

As a second step the relevant data are extracted and transferred into a standardized spreadsheet. The JMP produces spreadsheets for each Member State with separate sheets for each of the three topics water, sanitation and hygiene. In the course of data compilation, the JMP prefers using metadata, though in a lot of cases has to use transcribed data from different reporting formats. When compiling data for producing country files, the three elements y*ear assignment*, *geographic scope* and *weighting* have to be considered. When a dataset extends over several years, the last year of data collection is assigned as the year of the dataset. If for a single year multiple records are available, they are combined. Their average is used as that year's value. The JMP aims to collect data on national, rural and urban level. Data that are not representing one of these levels are either not used at all or marked as non-representative. While it is the *proportion of population* not the *proportion of households* that is provided by the JMP, the data should include population weights. When the data lacks this information, it can be calculated through multiplying household weights and number of household residents or drawn from statistics based on household weightings. (WHO and UNICEF 2017a, p. 8)

Ladders and classifications of technologies

Since 2015 the JMP is responsible for monitoring the SDG targets related to WASH, which are 6.1 and 6.2. For monitoring the reduction of inequalities, the JMP developed 5 service ladders that provide information of the used type of facilities and the level of service (WHO and UNICEF 2017a). Two ladders are dedicated to the definitions of service levels of access to drinking water and sanitation, one ladder defines the service levels concerning hygiene and the two ladders define service level of WASH in schools and health-care facilities. Table 5 displays the 5 service ladders. Since the categories WASH in schools and WASH in health care facilities are not categorized as *safely managed* but instead as *advanced*, these two service levels are displayed in one row, the same applies to the last two rows which both display several service levels for the sake of clarity. (WHO and UNICEF 2017a, pp. 8–9)

Since monitoring the MDGs in 2000 the JMP classified the access types of drinking water and sanitation in *improved* and *unimproved* (WHO and UNICEF 2017c, p. 12). To further disaggregate service levels the JMP uses the mentioned ladders. In 2015 the JMP enhanced its service ladders to

adjust them to the SDG indicators and improve monitoring (WHO and UNICEF 2017c, p. 12). Concerning the drinking water ladder the existing categories got complemented by additional criteria that cover the new priorities *accessibility*, *availability* and *service quality* (WHO and UNICEF 2017c, p. 12). The thought behind adding additional criteria is giving all countries the opportunity to benchmark their status quo and compare it over time regardless of their development level (WHO and UNICEF 2017c, p. 12). The bottom level still reflects having *no service* in form of using surface water and on the other all other types of sources which are categorized as *unimproved*. Having *improved sources* of drinking water is one precondition of having an either *limited*, *basic* or *safely managed* service *level*. These sources are potentially capable of meeting the requirements to be classified as safe water (WHO and UNICEF 2017c, p. 13). The difference between *basic* and *limited* service level is the duration of collection time. While the *basic* level is used for drinking water from *improved sources* with a collection time of 30 minutes or less, *limited* level is defined as drinking water from an *improved source* but a collection time over 30 minutes (WHO and UNICEF 2017c, p. 12). To classify as *safely managed* service, drinking water from an *improved source* has so meet the conditions *located on premises*, *available when needed and free from faecal and priority chemical contamination* (WHO and UNICEF 2017c, p. 13). Using surface water does not classify as a drinking water service (WHO and UNICEF 2017a, p. 9). The same service levels apply to sanitation (WHO and UNICEF 2017b, p. 8). The definitions are listed in Table 6.

In contrast to that there are only three hygiene service levels, the highest being *basic* level, defined as *availability of hand washing facility on premises with water and soap* (WHO and UNICEF 2017b, p. 9). If soap and water is not available the service only classifies as *limited* (WHO and UNICEF 2017b, p. 9). Both service levels count as *improved service* (WHO and UNICEF 2017b, p. 9). An *unimproved* hygiene service is defined as *not having a handwashing facility on the premises*. In practical implementation the definitions *improved* and *unimproved* refer to different technical designs (WHO and UNICEF 2017a, p. 9).

Table 6 JMP Service ladders based on (WHO and UNICEF 2019e, p. 2) (WHO and UNICEF 2018b, p. 11) (WHO and UNICEF 2017b, p. 8)

Service level	Households			WASH in schools			WASH in HCF				
	Drinking water	Sanitation	Hygiene	Drinking water	Sanitation	Hygiene	Water	Sanitation	Hygiene	Health Care Waste	Environmental cleaning
Safely managed/ Advanced (WASH in schools and HCF)	Drinking water from an improved water source which is located on premises, available when needed and free from faecal and priority chemical contamination	Use of improved facilities which are not shared with other households and where excreta are safely disposed in situ or transported and treated off-site		To be defined at national level	To be defined at national level	To be defined at national level	To be defined at national level	To be defined at national level	To be defined at national level	To be defined at national level	To be defined at national level
Basic	Drinking water from an improved source, provided collection time is not more than 30 minutes for a roundtrip including queuing	Use of improved facilities which are not shared with other households	Availability of a handwashing facility on premises with soap and water	Drinking water from an improved source is available at the school	Improved facilities, which are single-sex and usable at the school	Handwashing facilities, which have water and soap available	Water is available from an improved source on the premises.	Improved sanitation facilities are usable with at least one toilet dedicated for staff, at least one sex-separated toilet with menstrual hygiene facilities, and at least one toilet accessible for people with limited mobility.	Functional hand hygiene facilities (with water and soap and/or alcohol-based hand rub) are available at points of care, and within 5 meters of toilets.	Waste is safely segregated into at least three bins, and sharps and infectious waste are treated and disposed of safely.	Basic protocols for cleaning are available, and staff with cleaning responsibilities have all received training.

Service level	Households			WASH in schools			WASH in HCF				
	Drinking water	Sanitation	Hygiene	Drinking water	Sanitation	Hygiene	Water	Sanitation	Hygiene	Health Care Waste	Environmental cleaning
Limited	Drinking water from an improved source for which collection time exceeds 30 minutes for a roundtrip including queuing	Use of improved facilities shared between two or more households	Availability of a handwashing facility on premises without soap and water	There is an improved source (piped, protected well/spring, rainwater, packaged/ delivered water), but water not available at time of survey	There are improved facilities (flush/pour-flush toilets, pit latrine with slab, composting toilet), but not single-sex or not usable at time of survey	Handwashing facilities with water, but no soap	An improved water source is within 500 meters of the premises, but not all requirements for basic service are met.	At least one improved sanitation facility, but not all requirements for basic service are met.	Functional hand hygiene facilities are available at either point of care or toilets, but not both.	There is limited separation and/or treatment and disposal of sharps and infectious waste, but not all requirements for basic service are met.	There are cleaning protocols and/or at least some staff have received training on cleaning.
Unimproved / no facility (Hygiene)/no services (WASH)	Drinking water from an unprotected dug well or unprotected spring	Use of pit latrines without a slab or platform, hanging latrines or bucket latrines	No handwashing facility on premises	No water source or unimproved source (unprotected well/spring, surface water)	No toilets or latrines, or unimproved facilities (pit latrines without a slab or platform, hanging latrines, bucket latrines)	No hand-washing facilities at the school or hand-washing facilities with no water	Water is taken from unprotected dug wells or springs, or surface water sources; or an improved source that is more than 500 meters from the facility; or the facility has no water source.	Toilet facilities are unimproved (pit latrines without a slab or platform, hanging latrines and bucket latrines), or there are no toilets or latrines at the facility.	No functional hand hygiene facilities are available at either point of care or toilets.	There are no separate bins for sharps or infectious waste, and sharps and/or infectious waste are not treated/disposed of safely.	No cleaning protocols are available and no staff have received training on cleaning.
Surface water (Drinking water)/ Open defecation (Sanitation)	Drinking water directly from a river, dam, lake, pond, stream, canal or irrigation canal	Disposal of human faeces in fields, forests, bushes, open bodies of water, beaches and other open spaces or with solid waste									

Data validation and acceptance

Whilst analysis data ambiguity might appear. In case of ambiguous data that cannot be classified in one of the JMP categories, the JMP adjusts the data by comparing it to a different data set for the same country and time. If there are several datasets, the closest in time is used. Assuming that the dataset provides data points that differ significantly from the data points of other datasets for the same country and time, the dataset can be excluded from the JMPs calculation of estimates. Other possible reason for exclusion are hints from national authorities indicating that the datasets are not reliable or appropriate, use of classifications that do not align with JMP classifications, data gaps for urban and rural population or obvious data gaps when summing up categories. (WHO and UNICEF 2017a, p. 12)

There are two approaches of dealing with conflicting data. Either all data, regardless of their contradictions, are fed into the database and the development is modelled by means of linear regression, or data points are switched off. This happens due to the nature of their collection, technical problems within the collection or too great discrepancy between the categories of data collection and the categories of indicators. Another reason for data exclusion may be the fact that the data represent too small a proportion of the population or utilities, so that this data is mentioned but not used to determine an estimate. (Huber 10/2/2019)

Producing national estimates

To produce national estimates the estimates for rural and urban areas are weighted based on population data from the latest UN Population Division report. In case a country's entire population is classified as urban or rural or data are not disaggregated into urban and rural, the estimates are generated directly. The estimates for the indicators safely managed drinking water or sanitation services can only be calculated as a combined value when estimates for all the required elements in case of drinking water *improved/unimproved*, *accessibility*, *availability* and *quality* are available. Often there are insufficient data on wastewater treatment and drinking water quality. In these cases, the JMP only produces estimates for the single indicators. When producing estimates for indicators the JMP differentiates between primary and secondary indicators and ratios which should not be confused with the SDG indicators. The primary indicator estimates are produced directly from data inputs while the secondary indicator estimates are calculated. For producing the estimates of those 9 primary indicators, indicators displayed in Table 7, there are several rules on interpolation, extrapolation and extension that have to be taken into account. In the estimating process only data points collected at least two years prior to the report are used. (WHO and UNICEF 2017a, p. 13)

Table 7 Primary indicators for producing estimates based on (WHO/UNICEF JMP 2017 p.13)

Water	***The proportion of the population that uses***
W1	*improved drinking water sources*
W2	*piped water drinking water sources*
W5	*no drinking water facility (surface water)*
Sanitation	***The proportion of the population that uses***
S1	*improved sanitation facilities*
S2	*Improved sanitation facilities connected to sewers*
S3	*Improved sanitation facilities connected to septic tanks*
S6	*no sanitation facilities (open defecation)*
Hygiene	***The proportion of the population that has***
H1	*a handwashing facility on premises*
H2	*a handwashing facility on premises with soap and water available (basic handwashing facility)*

Interpolation: When data inputs within the covered years are at least five years apart, the estimates are interpolated by using ordinary least squares linear regression. Time intervals between data points that are below five years lead to estimating by using averages. (WHO and UNICEF 2017a, p. 13)

Extrapolation: Outside of the years, covered by data input, estimates are extrapolated through linear regression two years forwards from the latest data point and two years backwards from the earliest when there are at least two data points. When there is only one data point there is no extrapolation made and when the extrapolated estimates exceed 100% or go below 0%, they are fixed at the respective border. (WHO and UNICEF 2017a, p. 13)

Extension: The estimates are extended four years forwards from the latest and backwards from the earliest estimate, unless the estimates are above 99,5% or below 0,5%. In these cases, the extensions are indefinite. (WHO and UNICEF 2017a, p. 13)

Figure 22 illustrates these rules. The time span between the earliest data point in 2008 and the latest data point in 2014 is six years, so the estimate is interpolated using linear regression. In addition, these two data points get extrapolated. The data point from 2008 is extrapolated to 2006 while the data point from 2014 is extrapolated to 2015 because it is a graph from the report published in 2017. That is also why only the data point from 2008 is extended backwards four years until 2002.

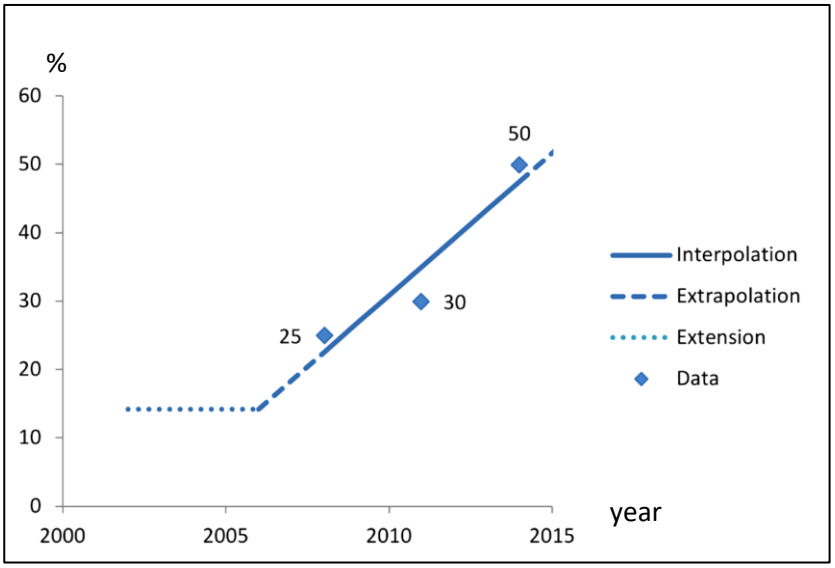


Figure 22 Rules of calculating estimates (WHO and UNICEF 2017a, p. 14)

Adding new data ultimately leads to changed estimates. This also applies to past estimates. Even the estimates of the baseline year 2000 can change due to the implications of these rules. Dependencies within the nine indicators lead to more considerations. One of them is that the sum of estimates for *sewered systems* and *septic tanks* can logically never exceed the estimate for *improved sanitation facilities*. Due to the process of regression this can possibly happen and requires standard corrections. If the addition of *sewered systems* and *septic tanks* leads to a value that exceeds the estimate for *improved sanitation*, they are both lowered proportionally until they equal the estimate, while the estimate for *improved latrines* is set to zero. (WHO and UNICEF 2017a, p. 15)

Ratios: There are ten ratios that the JMP estimates from data input displayed inTable 8. They are not published but necessary for calculating secondary indicators. Although they are all population ratios, some of them are actually produced by using volumes of wastewater or excreta, like RS3 and RS5. Many of the ratios are used to estimate safely managed services for both water and sanitation. These are calculated in the same way that the primary estimates are calculated. Only the two ratios RW1 and RS1 are produced using averages. If the ratio of RW1 exceeds the ratio of RW2, it is set equal to RW2 because of the assumption that premises have a spatial extension, which allows to reach the facility within 30 minutes . (WHO and UNICEF 2017a, pp. 15–16)

Table 8 Ratios based on (WHO/UNICEF JMP 2017, p.16)

Sanitation	***The ratio of the population using***
RS1	*improved facilities which are not shared with other households*
RS2	*sewer connections where wastes treatment plants*
RS3	*sewer connections where wastes reach treatment plants and are treated*
RS4	*improved on-site sanitation facilities where wastes reach treatment plants*
RS5	*improved on-site sanitation facilities where wastes reach treatment plants and are treated*
RS6	*improved on-site sanitation facilities where wastes are treated and disposed in of situ*
Water	***The ratio of the population using***
RW1	*improved sources not exceeding 30 minutes collection time*
RW2	*improved sources which are accessible on premises*
RW3	*improved sources which are available when needed*
RW4	*improved sources which are free from contamination*

To finally produce estimates for the 16 secondary indicators, primary indicators and ratios are combined. To calculate an estimate for *basic drinking water services* the estimates for the primary indicator *population using improved sources* is multiplied by the ratio *population using improved sources within 30 minutes collection time*. For *limited drinking water services*, the same primary indicator is multiplied by 100% minus the ratio of the *population using improved sources within 30 minutes collection time*. The indicator *safely managed drinking water services* is the most complex in calculation. Beforehand three other indicators have to be calculated by multiplying the *proportion of population using improved water services* with the ratios *improved sources which are accessible on premise*, *available when needed* and *free from contamination*. The minimum of these three indicators is the estimate *safely managed drinking water services*. (WHO and UNICEF 2017a, p. 16)

For secondary indicators for sanitation the same calculation methods are applied to estimate *basic* and *limited sanitation services*. In case there are no further specification on the type of on-site sanitation facility the JMP handles them as being improved latrines or other. *Safely managed*

sanitation services are estimated as the sum of the three indicators *sewer connections where wastes reach treatment plants and are treated*, *on-site sanitation facilities where wastes reach treatment plants and are treated* and *improved on-site sanitation facilities where wastes treated are disposed of in situ*. The secondary hygiene indicator is the *proportion of the population which has a handwashing station in the home lacking soap*. To further analyse the change of indicators over time, the JMP uses annual rates of change (ARC) as the difference between two estimates and dividing them by their temporal distance in number of years. A negative ARC is a decline in proportion of population using the respective level of services. In case of open defecation, a negative ACR indicates a positive development. (WHO and UNICEF 2017a, p. 18)

A table of all indicators primary and secondary indicators can be found in the Appendix B. The JMP assesses inequalities to basic services by using wealth quintiles and subnational regions. For 80 countries the JMP has calculated wealth quintiles through data from DHS or MICS. Sub-national regions like divisions and provinces are reported in household surveys. (WHO and UNICEF 2017a, p. 19)

Country consultations

After producing national estimates, the fourth step is country consultation. The purpose of this step is to provide feedback from countries concerning missing data, reliability of data sources and accuracy of national data interpretation. For this cause the JMP launches a data drive that functions as a platform to collect complementary data. The countries are asked to upload additional data. After the production of preliminary estimated as described above, the country files are sent to the countries accompanied by a guidance note including the three main questions on whether relevant sources of data are missing, whether the listed data sources are reliable and whether the JMP interpretation of national data is accurate and appropriate. The countries have the chance to answer within a fixed timespan. In the calculation process of the JMP's 2017 progress report, over 100 countries provided feedback, requesting clarifications, correction and presented additional data sources. (WHO and UNICEF 2017a, p. 20)

Producing regional and global estimates

As a last step regional and global estimates are calculated. The used population data is drawn from the UN Population Divisions latest report. Missing country estimates get imputed and used for aggregation only when exceeding a fixed level of population with data coverage. To calculate national estimates the regional population-weighted average for indicators is calculated for several *master regions* that include similar countries. For regional estimates, the estimates for *basic drinking water*, *sanitation and hygiene servic*es get calculated through summation of national estimates, in case the data covers a minimum of 50% of the region's relevant population. The same applies to global estimates. (WHO and UNICEF 2017a, p. 21)

To produce regional estimates for elements of *safely managed services*, the data has to reflect a minimum of 30% of a region's population. For estimating the indicator *safely managed drinking water services* the three ratios RW1–4 have to be calculated and then multiplied by the regional *proportion of population using improved water sources*. The minimum of the three element or two (safety plus one of the other two) elements is used to produce global and regional estimates in both

urban and rural areas. When possible the urban and rural estimates are combined by using a weighted average to produce a total estimate for the regions and a global estimate. (WHO and UNICEF 2017a, pp. 21–22)

When estimating *safely managed sanitation services* the required data has to specifically concern the dominant form of the regional sanitation type. When the data on the non-dominant sanitation form covers less than 30% of the regional population, only the data on the dominant form is used for regional and global estimates. The regional and global population using on-site and sewered sanitation is separately summed for each rural and urban areas. Total regional and global values are only estimated, when the data coverages exceed the required 30 % in both urban and rural areas. (WHO and UNICEF 2017a, p. 22)

Monitoring WASH in schools and health-care facilities

As mentioned before, besides access to WASH in households the targets 6.1 and 6.2 ask for universal access, which indicates that institutional settings like educational and health-care facilities (HCF) are included as well (WHO and UNICEF 2019e, p. 10). The JMP monitors WASH in schools and health-care facilities additionally to WASH in households and thereby complements the monitoring of other SDGs such as SDG 3 and SDG 4. In SDG 3 the reduction whoof diseases that are caused by a lack of WASH and the reduction of maternal deaths, death of under-five-year-olds and unborn children are addressed which is directly related to an improvement of WASH in health-care facilities, since the absence of hygiene facilities and intact sanitation facilities can lead to an increased spread of pathogens and illness (WHO and UNICEF 2019e, p. 10). Especially when sick or in a state of having a weakened immune system access to safe water and protection from disease-causing pathogens is crucial (WHO and UNICEF 2019e, p. 26). SDG 4 however is devoted to improving educational systems including educational outcomes that are highly affected by the lack of WASH (WHO and UNICEF 2018b, p. 28). Avoiding the sanitation facilities due to their poor state or their sheer absence can provoke open defecation, is a violation of human rights and diminishes welfare and dignity (WHO and UNICEF 2019e, p. 2). Using unimproved water sources or having no hygiene facilities might once again increase the spread of pathogens and disease (WHO and UNICEF 2019e, p. 38). A lack of WASH in schools can cause more disease incidences and decreased learning efficiency due to illness and discomfort (WHO and UNICEF 2018b, p. 8). To monitor both WASH in schools and health-care facilities, the JMP uses a very similar approach as it does for the targets 6.1 and 6.2. The differences between the relevant facilities however, call for a separate consideration.

WASH in health-care facilities

First of all, JMP monitors WASH in health-care facilities but also waste management and environmental cleaning services since their neglect can contribute significantly to the potentially dangerous contact with pathogens and to the impairment of human health (WHO and UNICEF 2019e, p. 12). In 2019 the JMP published the first global assessment, since these are new considerations, not covered until March 2018, when the General Assembly launched a call for action for WASH in health-care facilities (WHO and UNICEF 2019e, p. 10). The assessment sets out baselines as starting points for the monitoring process throughout the SDG period (WHO and UNICEF 2019e, p. 10).

To implement the target of improving WASH the JMP developed a document explaining the following eight practical steps (WHO and UNICEF 2019f, ix):

1. Conduct situation analysis and assessment
2. Set targets and define roadmap
3. Establish national standards and regulation
4. Improve infrastructure and maintenance
5. Monitor and review data
6. Develop health workforce
7. Engage communities
8. Conduct operational research and share learning

The facility types that are implied under the collective term health-care facilities are not universally classified (WHO and UNICEF 2019e, p. 67). Apart from hospitals the JMP considers the following facilities as health care facilities (WHO and UNICEF 2019e, p. 67): health center, primary health center, community health center, clinic, polyclinic, health post, basic health unit, infirmary, dispensary, specialty clinic, physician's office, mobile clinic. The JMP introduced service ladders that build on the JMPs definition of *improved* and *unimproved services* (WHO and UNICEF 2019e, p. 17, 2019e, p. 30). These service ladders are displayed in Table 5. The indicators for *basic services* were developed between 2015 and 2017 starting with a review of global norms and standards as well as existing national indicators (WHO and UNICEF 2019e, p. 12).

Water usage in health-care facilities serves several purposes close to those in households such as drinking, cooking, handy hygiene, showering, bathing but also medical use and environmental cleaning (WHO and UNICEF 2019e, p. 14). The service ladder for water includes the levels *basic*, *limited and no service* which are dependent on the type of water source and its *accessibility* (WHO and UNICEF 2019e, p. 2). To gain basic water services a health-care facility has to provide water from an improved water source *accessible on the premises* (WHO and UNICEF 2019e, p. 15). Data that goes beyond the type of water source and accessibility can be used as part of advanced monitoring exercises (WHO and UNICEF 2019e, p. 15). Useful additional indicators can concern water quality, quantity, continuity and sufficiency, but are currently not standardized or available to a degree that allows their global monitoring (WHO and UNICEF 2019e, p. 8). In detail these indicators could measure the *percentage of piped water supplies, water quality* in comparison to WHO guideline values, *presence of water safety plans*, *amount of stored water volume*, *adequate quantity* depending of the facilities size and types of services (WHO and UNICEF 2019e, p. 8). The data coverage for estimating *basic water services* represented 2.6 billion people in 2016 (WHO and UNICEF 2019e, p. 16). To estimate for the indicator *no service* is available for 61% of the world population (WHO and UNICEF 2019e, p. 16).

The sanitation service ladder classifies the same three levels of *basic*, *limited an no service* (WHO and UNICEF 2019e, p. 26). To classify as *basic sanitation service*, the facility has to be *improved* as per JMP definition and *usable*, meaning accessible, functional and private (WHO and UNICEF 2019e, p. 27). These definitions imply that the facility is *accessible on the premises* and not locked, not leaking or blocked and in case of a flush toilet with available water and with a lockable door without holes (WHO and UNICEF 2019e, p. 27). In addition, there has to be *at least one facility for the staff* and one for the patients including *menstrual hygiene facilities* like a bin with a lid and *sex-separated* (WHO and UNICEF 2019e, p. 28). The facility must be *accessible for people with limited mobility* (WHO and UNICEF 2019e, p. 28). For advanced monitoring purposes the indicators *number of toilets*, *faecal sludge management*, *toilet cleanliness* and *menstrual hygiene* can be useful (WHO and UNICEF 2019e, p. 22). A guiding value for toilet numbers is one per twenty users, the facility should not be

further away than thirty meters from the user (WHO and UNICEF 2019e, p. 34). The aspects lighting, privacy and presence of baby changing stations can affect the users' acceptance for sanitation facilities (WHO and UNICEF 2019e, p. 36). The cleanliness is a subjective indicator, but can be standardized to a certain degree by using enumerators like clean toilet bowl, walls, floor and ceiling, absence of strong smell and faecal matter (WHO and UNICEF 2019e, p. 36). The estimate the indicator *basic services* JMP uses the minimum of the aggregated values for the sub-indicators (WHO and UNICEF 2019e, p. 27). The available global data that allows for estimating the indicator *basic services* covers 7 % of global population (WHO and UNICEF 2019e, p. 28). An estimate for the indicator *no service* was possible for 59 % of the global population (WHO and UNICEF 2019e, p. 28).

The hygiene services in health-care facilities serve the primary prevention of infections risked through receiving health-care as well as an increase in antimicrobial resistance (WHO and UNICEF 2019e, p. 38). Since health-care workers are in contact with several patients and therefor exposed to their diseases, they have the highest risk of either get infected or transfer pathogens to other patients (WHO and UNICEF 2019e, p. 38). That is why health-care workers are the main target group of this indicator (WHO and UNICEF 2019e, p. 38). The JMP developed a service ladder containing the levels *basic*, *limited* and *no service* (WHO and UNICEF 2019e, p. 38). To reach the *basic service* level, the health-care facility should have *hand hygiene facilities at the point of care and within five meters of the toilet that offers soap or alcohol-based lotion and water* (WHO and UNICEF 2019e, p. 38). Beyond that, the WHO defined five key moments for health-care workers, caregivers and patients that should all be covered by hand hygiene facilities (WHO and UNICEF 2019e, p. 38). The five points are the moment: (1) before touching a patient, (2) before clean/aseptic procedures, (3) after body fluid exposure/risk, (4) after touching a patient and (5) after touching patient surroundings (WHO and UNICEF 2019e, p. 38). The monitoring of *compliance at key moments* and the *accessibility of handwashing stations in all points of care* can be subject of advanced monitoring (WHO and UNICEF 2019e, p. 44). Other possible indicators may involve the *hand hygiene techniques* or the *presence and condition of showers* (WHO and UNICEF 2019e, p. 44). The WHO recommends a monitoring approach including workplace reminders, evaluation and feedback (WHO and UNICEF 2019e, p. 38). In 2016 19% of the global population were represented by the available data on *basic hygiene services* in health-care facilities (WHO and UNICEF 2019e, p. 42). Estimating a global value was not possible due to missing data (WHO and UNICEF 2019e, p. 42).

Both of the other aspects of monitoring WASH in health-care facilities, namely health-care waste and environmental cleaning are explained in detail, since they do not directly concern SDG 6. However, their service ladders are displayed in Table 6. For the JMP' first assessment of WASH in health-care facilities, the following programs provided half of the data sources of the (WHO and UNICEF 2019e, p. 81):

- Service Availability and Readiness Assessment (SARA) program
- Service Provision Assessment (SPA) program
- Performance Monitoring and Accountability 2020 (PMA2020) initiative
- Emergency Obstetric and Newborn Care (EMONC)
- Pacific Hazardous Waste Management Project (PHWMP)
- Service Delivery Indicators (SDI) project
- World Vision

The other half of used data sources were identified by the JMP itself (WHO and UNICEF 2019e, p. 81). The categories that the JMP anticipates in monitoring are hospital/non-hospital, government/non-government and national/ urban/rural (WHO and UNICEF 2019e, p. 80). A special rule applies to generating national estimates for *basic sanitation services*. The JMP generates an estimate, when data on the facility type, its *usability* and at last two of the four remaining indicators is available (*toilet for staff, sex-separated toilet, menstrual hygiene facility, access for people with limited mobility*) (WHO and UNICEF 2019e, p. 82). If there is no data on the total number of facilities of each class for a country, the JMP uses national population to weigh estimates (WHO and UNICEF 2019e, p. 83).

WASH in schools

The monitoring process for WASH in schools is similar to the process for WASH in households and health-care facilities. The JMP introduced new service ladders for water, sanitation and hygiene for tracking the progress toward basic services (WHO and UNICEF 2018b, p. 4). The process of developing the monitoring framework started with an international consultation phase between 2011 and 2013 (WHO and UNICEF 2018b, p. 11). In this time schools, were identified as one of the priority settings of WASH monitoring within the SDG era (WHO and UNICEF 2018b, p. 11). UNICEF identified national data in 149 countries that mostly lacked indicator definitions (WHO and UNICEF 2018b, p. 11). In order to define standards and harmonized indicators and core questions the JMP formed a task team attended by WASH and education experts (WHO and UNICEF 2018b, p. 11).

Since the indicators resemble the indicators for health-care facilities, they will not be outlined in detailed. The chosen ladders refer to water, sanitation and hygiene services and differentiate between *basic*, *limited* and *no services.* Basic water services are defined as *having an improved water source that is available on the day of the survey.* Additional indicators can cover *water quality* and *quantity*. Basic sanitation services are characterized by an *improved facility for each sex that is usable during the survey's conduction.* Indicators that go beyond the basic level can include the *student per toilet ratio* and *menstrual hygiene management (MHM) services*. The indicators for basic hygiene services *are having a handwashing facility with soap and water available at the time of the survey*. Advanced monitoring can include factors such as *handwashing at critical times* and *presence of materials for MHM.* (WHO and UNICEF 2018b, p. 11)

The national data sources, used by the JMP within its first assessment of WASH in schools in 2016, published in 2019, were routine administrative reporting systems such as the Educational Management Information System (EMIS) and censuses or surveys (WHO and UNICEF 2018b, p. 13). International data sources the JMP used were the Protocol on Water and Health and UNESCO. In 2016, 68 countries provided data that allowed calculating a national estimate for all three types of WASH (WHO and UNICEF 2018b, p. 14). Survey are used, if they reflect at least 50 schools of a domain (WHO and UNICEF 2018b, p. 60). In terms of sub-national surveys, the data has to be representative of rural or urban schools to be used (WHO and UNICEF 2018b, p. 60). The classification as pre-primary, primary and secondary schools can lead to double-counting, when there are schools having for example primary and secondary level students (WHO and UNICEF 2018b, p. 60). That is why the total number of schools equal the added value of the three types of schools (WHO and UNICEF 2018b, p. 60).

3.4.3 The GEMI initiative

History

Commentary: Within the course or writing this thesis, an Interview with William Reidhead, the head of UN Water was conducted. He clarified that the GEMI was originally founded to promote the seven new SDG 6 indicators 6.3 to 6.6. But the work of the last years has resulted in progress in monitoring those new indicators. Today all 11 indicators can be treated equally, the processing of the new indicators has, so to speak, caught up with the status of the old ones. The introduction of methodologies and the clarification of responsibilities are, for example, at the same level as the case the old indicators. Therefore, in the context of SDG 6 monitoring, the term IMI is simply used today. Nevertheless, JMP and GLAAS continue to be named as such because these initiatives are much older and SDG 6 monitoring is only a fraction of the work they do. Nevertheless, this thesis refers to the GEMI, since the first and only progress reports on these indicators were conducted when the initiative was still working under this name.

The Global Expanded Monitoring Initiative (GEMI) was established in 2014 and is responsible for monitoring the targets 6.3 to 6.6 (UN Water 2017b, p. 13). The involved agencies are

- the United Nations Environment Program (UNEP),
- the United Nations Human Settlements Program (UN-Habitat),
- the United Nations Children's Fund (UNICEF),
- the Food and Agriculture Organization of the United Nations (FAO),
- the United Nations Educational, Scientific and Cultural Organization (UNESCO),
- the World Health Organization (WHO) and
- the World Meteorological Organization (WMO) (UN Water 2017b, p. 13).

In contrast to the other two initiatives, GLAAS and JMP, which were already established in 2015, GEMI was not launched until 2014 in order to monitor the developmental progress of the new indicators concerning management of water, wastewater and ecosystem resources (UN Water 2017b, p. 13). The aim was to extend existing monitoring approaches in these areas and to manage them together in order to find efficient integrated solutions that accelerate the development progress (UN-Water 2016a, p. 11). Existing monitoring activities include the FAO AQUASTAT system, which collects data on water resources, and the UNEP GEMStat database.

For each of the seven indictors, methodologies and in some cases, questionnaires were developed and a baseline report was published. In the following, the monitoring of each individual indicator will be explained.

Monitoring SDG 6 target 6.3

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	*6.3.1 Proportion of wastewater safely treated* *6.3.2 Proportion of bodies of water with good ambient water quality*

The monitoring process for target 6.3 includes the two separate indicators 6.3.1 and 6.3.2. Whilst 6.3.1 addresses the water quality from the point of view of wastewater management and therefore the pollution that affects it, 6.3.2 concerns the status of actual water quality of waterbodies. In combination the monitoring of these two indicators provides information on the success of pollution reduction through wastewater treatment and its effects on waterbodies.

Indicator 6.3.1

Throughout the development of the methodology for monitoring indicator 6.3.1 in 2015 and 2016 various wastewater and national sector experts, statistical authorities and members of the UN Statistics Division met in expert meetings and a treatment working group. UN-Water members also provided feedback on the matter. Prior to adopting the methodology workshops and pilot testing were conducted in nine countries. In addition, in 2016 a joint data drive in cooperation with the JMP was launched. In the context of indicator 6.3.1 wastewater is defined as *water that is of no further immediate value for the purpose for which it had been used or produced because of its quality, quantity or time of occurrence* (WHO and UN-Habitat 2018, p. 11). The indicator is subdivided into 6.3.1a and 6.3.1b (WHO and UN-Habitat 2018, p. 11). The former measures the *percentage of safely treated domestic wastewater flows* while the latter measures the *percentage of safely treated industrial wastewater flows* (WHO and UN-Habitat 2018, p. 11).

Indicators 6.3.1a: Percentage of safely treated domestic wastewater flows

The types of domestic wastewater flows that are included in 6.3.1a are *sewage treated at treatment plants*, *wastewater from on-site facilities treated on-site* or *emptied, transported and treated off-site* (WHO and UN-Habitat 2018, p. 14). These wastewater flows are generated either in households or services that do not have an International Standard Industrial Classification (ISIC) code (WHO and UN-Habitat 2018, p. 14). Only if the service has an International Standard Industrial Classification Code (ISIC code), it will be excluded (WHO and UN-Habitat 2018, p. 14). The term safely treated is defined as *meeting national or local treatment standards for discharge of the treated effluent* (WHO and UN-Habitat 2018, p. 14). For calculating an estimate for the indicator, the volume of wastewater flows that are treated safely has to be divided by the total volume of wastewater flows generated by households and services (WHO and UN-Habitat 2018, p. 15). In order to calculate both the numerator and the denominator the GEMI uses 18 variables that characterize the wastewater flows from generation to treatment (WHO and UN-Habitat 2018, p. 15). The variables are displayed in Table 9. The data covered by the variables are population data, data on the amount of water used and on the type of sanitation (WHO and UN-Habitat 2018, p. 15). Most of the data can be taken from the JMP's database (WHO and UN-Habitat 2018, p. 15). However, there is no specification on data sources of variables 11 to 16 in this source (WHO and UN-Habitat 2018, p. 15). In case there is no information available for a certain variable, assumptions are made (WHO and UN-Habitat 2018, p. 15). Ultimately

data has to be available for at least 50% of population using each service type in order to calculate estimates (WHO and UN-Habitat 2018, p. 15). To further determine whether the treatment can be defined as safe, the performance of the technology has to either ensure a certain nationally defined effluent quality or indicate a secondary treatment level or higher if performance data is not available (WHO and UN-Habitat 2018, p. 16). With the help of the collected data on the variables, for the three areas wastewater treatment, treated in situ and faecal sludge treatment, the share defined as *safely treated* is calculated and then added (WHO and UN-Habitat 2018, p. 16). The individual estimates always result from the division of the collected wastewater that the type of disposal reaches by the total volume of wastewater produced (WHO and UN-Habitat 2018, p. 16).

Table 9 Variables of 6.3.1 and their data source based on (WHO and UN-Habitat 2018, p. 15)

Variable No.	*Variable name*	*Service type*	*Unit*	*Source*	*Assumption used where data not available*
1	*population*		*Number*	*UNPD**	*n/a*
2	*Population with water on premises*		*%*	*JMP** 2015*	*n/a*
3	*population with water not on premises*		*%*	*JMP 2015*	*n/a*
4	*water use on premises*		*litre/person/day*	*JMP 2015*	*120*
5	*water use not on premises*		*litre/person/day*	*JMP 2015*	*20*
6	*piped sewers*		*%*	*JMP 2015*	*n/a*
7	*septic tanks*		*%*	*JMP 2015*	*n/a*
8	*other improved facilities*		*%*	*JMP 2015*	*n/a*
9	*unimproved facilities*		*%*	*JMP 2015*	*n/a*
10	*open defecation*		*%*	*JMP 2015*	*n/a*
11	*contained*	*piped sewers*	*%*		*100*
12	*delivered to treatment plant*	*piped sewers*	*%*		*100*
13	*contained*	*septic tanks*	*%*		*100*
14	*not emptied*	*septic tanks*	*%*		*50*
15	*emptied and removed off-site*	*septic tanks*	*%*		*50*
16	*delivered to treatment plant*	*septic tanks*	*%*		*100*
17	*treated at treatment plant*	*piped sewers*	*%*	*data sets reflecting treatment technology or national performance data*	*50*
18	*treated at treatment plant*	*septic tanks*	*%*	*as above*	*yes*

*United Nations Population Division **WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene

The following shows an example for calculating an estimate for safely treated domestic wastewater.

Table 10 Calculation for indicator 6.3.1a (WHO and UN-Habitat 2018, p. 16)

	Water supply [%]		Water use [litre/person/day]*		Sanitation [%]		Wastewater [thousand m³/day]		Sanitation service chain [%]					Safely treated wastewater [%]			
Population [thousands]	Population with water on premises	Population with water not on premises	On-premises	Not on-premises	Type	Population using type (including shared)	Generation [G]	Collection [C]	Contained	Emptied and removed off-site	Not emptied	Delivered to treatment plant	Treated at treatment plant	Wastewater treatment	Treated in situ	Faecal sludge treatment	6.3.1a
[1]	[2]	[3]	[4]	[5]	Piped sewers	[6]	=[6]x[1]x[4]*	=[G]x1	[11]	N/A		[12]	[17]	A = [C]x[11]x[12]x[17]/G(total)x100			
					Septic tanks	[7]	=[7]x[1]x[4]*	=[G]x1	[13]	[15]	[14]	[16]	[18]		B = [C]x[13]x[14]/G(total)x100	C= [C]x[13]x[16]x[18]/G(total)x100	=A+B+C
					Other improved facilities	[8]	=[8]x[1]x[5]*	=[G]x0	0	0	0	0	0		0	0	
					Unimproved facilities	[9]	=[9]x[1]x[5]*	=[G]x0									
					Open defecation	[10]	=[10]x[1]x[5]*	=[G]x0									
TOTAL							G(total)	C(total)									

* Actual calculation distributes "on-premises" water use [4] to households with sewer connections, then to septic tanks, then other service type, until all on-premises water is allocated, after which "not on-premises" [5] is applied.

Data on treatment performance was mostly available in Europe in 2018, due to data gathering in the context of the European Urban Wastewater Treatment Directive (UWWTD). The UWWTD defines compliance of a treatment plant as a BOD effluent concentration of maximally 25 mg/l or a minimum percentage of reduction which lies between 70% and 90%. Outside of Europe there were several countries who could provide this type of data from national performance reports. (WHO and UN-Habitat 2018, p. 22)

Indicator 6.3.1.b: Percentage of safely treated industrial wastewater flows

As mentioned before, 6.3.1b measures the *proportion of safely treated industrial wastewater flows* (WHO and UN-Habitat 2018, p. 14). Similar to the calculation of estimates for 6.3.1a the volume of wastewater flows that are compliant with in this case regulations and discharge permits have to be measured (WHO and UN-Habitat 2018, p. 16). This counts for wastewater flows which reach treatment plants or the environment (WHO and UN-Habitat 2018, p. 16). Industrial wastewater is defined as the *flow from industrial premises* following the ISIC classification (WHO and UN-Habitat 2018, p. 16). The safely treated volume is divided by the *total volume of industrial wastewater discharged into public sewers and the environment* and results in an estimate for the *proportion of safely treated industrial wastewater* (WHO and UN-Habitat 2018, p. 16). In contrast to 6.3.1a only four variables are used for the calculation of the estimate: the industry type, the industrial wastewater flow generated, the permit compliance and the discharge to the service type, shown in

Table 11 (WHO and UN-Habitat 2018, pp. 16–17). To calculate the total volume of industrial wastewater flows, the reported volume in m^3/year is added (WHO and UN-Habitat 2018, p. 17). The wastewater flows that result in effluent quality that does not comply with the treatment plants

permit, are not taken into account when calculating the safely treated wastewater flows (WHO and UN-Habitat 2018, p. 17). The example displayed Table 12 results in 71% of safely treated wastewater.

Table 11 Variables for calculating indicator 6.3.1b based on (UN-Water, WHO, UN Habitat 2018, p. 17)

Variable No.	*Variable name*	*Unit*	*Source*	*Assumption used where data not available*
1	*Industry type*	*ISIC code*	*data on compliance with discharge permits*	*n/a*
2	*Industrial wastewater flow generated*	*m^3/year*	*data on compliance with discharge permits*	*n/a*
3	*Permit compliance*	*yes/no*	*data on compliance with discharge permits*	*n/a*
4	*Discharge to service type*	*into sewer or environment*	*data on compliance with discharge permits*	*n/a*

Table 12 Calculation of indicator 6.3.1b based on (UN-Water, WHO, UN Habitat 2018, p. 17)

Industrial type (aggregated by ISIC category)	**Industrial wastewater flow generated m^3/year ($\times 10^6$)**	**Permit compliance**	**Industrial wastewater flow treated m^3/year ($\times 10^6$)**	**Discharge to service type**
13. Manufacture of textiles	1.2	Yes	1.2	Sewer
20. Manufacture of chemicals and chemical products	0.6	No	0	Sewer
22. Manufacture of rubber and plactics products	0.5	No	0	Environment
6. Extraction of crude petroleum and natural gas	2.2	Yes	2.2	Sewer
17. Manufacture of paper and paper products	0.9	Yes	0.9	Environment
35. Electricity, gas, steam and airconditioning supply	0.7	No	0	Sewer
86. Human health activities	0.1	Yes	0.1	Sewer
Total	6.2 m^3/year ($\times 10^6$)		4.4 m^3/year ($\times 10^6$)	

$$\frac{\text{Total flow of industrial wastewater in compliance}}{\text{Total flow of industrial wastewater generated}} = \text{Percentage of industrial wastewater safely treated}$$

$$\frac{4.4\frac{m^3}{year(\times 10^6)}}{6.2\frac{m^3}{year(\times 10^6)}} = 71\%$$

Data on the variables is provided at country level (WHO and UN-Habitat 2018, p. 16). The permit compliance is a weighted average of the flows in each particular industry type meeting their permits divided by total flows (WHO and UN-Habitat 2018, p. 16).

Indicator 6.3.2

Indicator 6.3.2 measures the *proportion of bodies of water with good ambient water quality*. Ambient water quality is defined as "natural and untreated water that is affected by natural influences and anthropogenic activities" for example agricultural run-off or wastewater discharges (UN-Water and UNEP 2018, p. 13). The methodology for monitoring 6.3.2 was built using best practice collected within the UN Environment GEMS/Water program since 1978 (UN-Water, p. 2).

The first measurement of a quality parameter was defined in 2007. After revisions at the end of the MDG-era it was tested in five countries throughout 2016 (UN-Water and UNEP 2018, p. 23). The test phase lead to feedback from experts and international organizations and resulted in a simplified version of the index and a revised methodology which used for the first data SDG 6 data collection (UN-Water and UNEP 2018, p. 23).

The advanced monitoring methodology is divided into two levels (UN-Water and UNEP 2018, p. 22). The first level includes collecting data on several core parameters that is compiled into a water quality index which indicates whether a water body's ambient water quality is classified as either good or not good (UN-Water and UNEP 2018, p. 22). When a minimum of 80% of all monitoring data, collected within the same water body complies with target values, the water quality is classified as good (UN-Water and UNEP 2018, p. 25). Since not all pressures on waterbodies are issued within the core parameters, the progressive monitoring approach of Level 2 involves additional parameters and approaches that can reflect national problem areas (UN-Water and UNEP 2018, p. 22).

Level 1

In Level 1 monitoring countries can use existing national water quality monitoring programs to generate data or get support from GEMS/Water (UN-Water, p. 3). The actual methodology of Level 1 includes five sequential steps (UN-Water, p. 4). At first a country needs to define its national river basins. When a country does not already have defined its river basins, GEM/Water will define suitable river basins using data from the HydroBASINS global dataset and the UNEP-GEF Transboundary Waters Assessment program (TWAP) data portal (UN-Water, p. 4). The so defined river basins will be validated by the country (UN-Water, p. 4). As a second step the waterbodies have to be defined within each river basin (UN-Water, p. 5). This includes differentiation between groundwater and surface water, moreover disaggregation of surface water into water body types like rivers and lakes (UN-Water, pp. 5–6). The defined units should display similar physical, chemical or other characteristics like pressures from pollution sources so the measured water quality does refer to the whole unit and not only a sub-division of it (UN-Water, pp. 5–6). If a country does not provide a definition of waterbodies GEM/Water uses data based on HydroBASINS and HydroSHEDS (UN-Water, pp. 5–6). In step 3 the monitoring locations get defined (UN-Water, p. 6). Every water body should be represented by at least one sampling station depending on the water body size (UN-Water, pp. 6–7).

The fourth step includes the actual collection of water quality data through five core parameters (UN-Water, p. 7). The core parameters are dissolved oxygen, electrical conductivity, pH, orthophosphate and total oxidized nitrogen (UN-Water, p. 7). All of the parameters serve the characterization of the water body or can indicate pollution or changes in the ecological balance and are thereby direct measures of water quality for ecosystems or human health (UN-Water and UNEP 2018, pp. 21–22).

Dissolved oxygen is mainly of importance for aquatic life and can be measured in situ or when chemically fixed in the laboratory. Low concentrations of dissolved oxygen indicate the presence of biodegradable matter for example sewage. Electrical conductivity provides information on dissolved substances such as salts, are used to characterize a water body and should be measured in situ. pH is relevant for many biological and chemical processes and changes in pH indicate pollution. Again, this parameter should be measured in situ. Orthophosphate and total oxidized nitrogen are essential

nutrients for aquatic life. A high concentration on orthophosphate though can lead to excessive algal growth and thereby affect the ecological balance of a water body as well as its usability for human purposes. For more accurate results this parameter should be measured in a laboratory but can also be measured in situ. Total oxidized nitrogen contains the parameters nitrate and nitrite. Although nitrate is the parameter that is of bigger importance in this context, the combined parameter is used because it is easier to measure and the share of nitrate is usually below 1% of the value. The parameter should be measured in situ. These five parameters are used to define water quality in rivers and lakes. In groundwater however only electrical conductivity, pH and nitrate are measured as illustrated in the following table. (UN-Water, pp. 8–9)

Table 13 Parameters of indicator 6.3.2 (UN-Water 2018g, p. 22)

Core Parameter	***River***	***Lake***	***Groundwater***
Dissolved oxygen	*x*	*x*	
Electrical conductivity	*x*	*x*	*x*
Total oxidized nitrogen	*x*	*x*	
Nitrate			*x*
Orthophosphate	*x*	*x*	
pH	*x*	*x*	*x*

All the samples should be taken in determined intervals and from the same locations to ensure comparability over time. If several agencies and organizations are involved in data collection there should be a centralized point at the national level that overviews the collection process and makes sure that the given data stays compatible. To further control data quality international standards should be applied in the process of sampling and data analysis and the metadata should also be collected at a centralized point. (UN-Water, p. 8)

In the fifth and last step the interpretation of the data is conducted and results in the assessment of water quality. If a country is not able to assess the data the metadata can be sent to GEMS/Water which will assess the water quality and return the assessment to the country for validation. The measured values are compared to defined national target values. To ensure a water quality that does not risk either human or ecosystem health the target values have to be met. They can be based on knowledge of the water body and do not have to consist of legally binding standards. They can also be applied to all national waterbodies or vary between them. (UN-Water, pp. 10–11)

Currently the methodology implies a step for countries which do not provide either the data to set target values or have the data but not yet defined target values. The goal is that these countries initiate programs to collect sufficient data, use other existing targets from another jurisdiction or apply existing standards as targets to water quality data to reach a definition of national ambient water quality standards as soon as possible. (UN-Water, p. 11)

For each water body the number of monitoring values in compliance with the target values is divided by the total number of monitoring values and composes the percentage of compliance. When the percentage reaches at least 80% the water body's quality is classified as good. On the national level the number of waterbodies classified as having good quality status is divided by the total number of monitored and classified waterbodies which results in the percentage of waterbodies classified as having good quality status. (UN-Water, p. 12)

Level 2

As capacity of monitoring increases, additional country-specific parameters such as emerging contaminants and biological parameters can be included. They can also serve to monitor pressures on water quality caused by certain industrial branches such as mining. In terms of groundwater additional parameters could be arsenic and fluoride. Another aspect of Level 2 monitoring is using Earth observation data that can currently cover optically detectable parameters such as turbidity and chlorophyll in lakes and wide rivers. Also, the potential of Citizen Science is mentioned as part of Level 2 monitoring. This concept builds upon the possibility of inexpensive in situ measurement conducted by trained civilians and electronically transferred to responsible organizations in order to provide an additional source of data. (UN-Water, pp. 12–13)

The national indicator on Level 1 is reported by countries to UN Environment every five years. To ensure comparability and timeliness, data is not to be older than five years at the time of reporting. After validating the national indicators GEMS/Water reports them to UNSD so they can be compared on a global level. Data on Level 2 monitoring can be reported to UN Environment in addition to Level 1 data and at any year. (UN-Water, pp. 13–14)

Monitoring target 6.4

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	*6.4.1 Change in water-use efficiency over time* *6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources*

Target 6.4 is monitored through two indicators. The purpose of indicator 6.4.1 is the reflection of the economic component of Target 6.4, while the indicator 6.4.2 addresses the environmental component by showing the physical availability of water resources (FAO 2018b, p. 14). Since both indicators were not a part of MDG monitoring, new methodologies had to be developed and tested (FAO 2018b, XII). The chosen pilot countries were Jordan, Netherlands, Peru, Senegal and Uganda (FAO 2018b, XII). Each country established working groups with stakeholders in order to ensure expert knowledge and addressed national institutions to coordinate the activities on the national basis (FAO 2018b, p. 22). Their experiences were later used to revise the indicator's methodologies (FAO 2018b, p. 22).

The international organization FAO serves as custodian agency for this target's monitoring and compiles regional and global data within its AQUASTAT program (FAO 2018b, p. 30). The data gathered in AQUASTAT is collected through questionnaires that are sent to national experts who rely on data provided by national institutions and ministries (FAO 2018b, p. 43, 2018b, p. 25).

Indicator 6.4.1

The definition of the indicator is the *change in water-use efficiency (WUE) over time*. It is designed to illustrate the dependence of economic growth on water resources as the value added (VU) per unit of water used in a defined economy sector (FAO 2018b, p. 6). The only water resources that are taken into account are run-off water and groundwater (FAO 2018b, p. 7). The resulting value,

measured in USD/m^3, cannot yet be compared to a target value, since there are no data on which the definition of target values can be based (FAO 2018b, p. 7). Instead the change of the value should at least resemble the trend of economic growth (FAO 2018b, p. 3). As soon as the trend of the water-use efficiency exceeds the rate of economic growth this indicates that a decoupling of water resources and economic growth and thereby a substantial part of the target has been achieved (FAO 2018b, p. 3).

The economic sectors are classified in three groups and follow the ISIC code (FAO 2018b, p. 6):

1. agriculture, forestry, fishing (ISIC A) = agriculture
2. mining, quarrying, manufacturing, electricity, gas, steam and air conditioning supply, constructions (ISIC B, C, D, F) = MIMEC
3. all the services (ISIC E, G-T) = services

Additionally, the methodology offers definition for both *water use* and *water abstraction* in the context of the indicator. *Water use* is defined as water that is received by one of the sectors from another sector or directly abstracted. *Water abstraction* however, is defined as water removed from the environment by an economic sector. (FAO 2018b, p. 9)

To calculate the water-use efficiency of a country, each sector's water-use efficiency has to be calculated separately. In case of agriculture only irrigated agriculture is of importance here, so the *proportion of agricultural gross value added produced by rainfed agriculture* has to be subtracted. The actual calculation consists of the division of the gross value added by agriculture in USD by the volume of water used by the sector in m^3. The same calculations are conducted to determine the WUE of the two remaining sectors MIMEC and services. (FAO 2018b, p. 7)

Example of computation for agriculture WUE (FAO 2018b, p. 7):

$$A_{we}=(GVA_a\times(1-C_r))/V_a$$

Where:

A_{we} = Irrigated agriculture water-use efficiency [USD/m^3]

GVA_a = Gross value added by agriculture (excluding river and marine fisheries and forestry) [USD]

C_r = Proportion of agricultural GVA produced by rainfed agriculture [%]

V_a = Volume of water used by the agricultural sector (including irrigation, livestock and aquaculture) [m^3]

C_r can be calculated as follows (FAO 2018b, p. 7):

$$C_r=1/(1+A_i/((1-Ai)\times 0.375))$$

Where:

A_i = proportion of irrigated land on the total cropland, in decimals

0.375 = generic default ratio between rainfed and irrigated yields

Globally available data

The global data on gross value added by the sectors are provided by national statistical systems and need to be converted in USD as well as deflated to be comparable to the baseline value. The Systems of National Accounting (SNA) published recommendations for compiling national accounts that most countries use which facilitates comparing financial data among countries. The SNA's output approach is the most suitable approach for computing data for 6.4.1, because it includes providing sectoral value-added data within the ISIC coding. Besides national statistical departments or national government agencies, international sources like the World Bank, UNSD and OECD databases can provide data on this indicator. The global data on volume of water used by each sector are obtained from national records or collected within questionnaires as in AQUASTAT. Although it has to be considered that AQUASTAT does not produce new data, but is dependent on national data collection and mainly serves as a system for data storage. (FAO 2018b, p. 13)

The following table depicted the institutions that were involved in the monitoring process in Jordan and the Netherlands throughout the pilot-testing phase. While in Jordan three ministries and the Statistics Department were involved in the data collection, in the Netherlands only Statistical Office was responsible for that process. Also, in the Netherlands more additional institutions such as universities somehow contributed.

Table 14 Responsibilities throughout the testing phase (FAO 2018b, p. 26)

Pilot country	***General coordination***	***Main data-Collection agencies***	***Other government bodies/institutions involved***
Jordan	*Ministry of Water and Irrigation*	*Ministry of Water and Irrigation Department of Statistics (DOS) Ministry of Agriculture Ministry of Planning and International Cooperation*	*Environment Statistics Division (DOS), FAO*
The Netherlands	*Ministry of Foreign Affairs*	*Statistics Netherlands (CBS)*	*Deltares, eLEAF University of Twente Water Footprint Network Utrecht University IHE Delft Institute for Water Education Netherlands Water Partnership Netherlands IHP-HWRP Committee*

To facilitate national efforts in data collection and coordination and also ensure data consistency, the FAO provides a calculation sheet similar to the AQUASTAT questionnaire that is meant to guide countries in their process of preparing metadata (FAO 2018b, XIII).

Water-use data

In case of agricultural water-use, data refers to water from renewable freshwater resources, over-abstraction of renewable groundwater or abstraction of fossil groundwater, agricultural drainage water, (treated) wastewater and desalinated water that is used by agricultural facilities that are not connected to a public water supply network. If a facility is connected to a network, its water use should be included in the service's water-use. Further the water-use in agriculture should be

disaggregated into its three main purposes irrigation, livestock and aquaculture and given in the unit km^3/year. The same definition applies to water-use in MIMEC with the exception of agricultural drainage water and the additional inclusion of losses for evaporation from artificial lakes that were built for hydropower production. Water used for powering hydroelectric turbines is not included. The water-use in services contains water from renewable freshwater resources, over-abstraction of renewable groundwater, abstraction of fossil groundwater or desalinated water or direct use of treated wastewater and equates the total water used by a public water distribution network, including connected parts of the sectors agriculture and MIMEC. (FAO 2018b, p. 7)

Economic data

The gross value added in agriculture is calculated by subtracting intermediate input from all added outputs. The sub-sectors fishing and forestry should be excluded as well as depreciation of fixed assets and degradation of natural resources. In MIMEC the value added of each section is summed up to gain the total value added of MIMEC. Special attention has to be paid to the use of different ISIC coding. The methodology uses ISIC rev.4, though it is possible that rev.3 is used by some countries or part of MIMEC, which is an older version and not compatible with the current one. Also, when compiling data from four different sections, hence also databases, double counting has to be prevented. Water distribution is not considered as part of MIMEC. The services sector includes water-use in households but also in several economic activities which can be misleading when using databases that count value added of ISIC coding E under industrial value added. In this case the value added must be subtracted from the industrial VA and added to the service sector's VA. (FAO 2018b, p. 17)

To determine a country's total water-use efficiency the following computation is made (FAO 2018b, XII):

$$WUE = A_{we} \times P_A + M_{we} \times P_M + S_{we} \times P_S$$

Where:

WUE = Water-use efficiency [USD/m^3]

$\mathrm{A_{we}}$ = Irrigated agriculture water-use efficiency [USD/m^3]

$\mathrm{M_{we}}$ = MIMEC water-use efficiency [USD/m^3]

$\mathrm{S_{we}}$ = Services water-use efficiency [USD/m^3]

$\mathrm{P_A}$ = Proportion of water used by the agricultural sector over the total use

$\mathrm{P_M}$ = Proportion of water used by the MIMEC sector over the total use

$\mathrm{P_S}$ = Proportion of water used by the service sector over the total use

The rationale of the indicator is to identify the change of water-use efficiency over time, which is why the countries are asked to collect the data for this indicator annually. The methodology also recommends establishing a national coordination system to ensure that all necessary data from the various sectors is available in time as well as consistent. It further addresses that countries are currently at different stages of implementing monitoring by offering a monitoring ladder that lets them start at their individual level of capacity. According to the ladder, a country that can determine an estimate for the indicator based on national information, possibly by using economic or water-use

data provided by international databases and can calculate C_r by using the methodologies guidelines is located on the first level. A country that is able to produce the estimate by using national data and calculating C_R by using the methodologies guidelines already reached the second level of the ladder. The third and highest level of the ladder is reached by countries that not only are able to calculated C_R by using national studies but also uses national data for estimates that are georeferenced or based on metered volume thus can be classified as having advanced quality. (FAO 2018b, p. 10)

After data collection, baseline selection, computation of WUE and its discussion, the final step of monitoring indicator 6.4.1 is computing the change in WUE (CWUE) by subtracting the last known value from the current value, dividing it by the last known value and then multiplying it by 100 to gain a percentage as shown in the following formula (FAO 2018b, p. 6):

$$CWUE=((WUE_t-WUE_{t-1})/WUE_{t-1})*100$$

Where:

CWUE = Change in water-use efficiency [%]

$\mathrm{WUE_t}$ = Water-use efficiency [USD/m^3]

$\mathrm{WUE_{t-1}}$ = Last known water-use efficiency [USD/m^3]

Indicator 6.4.2

The indicator 6.4.2 displays the *level of water stress* by measuring *freshwater withdrawal as a proportion of available freshwater resources* (FAO 2018a, XII). Water stress has already been monitored during the MDG period (FAO 2018a, XII). The difference between the MDG's approach and the current SDG approach is that *environmental flow requirements (EFR)* are now measured as well and subtracted from the renewable freshwater resources to clarify that the share of the resource required for the ecosystem is not available for human activities (FAO 2018a, XII). The approach also facilitates the assessment of environmental water scarcity, assuming that all environmental concerns are covered by the *ERF* and accepting that human needs connected to the environment like recreation are not involved, because then every value below 100% indicates that all *environmental flow requirements* are met (FAO 2018a, p. 10).

The indicator basically provides information that can help policymakers to make smart decisions on necessary improvements in water resource management and water saving (FAO 2018a, XV). A high *level of water stress* indicates possible problems in resource sustainability and also foreshadows conflict among water users such as industry and agriculture (FAO 2018a, p. 4).

In detail the methodology requires the calculation of three variables. First of all, the *total freshwater withdrawal (TFWW)* by the sectors agriculture, industry and municipality has to be determined in km^3/year. Therefore, data on 6.4.1 can be partly used such as the withdrawal from renewable freshwater resources and fossil groundwater for agriculture, industry and services which are of importance in this context. Non-conventional water such as treated wastewater, desalinated water and drainage water, however, have to be subtracted if implied in the values. Agricultural withdrawal refers to water that is used for irrigation, livestock and aquaculture purposes. Industrial withdrawal includes the MIMEC sectors as well as water for cooling thermoelectric plants and evaporation from artificial lakes used for hydropower production, though excludes water for hydropower generation.

Municipal water withdrawal is calculated as the withdrawal by the public water supply system. (FAO 2018a, pp. 6–7)

Secondly, the *volume of total renewable freshwater resources (TRWR)* is calculated by adding the internal and external renewable freshwater resources in km^3/year. Internal renewable freshwater resources refer to water that emerges from endogenous precipitation while the term external renewable freshwater resources addresses water that crosses a countries borders through rivers or streams. (FAO 2018a, p. 7)

The third and newly established variable, necessary to calculate the level of water stress is defined as *environmental flow requirements (EFR)* and also specified in the unit km^3/year. The purpose of *EFR* is taking into account the volume and timing of freshwater flows that freshwater ecosystems and hence human livelihoods depending on them require to uphold their functioning. The reason for adding this variable is preventing the positive impression that occurs when the calculated result not implying the ecosystems' need indicate that a country does not experience water stress. (FAO 2018a, p. 7)

The data on this indicator should be collected annually and be reported every two to three years (FAO 2018a, XV). The computation that is made to produce a national estimate for water stress consists of a combination of these three variables as follows (FAO 2018a, p. 6):

$$\text{Water stress } \% = \text{TFWW}/(\text{TRWR-EFR}) * 100$$

Where:

TFWW = Total freshwater withdrawal [km^3/year]

TRWR = Total renewable freshwater resources [km3 / year]

EFR = Environmental flow requirements [km^3/ year]

The *EFR* can be provided by the IWMI water portal or national sources, which may have a more accurate insight on the national circumstances concerning development, population density, non-conventional water sources and climate conditions. As in monitoring 6.4.1 the monitoring methodology of 6.4.2 comprises a ladder with three levels to offer countries the opportunity to classify their current state in implementation of the methodology and define their next steps. On the first level of the monitoring ladder countries are located that can calculate estimates based on national or international databases and use literature values for calculating *EFR*. The second level is characterized by only using nationally produced data that is disaggregated in subnational basin levels while *EFR* is again based on literature values. Countries for which nationally produced data with high spatial and temporal resolution is available, disaggregated by source and use as well as an assessment of *EFR* using knowledge on national characteristics, have reached the third and highest monitoring level. (FAO 2018b, p. 10)

The globally available data on indicator 6.4.2 is provided by the AQUASTAT database of FAO. However, national data has to be gathered from water-related institutions since AQUASTAT does not produce new data but relies on the submission of national data. The sources the five pilot countries used are mainly consist of national statistical offices, ministries and international databases such as IWMI and AQUASTAT. Implementing the new methodology on this indicator is still in process which is why in 2019 the data collection was conducted for the first time in one of two ways. The countries

were obligated to either send their data to the FAO, responsible for compilation and publication or the FAO collected the data and shared them with the national government for confirmation. (FAO 2018a, XIV)

Guidance concerning preparation of metadata or calculation methodology was offered by the AQUASTAT questionnaire and the FAO calculation sheet (FAO 2018a, p. 30).

Monitoring target 6.5

6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate	*6.5.1 Degree of integrated water resources management implementation (0-100)* *6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation*

For monitoring Target 6.5 two indicators were developed, to cover both main elements of the target appropriately. These are the implementation of IWRM, covered by indicator 6.5.1 and transboundary cooperation, which is addressed in indicator 6.5.2. The development of the methodology for indicator 6.5.1 started in 2014 when a Task Group composed of UN representatives and other stakeholders was established (UNEP 2018a, p. 88). Their work included workshops and pilot testing in cooperation with UN Water and ended in a draft that was finalized in 2017 and revised in 2018 (UNEP 2018a, p. 88).

Indicator 6.5.1

Indicator 6.5.1 is monitored by a questionnaire that is conducted every three years, which allows the countries to assess their current *degree of integrated water resources management implementation*. The methodology takes into account that several Member States have already implemented national monitoring systems for IWRM, so a new additional monitoring would only imply bigger and probably duplicated efforts for them. Instead countries can further advance from their individual status of implementation and quantify their current situation through the questionnaire. It contains 33 questions on the main elements of IWRM that are divided in the four sections *enabling environment*, *institutions and participations*, *management instruments* and *financing*. The section *enabling environment* serves the purpose of identifying the amount of strategic, policy and legal tools such as laws, plans and arrangements that are dedicated to support the IWRM implementation and thereby create a beneficial environment for it. The second element called *institutions and participation* is meant to illustrate a picture of the variety of people, stakeholders, cross-sectoral coordination and institutions that take part in the implementation process. The section on *management instruments* is dedicated to display the presence of tools and programs that facilitate decision-making such as programs on water availability monitoring, pollution control, data and information sharing. The last section called *financing* displays what kind of investments and budgets are used in water resource development and management activities. Each section is further divided into the two sub-sectional *national level* and *all levels* including transboundary levels and aquifers. (UNEP 2018a, p. 10)

The questionnaire is designed in a way that allows countries to assess their status of implementation within one of six categories, ranging from very low to very high and scored on a scale between zero and 100, in the increment of 10. Each question provides a threshold description for scores 0 (very low), 20 (low), 40 (medium-low), 60 (medium-high), 80 (high), 100 (very high). The score for each section is calculated as the average of the single scores given at the questions. The four section's

values are used to produce one averaged value that represents the degree of IWRM implementation. (UNEP 2018a, p. 12)

This score is then interpreted as follows:

- 0 – <=10 **Very low**: development of elements of IWRM has generally not begun, or development has stalled (UN-Water 2018h, p. 12)
- >10 – <=30 **Low**: implementation of elements of IWRM has generally begun, but with limited uptake across the country and potentially low engagement of stakeholder groups (UN-Water 2018h, p. 12)
- >30 – <=50 **Medium-low**: elements of IWRM are generally institutionalized and implementation is underway (UN-Water 2018h, p. 12)
- >50 – <=70 **Medium-high**: capacity to implement elements of IWRM is generally adequate and elements are generally being implemented under long-term programs (UN-Water 2018h, p. 12)
- >70 – <=90 **High**: IWRM objectives of plans and programs are generally being met, and geographic coverage and stakeholder engagement is generally good (UN-Water 2018h, p. 12)
- >90 – <=100 **Very high**: the vast majority of the elements of IWRM are fully implemented, with objectives consistently achieved, and plans and programs periodically assessed and revised (UN-Water 2018h, p. 12)

UN Environment, being the UN agency chosen as custodian for this indicator, is responsible for contacting national ministries that are asked to take on the national coordination of IWRM monitoring processes, including completing the questionnaire, reporting to a central database and assignment of a national IWRM Focal Point (UNEP 2018a, p. 13). The IWRM Focal Point is asked to manage the activities, needed for completing the questionnaire, and also decide on an appropriate process therefor, taking into account national capacity and resources (UNEP 2018a, p. 13). However, the process should include consultations with stakeholders such as representatives from water-related ministries, organizations responsible for IWRM at river, lake or aquifer level and other stakeholders like community groups, the private sector, NGOs or academia (UNEP 2018a, p. 39). To engage with the various stakeholders, workshops, complemented by other meetings and phone calls, under consideration of stakeholder representation in form of gender equality and representation of minorities have proven to be most effective (UNEP 2018a, p. 14). The responses on the questionnaire can either be developed in parallel, meaning that all stakeholders are asked to fill out the same questionnaire, or in series (UNEP 2018a, p. 14). The series approach implies that different stakeholders respond to different drafts of the questionnaire consecutively (UNEP 2018a, p. 14). In the end one final response has to be determined through discussion (UNEP 2018a, p. 14).

The source of data, asked for in the questionnaire, is expected to be available at national governments and other stakeholders (UNEP 2018a, p. 1). To ensure objectivity and comprehensiveness the data's justification is asked for within each question (UNEP 2018a, p. 90).

Indicator 6.5.2

The indicator 6.5.2 was developed to quantify the *transboundary basin area within a country with an operational arrangement for water cooperation in place*. It was first introduced by UN Water. The framework on the indicator was established in 2017 by the IAEG-SDG and adopted by the UN General Assembly in the same year. The two custodian agencies responsible for overseeing and supporting its

implementation are UNECE and UNESCO. The definition of the indicator includes bilateral and multilateral treaties, conventions, agreements or other forms of arrangements among countries that provide a framework for cooperation (UNECE and UNESCO 2018, p. 18). It is calculated on the national level by dividing the aggregated surface area of transboundary surface water catchments and aquifers that are covered by such a cooperation arrangement by the total area of transboundary catchments and aquifers and multiplying it by 100 to create a percentage share as displayed in the following formula (UNECE and UNESCO 2018, p. 19):

$$(\mathrm{A} + \mathrm{C}) / (\mathrm{B} + \mathrm{D}) \times 100 = \text{transboundary basin area within a country with an operational arrangement for water cooperation in place } \%$$

[A] Total surface area of transboundary basins/sub-basins of rivers and lakes covered by operational arrangements within the territory of the country in km^2

[B] Total surface area of transboundary basins of rivers and lakes within the territory of the country in km^2

[C] Total surface area of transboundary aquifers covered by operational arrangements within the territory of a country in km^2

[D] Total surface area of transboundary aquifers within the territory of a country in km^2

The definition clarifies that the arrangement of any sort in question has to be operational. The term *operational* is further defined in the methodology as fulfilling the following criteria (UNECE and UNESCO 2018, pp. 18–19):

- presence of a joint body, mechanism or commission (e.g. a river basin organization) for cooperation
- conduction of regular meetings between countries both on technical and political topics
- implementation of a joint, water management plan or common objectives
- maintenance of regular data exchange

The definition for transboundary basins, used in the methodology, contains any surface waters or groundwaters which are located at boundaries between states or mark them respectively (UNECE and UNESCO 2018, pp. 18–19). The area of a basin is understood as the extent of the catchment area concerning surface waters and the extent of the aquifer (UNECE and UNESCO 2018, p. 59). The agreements of importance for this indicator can be intergovernmental, interministerial, interagency, interstate or between regional authorities (UNECE and UNESCO 2018, p. 18, 2018, p. 44)

The data sources at country level are usually water or environment ministries and agencies depending on the country (UNECE and UNESCO 2018, p. 23). Data on transboundary basins often are available at organizations with a mandate for transboundary cooperation (UNECE and UNESCO 2018, p. 23). Moreover, the reporting under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) that over 100 countries participate in and is conducted every three years since 2017, is a possible data source for this indicator (UNECE and UNESCO 2018, p. 22). The UNECE leads the Water Conventions Secretariat and is thereby responsible for reviewing reports and source of data on indicator 6.5.2 (UNECE and UNESCO 2018, p. 22).

The reporting on indicator 6.5.2 is managed through a reporting template that is sent to the countries and offers the opportunity to not only report the indicator's value but also give additional information on national laws and policies supporting transboundary water as well as challenges and achievements concerning transboundary waters. In designing the template, the custodian agencies orientated themselves by the Water Conventions template that was developed in 2014 and 2015. (UNECE and UNESCO 2018, p. 23)

Other international datasets that can be used until national data is available include the Transboundary Waters Assessment Program (TWAP) for delineations of transboundary basins, the International Freshwater Treaties Database obtained by Oregon State University (OSU), the International River Basin Organization (RBO) Database or the Internationally Shared Aquifer Resources Management program (UNESCO's International Hydrological Program) for data on cooperation agreements. (UN Water 2017a, p. 6)

Monitoring target 6.6

6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	*6.6.1 Change in the extent of water-related ecosystems over time*

Progress on Target 6.6 is measured through indicator 6.6.1 which is defined as the *change in the extent of water-related ecosystems over time*. The first draft of its methodology was created in 2014, followed by a testing phase and further development until 2017 (UNEP 2018b, p. 14). After the last revision in 2018 the methodology was approved by the IAEG-SDG (UNEP 2018b, p. 14). Monitoring this indicator requires the collection of data on water-related ecosystems and their water quantity and quality. The combination of these three elements is referred to with the term *extent* (UNEP 2018b, p. 15). The following table illustrates which three components is applicable to the different ecosystem categories lakes, rivers and estuaries, vegetated wetlands, aquifers and artificial waterbodies.

Table 15 Ecosystem categories and their applicable extent components based on (UN Water 2018a, p. 2)

Extent component	***Lakes***	***Rivers and estuaries***	***Vegetated wetlands***	***Aquifers***	***Artificial waterbodies***
Spatial extent	*X*	*X*	*X*		*X*
Quality	*X*	*X*	*X*	*X*	*X*
Quantity		*X*		*X*	

Reason for the separated categorizing of vegetated wetlands such as swamps, fens, peatlands, marshes and mangroves, is their great importance for achieving target 6.6 as well as the fact that only their monitoring requires Earth observation techniques (UNEP 2018b, p. 15). Artificial waterbodies are unlike the other categories no traditional water-ecosystems but play a decisive role in some countries freshwater resources which is why they are included in the monitoring methodology (UNEP 2018b, p. 15). The data collected on these two categories should not be calculated as part of the extent values for lakes, rivers and estuaries and reported on separately (UNEP 2018b, p. 15).

The data on quality, quantity and spatial extent that has to be monitored depends on the category, since not every component is relevant for every category (UNEP 2018b, p. 15).

The methodology development was supported by an expert group including members of the UN World Water Assessment Program, 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 UN University Institute for Water Environment and Health, the European Space Agency, the International Water Management Institute, the Group on Earth observations (GEO) Secretariat and finally UN Environment, the custodian agency for indicator 6.6.1. (UNEP 2018b, p. 20)

The methodology's development started with a testing phase in 2016, followed by revision through several water experts and statistical offices. In 2017, before launching a global data drive, webinars and capacity-building tools alongside training workshops were held and rolled out. In the course of the following data drive countries were asked to submit data for the first time which was reviewed by UN Environment beforehand and then transmitted to UNSD. (UNEP 2018b, pp. 20–21)

In 2018 the methodology was approved by the IAEG-SDG (UNEP 2018b, p. 14). Additionally, the Ramsar Convention Secretariat was appointed to launch a reporting line, separate from the UNSDs efforts (UNEP 2018b, p. 28).

The methodology involves five sub-indicators that are further classified into two levels, since the pilot testing revealed that many countries weren't able to monitor the scope of all sub-indicators (UNEP 2018b, p. 29). The sub-indicators that got categorized as part of Level 1 monitoring are *spatial extent of water-related ecosystems* and *water quality of lakes and artificial waterbodies*, for which data is globally available (UNEP 2018b, p. 29). As countries manage to strengthen their monitoring capacities, they are asked to report on the Level 2 sub-indicators *quantity of water (discharge) in rivers and estuaries*, *water quality imported from indicator 6.3.2* and *quantity of groundwater within aquifers* (UNEP 2018b, p. 29).

Sub-indicator 1 separately addresses the *spatial extent of open water like lakes, rivers, estuaries and artificial waterbodies* and the *spatial extent of vegetated wetlands* (UNEP 2018b, p. 29). To determine the extent of lakes, rivers and estuaries, satellite images with either a 30 m resolution or since 2016 a 10 m resolution are used (UNEP 2018b, p. 29). The images enable differentiating between open water and other types of surface waters (UNEP 2018b, p. 29). Different satellites including radar were used to create the 2001-2015 dataset (UNEP 2018b, p. 29). Artificial waterbodies are generated with the help of this dataset (UNEP 2018b, p. 33). For this cause, open waterbodies that show a significant change in extent that lasts over a year, are considered to be artificial waterbodies (UNEP 2018b, p. 33). Then the Global Reservoir and Dam geospatial database (GRanD) is used to validate the assumed artificial waterbodies and produce a global dataset. The process of determining the extent of vegetated wetlands is more complicated due to their various forms and constant natural change (UN Water 2018a, p. 8). However, the approach is similar to the approach for open water and combines satellite imagery, SAR (Synthetic Aperture Radar) and other geospatial datasets that provide data on topography, hydrography and soil types (UNEP 2018b, p. 34). The goal is detecting physical properties of wetland areas such as soil moisture and vegetation water content (UNEP 2018b, p. 34). In both categories, open water and vegetated wetlands, the *percentage of change in spatial extent* is calculated by subtracting the average national spatial extent

of any five-year period from the average of the baseline value from the 2001-2005 period, dividing the change by the baseline value and multiplying it by 100 to create a percentage (UN Water 2018a, p. 8).

$$Percentage\ Change\ in\ Spatial\ Extent = (\beta - \gamma) / \beta \times 100$$

Where β = the average national spatial extent from 2001-2005
Where γ = the average national spatial extent of any other five-year period

The second sub-indicator *water quality of lakes and artificial waterbodies* requires the monitoring of chlorophyll and total suspended solids through their effect on surface water color (UNEP 2018b, p. 30). The approach was developed by NASA, GEO AquaWatch and the European Space Agency (UN Water 2018a, p. 12). The resulting concentrations are averaged over a year for each lake while the annual averages are averaged every five years and compared to the baseline to identify changes (UN Water 2018a, p. 12).

Sub-indicator 3 is defined as *quantity (discharge) of water in rivers and estuaries* and refers to the volume of water per unit of time, leaving a water-ecosystem by downstream movement. Possible in situ monitoring methods are gauging stations, measuring the height of water surface at a fixed position, discharge meters and other instruments such as propeller or electromagnetic current meters that measure velocity. In combination with cross sectional area data and bed depths they enable calculating discharge volume and citizen-science approaches for small rivers. The timed volume method and cross-sectional methods are examples for that. In monitoring this sub-indicator, several aspects have to be considered. The chosen location of monitoring should represent the whole water body, the chosen frequency should ensure determining long-term trends and in addition to the in-situ monitoring, the discharge should be modelled to estimate natural and present-day flows. The generated data is to be submitted in the unit million m^3 /year, collected at least once per month and averaged annually per river and estuary. Each basin should contain a minimum of one sampling station. Just like the other sub-indicators, the calculation of the change of the third indicator includes subtracting the average discharge of a five-year period from a baseline period, dividing it by the baseline value and multiplying it by 100 to obtain the change as a percentage. (UN Water 2018a, pp. 15–17)

Sub-indicator 4 concerns the *quality of water related ecosystems* and complements sub-indicator 2 by adding data on other parameters measured in situ. Since indicator 6.3.2 already includes measurement of five core parameters on water quality, this data is used for the calculation of sub-indicator 4. As the other sub-indicators, the value has to represent change. Hence, data collected for indicator 6.3.2 has to be converted into the percentage change of water quality over time.

Sub-indicator 5 includes measuring the *quantity of groundwater within aquifers* by using boreholes and sampling at least twice a year during wet and dry seasons. Although collecting data on an aquifer's thickness and storage ability would be the common approach to estimate its volume, the sub-indicator only asks for measuring the level of groundwater within an aquifer. The percentage of change is calculated in the same manner as for the other sub-indicators. (UN Water 2018a, pp. 17–18)

The existing global database of Earth observations entails images reaching back to the year 2000, with at least seven pictures a year and a resolution of 10-metre pixels since 2016 (UNEP 2018b,

p. 29). The high amount of globally available data allows the establishment of a baseline period that helps identifying seasonal changes (UNEP 2018b, p. 29). The methodology reflects the SDG's idea of monitoring being a country-led process by highlighting the countries' responsibility and ownership, but also acknowledges that the globally available database offers the opportunity to fill national data gaps, facilitate and accelerate national progress to achieving the target (UNEP 2018b, p. 23) . The countries are supposed to provide data on the sub-indicators every five years to UNSD after national data drives (UNEP 2018b, p. 31). The last one was conducted in 2017 (UNEP 2018b, p. 31).

3.4.4 The GLAAS initiative

History

The first publication of the UN initiative Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS), coordinated by WHO, is the 2008 pilot report (WHO 2008, p. 3). It states that despite the high relevance of investments in water and sanitation and their associated chances of combating avoidable deaths caused by diarrhea, the necessary investments and political decisions are not made (WHO 2008, p. 1). The reason given in the report is the complexity of the data basis in the water and wastewater sector, which at the time did not allow a determination of investments made in the respective water-related problem areas (WHO 2008, p. 3). At that time, there were also numerous reports on individual topics in the water and sanitation sector, but no institution that could present the overall picture and thus create a comprehensible information basis for policy makers (WHO 2008, p. 1). The GLAAS initiative has set itself this goal in order to facilitate the monitoring of the MDGs by means of this new approach (WHO 2008, p. 3). To achieve this goal, GLAAS has undertaken several subtasks (WHO 2019, p. 1). The nationally available capacities of agencies to implement MDG 7.C were identified, as well as the globally available resources for implementation in relation to the status quo and trends in the water and sanitation sector (WHO 2019, p. 5). Existing problems and drivers in the sectors were and the value of monitoring itself was realized by identifying the large number of organizations (UN, NGOs, multilateral agencies, governments) involved (GLAAS 2018a, p. 3). In addition, other existing initiatives such as the JMP and the UN World Water Development Report were supported by GLASS compiling national, regional and global data (WHO 2008, p. 6). Finally, policy-makers at all levels were supported by the data and findings produced (GLAAS 2018b). The summary of the data was also intended to relieve countries of the burden of reporting and to align and bundle the various reporting mechanisms. Nevertheless, the MDG process has been criticized for mainly emphasizing outcomes whilst neglecting the means of implementation (MoI) (GLAAS 2018a, p. 2). The term summarizes all sorts of resources that are required to achieve the global globes, including financial and technological resources, capacity-building, regional integration and national enabling environment (GLAAS 2018a, p. 2). For this reason, every SDG involves MoI targets, in case of Goal 6 they are represented by targets 6.a and 6.b, which are monitored through the GLAAS country survey complemented by the TrackFin Initiative (GLAAS 2018a, p. 3). The GLAAS survey was modified to cover all aspects of SDG 6 to quantify all types of resources, laws, policies, institutional and monitoring arrangements and identify drivers, data gaps and challenges (GLAAS 2018a, p. 13). To this end national focal points were appointed to coordinate data collection, compiling and validation for responding to the survey (GLAAS 2018a, p. 3).

Monitoring target 6.a

6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies	*6.a.1 Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan*

The indicator 6.a.1 aims at quantifying international cooperation and support to developing countries by measuring the amount of official development aid (ODA) that is specifically mobilized for subjects water and sanitation and also is part of an official spending plan (UN Water 2017c, p. 31). The methodology for monitoring it presumes definitions of each term of the indicator, presented in the following.

- **ODA**: official financing with the goal of supporting economic and social development of developing countries, the definition explicitly excludes loans by credit agencies that solely foster export (UN Water 2017c, p. 31)
- **Water and sanitation-related activities and programs**: as described in the target "activities and programs for water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies" (UN Water 2017c, p. 31)
- **Government coordinated spending plan**: a detailed government plan or budget for the finances available for the respective activities in the water and sanitation sector (UN Water 2017c, p. 31)

The data needed is the *amount of water and sanitation-related ODA included in government budget* as well as *the amount of total water and sanitation-related ODA disbursements*. By dividing the former by the latter and multiplying the result by 100% the indicator is generated. A value close to zero percent implies that there are international investments in the WASH sector that are independent of a government's budget. A high value close to 100 percent, however, suggests that donors mostly place their investments within a governments WASH strategy. (GLAAS 2018a, p. 6)

The data for both WASH related ODA within a government's budgets and total disbursements are collected through the GLAAS country survey that was updated in 2018 to be further aligned with the SDGs. For further disaggregation into local or regional level, countries can implement TrackFin. IWRM reporting in the context of monitoring Target 6.5 can complement the data for this part of the methodology. Main source of WASH ODA is the OECD Creditor Reporting System (OECD-CRS), which collects data according to so called Purpose Codes to specify them and allow a disaggregated view on the level of international cooperation in WASH. (GLAAS 2018a, p. 7)

Indicator 6.a includes three more supporting sub-indicators aside the *proportion of ODA included in government budget*. One of them is the *proportion of water and sanitation-related ODA channeled through treasury*. The difference between ODA within the budget and channeled through treasury is the level of control the government has over them. In case of ODA that is part of the government budget, their management might be carried out by donors, whilst treasury led ODA is completely under the government's control which indicates a higher level of cooperation between government and donors. Another sub-indicator is the *total amount of water and sanitation-related ODA* itself. Only observing this part of the main indicator enables a country to assess how the amount of WASH-related ODA is changing over time. The last sub-indicator is the *state of implementation of the Four*

Collaborative Behaviors as part of the Sanitation and Water for All (SWA) initiative. Implementing them is supposed to improve the cooperation between a government and its partners and thereby facilitate and enhance their efforts to improve the WASH sector's development. (GLAAS 2018a, p. 10)

Monitoring target 6.b

6.b Support and strengthen the participation of local communities in improving water and sanitation management	*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*

The second target monitored by GLAAS is Target 6.b. The indicator developed for this target is the measures the share of administrative units that have established structures enabling communities to have a voice in managing water and sanitation. In this context *local administrative units* are all types of communities on the local level such as sub-districts, communes and municipalities in urban and rural areas. The *policies and procedures for participation of local communities*, the indicator refers to are any kind of approach or method that enables the residents of those communities to have an impact on water and sanitation activities. These have to meet the criteria of being *established* and *operational*, meaning that that they are statutory or officially approved by the government and already implemented and carried out. Water and sanitation management is in this context all management related to the SDG 6 targets. (GLAAS 2018a, p. 12)

The data on this indicator is collected through the GLAAS survey which contains a question on those types of procedures. If a country has data for the local unit level, more specific questions on operationality, number of local administrative units assesses and total number of national units follow. To ultimately calculate the indicator, the *number of local administrative units with operational policies and procedures for local participation* is divided by the *total number of local administrative unit in the country*. The indicator therefore depicts the level of participation of local communities in WASH management. (GLAAS 2018a, p. 13)

The indicators methodology includes monitoring sub-indicators. One sub-indicator is *the presence of defined procedures for local participation at the national level*, also monitored through the survey. The other sub-indicator is participatory development and good governance. To monitor it, the OECD-DAC PD/GG-orientations are used that define which aspects an activity must have to be classified as PD/GG-oriented. These aspects are for example participatory development such as establishing new systems, structures or institutions through which communities can participate in shaping decisions that affect their lives, democratization which integrates participation and pluralism, good governance such as accountability, efficiency, and effectiveness of the official sector or human rights. The sub-indicator is calculated as the *proportion of WASH-related ODA that is PD/GG-oriented*. (GLAAS 2018a, pp. 13–14)

Since the availability of the data on indicator 6.b.1 is usually low at the local administrative unit level, the methodology suggests other data sources. It mentions the OECD Water Governance Indicators, a framework for the measurement of stakeholder engagement for inclusive water governance that was tested in 2017 and includes an indicator on local participation. Other sources or monitoring mechanisms might be censuses of municipalities, the inclusion of the indicator into administrative

data to be collected at local administrative unit level, focus groups, community dialogues or existing projects. (GLAAS 2018a, pp. 14–15)

In addition to national data the GLAAS initiative collects data from external support agencies within its ESA survey to fill data gaps. It was revised in 2018 and addresses NGOs, development banks, donors and private foundations. The latest conducted survey cycle in 2018/2019 involved a revised review process of national data with the goal of strengthening national data quality. (WHO 2019, p. 74)

The three steps of this process were as follows:

1. "Review of data by national GLAAS focal points and stakeholders, followed by review by WHO country and/or regional offices against a checklist of common issues." (WHO 2019, p. 74)
2. "Review by WHO headquarters including analysis of responses and data, comparison with previous cycle data, review of source and supporting documents provided by countries and cross-checking of information with additional data sources such as OECD when applicable." (WHO 2019, p. 74)
3. "Requests for clarifications to national GLAAS focal point and teams, who provide explanations, corrections and additional information." (WHO 2019, p. 74)

3.5 Overview on monitoring SDG 6

As depicted in the previous sub-chapters, monitoring SDG 6 is a complex process, involving the efforts of various UN agencies, ministries, statistical offices and sectors on the national, regional and global level. In general, the basis of data collection should always be national data. Each indicator's monitoring process is led by UN custodian agencies, specialized in the respective field. The types of data that need to be collected in order to monitor SDG 6 as intended by the IMI are numerous. Some of the are depicted in the following list.

- Population data
- WASH in households produced through surveys
- ambient water quality
- disposal and treatment of wastewater and excreta
- number of arrangements for transboundary cooperation
- data on treatment facilities' permit
- drinking water quality
- extent, quality and quantity of water-eco-systems
- sector data on water use and value added
- existence of procedures for local participation
- elements of IWRM, the amount of water-related ODA and
- water basin delineation

An overview on all data required for monitoring SDG 6 and their interlinkages are illustrated in Figure 23. In some cases, the same data is needed for several indicators such as population data for indicators 6.11, 6.2.1 and 6.3.1. The same applies to data on types of sanitation facilities, emptying and transport, treatment and disposal of wastewater and faecal sludge that are used for monitoring both 6.2.1 and 6.3.1. Collected data sets can be used for estimating several indicators. These synergies should be noted to avert an inefficient double collection. In other cases, the indicator's components are interlinked as in case of operationalized arrangements for cooperation for indicator 6.5.2 that have an impact on indicator 6.5.1. Another example is industrial wastewater in 6.3.1 that is

directly related to the sectoral water use which is part of indicators 6.4.1 and 6.4.2. In these cases, the collection processes and stakeholders are similar and the data can potentially complement each other. Synergies and possibilities for enhancing efficiency derive from existing monitoring efforts that partly or completely cover the data relevant for SDG 6 monitoring. Collected data but also established mechanisms and experience can be used to facilitate SDG 6 monitoring. This is especially beneficial for the monitoring of new indicators.

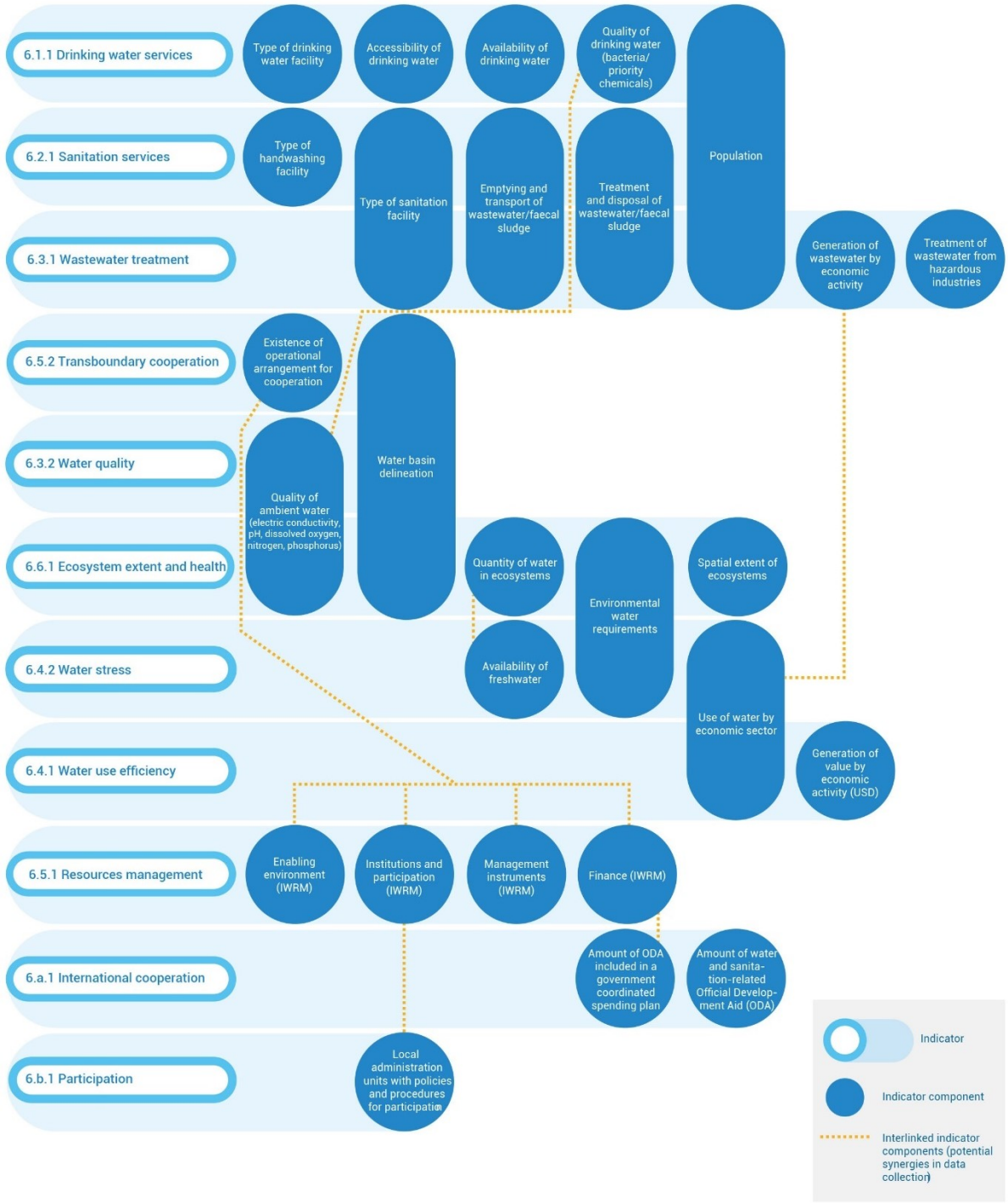


Figure 23 Data interlinkages (UN Water 2017c, p. 37)

As mentioned before the IMI uses a phased approach in order to support the achievement of SDG 6 and currently stands at the beginning of the second phase. When considering challenges in the monitoring process, it should be kept in mind that it is a progressive process that just finished the first phase of setting baselines.

3.6 Monitoring SDG 6 in Germany

This section explains how the data necessary for national monitoring are collected at national level and which national indicators have been defined by Germany for SDG 6 within its national sustainable development strategy.

Germany, like every Member State, appointed a focal point who is responsible for coordinating the monitoring of all SDG indicators. In Germany, this position is held by the BMU. The Federal Statistical Office, on the other hand, provides data which the BMU forwards to the UN custodian agencies. In the case of SDG 6, the Federal Statistical Office collects data from other offices and additionally collects data on its own, analyses them and passes estimates on to the BMU.

The use of secondary data implies that Destatis, for example, provides surveys requesting data from local water suppliers. The challenge experienced within Germany's data collection for SDG 6 is that some of the indicators defined by the IAEG are defined in a way that rather reflects the situation in developing countries which in some cases leads to the circumstance that Germany as well as other developed countries not regularly collect that type of data, since it meets relatively low requirements. It is therefore essential that the definitions in the national survey be slightly modified. Examples are the indicators 6.1.1, 6.2.1 and 6.b.1. In the case of indicator 6.1.1, for example, almost 100 % of the population use safely manged services since they are connected to the public supply system are examined. For the remaining 0.6 % of the population, e.g. those using private wells, data is available from local water authorities, but this data is not collected centrally, due to their very small number. In comparison to developing countries, the proportion of people using any other service level as safely managed is significantly lower and therefor hard to generate. That is why Germany uses the indicator population connected to the central water supply system.

Indicator 6.2.1 does not distinguish between wastewater that needs to be treated and wastewater that can be reused or discharged untreated. In Germany, however, the share of cooling water that does not require treatment and the share of water used and discharged in agriculture pose a significant amount of wastewater but according to the indicator’s methodology is classified as being untreated. Germany therefore interpreted these types of disposal as suitable treatment, but listed them separately in order to avoid misunderstandings. The indicator 6.b.1 does not really apply to Germany in the same way as it does to developing countries. For that cause, Germany is currently exploring possible data sources but does not provide an estimate yet.

There is no German estimate available for the indicator 6.b.1. The same applies to indicator 6.6.1. However, in the case of 6.6.1, data sources have already been identified. Work is in progress to create time series. However, vegetated wetlands are not recorded and the annual change in spatial extent, not the change in the five-year average, is calculated. Area data from the area statistics available to Destatis are used for this purpose. Whether international data will be used for the other sub-indicators of the indicator is still being examined. (Huber 12/2/2019)

A further indicator, which is reported in the same way as the definition, but requires a great deal of national effort and for which an estimate is therefore only available for one year despite the country's large database, is indicator 6.3.2. Data on water quality in German waterbodies are generated by the German Environment Agency. However, considerably more parameters are taken into account than the five parameters suggested by the indicator. This means that a new, less meaningful estimate had to be calculated from the existing data, containing only these five parameters.

With regard to Earth observation data, Germany also uses nationally produced data. If the processing of this data exceeds the competencies of Destatis, it contacts the Federal Office of Cartography and Geodesy. In the case of indicator 6.4.2 there is another peculiarity. The calculation of the environmental flow requirements is currently still problematic, which is why the value for 6.4.1 stated by Germany does not include EFR and thus deviates greatly from the value determined by the custodian agency which includes international sources for EFR. In this respect, it should be added that the Member States should have sovereignty over their national monitoring process and that data collected nationally should be preferred by custodian agencies. So, if such differences arise and the custodian agency nevertheless publishes these data in competition with the nationally collected data, inconsistencies and conflicting situations may arise. In theory, all national estimates should be reviewed and confirmed by the countries before publication. Mr. Felgendreher from the Federal Statistical Office, however, indicates that this is not always the case and that active efforts are sometimes needed to revise the data. In contrast, too many data request by the custodian agencies may exceed the national capacities. A balance that satisfies both national monitoring actors and custodian agencies and enables a reliable and strong monitoring system should be adhered to. The following table shows the indicators and data sources used by the Federal Statistical Office, their comparability with UN metadata and the challenges inherent in the process of data collection. (Huber 12/2/2019)

Table 16 Monitoring global SDG 6 indicators in Germany based on (Destatis 2019a)

Indicator	Indicator available	Data source	Comparability with UN metadata	Challenges
6.1.1	Population connected to the public water supply system Population using safely managed drinking water services	Federal Statistical Office (Destatis)	The time series is compliant with the international metadata description, but the estimation method deviates from the proposed methodology.	The part of the population that is not connected to the public supply system most likely uses wells in houses. Although these are monitored by local monitoring authorities, these data are not routinely transmitted to the Federal Statistical Office. Basically, therefore, the data required for the water supply of 100% of the German population is not available. The definition chosen by the UN is rather oriented at the needs of developing countries which is why Germany chose a slightly differing definition and estimation method.
6.2.1a **6.2.1b**	a) Population using safely managed sanitation services b) Population with a bathtub or a shower	Eurostat	The time series "Population using safely managed sanitation services" is compliant with the international metadata description. The time series "Population with a bathtub or a shower" does not measure explicitly if households have access to a hand-washing facility.	The definition chosen by the UN is rather oriented at the needs of developing countries which is why Germany chose a slightly differing definition and estimation method.
6.3.1	Wastewater safely treated	Federal Statistical Office (Destatis)	The time series is compliant with the international metadata description	
6.3.2	Water bodies with good quality	Federal Ministry of Environment, Nature Conservation and Nuclear Safety (BMU)	The indicator takes only a selected set of the parameters listed in the metadata into account to measure good ambient water quality. Further, only open water bodies and river water bodies are considered and not groundwater bodies.	There are no data on groundwater available. Since only five of the parameters, the UBA uses to estimate water quality are part of this indicators scope, The UBA to recalculate the estimate only using those five parameters. The estimate is therefor only available for one year, although there is a more detailed data series, that does not fit the indicator's methodology.
6.4.1	Water use efficiency	Federal Statistical Office (Destatis)	According to the metadata, only irrigated agriculture should be included in the calculation, whereas this indicator considers all types of agriculture.	

Indicator	Indicator available	Data source	Comparability with UN metadata	Challenges
6.5.1	Degree of integrated water resources management implementation	Federal Ministry for the Environment (BMU)	The time series is compliant with the international metadata description.	
6.5.2	Transboundary basin area with an operational arrangement for water cooperation	Special Analysis	The time series is compliant with the international metadata description.	
6.6.1	Spatial extent of water-related ecosystems Quantity discharge of water in rivers Water bodies with good quality	A suitable data source has been identified.	For Sub-indicator 1, vegetated wetlands are not taken into account. Also, the annual change in the spatial extent is calculated and not the change in the five year mean as suggested in the international metadata. Sub-indicator 3 is compliant with the international metadata description.	Statistics in progress: The corresponding time series are currently being processed to be included in this reporting platform.
6.a.1	ODA (gross disbursements) for water and sanitation ODA (gross disbursements) for other related water and sanitation purposes	Organisation for Economic Co-operation and Development (OECD)	The data series provided are compliant with the global SDG Metadata. As the global SDG Metadata are not conclusive as to whether "ODA for other related water and sanitation purposes" have to be included, these are presented in a separate time series.	
6.b.1		Suitable data sources are currently being explored.		Exploring data sources

Germany also implemented national indicators that are not transmitted to custodians but are part of the national sustainability strategy based on the SDGs (Destatis 2017, p. 96). The sustainability strategy's preparation started in 2002 and was followed by revisions and supplements every four years since 2004. The current version was revised in 2016 for alignment with the SDGs and adopted by the Federal Cabinet in 2017 (Destatis 2017, p. 96, 2017, p. 97). Its latest revision took place in 2018 (Die Bundesregierung 2018, p. 7). The three targets related to SDG 6 are shown in the table below.

Table 17 National indicators concerning SDG 6 based on (Die Bundesregierung 2018, p. 54)

SDG 6: Ensuring the availability and sustainable management of water and sanitation for all

Nr.	***Indicator area Sustainability postulate***	***Indicator***	***Target***
6.1.a	*Water quality Reduction of substantial pollution of water bodies*	*Phosphorus in watercourses*	*At all measuring points the orientation values typical for the water are maintained or undercut until 2030.*
6.1.b		*Nitrate in groundwater - proportion of monitoring sites in Germany at which the threshold value of 50mg/l nitrate is exceeded*	*Until 2030 Compliance with "50 mg/l" nitrate threshold value in groundwater*
6.2	*Drinking water and sanitation Better access to drinking water and sanitation worldwide, higher (safe) quality*	*Number of people newly given access to drinking water and sanitation through German support*	*By 2030, 10 million people a year should gain access to water.*

The monitoring methodology of the German sustainability strategy comprises a biannual report on the status of the sustainability indicators provided by the Federal Statistical Office. A progress report is to be prepared for each legislative period, which will contribute to the further development of the strategy by assessing the current status, identifying measures for further achievement and defining strategies for priority areas. In addition, the further development of the public strategy must also include public participation. The ministries involved in the State Secretary Committee for Sustainable Development should report regularly on current issues. The Federal Statistical Office uses official statistics, administrative data and other sources for data collection. (Destatis 2017, p. 97)

In addition to the national sustainability strategy, almost all German federal states defined their own sustainability strategies, some of which have already been aligned with the Agenda 2030 (Destatis 2019b). The regional pendant to the agenda is the European SDG indicator set, which comprises 51 indicators oriented at the SDGs and managed by Eurostat (Statistical Office of the European Communities 2016, p. 9, 2016, p. 144).

4. Challenges in monitoring SDG 6

In this chapter, the problems and challenges in the global monitoring of SDG 6 that have been addressed and identified in the research and interviews, are discussed in detail, and solutions are proposed. The chapter's focus lays on data collection and analysis. At first glance, data gaps play a role in the monitoring process of each indicator. However, their causes and future elimination must be considered indicator-specifically, as there are methodological or data-related differences, which would not be taken into account by generalization. An example of this is the data collection method, which in some cases is based on data gathered in household surveys, in others on administrative data or satellite-based data. Data gaps in survey-based data are for example caused by the fact that the desired data is not covered in a survey's scope, while administrative data may not be collected nationally or routinely. In data analysis, it is also relevant, what type of data are involved and which methodologies are used to calculate estimates. Depending on the indicator-specific process, for example, a certain data quality or quantity may be necessary. A generalization can be carried out only after all individual indicators have been considered separately, taking into account their mentioned specifications. For this reason, the chapter begins with an examination of the problems and challenges of each individual indicator and concludes with a description of the general and structural problems and challenges that currently apply to several or all indicators.

In this context a challenge is defined as a circumstance that impedes the creation of the required data or their analysis and thus the monitoring process. This can be due to either the indicator, its methodology, or to external influences. In this thesis, a problem is understood as a situation that has a negative impact on monitoring in the long term and requires an actively developed solution approach of greater scope and complexity than a challenge. This definition is freely chosen by the author, and the assessment between challenge and problem is based on the subjective evaluation of the underlying information. The approach of this discussion is to present the current data availability and to identify reasons for possible data gaps and thus potential challenges and problems. Possible solutions are then identified. Whether data availability alone can serve as a measure of monitoring success, is discussed in the concluding, generalizing part of the chapter.

4.1 Expert interviews

4.1.1 Approach

The aim of the thesis is to identify current problems and challenges in SDG 6 monitoring. For this reason, it makes sense to gather the experiences of people who are currently working on the monitoring process. Thanks to the contact with the German Environment Agency, there were several possibilities. The interview questions were based on the background and position of the interviewee. It was not sensible to use a standardized catalogue of questions, as details of the respective areas of work could not be dealt with in this way. The aim was to capture personal experiences that go beyond the consensus recorded in the reports. However, the fundamental question of problems and challenges in the monitoring process of each interviewee was asked. Both open and closed questions were used to stimulate the presentation of the interview partner's opinions and impressions on the one hand and to verify assumptions by either/or questions in concrete cases on the other. The transcripts can be found in Appendix D. The main statements and findings of the three interviews are summarized below.

4.1.2 Interview partners

- **Interview with Dr. Richard Johnston and Francesco Mitis (WHO/UNICEF-JMP):** Dr. Richard Johnston works as a technical officer for the Joint Monitoring Program at the WHO since 2013. He manages the WHO side of this WHO/UNICEF collaboration and works on thematic issues related to global monitoring, including ways to improve methods of monitoring drinking water quality and safety. Francesco Mitis has been working as a statistician for WHO for 21 years. The interview was conducted in September 2019 and lasted 38 minutes. The subject of the interview was mainly the goal of global monitoring and challenges in monitoring indicators 6.1.1 and 6.2.1.
- **Interview with William Reidhead (UN Water):** William Read is a global monitoring officer at UN-Water since 2016. He is responsible for coordinating the IMI for monitoring SDG 6. The interview was conducted in November 2019 and lasted about 42 minutes. The conversation with William Reidhead resulted in findings about the structure and work of the IMI as well as the objectives of global monitoring and problems in its implementation.
- **Interview with Stuart Crane (UNEP):** Stuart Crane is an International Specialist on water, climate change and ecosystems. He works as program officer at UN Environment and is the agency's focal point concerning SDG 6 monitoring. The interview was conducted in November 2019 and lasted about 35 minutes. Mr. Crane provided an inside to challenges in monitoring indicators 6.3.2 and 6.6.1.
- **Interview with Riccardo Biancalani (FAO):** Riccardo Biancalani is coordinating the monitoring of the indicators 6.4.1 and 6.4.2. The interview's topics were challenges in monitoring those indicators. The interview lasted 26 minutes.
- **Simon Felgendreher (Destatis):** Simon Felgendreher is a Desk Officer at the German Federal Statistical Office. He is member of the sustainable reporting unit which works on the calculation of national and global sustainable indicators as well as on the improvement of their methodologies. This interview was not recorded. The information therefore originates from a memory protocol.

In order to avoid repetitions, the findings on challenges obtained in the interviews are integrated into the following chapter. Some content has also been used to supplement previous chapters. They are provided with the corresponding source.

4.2 Challenges in monitoring target 6.1

Indicator 6.1.1 determines the *proportion of the population with access to safely managed drinking water services* and is intended to make the achievement of target 6.1 *by 2030, achieve universal and equitable access to safe and affordable drinking water for a*ll quantifiable and thus verifiable. In itself, this indicator is not one of the new indicators that didn't exist in this form during the MDG era. This means that concerning the monitoring process for 6.1.1, the JMP was able to benefit from both existing methodologies and a database. The decisive difference between this indicator and the earlier monitoring of access to drinking water is the implementation of new service levels, including new sub-indicators. In addition to the previously investigated classification into *improved* and *not improved* water sources, the sub-parameters *availability*, *accessibility*, and *drinking water quality* have to be collected in order to determine the estimates for *limited*, *basic* and *safely managed services*.

Data availability

In the JMP's latest published progress report, estimates of the indicator are available for 117 countries and four of the eight SDG regions, based on data from 2017 (WHO and UNICEF 2019d, p. 7). The data thus represent 38% of the world population (WHO and UNICEF 2019d, p. 7). Figure 24 shows how high the *proportion of the population with access to safely managed drinking water services* is according to the latest figures. The grey-colored countries are those for which the available data were not sufficient to calculate an estimate. For several countries in South America and Africa, but also very populous countries such as China and India, there are currently not enough data available to calculate estimates.

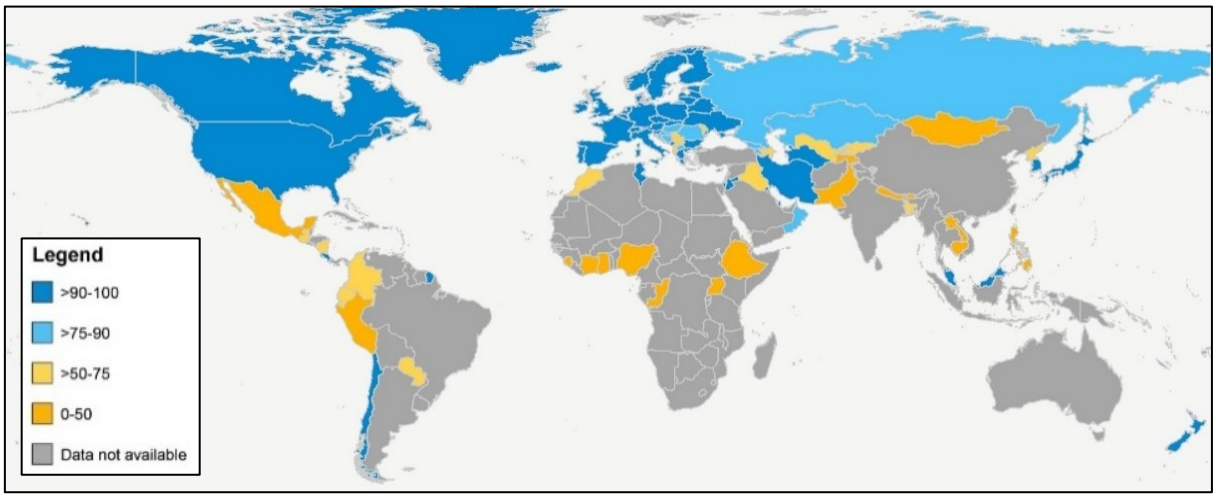


Figure 24 Percentage of people having access to safely managed drinking water services (UN Water 2019e)

In comparison, however, it is possible to determine the *proportion of population using improved water sources* for almost 100% of the world population. Figure 25 illustrates that. In this figure, the most recently available data have been used, since the latest estimates for 2017 cover only a small number of countries (Italy, Argentina, Central Africa). Several estimates for 2016 or even earlier years are available, since this indicator has been determined within previous reporting cycles.

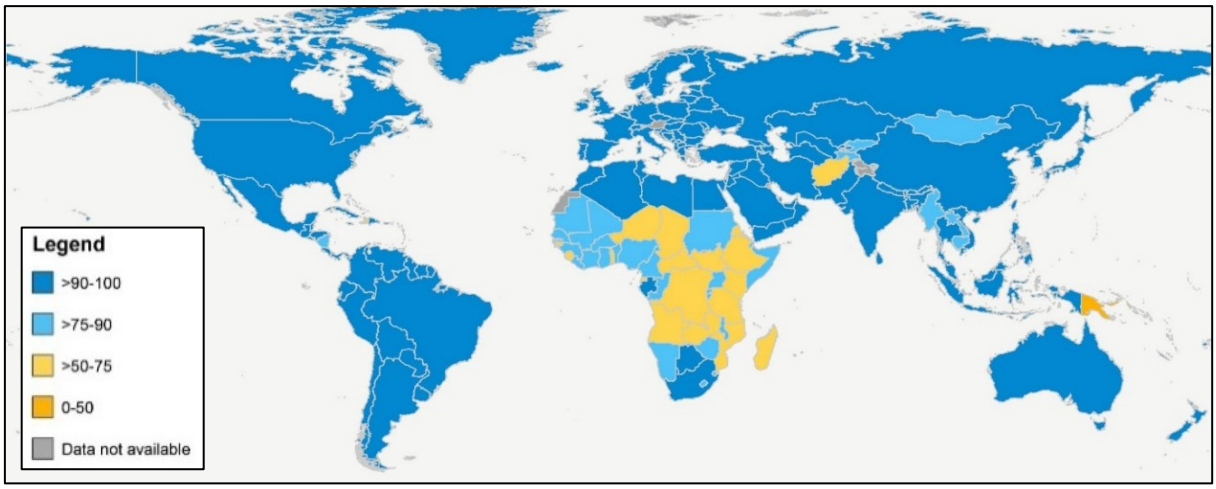


Figure 25 Percentage of population having access to improved water sources (UN Water 2019e)

Table 18 illustrates the share of the population covered by the available data on sub-indicators according to the latest progress report.

Table 18 Data availability of sub-indicators of the indicator 6.1.1 (WHO and UNICEF 2019d, p. 85)

% of population covered by available data (# countries) in 2017	Drinking water			
	Basic water	Accessible on premises	Available when needed	Free from contamination
World (233)	99% (220)	100% (220)	67% (93)	51% (116)
Rural	100% (207)	100% (206)	71% (75)	48% (55)
Urban	100% (212)	100% (211)	63% (98)	54% (75)
SDG regions				
Australia and New Zealand (2)	100% (2)	100% (2)	98% (1)	88% (1)
Central and Southern Asia (14)	100% (14)	100% (14)	73% (6)	72% (10)
Eastern and South-Eastern Asia (19)	100% (19)	100% (19)	83% (8)	53% (11)
Europe and Northern America (53)	100% (52)	100% (52)	17% (13)	100% (50)
Latin America and the Caribbean (48)	93% (40)	99% (40)	87% (25)	54% (14)
Northern Africa and Western Asia (25)	99% (23)	99% (23)	65% (14)	27% (13)
Oceania (21)	100% (21)	100% (21)	25% (7)	15% (7)
Sub-Saharan Africa (51)	99% (49)	99% (49)	76% (19)	51% (10)
Other regional groupings				
Least Developed Countries (47)	99% (45)	99% (45)	49% (19)	45% (9)
Landlocked Developing Countries (32)	99% (31)	99% (31)	68% (15)	59% (16)
Small Island Developing States (57)	99% (50)	99% (50)	35% (20)	18% (11)

The values highlighted in yellow are particularly low and can only be found in the columns *availability* and *quality*. There are estimates for the *availability* of drinking water for 93 countries and for *drinking water quality* for 116 countries. This suggests that the collection of these two sub-indicators still is a challenge. The SDG 6 data portal contains data on *availability* for various years (2013, 2015, 2016, 2017), illustrated in the following Figure 26. It should be noted, that this figure not only counts countries but also States within countries, or else the number 220 does not make sense.

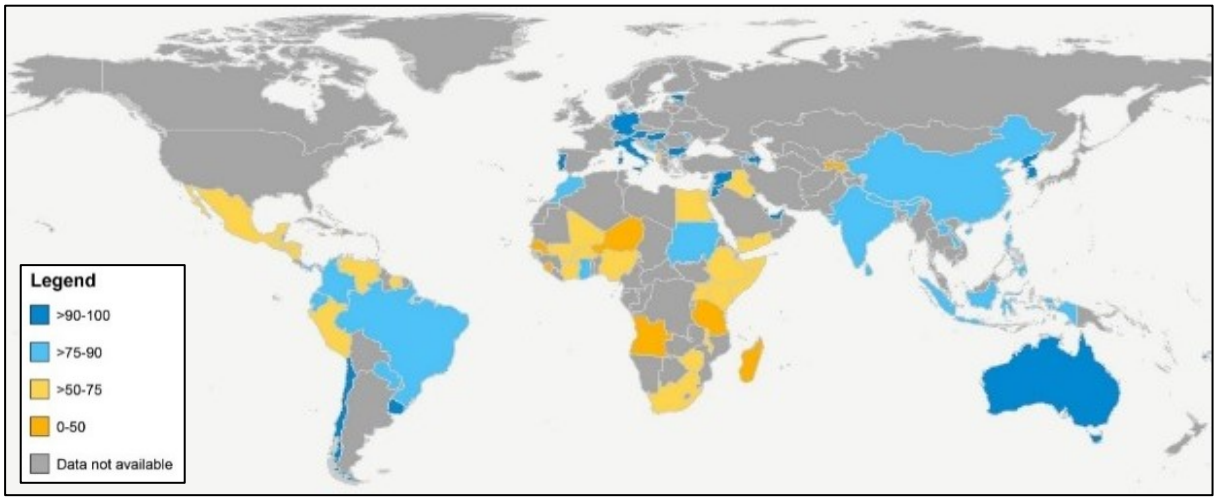


Figure 26 Percentage of population using improved drinking water services that are available when needed (UN Water 2019e)

What is striking here is that, unlike the estimates for *safely managed* and *improved* water sources, the data for estimating *availability* are not provided by many high-income countries. One possible

reason for this circumstance is the fact that many of these countries take *availability* for granted and therefore do not explicitly ask for it in survey formats. Data on *drinking water quality* can be presented only for the year 2017 as presented in Figure 27.

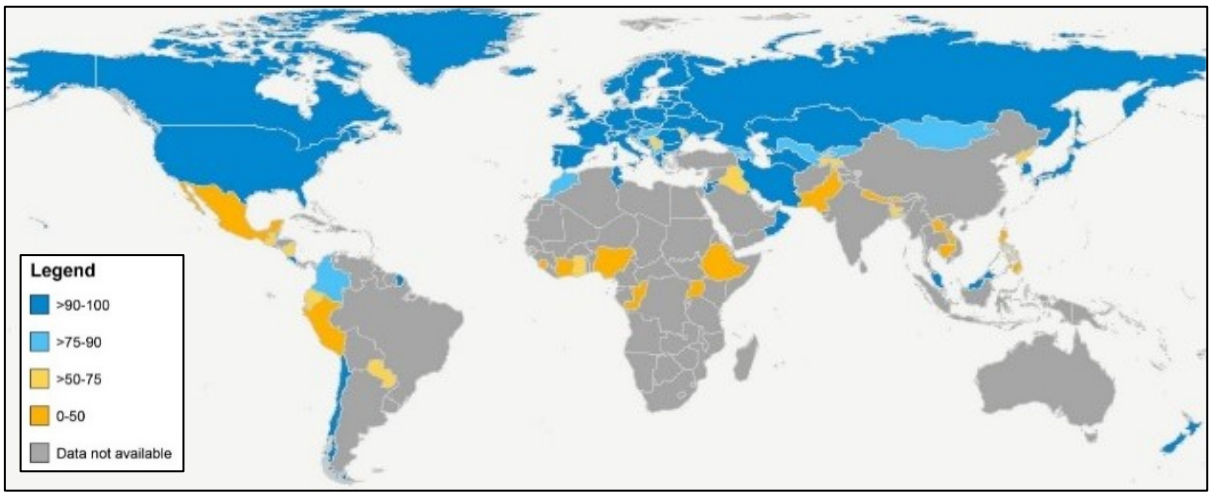


Figure 27 Percentage of population using improved drinking water services that are free of contamination (UN Water 2019e)

The sub-indicator on *drinking water quality* is determined for half of the countries in 2017. Disaggregated data by urban and rural populations is even more scarce. Representative data on *drinking water quality* are available for urban populations in 75 countries and for rural populations in 55 countries (WHO and UNICEF 2019d, p. 85). In contrast to *availability*, the assessment of *drinking water quality* is more problematic in low- and middle-income countries. Also, there is only one available data set on the Data Portal.

Challenges

The biggest challenge is to integrate these partly new sub-indicators into established monitoring procedures and thus be able to calculate the complex indicator of *safely managed services*. The reason for the sub-indicators' difference in data availability and also the challenge of indicator 6.1.1 is their novelty but also the requirement monitoring smaller and more disaggregated user groups. Since the MDGs already differentiated between *piped on premises* and *non-piped*, the data for the sub-indicator *accessible on premises* are almost as numerous as the data for access to *improved water sources*. (Huber 10/2/2019)

The various figures illustrate the diversity of sub-components mentioned above. The at first glance dramatically low percentage of data availability for *safely managed services* must therefore not be misinterpreted as a general maladministration with regard to drinking water supply data. The novelty of the more complex indicator and the short time span for reporting are factors which must find consideration in the interpretation of these estimates. The same applies to the number of sub-indicators included. If it is not possible to calculate a national estimate, one, two or all of the three components of the indicator may not be available. In theory, data could also be available for *accessibility* and *availability*, and only the inadequate data availability for *drinking water quality* could be decisive for the absence of a national estimate (see p.36). It is a basic requirement of the

JMP methodology that *drinking water quality* and one other component must be calculable. Each of the individual components in turn is connected with new challenges in its collection and analysis.

Accessibility is the component for which the greatest data availability is reached yet. Problems can, however, occur due to different wording in the survey questionnaires. The same applies to surveys on *availability*. Especially countries in Europe and Northern America *availability* that assumedly have a high level of availability and the capacity of monitoring it, need to enhance their efforts.

The sub-indicator *drinking water quality* reveals data gaps in all regions except Europe and Northern America. One reason for this is the fact that the primary data sources of these data, mostly public health surveillance or regulatory institutions, cover mainly piped systems in urban areas. Data on non-piped systems and in rural areas are usually less available, since they are harder to generate. This circumstance, however, leads to another challenge. If these data cover over 80% of the population using piped supplies, the JMP uses them to calculate national estimates, which can lead to an overestimation of water quality, as smaller piped systems and all other supply sources are not mapped and have potentially worse quality (WHO and UNICEF 2017a, p. 11). No representation or underrepresentation of people using non-piped systems or living in rural areas also means that the most vulnerable and marginalized groups of the population are not adequately represented in the data. This is one of the biggest challenges in monitoring this but also other indicators, since it contradicts the SDG's principle of leaving no one behind.

Another challenge, that applies to Federated States such as India or the U.S. is, that the data is often not collected at a central level, but within each state. Collecting the data from each State with possibly differing data quantity or quality makes the monitoring more difficult. (Huber 10/2/2019)

And lastly, an increasing consumption of packaged water, especially in urban areas, can potentially complicate monitoring. While the quality of packaged water is to be provided either in household surveys or ideally by regulatory institutions that conduct sampling of bottled water on a regular basis. In the future the availability and accessibility of a second water resource used for other domestic purposes will also have to be investigated, as e.g. cooking or washing is not carried out with packaged water. Such data is currently not always available. (WHO and UNICEF 2019d, p. 42)

Solution approaches

Since the overarching challenge is this indicators novelty, data gaps are likely to decrease over time, when countries get more familiar with its methodology and have more time and possibly capacity for data collection and analysis.

In order to counteract incompatible data on accessibility and availability collected in household surveys, the JMP's core questions, last revised in 2017, should be used (WHO and UNICEF 2018a, p. 5). An example of these can be found in the Appendix D.

Data on *drinking water quality* can be increased by implementing the new approach "Rapid Assessment of Drinking Water Quality (RADWQ)". It combines regular quality surveys and household surveys by having public health authorities carry out random field assessments in a selection of nationally representative water supplies. In 2016, such a survey was conducted by the Serbian Institute of Public Health. Within the scope of the study, 1,318 piped systems and individual supplies

in rural areas were investigated with regard to chemical and microbiological quality. The investigation revealed an *E.coli* contamination of one third of the water supplies. Such an assessment allows public health authorities to identify susceptible systems, prioritize them and thus improve the quality of drinking water as well as the management in small supply systems. In the specific case of Serbia, the investigation led to the enactment of a law requiring water supply systems producing at least 10 m^3 per day to introduce a risk assessment and risk management approach. Additionally, the data collection in general has to be enhanced especially in those countries currently not able to provide an estimate. (WHO and UNICEF 2019d, p. 42)

Between 2012 and 2018 these tests got included into survey formats in 35 countries (WHO and UNICEF 2019c, p. 23). The already implemented approach of integrating water sampling into survey formats has proven to be functional and practicable and is anticipated for another 20 countries for the period 2019–2020 (WHO and UNICEF 2019c, p. 23). This approach also helps generating more data in rural areas and on marginalized groups. In order to promote these even further, an increase in national monitoring capacities is necessary, both in terms of personnel and financial resources. The JMP also works on integrating additional data sources into the data collection process. An increase in data from administrative sources and regulators has already been assessed in case studies in Italy and Kenya (WHO and UNICEF 2019a). The JMP took part in a meeting of the regional association of drinking water regulators in Eastern and Southern Africa (ESAWAS) and identified the European Union's Urban Waste Water Treatment Directive as possible and valuable data source (WHO and UNICEF 2019a).

To improve the monitoring in Federated States, those could implement a better communication system and central collection platform. The JMP should support such processes as well as capacity building, since a lack of capacity might be one aspect of this challenge. At this point, it can also help to further clarify the advantages of monitoring in itself and at national level for each country in detail.

Data on a second water resource could be collected through household surveys. However, it must be investigated whether it is possible to generate information about quality, accessibility and availability of this second water resource, as this can also involve numerous challenges. An example would be the use of rainwater for washing clothes. It can be assumed that neither the quality nor the availability of this water resource is quantifiable in detail by households.

Overview

The data availability of indicator 6.1.1 has not reached its maximum due to the lack of availability of individual sub-indicators. Nevertheless, in the context of the IAEG's tiering system, the indicator is classified as TIER II (IAEG-SDG 2019b, p. 16). The highest level that an indicator can reach is TIER I, whose definition contains the premise that data from at least 50% of the countries and population of a region are collected regularly. The estimation of *safely managed drinking water services* of currently 117 countries and 38% of the world population is therefore not fundamentally problematic. The interview with Mr. Johnston and Mr. Mitis reveals that the addition of data covering a very populous country such as China or India would make a big difference in terms of global coverage (Huber 11/8/2019). Mr. Reidhead, head of IMI, stresses that it is not the goal of global monitoring to achieve 100% data coverage, but that it is a success to raise each of the 11 indicators to the levels

TIER I or TIER II (Huber 11/8/2019). According to Reidhead, the JMP is a very successful program within the framework of SDG 6 monitoring (Huber 11/8/2019). It has been running for over 20 years, looks back on a huge wealth of experience and knowledge, and does far more than the collection of indicators 6.1.1 and 6.2.1/6.2.2 (Huber 11/8/2019). The data not yet collected can be justified by the fact that the safely managed indicator is still comparatively new and that there was simply too little time and/or capacity for collection (Huber 11/8/2019).

However, it can still be questioned whether the indicator contains all aspects of target 6.1 and is thus suitable for monitoring it. Since its suitability has been confirmed by a large number of experts in the indicator's definition process, it is fundamentally beyond question. It is also clear that the definition of global indicators through the participation of all Member States and political representatives are basically the lowest common denominator and that other definitions are conceivable (Huber 11/8/2019). One aspect of the target that is not directly contained in the indicator is equity. What is certainly not concerned as a challenge in the view of the UN custodian, since this indicator is intended in this way and it monitors many other indicators beyond that, is a deficit for the neutral observer of the indicator, since the original idea of monitoring the goal with this special indicator fails with regard to this aspect. In addition, it should not be overlooked that the available data indicate that particularly the disadvantaged population groups with lower quality drinking water services are not yet adequately covered. In order to reduce inequalities and truly reach universal access for all, this this deficiency must be remedied. The same applies to affordability which is not a part of the indicator's methodology, though mentioned in the wording of target 6.1.

The above solutions relate to the increase in the data volume of the sub-indicators water quality and availability. It can be assumed that the different approaches will generate more data on drinking water quality and also help to harmonize the point of sampling. The further integration of questions on availability into survey formats should also lead to an increase in data. In combination with support in capacity building and data collection, these approaches will contribute to an increase in data availability and improvement of monitoring of target 6.1. However, whether they are sufficient to reach TIER I and ultimately generate estimates for all countries also depends on which national challenge currently prevent estimates from being calculated. To this end, it is necessary to examine the dimension of data deficits in individual countries as well as their causes at the national level. Such an investigation is not possible in the context of this thesis. Nevertheless, the steady increase in data sources to date and the willingness of countries to strengthen monitoring indicate a positive development of monitoring success. In addition to the regular progress report, a report will be published in 2023 that details the progress in monitoring, including remaining data gaps.

4.3 Challenges in monitoring target 6.2

Target 6.2 *by 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations* is monitored through the indicators 6.2.1.a p*roportion of population using safely managed sanitation services* and 6.2.1.b *proportion of population using hygiene facilities including a hand-washing facility with soap and water*. The indicator on access to sanitation involves some new aspects, just as 6.1.1 does. The indicator on hygiene is completely new. Both parts of the indicator are monitored by the JMP.

Indicator 6.2.1.a

Data availability

In 2017, 92 countries and three quarters of the SDG regions had the required data to estimate the indicator *safely managed sanitation services* as shown in Figure 28 (WHO and UNICEF 2019d, p. 8). They represent 54% of the global population (WHO and UNICEF 2019d, p. 8). In Figure 28, grey-colored countries lack the required data to calculate an estimate.

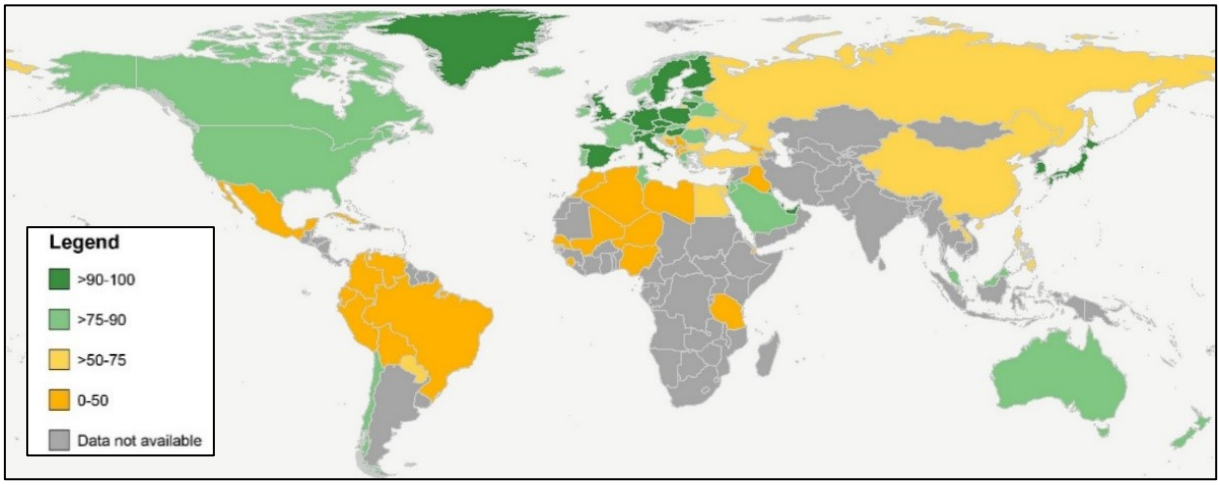


Figure 28 Percentage of population using safely managed sanitation services (UN Water 2019e)

Data on population *using improved sanitation facilities* in 2017 is illustrated in Figure 29.

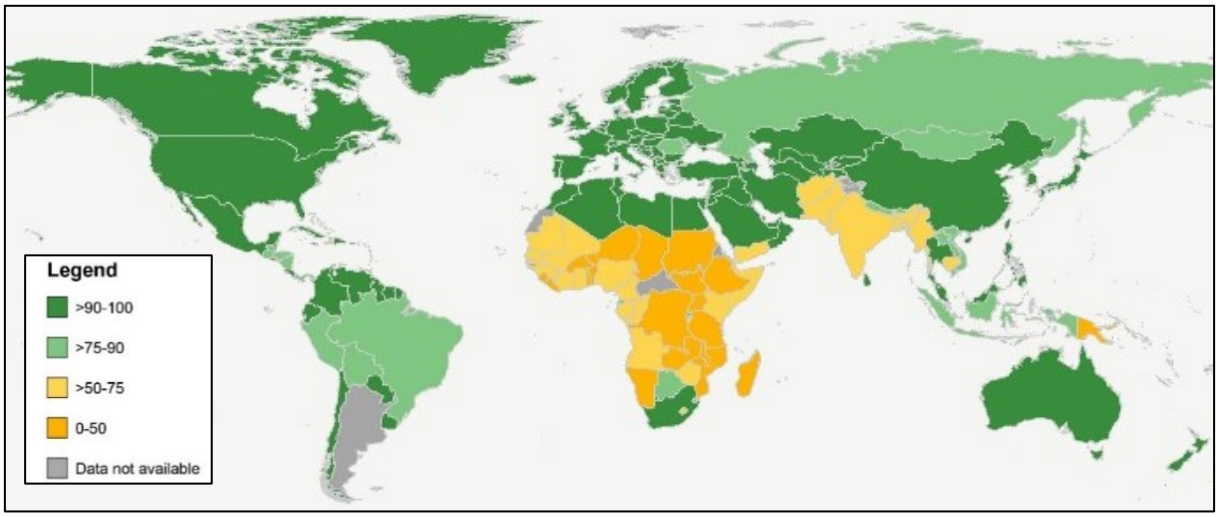


Figure 29 Percentage of population using improved facilities (UN Water 2019e)

Figure 29 shows that data are available for almost 100 % of the world population for *basic sanitation services* (WHO and UNICEF 2019d, p. 85). In order to be able to determine the indicator *safely managed sanitation services*, however, it is still necessary to generate data on the sub-indicators *safely disposed in situ*, *emptied and treated*, and *wastewater treated*. *Wastewater treated* is, according to the table, the sub-indicator, with the largest number of countries with data coverage.

Table 19 Percentage of population covered by available data (WHO and UNICEF 2019d, p. 85)

% of population covered by available data (# countries) in 2017	Sanitation			
	Basic sanitation	Safely disposed of in situ	Emptied and treated	Wastewater treated
World (233)	99% (212)	43% (23)	1% (9)	92% (107)
Rural	100% (203)	57% (22)	0% (0)	87% (92)
Urban	100% (207)	24% (17)	0% (0)	88% (95)
SDG regions				
Australia and New Zealand (2)	100% (2)	0% (0)	0% (0)	100% (2)
Central and Southern Asia (14)	100% (14)	51% (0)	0% (0)	70% (4)
Eastern and South-Eastern Asia (19)	100% (17)	53% (5)	3% (2)	95% (8)
Europe and Northern America (53)	100% (49)	18% (18)	8% (7)	100% (48)
Latin America and the Caribbean (48)	93% (39)	7% (0)	0% (0)	90% (15)
Northern Africa and Western Asia (25)	99% (23)	16% (0)	0% (0)	94% (21)
Oceania (21)	99% (20)	6% (0)	0% (0)	37% (3)
Sub-Saharan Africa (51)	99% (48)	37% (0)	0% (0)	8% (6)
Other regional groupings				
Least Developed Countries (47)	99% (45)	30% (0)	0% (0)	29% (5)
Landlocked Developing Countries (32)	99% (31)	14% (0)	0% (0)	61% (11)
Small Island Developing States (57)	99% (48)	1% (0)	0% (0)	90% (11)

In contrast, the sub-indicator *safely disposed of in situ* can be quantified for 43% of the world population, and the sub-indicator *emptied and treated* for only 1% of the world population, indicating that their monitoring is a big challenge of monitoring indicator 6.2.1a (WHO and UNICEF 2019d, p. 85). Also, the large amount of yellow colored values, indicate that there are several regions without data on these two sub-indicators. When comparing it with the equivalent table for indicator 6.1.1, there are strikingly more highlighted values than for 6.2.1. However, that observation contrasts the fact that there are more national estimates for the safely managed indicator available for 6.2.1 than for 6.1.1. The reason for that is their difference in methodological approaches. For indicator 6.1.1 all or at least two of the three sub-indicators have to be available for estimating this value, while 6.2.1 is based on an entirely different approach.

Challenges

The biggest challenges in monitoring this indicator is the introduction of the new service levels which implies monitoring smaller population groups, similar to 6.1.1. The sub-indicator showing the greatest data gaps and therefore posing a serious challenge in monitoring is *emptied and treated* which refers to on-site sanitation facilities such as septic tanks or latrines (UN Water 2018c, p. 54). Those have to be emptied regularly and it has to be ensured that the collected excreta are treated. The condition and emptying intervals of on-site sanitation systems can theoretically be recorded in household surveys or by companies carrying out transport, for example. At the moment, however, there is too little data available because either no knowledge of the facilities' condition or only knowledge of the condition but no information on the excreta's transport and further (Huber 10/2/2019). Its use and quality are not sufficiently documented at the moment (Huber 10/2/2019). It is precisely this user group that rather is at risk of sanitation-related diseases. Also, excreta that is not disposed, transported or treated safely can pose a major risk to the environment, especially water resources which might again be used domestic purposes though also risking human health.

Due to the lack of knowledge on these facilities, the JMP assumes that 100% of the excreta are contained by them, meaning there are no leaks in theory. If data for emptying such a system is collected in surveys, but no data is available for subsequent transport, the JMP assumes that the excreta is not removed and treated. The same applies to on-site sanitation facilities that intend safe disposal in situ. This approach can lead to overestimations of the sub-indicators *emptied and treated* and *safely disposed of in situ*. (WHO and UNICEF 2017a, p. 17)

In Federal States there is often the problem that data on on-site sanitation is only available at state level only but not at the national level. This means that these data have to be collected for each individual federal state, which means a considerable effort and a very large amount of data. (Huber 10/2/2019)

To understand the extent of these data gaps, one must be aware that almost half of the global population using improved systems use non-sewered sanitation which in this context are facilities which classify as either *emptied and treated off-site* and *disposed of in situ*. (UN Water 2018c, p. 54)

Although data on the sub-indicator *wastewater treated* is available for most regions, two challenges appear in context with its estimation. One challenge is the lack of knowledge about the quality of transport of wastewater collected in pipelines as well as their treatment. In order to be considered as *safely managed*, piped systems include an at least secondary treatment. Data on leakages or the amount of excreta that bypass treatment plants or are discharged without receiving the required secondary treatment are currently not available, therefore the JMP assumes that 100% of the excrements collected in sewered systems arrive through these at the wastewater treatment plants. (WHO and UNICEF 2017a, p. 17)

Leaking wastewater can contaminate the soil below and possibly the groundwater. In addition, high levels of groundwater can infiltrate the sewers and thus increase the amount of wastewater to be treated. Also, sewage overflows from wastewater networks can pose a risk to environmental and public health and impede safe management of wastewater. In New Zealand, for example, about 10 sewers per 10,000 connections overflowed in 2015 (WHO and UN-Habitat 2018, p. 24). In a municipality in Buthan, 507 sewer blockages were recorded in 2016 which, when assumedly leading to overflows, equal about 3,160 overflows per 10,000 connections (UN-Water, WHO, UN Habitat 2018, S. 24). The extent and effects of leakages and overflows should be assessed on a national level and can vary greatly depending on the type of soil, groundwater resources, age of the system, material and design. It can be assumed that the JMP's assumption of 100% is an overestimation. Investigations of sewer systems can take place in different ways, but are more cost-intensive and complex with increasing system length. In this sense, a more precise assessment of the situation can be useful after weighing its necessity. Since assumptions must also be made when calculating other indicators, this circumstance cannot be explicitly seen as a challenge, but should be taken into account when interpreting the estimates.

The quality of treatment quality, however, has to be drawn from discharge permits, which in some cases are not available or require immense collection efforts. Additionally, in the context of the sub-indicator *wastewater treated*, the data used for estimates mainly reflect urban areas, which implies a lack of data for rural piped systems. Although these systems are used more often in urban areas, a

representative estimate is only guaranteed, if rural areas are adequately represented in the calculation as well.

At the moment it is also the case that mostly either data about sewered systems or on-site sanitation are available, depending on which is the dominant sanitation system in the respective country. In order to calculate the safely managed indicator in this case, assumptions must be made about the non-dominant systems. (Huber 10/2/2019)

Solution approaches

To close remaining data gaps, the JMP cooperates with national governments on improving household surveys and authorities responsible for regulating sanitation systems on enhancing their surveillance capacity. Household surveys should include questions about containment or emptying of excreta in onsite storage facilities in a simplified way, so survey teams and household members are able to answer them without knowledge of technical details.

In 2018, additional WHO Guidelines on Sanitation and Health were published to instruct people without technical knowledge to carry out sanitary inspections. However, experts such as public health inspectors can conduct much more detailed investigations on the functionality and effectiveness of on-site sanitation systems. Therefore, a long-term regular survey conducted by local authorities and service providers is an option to create a database in the future. In this context, more data will should collected on the extent of excreta collected in on-site sanitation systems, the treatment level of the faecal sludge or the co-treatment with wastewater. Over the next few years, work will be carried out on indicators and data collection methods to simplify the institution's assessment of the on-site sanitation systems. (WHO and UNICEF 2019d, p. 82)

Data on the quality of the network infrastructure and discharges before the arrival of the treatment plants can be generated and passed on through the commitment of network operators. For this cause the JMP has already developed a questionnaire for collecting information on excreta management from service operators in cooperation with a Sanitation Treatment Task Force. (WHO and UNICEF 2019b)

Since the wastewater flows from households and industry are to be recorded within the framework of target 6.3, cooperation with the custodian agency of target 6.3 is certainly advantageous here in order to avoid double collection or reporting of data. If the wastewater flows of the consumers are known, losses can at least be roughly determined with the aid of the wastewater flows into the wastewater treatment plants. Since infiltration with groundwater can occur in addition to exfiltration, an exact determination of the losses is not directly apparent here. The question remains as to in how detailed a manner this information should and could be collected and how realistic such a survey is with regard to the associated costs.

In the future, however, it will certainly be possible to ask operators more explicitly about input flows in sewage treatment plants, as well as the quality of plant performance. The guidelines mentioned above can help to increase data density with regard to on-site sanitation. However, it is also important to strengthen national monitoring in countries with little data on this topic by continuing to promote and support awareness for the necessity of monitoring.

A positive example is the implementation of Ecuador' monitoring system. In order to monitor targets 6.1 and 6.2, the National Statistical Office in cooperation with the World Bank Global Water Practice and the JMP has expanded an existing survey format to include questions on the quality of sanitation facilities, the testing of drinking water systems and the observation of handwashing facilities. Questions are now asked about on-site sanitation facilities and their effluent discharge and emptying. Due to these efforts and in combination with data from municipalities on wastewater treatment, the JMP was able to determine a baseline value for *safely managed sanitation services*. (UN Water 2018c, p. 43)

Another positive example is Japan. In order to assess the quality of on-site sanitation facilities, their containment and in-situ treatment, a regular census is carried out. Its results are analyzed for compliance with national standards. France uses a similar approach by regularly inspecting on-site sanitation facilities and producing administrative reports including their suitability in protecting human and environmental health.(WHO and UNICEF 2019d, p. 76)

Indicator 6.2.1b

Data availability

The second indicator of target 6.2 concerns access to hygiene facilities. Currently, estimates for the sub-indicator *basic handwashing facilities* can be calculated for 78 countries and three of the eight SDG regions, representing 52% of the global population (WHO and UNICEF 2019d, p. 8). Figure 30 illustrates the proportion of each region's population, covered by available data in 2017.

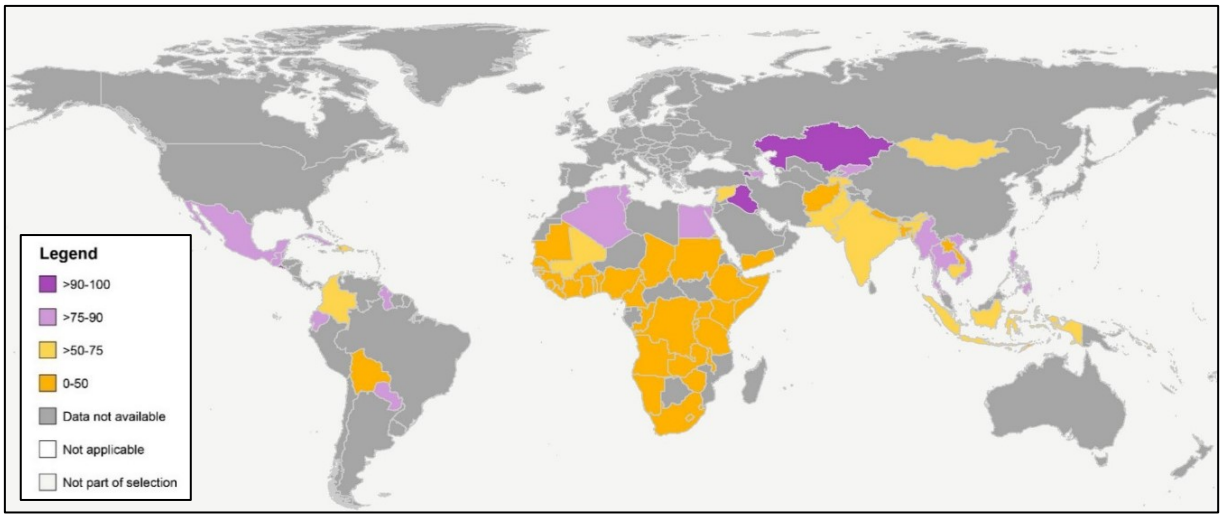


Figure 30 Proportion of population with access to hygiene services (UN Water 2019e)

Challenges

The challenge of this indicator and causes for remaining data gaps are its novelty and the fact that developed countries usually do not routinely collect data on it. There are still many surveys that do not include questions on hygiene facilities and hence don't generate data on the indicator. What is noticeable is that many high-income countries have no data on hygiene facilities. They usually assume the access to be universal so no survey is required, since every building has standardized hygiene facilities. The problem with this statement, however, is that even in these countries a small

proportion of the population has no access to such facilities. This could involve, for example, the homeless or other sections of the population affected by poverty.

Solution approach

These vulnerable groups must also be represented by the data, which is why it will be necessary to revise existing survey formats in the future, for example by adding other proxies such as availability of piped water, hot water, showers or bathrooms. Through those proxies, countries that suspect high access figures are enabled to substantiate their assumption with data (Huber 10/2/2019). Another option of facilitating monitoring on hygiene facilities, that is already carried out within household surveys is that interviewers actively inspect and assess the facilities themselves. Figure 31 illustrates how many data sources were used for the JMP report published in 2019. It clearly shows that fewer surveys are available on the subject of hygiene than on drinking water, sanitation and WASH. Basically, an increased use of the existing survey formats on hygiene or an integration of these questions into the surveys on sanitation and drinking water could generate a larger data volume.

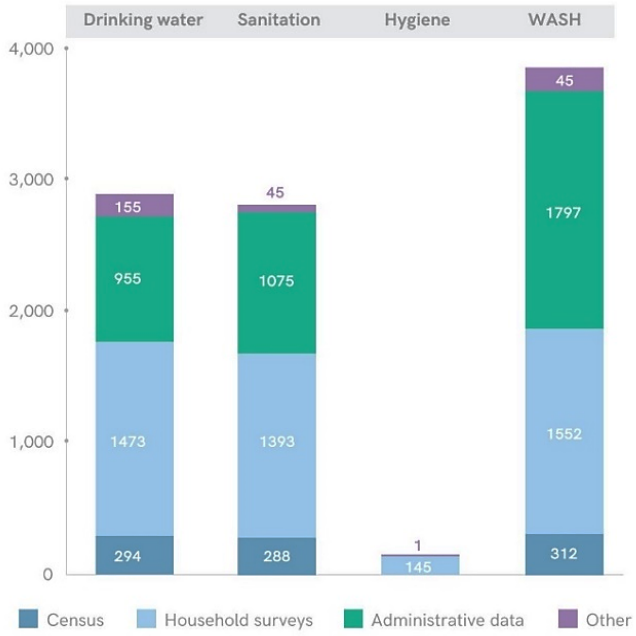


Figure 31 National data sources used for the JMP 2019 progress report (WHO/UNICEF JMP 2019d, p. 82)

Overview

The indicator 6.2.1 is classified as TIER II, which means that its conception is clear, methodologies and standards for its collection have been completed but also that data are not yet collected regularly by over half of the countries. However, the data availability on some sub-indicators is already very high and there are no major methodological problems. However, some new aspects of *safely managed sanitation services* still pose challenges due to their novelty and difficulties in gathering data concerning the treatment, on-site sanitation and transport of excreta. By supporting countries in their efforts to generate data especially on on-site sanitation, by including more questions on them as well as hygiene facilities, training people to assess their sanitation facilities, gaining more data sources and enhancing the quality and quantity of data provided by service operators and administration, it is likely that the data availability will increase over time. However, similar to the challenges of 6.1.1, the goal of gaining universal access for all requires special attention to those population groups living in rural areas and using on-site sanitation.

The remaining question is whether the indicators 6.2.1a and 6.2.1b cover all of the target's aspects such as the sub-areas *open defecation* and *special attention to the needs of women and girls and those in vulnerable situations*. The sub-indicators themselves do not directly cover these areas of the target, nevertheless these aspects are assessed as part of the JMP's additional work. On the subject

of open defecation, the majority of countries have data that make it possible to determine national estimates. Special attention to needs of girls and women is identified in the JMP's report in 2017 by using some national examples, but no regional or global estimates are available (WHO and UNICEF 2019d, p. 64). The entire report is dedicated to inequalities and contains an assessment of the trends in services among richest and poorest wealth quintiles in rural and urban areas (WHO and UNICEF 2019d, p. 49). National examples and the comparison of national urban and rural values are mentioned. The report does not indicate whether these statements can also be made for other countries. Reidhead mentions that special attention should be paid to gender-specific differences in the further course of monitoring (Huber 11/8/2019). In fact, this is a task, the IMI is currently discussing (Huber 11/8/2019).

WASH in schools and health-care facilities

Although WASH in schools and HCF is not part of the SDG 6 monitoring, it is briefly discussed, since the data on these topics are examined by the JMP and are covered by both targets' claim to gain universal access. Some countries already routinely collect data on sanitation and hygiene in schools and in facilities, related to the specific needs of women and girls, such as providing single-sex toilets and making facilities available for menstrual hygiene management. Work is ongoing to harmonize the questions and indicators used for monitoring and to compile national data for the purpose of global reporting.

The latest report drew data from 616 national datasets, 495 of whom were used to produce a total of 152 national estimates (WHO and UNICEF 2018b, p. 60). Between 50 and 55% of the students are covered by the data on drinking water, sanitation and hygiene (WHO and UNICEF 2018b, p. 62). In particular, it is noticeable that there are few disaggregated data on urban and rural areas and that there are significantly more data on primary and secondary than on pre-primary schools. Figure 32 illustrates the data coverage and their dependence on the type of school and type of area. Dark colors indicate values above 50%, thus high data coverage.

	DRINKING WATER						SANITATION						HYGIENE					
	Total	Urban	Rural	Pre-primary	Primary	Secondary	Total	Urban	Rural	Pre-primary	Primary	Secondary	Total	Urban	Rural	Pre-primary	Primary	Secondary
Australia and New Zealand	82	0	0	0	85	80	82	0	0	0	85	80	82	0	0	0	85	80
Central and Southern Asia	93	66	72	0	90	93	81	66	72	0	78	81	80	66	72	0	77	80
Eastern and South-Eastern Asia	28	1	0	0	30	25	26	1	2	1	28	26	26	1	2	1	28	26
Europe and Northern America	65	0	0	0	67	65	64	0	1	0	65	64	68	0	1	0	69	68
Latin America and the Caribbean	24	5	5	14	19	10	92	80	75	7	83	5	34	31	19	28	31	40
Northern Africa and Western Asia	32	2	1	1	21	27	52	8	7	1	43	32	42	2	1	1	34	32
Oceania	86	0	6	75	81	78	86	0	6	75	81	76	86	43	87	75	75	70
Sub-Saharan Africa	26	4	9	1	15	6	30	13	23	0	21	12	36	11	17	0	29	16
Least Developed Countries	41	4	7	1	28	28	49	17	24	1	35	30	55	14	18	1	45	34
Landlocked Developing Countries	45	13	17	2	31	28	46	17	25	0	28	25	59	9	14	0	45	39
Small island Developing States	29	5	2	17	29	25	46	29	10	17	47	25	27	9	35	17	27	22
World	51	15	31	2	45	47	55	28	37	1	49	45	50	20	34	3	46	49

<30% 30-50% >50% <30% 30-50% >50% <30% 30-50% >50%

Figure 32 Global availability of data on basic WASH in schools (WHO and UNICEF 2018b, p. 62)

In the area of health-care facilities, 550,000 facilities have so far been recorded in the JMP's database (WHO and UNICEF 2019e, p. 80). Depending on the type of facility and the region, there are still large data gaps (WHO and UNICEF 2019e, p. 84). Overall, there is more data available on rural facilities than on urban ones and the regions with the lowest data coverage are Europe and Northern America and Northern and Western Africa (WHO and UNICEF 2019e, p. 84).

4.4 Challenges in monitoring target 6.3

Both indicators for monitoring target 6.3 are new indicators, meaning their methodologies were recently developed. Their first progress reports were published in 2018. Currently, domestic and industrial wastewater flows are monitored separately by the WHO and UN-Habitat. An overall estimate cannot be calculated yet. The only available data on the SDG 6 data portal concerns domestic wastewater flows, without considering flows produced by services. It is closely connected to indicator 6.2.1 and disaggregates between *treated sewage*, *treated from on-site*, and *treated in-situ*.

Indicator 6.3.1a

Data availability

The availability of data on domestic wastewater flows is shown in Figure 33. An estimate is calculated for 79 mostly high- and middle-income countries (WHO and UN-Habitat 2018, p. 22). In these countries, 71% of domestic wastewater is collected in sewers, 9% in on-site sanitation facilities and the remaining 20% not at all (WHO and UN-Habitat 2018, p. 22). There are large data gaps in Sub-Saharan Africa, Central and Southern Asia, Eastern and South-Eastern Asia with the exception of China and parts of Latin America and the Caribbean.

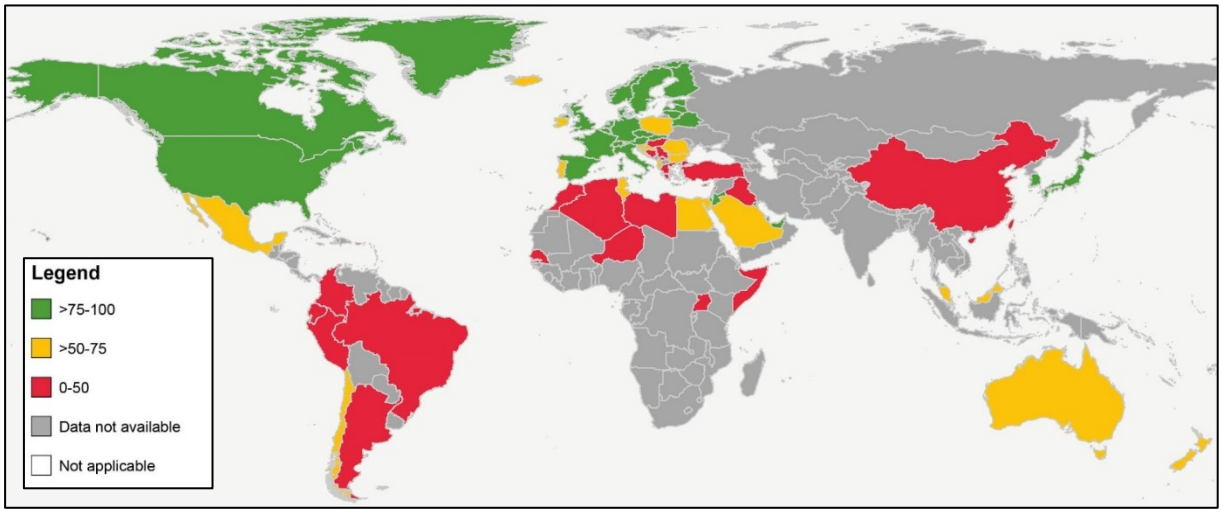


Figure 33 Proportion of domestic wastewater safely treated, data from 2015 (UN Water 2019c)

The data availability of the three sub-indicators *treated sewage*, *treated from on-site* and *treated in-situ* is very similar. There are, however, large data gaps, especially in countries where on-site sanitation is the dominant form of sanitation. 52 of the 79 countries with sufficient data coverage have provided technology-based data on domestic wastewater, as illustrated in

Figure 34 (WHO and UN-Habitat 2018, p. 22). The remaining 27 countries provided performance-based data.

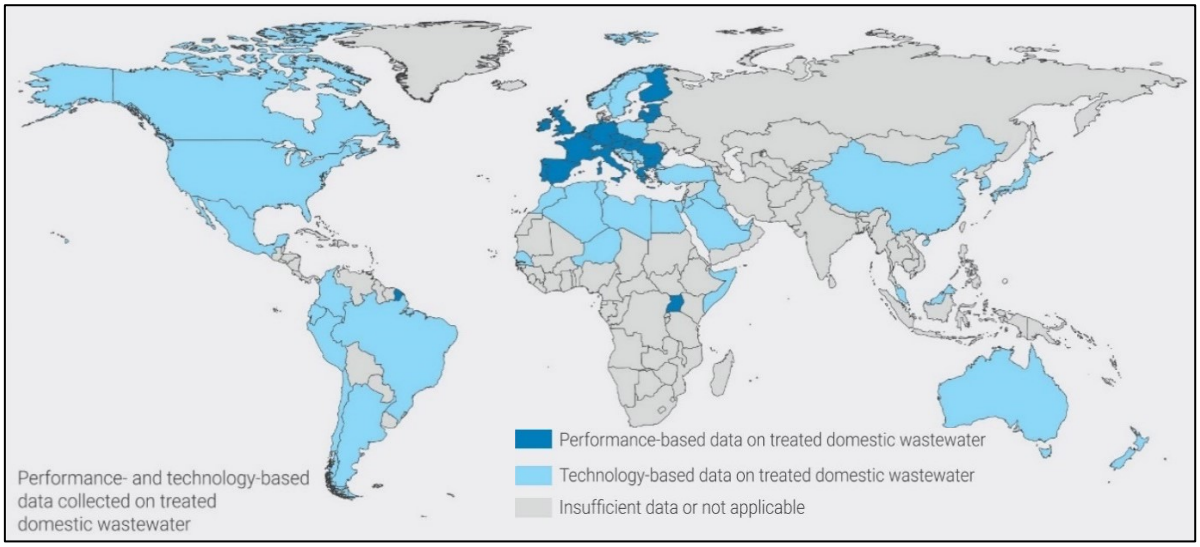


Figure 34 Performance- and technology-based data collection on treated domestic wastewater (WHO and UN-Habitat 2018, p. 22)

Challenges

One challenge is the collection of performance-based data, as their information content regarding impact of overloading, unregulated industrial discharge, poor maintenance and operation of treatment plants is significantly higher than it is the case for technology-based data. The reason for the availability of performance-based data in Europe is related to the reporting on the European Urban Wastewater Treatment Directive (UWWTD). This includes the verification of the biological oxygen demand (BOD) concentration of the treated wastewater and the treatment performance in percent and thus enables an assessment of a treatment plant's performance. However, a challenge connected to the performance approach is that there is only a classification for wastewater and sludge treated in treatment plants. This sort of classification is not available for on-site sanitation. Hence the performance of on-site sanitation which is mainly used in low- and middle-income countries cannot be evaluated at this point. (WHO and UN-Habitat 2018, p. 22)

A challenge revealed by the current data availability is the lack of data on services which, per the methodology's definition, should be included into the estimation unless the service in question has in ISIC code. Other challenges are related to technical details, but also to the large number of variables needed to calculate this indicator. Data must be collected and combined for 18 variables, some of which are collected for the first time. Hence, lack of time or capacity may be possible reasons for countries not being able to provide the required data. Apart from that, the indicator does not capture the performance of on-site sanitation, as there are no classification possibilities such as primary or secondary treatment for wastewater and sludge from on-site sanitation or consideration of leakages and spills that can have negative effects on the environment and human health. Similar to the findings for indicator 6.2.1 there are major data gaps concerning treatment of excreta from on-site sanitation. (WHO and UN-Habitat 2018, p. 8)

In addition to the *safely treated wastewater flows*, the calculation also includes the *total volume of wastewater*. If this value is assumed too low because, since illegally discharged wastewater or unknown sources cannot be included, the calculated value of treated wastewater becomes higher than it actually is. Overall, the current estimates have to be considered as upper limits, due to the lack of data about treatment performance and several assumptions within the calculation process, that can both lead to overestimation. Another challenge is connected to varying national standards for wastewater treatment since they reduce the data's comparability on the global level (WHO and UN-Habitat 2018, p. 26).

Solution approach

The challenge of deviating national standards can be addressed by better aligning them to international standards (WHO and UN-Habitat 2018, p. 26). All of the other challenges, however, can only be solved by improving national monitoring systems, to close data gaps and enhance data quality. Since the data used for this indicator is partly drawn from data collected for indicator 6.2.1 the same solution approaches concerning data availability on treatment quality apply. To further support countries the custodians can use tool such as technical webinars, a helpdesk, online tutorials, regional exchange within workshops or country support by technical experts. Data on services has to be added to the calculation. Since there is no indication for the reasons of this lack of data, only enhancing national monitoring capacity can be recommended.

Indicator 6.3.1b

Data availability

The second part of the 6.3.1 indicator concerns the percentage of *safely managed industrial wastewater flows*. Currently, there are insufficient data to allow the calculation of estimates of industrial wastewater flows into sewers or the environment. However, a part of industrial wastewater is discharged into sewers and treated in the same facilities as domestic wastewater, so in a way the estimates for domestic wastewater flows include some knowledge about the treatment of industrial wastewater as well (WHO and UN-Habitat 2018, p. 25). For 13 countries there are national estimates for industrial wastewater treatment provided by EuroStat and including wastewater that doesn't need to be treated but is nevertheless defined as untreated, which can be misleading (WHO and UN-Habitat 2018, p. 25). Figure 35 shows the mentioned national estimates. However, keeping in mind that the untreated wastewater might be of a quality that does not require treatment, the estimates have only little informative value.

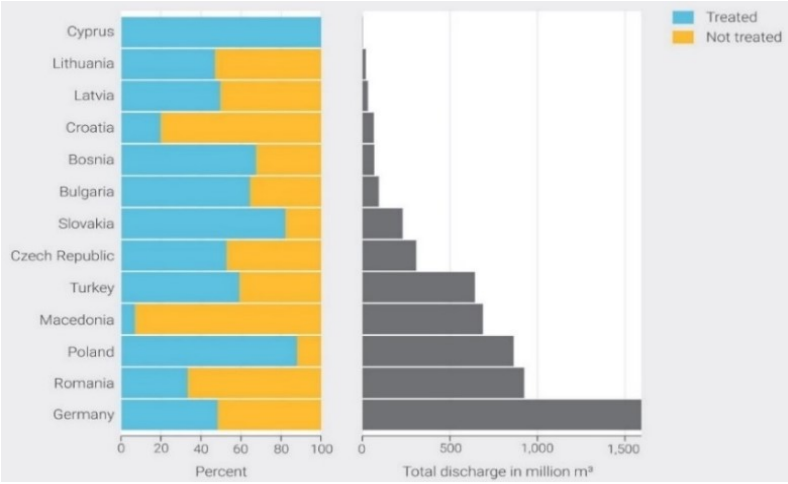


Figure 35 National estimates for industrial wastewater

Challenges

Data on discharges of industrial wastewater are usually not collected on the national level and the needed permit records are kept at utilities, environmental protection agencies or at the municipal level (WHO and UN-Habitat 2018, p. 25). Therefore, there are major data gaps on those records both for industrial discharges into sewers and into the environment (WHO and UN-Habitat 2018, p. 25). The same applies to the quality of wastewater treatment measured and the discharge quality (WHO and UN-Habitat 2018, p. 25). For this purpose, data must be collected from all small industrial enterprises on their wastewater flows and disposal, and this still poses a major problem at the moment. In addition, the methodology does not imply a distinction the wastewater's need of treatment. Some industrial processes such as cooling, do not necessarily require a wastewater treatment. Within the methodology's definition this in some countries high water volume would be classified as not treated (Huber 11/19/2019). Another challenge when trying to achieve an effluent quality that does not risk the environment or human health or even is suitable for reuse, are differing national standards. The following Figure 36 indicates that most countries use the parameters Total Suspended Solids (TSS), biological oxygen demand (BOD) and chemical oxygen demand (COD) (WHO and UN-Habitat 2018, p. 26). Less countries imply the parameters TN and Phosphate in their national standards. Chemical and biological parameters are only addressed in the standards of less than 40 out of 100 standards (WHO and UN-Habitat 2018, p. 26).

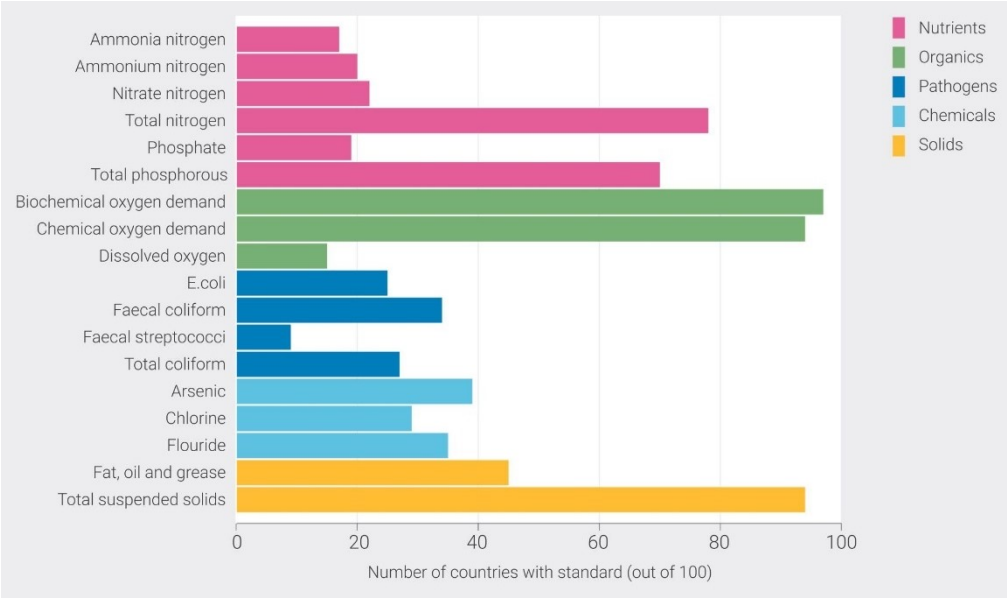


Figure 36 Summary of national standards for wastewater effluent (WHO and UN-Habitat 2018, p. 26)

Solution approaches

In order to report on indicator 6.3.1b, all industries that do not have a permit yet need to receive one and data on discharges have to be collected and disaggregated by ISIC code. In addition, the national monitoring systems need to be able to perform the elaborate task of gathering all these permits at a central level. Again, strengthening national monitoring systems and support capacity-building seem to be indispensable for future monitoring success (UN Water 2018b, p. 66).

To address wastewater that does not require treatment and thereby enhance the indicators informative value, those can be listed separately. This approach would also enable an assessment for possible reuse or recycling of water resources which is a part of target 6.3 but not specifically mentioned in the indicators 6.3.1 and 6.3.2. By further disaggregating the pollution load by household, services or industry, the polluter pays principle can be enforced to improve treatment in general. In order to increase global comparability and in some cases the quality of national standards, aligning those standards is an option.

Indicator 6.3.2

The new indicator *proportion of waterbodies with good ambient water quality* is one of the new indicators, and so far, only baseline values are available that were transmitted in the course of the global data drive in 2017. It is monitored by UNEP.

Data availability

Of the 52 countries that submitted data, 47 rated one or more river, groundwater or open waterbodies. 43 countries rated river waterbodies, 39 rated open waterbodies and 32 rated groundwater bodies (UN-Water and UNEP 2018, p. 31). The remaining five countries provided empty or partially completed reports due to time pressure or lack of data or analysis capacity. Figure 37 displays the countries that have currently provided data on water body quality. The map illustrates

that there are large data gaps, especially in Asia and North America, but also in some of the other regions.

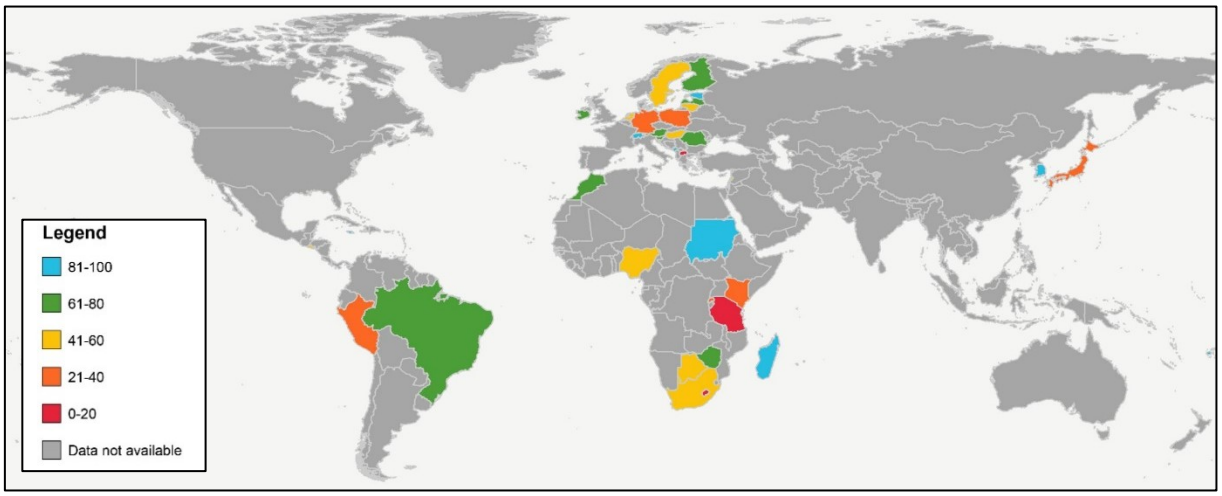


Figure 37 Proportion of waterbodies with good ambient water quality in % (UN Water 2019b)

Approx. 9,300 groundwater bodies, 15,300 open waterbodies and 41,000 river waterbodies got assessed (UN-Water and UNEP 2018, p. 31).

Figure 38 shows more clearly how many countries currently provide data on the different water body types and the distribution of the classification.

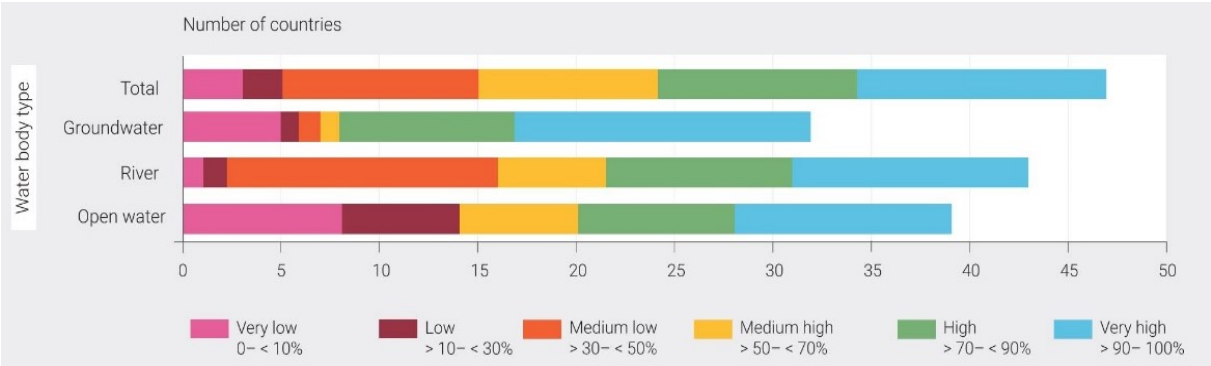


Figure 38 Number of countries providing data on waterbodies disaggregated by type and including their assessment (UN-Water and UNEP 2018, p. 32)

The mainly high and very high quality of groundwater bodies, as depicted in Figure 38 can be explained by the fact that fewer groundwater bodies are assessed and that fewer parameters and higher limit values are used than in the case of the other two categories.

Challenges

Data on the size of the river basin districts and the number of monitoring stations indicate that the data reach different degrees of representativeness. While some countries use more than 10,000 data points to calculate the indicator, other countries use only one or a few waterbodies that are highly unlikely to represent the actual national water quality status (UN-Water and UNEP 2018, p. 33).

In many developed countries, the protection and restoration of water resources is nationally monitored, nevertheless data collection and analysis required for reporting on indicator 6.3.2 lacks capacity. According to Mr. Crane, the two major challenges are implementing a functioning monitoring program on country level, implying a high level of human and financial capacity, and defining good ambient water quality (Huber 11/19/2019). The different amount of data on different parts of the indicator as shown in Figure 38 and the fact that many countries didn't provide any data suggest that national capacities vary greatly in terms of monitoring stations, data management, equipment and trained staff.

The second big challenge is that countries have to define national target values. Setting global target values for the five given core parameters would have been insensible, since some of the parameters have naturally varying levels depending on the country. Every country is asked to set its own national target value, leading to another complicated task requiring data that goes back in time and depicts a situation with good ambient water quality. This is a challenge because they might end up choosing a threshold value based on a period of time in which this parameter had higher levels than usual. Defining good ambient quality requires knowledge of data that goes back in time and can represent the undisturbed state of a water body. This is a complex challenge that exceeds many countries monitoring capacity. (Huber 11/19/2019)

In addition, not all countries follow the methodologies' defined core parameters but only use parts of them or entirely different parameters and also disregarded the suggested assessment period of three years prior to reporting. In some cases, countries that report on transboundary waterbodies use different parameters and target values, such as riparian countries of the Rhine-Meuse river basin and the Limpopo river basin. This makes it more difficult to compare these data, which would be necessary to estimate the entire body of water. (UN-Water and UNEP 2018, pp. 39–40, 2018, p. 34)

Differing upper target values especially for groundwater bodies currently also limit the comparability of the estimates submitted. Incorrect parameter units, conversion between units or different interpretation of the methodology concerning target setting can be the cause for those upper target values. Some countries use water quality standards instead of the suggested guidelines which does not only diminish the international comparability but results in upper limits that are not fit for monitoring ambient water quality. For example, choosing the upper value of 50 mg/l for nitrate, as defined in water quality standards, is very high in the context of a freshwater ecosystem. Reaching that limit would actually risk its health. The Irish Environmental Protection Agency uses the upper value 7.53 mg/l instead. Another challenge deriving from interpretation of the methodology and leading to various approaches is the delineation of RBDs and waterbodies. Since the country's methods aren't part of the collected metadata, the approaches cannot be reproduced. The resulting contradicting unit sizes diminish the indicator's comparability. (UN-Water and UNEP 2018, p. 33)

Other challenges arise from the fact that this is a new indicator that has been collected for the first time and under time pressure that data on groundwater monitoring is generally scarce that many countries find it difficult to produce such a report due to a lack of institutional capacity and coordination, and that the methodology is not aligned with national frameworks. Countries that report under the EU WFD and the African AMCOW noted that the indicator's methodology differs too much from the frameworks, resulting in higher reporting expenses and efforts for them. (UN-Water and UNEP 2018, p. 45)

Often several ministries are responsible for water quality, leading to a fragmentation of the sector and complicating the allocation of responsibility and collection of data. This also leads to data being stored at different institutions instead of a central database for water quality data, data collection and reporting. (UN-Water and UNEP 2018, p. 40)

The chosen core parameters represent only the lowest common denominator and might not even be sufficient to define *good ambient water quality*. A feacal parameter for example that could indicate the presence of sewage is not included. In order to get a realistic and more detailed picture *of good ambient water quality*, the methodology should include as many parameters as possible, which in turn would make monitoring very difficult for many countries. In this case, the significance of the indicator was subordinated to global comparability. (Huber 11/19/2019)

Solution approaches

Basically, increasing capacity in countries, that are not able to monitor this indicator is a challenge that has to be addressed in the years to follow. Several solutions are also included in the preparation of the first progress report. Addressing the lacking monitoring capacity can be realized in form of a capacity assessment phase which identifies existing government plans, policies and laws related to freshwater quality, institutional and human capacity on all levels of the sector that take part in management and protection of freshwater ecosystems and structures that enable communication with the private sector and other relevant stakeholders. Moreover, the available financial resources in the sector and especially for monitoring and existing management instruments as monitoring programs have to be assessed. (UN-Water and UNEP 2018, pp. 41–42)

Regular and long-term monitoring programs related to freshwater ecosystems are generally underfunded, in contrast to crisis-related water-quality programs (UN-Water and UNEP 2018, p. 42). In order to change this situation and thus strengthen monitoring and increase awareness of its relevance, the UNEP/EA.3/Res.10 resolution was adopted (UN-Water and UNEP 2018, p. 42). It literally requires that the Member States “addressing water pollution in inland, coastal and marine ecosystems and improve water quality through improved water quality data collection and their sharing on a voluntary basis” (UN-Water and UNEP 2018, p. 42). For this cause, the UN Environment GEMS/Water program already seeks to support countries within its Capacity Development Centre and Data Centre (UN-Water and UNEP 2018, p. 42).

To prevent misinterpretations of the methodology and clarify target value setting, its future version should include clearly defined implementation steps. Until the next data drive in 2021, the 6.3.2 Expanded Methodology will be finished and published for that cause. But even unrelated to misinterpretations, the methodology foresees a national goal setting that results in different target values and thus makes it more difficult to compare them. In order to minimize this problem, in addition to collecting absolute values, it is being considered to introduce the measurement of development on the basis of three categories: *improving*, *stable*, and *degrading*. Thus, each country can relate the current value to the last value and thereby enable the international opportunity to see how development is progressing over time. However, this approach is based on the measurement of the absolute value, which means that this must be ensured for the time being. However, feedback from some countries on the progress measuring approach has been positive. (UN-Water and UNEP 2018, p. 42)

The mentioned differences in approaches for delineation of RBDs and waterbodies can be reduced by promoting the use of an online database that allows countries to download and use existing hydrological units, as for example the HydroBASINS and HydroLAKES databases, as a common and comprehensive starting point to validate national RBD's and waterbodies (UN-Water and UNEP 2018, p. 43). Though some problems might still evolve due to different degrees of surface model resolution or range of spatial scales, using the same existing system provides a solid foundation and support especially for countries with little national data (UN-Water and UNEP 2018, p. 43). In the future, instead of core parameters, groups of parameters can be proposed from which countries can choose the ones they are able to examine (UN-Water and UNEP 2018, pp. 43–46). The resulting increase in flexibility should lead to more countries orienting themselves towards the methodology and thus produce more higher data coverage (UN-Water and UNEP 2018, pp. 43–46). In addition, the next data drive is not to take place until 2021, so that the countries will be given a longer period of time to prepare the reports (UN-Water and UNEP 2018, p. 45). In the meantime, the methodology has to be adapted to the existing frameworks, and groundwater monitoring has to be promoted in countries where its capacity is the lowest and the condition of the groundwater bodies suggests the greatest risks for human health and the environment (UN-Water and UNEP 2018, p. 45). In this context, capacity development and support in the design of monitoring programs, for example in the choice of sites and borehole design and their implementation, have to be supported by the custodian agency (UN-Water and UNEP 2018, p. 45). In order to strengthen the institutional structures, the mentioned resolution was adopted and a Framework for Freshwater Ecosystem Management was drafted (UN-Water and UNEP 2018, p. 45).

To finally ensure the comparability of previous data with data collected in the future, which may be collected and analyzed using revised or adapted methodologies, countries must be encouraged to transmit metadata. A harmonization of data standards and the establishment of open data access can facilitate not only monitoring but also data sharing, intersectoral and international cooperation. In the future, the collection of biological parameters is a possible additional task within the framework of advanced monitoring as well as the use of further data resources such as Earth observation, citizen science projects and the private sector. (UN-Water and UNEP 2018, pp. 47–48)

Overview

Both indicators are new indicators, classified as TIER II indicators, without global estimates, due to their lack of data (IAEG-SDG 2019a). The indicators are both very complex and require a big amount of data that are difficult to collect and generate. Data availability has to increase throughout the next reporting cycles. Since data used for indicator 6.3.1 draws from data used for indicator 6.2.1 it is dependent of its increase in data coverage. The responsible custodian agencies are working on supporting countries in implementing national monitoring systems and clarifying methodologies. In both cases there are solution approaches, however, for indicator 6.3.1 the generation of data on industrial wastewater flows is a big challenge which will still require immense efforts throughout the next reporting cycles.

The first part of target 6.3 *improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials* is monitored by indicator 6.3.2. However, it is questionable whether the small number of parameters is actually sufficient to adequately monitor this target, since they only represent the lowest common denominator agreed by the Member

States. The second part of the indicator *halving the proportion of untreated wastewater* is monitored through indicator 6.3.1. It should be noted, that the third part of the target *substantially increasing recycling and safe reuse globally* is currently not reflected in either of the indicators. An indicator that monitors these aspects would be required in order to fully address all aspects of the target (WHO and UN-Habitat 2018, p. 8).

4.5 Challenges in monitoring target 6.4

Indicator 6.4.1

Target 6.4 reaches for *substantially increasing water-use efficiency across all sectors and ensuring sustainable withdrawals and supply of freshwater to address water scarcity and a substantial reduction of the number of people suffering from water scarcity by 2030*. The first and new indicator chosen to monitor this target is defined as the *change in water-use efficiency over time*. The indicators custodian agency is the FAO.

Data availability

The *change in water-use efficiency over time* as defined in indicator 6.4.1 can currently be determined for 168 countries and is the indicator with the second highest data availability according to the SDG 6 data portal. Figure 39 displays the countries that provided data in the 2018 data drive, though it should be noted that the timeliness of provided data differs within the time range 2000–2015.

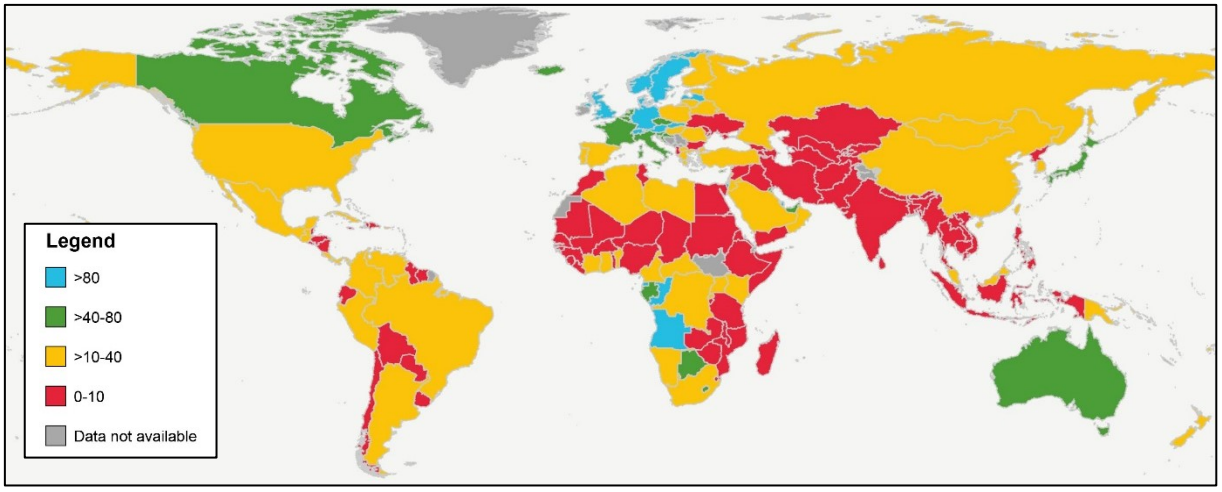


Figure 39 Change in water-use efficiency over time as USD/m³ with data from 2000–2015 (UN Water 2019a)

Challenges

Despite the already high availability of data, challenges were already identified in the preparation of the indicator's baseline report. The methodology is designed for a temporal view, meaning an assessment of the development of the value. Since in some countries the indicator is only available for one specific time range, a change can only be calculated in the future. This challenge will therefore become obsolete in the next report. Also, an identification of the breaking point, from which the increase in water use is decoupled from the increase of value added produced by each

sector cannot yet be given yet, since that will be a result of long-term comparisons. Another challenge is the international data sources' dependence on countries' data transmission. In some cases, only outdated data sets were available. Data inconsistency can also play a role in data collection and management of this indicator, as there are often several data sources whose data do not coincide because of different observation periods or inclusion of different sub-sectors. (FAO 2018b, pp. 17–18)

The available data does not have the quality, quantity and form required for monitoring in every country. In general, the non-exact definition of the sectors covered, the failure to comply with the methodology's definition, wrong currency conversion and double-counting are challenges that leads to very deviating results. (FAO 2018b, pp. 17–18)

Solution approaches

Data inconsistency can be prevented by harmonizing data from different data sources or choosing and adhering to the source that best fits the methodology's definition. Countries should be asked to follow the methodology closely concerning the inclusion of sub-sectors. To improve data quality and quantity, capacity building and enhanced cooperation between institutions must be further supported. Since economic growth can change quite quickly, data should be updated at least every two years. (FAO 2018b, p. 41)

The indicator itself is of course dependent on the national economy and the water intensity of the strongest sectors. When interpreting the estimates, in addition to actual changes, changes in economic and social structures, such as population growth, should be considered. Moreover, decoupling water use from economic growth should not be confused or equated with reducing water demand. One way of enabling more detailed national insight into water-intensive sectors and thus targeted interventions for water reduction is to further disaggregate them into nationally relevant sub-sectors. Knowledge about efficiency of agricultural irrigation or industrial and energy cooling but also losses in municipal distribution networks could complement the data and add useful information for decisionmakers. Overall, the data availability and reporting of this indicator is at a very high level. (FAO 2018b, p. 42)

At the end of 2018, all countries received a compilation of current data for correction and review. The AUQASTAT database has also been updated with the aim of networking national representatives, who will henceforth be responsible for regular data collection. (FAO 2018b, p. 42)

One aspect that could be improved in monitoring this indicator could be including irrigation efficiency and distribution network efficiency, which are currently not reflected in the methodology. Also, the indicator does not automatically display reduction of total water use which is why it has to be combined with indicator 6.4.2.

Indicator 6.4.2

The second indicator for monitoring target 6.4 is defined as *level of water stress: freshwater withdrawal as a proportion of available freshwater resources*. Monitoring indicator 6.4.2 is related to similar challenges as *water-use efficiency*. The FAO is responsible for monitoring this indicator which

apart from its new aspect of environmental flow requirements is an already existing indicator that was formerly known as MDG indicator 7.5.

Data availability

Again, there are already data at AQUASTAT for a large number of countries, namely 180, for two of the three sub-indicators. In some cases, the data is outdated. The challenge concerning the sub-indicators TRWR (total renewable water resources) and TFWW (total freshwater withdrawal) is ensuring that national data is generated on a regular basis. The new and potentially problematic sub-indicator EFR (environmental flow requirements) is usually not collected at a national level. The IMI Water Data Portal, however, has data on EFR for 166 countries. (FAO 2018a, p. 29)

If all available data from the period 2000–2017 are included, the EFR (Figure 40) and the level of water stress (Figure 41) can be estimated for the majority of countries as depicted in Figure 40 and Figure 41.

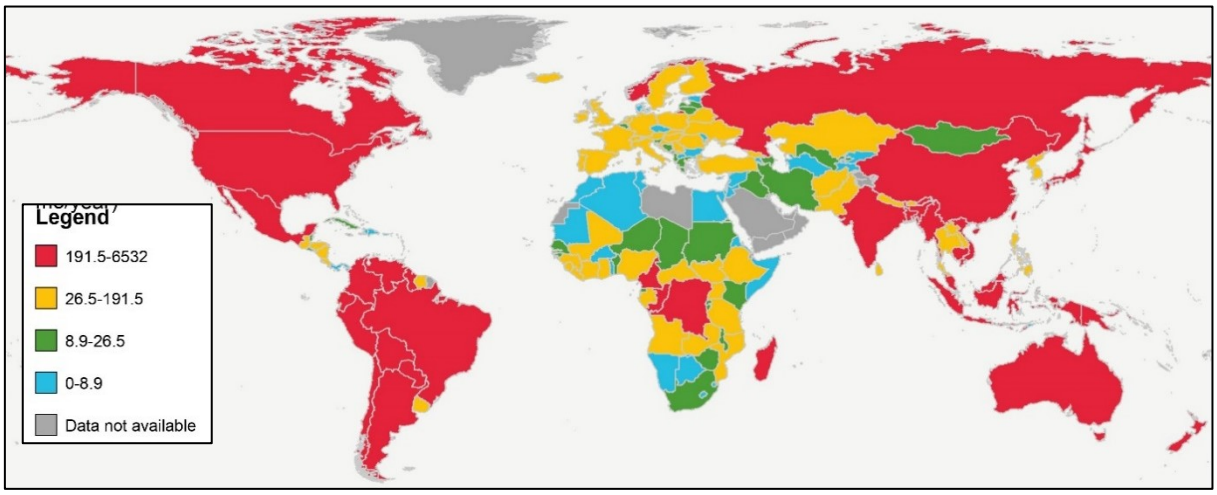


Figure 40 Environmental flow requirements in 10^9 m^3/year, data from 2017 (UN Water 2019a)

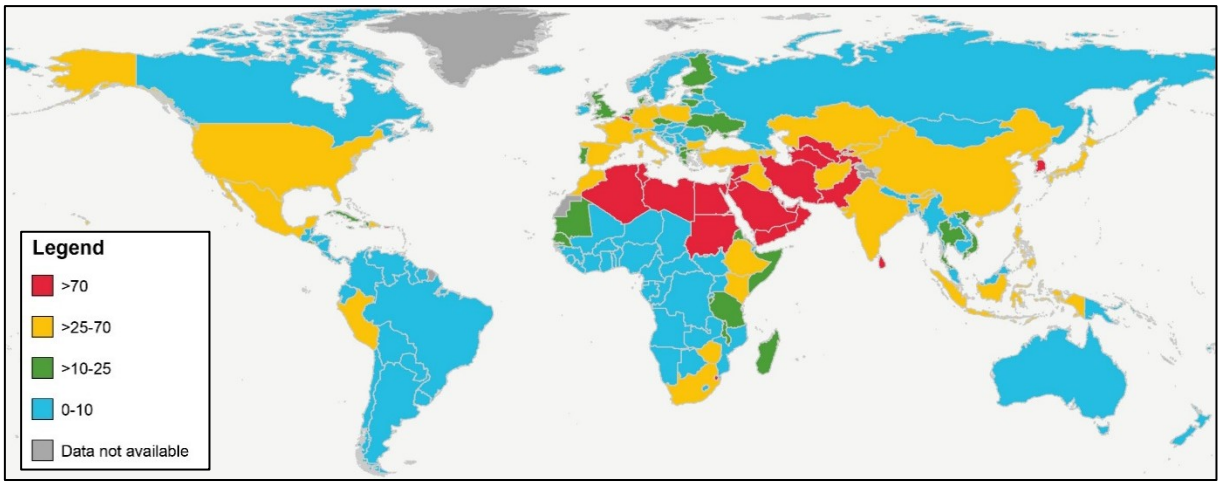


Figure 41 Freshwater withdrawal as proportion of available freshwater resources in %, data from 2000–2017 (UN Water 2019a)

At this point it should be added that the conversation with Mr. Biancalani revealed that the FAO has not yet forwarded all the available data to the data portal. However, their own presentation of the data is less suitable to show data availability. Therefor the data portal's figures are used with the hint that they do not present the latest state of data availability. (Huber 11/27/2019)

Challenges

Data availability is very high for this indicator. However, some countries provide outdated data which is challenging when it impedes comparison with other countries or is meant to represent the current status. Generating and transmitting national up-to-date data is therefore a challenge related to this indicator. (FAO 2018a, p. 28)

Another challenge that appeared after the pilot phase was that averaging two countries' water stress levels, which is necessary for providing regional and global estimates, can be misleading, so the water stress of regions should rather be calculated from aggregated variables. The main challenge, though, was estimating EFR, since almost no countries had existing national studies on it. The FAO used international data sources to close those data gaps. The use of international data, however, in a way deprives countries of their national data ownership and hence a principle of SDG monitoring. (FAO 2018a, p. 28)

There were also data gaps in estimating TRWR and TFWW which were filled with data from the AQUASTAT database. Data collection is complicated in some countries by the fact that contradicting data from different sources is gathered. In other cases, sources report the same data, but then lead to double counting. Also, the national capacity and resources available for monitoring the required data is weak in several countries as well as their reporting to international databases. (FAO 2018a, p. 28)

Solution approaches

In 2019, the FAO published a paper introducing an approach to use the Global Environmental Flow Information System (GEFIS) as the basis of national EFR estimation, which by now is implemented and generates data on EFR. Similar to the solution approaches, mentioned for indicator 6.4.1, the FAO has sent gathered data to all Member States for evaluation and correction to stipulate ownership and production of new national data. (Huber 11/27/2019)

The AQUASTAT modification, leading to cooperation of national correspondents, is meant to secure this production of regular and consistent data. In order to actively implement the idea of ownership, from 2019 on collected data will either be forwarded by the FAO to the governments for confirmation or the countries will send data directly to the FAO. In the long run, the countries have to gain the knowledge and capacity to be able to provide data on EFR themselves to ensure meeting the SDG's principle of country ownership and also produce more detailed data, considering specific national knowledge of natural and social circumstances. The understanding of the methodology and required metadata is supported by the FAO through an online course and a questionnaire. (FAO 2018a, p. 30)

Overview

Both indicators are categorized as TIER I indicators. Indicator 6.4.1 has been upgraded from TIER II to TIER I in October 2019 (IAEG-SDG 2019a, p. 17). The newly implemented GEFIS has proven to be a very useful renewal in monitoring. In addition to the subjects addressed by the two indicators, the target calls for "substantially reducing the number of people suffering from water scarcity" (IAEG-SDG 2019b). There is no indicator to monitor this aspect of the target. Since an additional indicator is not an option in Biancalani's opinion, due to the already high number of indicators, countries can only include it into their national set of indicators (Huber 11/27/2019)

4.6 Challenges in monitoring target 6.5

Indicator 6.5.1

The indicator 6.5.1 measures the *degree of IWRM implementation* and thereby monitors target 6.5 on *implementing integrated water resources management at all levels, including through transboundary cooperation as appropriate*. It is a new indicator, monitored by the UNEP.

Data availability

A baseline estimate is currently available for 172 countries, making it the indicator with the highest number of countries reporting on an indicator during the last 5 years, according to the data portal (UNEP 2018a, p. 2). Figure 42 is a figure generated at the UNECE data portal showing the status of implementation in 2017. Since this indicator was not collected for the first time, but is based on two global status reports on the implementation of integrated approaches to water resource management carried out in 2008 and 2012, it has been known for some time despite its novelty as an SDG indicator (UNEP 2018a, p. 17).

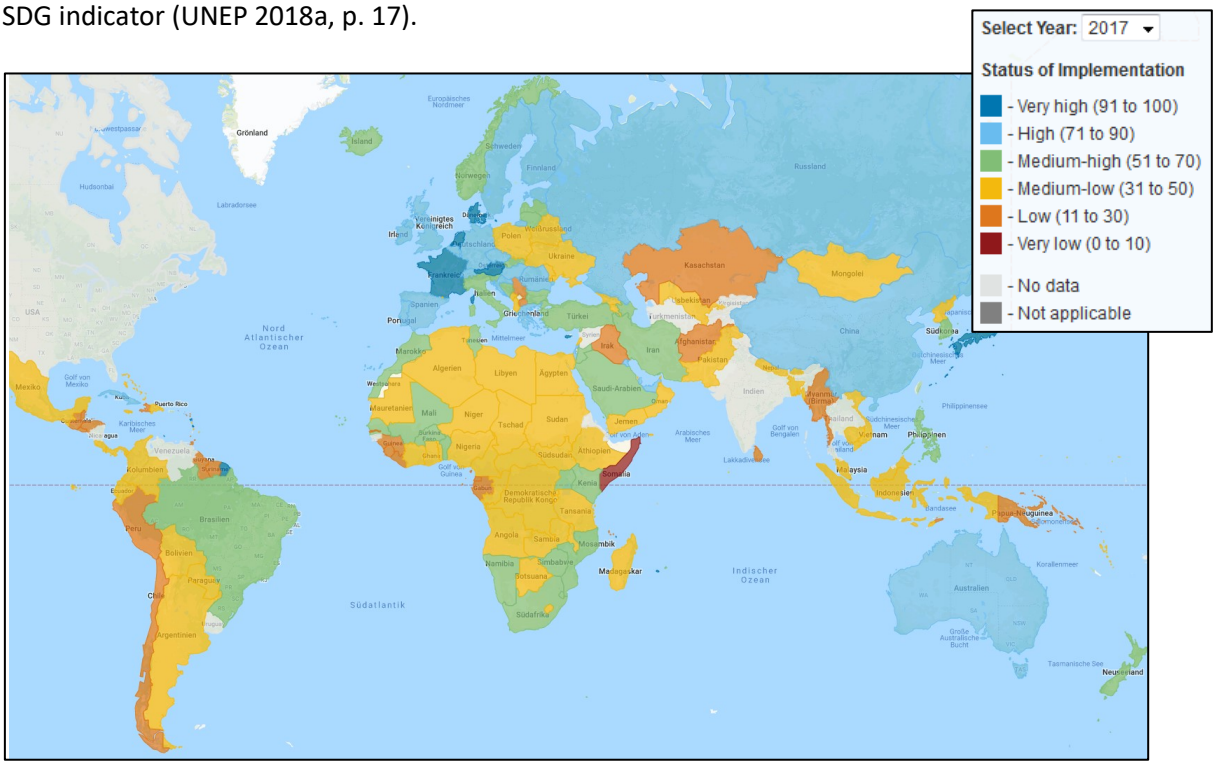


Figure 42 Degree of IWRM implementation, data from 2017 data drive (UNEP and DHI 2019)

Challenges

However, there were challenges that impeded the provision of estimates by a small number of countries. Some of those countries reported a lack of capacity for monitoring the indicator, others stated that the given time frame was insufficient or that the indicator's priority was not as high as other indicators' priority. Especially federal states such as the U.S., India, or Canada had problems due to methodological specifications concerning arrangements for data collection and due to discrepancies concerning reporting responsibilities. (UNEP 2018a, p. 87)

Solution approaches

Time pressure and lower priority are no longer to be expected in the next reporting cycles, as the indicator and its survey have been known for some time and the priority of the indicator is not inferior to that of the other indicators. It is possible that other indicators in the baseline survey were of greater importance nationally, so that the combination of time pressure and limited capacity was not sufficient for the survey of all indicators. The increase in national monitoring capacity should be pursued more intensively in these countries. The problems stated by strongly federalized states should also be limited in the future by increasing capacity and strengthening national structures for coordinating and clarifying responsibilities. The responsible custodian agency UNEP announced a review and revision phase following the baseline reporting process to further optimize the indicators' methodology and monitoring process. Possible results of this phase are clarifications of questions and enhancement of participation in and strengthening of national data collection. The methodology itself is based on an assessment of the situation in the form of figures between 0 and 100. There is a potential that the national assessment may not be fully comprehensible as no metadata are provided. For this purpose, however, there are free text fields for each question in which countries should explain their assessment. The controls of the questionnaires include, among other things, the evaluation of these explanations and can thus lead requesting clarification. Despite the enormous length of the survey format, many countries are able to determine estimates for this indicator.

Indicator 6.5.2

The second and new indicator that monitors target 6.5 is defined as the *proportion of transboundary water basin areas with an operational arrangement for water cooperation*. Its custodian agencies are UNECE and UNESCO.

Data availability

153 countries are addressed by this indicator, since they encompass transboundary water basin areas (UNECE and UNESCO 2018, p. 9). In 2017 the data required to calculate an estimate was available for 62 of those 153 countries covering 59% of transboundary basin areas (UNECE and UNESCO 2018, p. 26). The regions Northern America and Europe, Latin America and the Caribbean, and Sub-Saharan Africa have the highest percentage of countries providing data (56%, 50%, 47%, respectively) (UNECE and UNESCO 2018, p. 51). In Northern Africa and Western Asia as well as Central and Southern Asia, the percentage of reporting countries is noticeably lower (33%, 28%, respectively) (UNECE and UNESCO 2018, p. 51). The region with the lowest percentage is Eastern and South-Eastern Asia with only 8% of countries reporting on indicator 6.5.2 (UNECE and UNESCO 2018,

p. 51). Figure 43 depicts the countries' current proportion of transboundary basin areas with an operational arrangement for water cooperation.

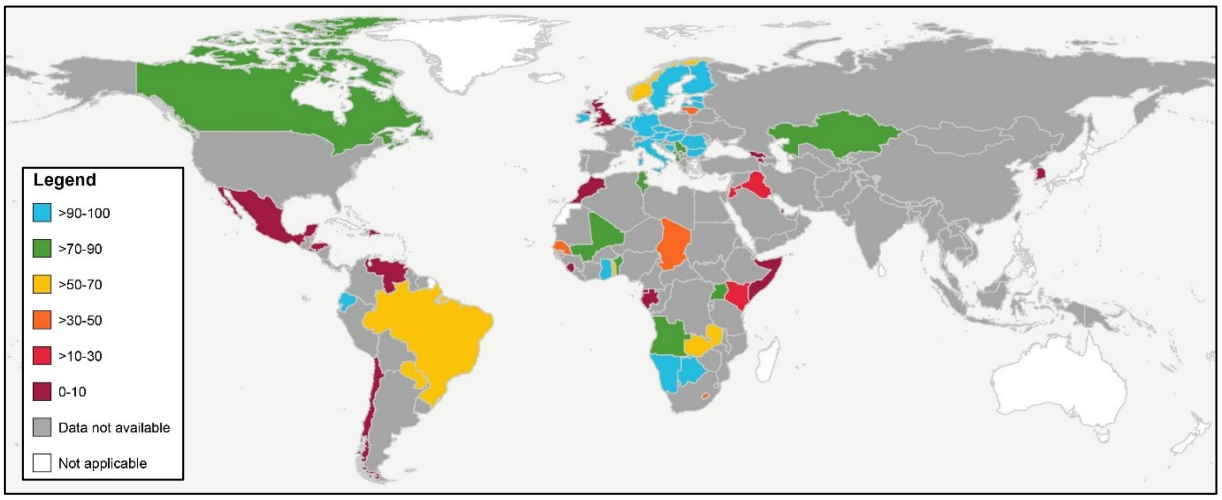


Figure 43 Proportion of transboundary basin areas with an operational arrangement for water cooperation in %, data from 2017 (UN Water 2019d)

When disaggregating between the two sub-indicators transboundary river and lake basins and transboundary aquifers, the former is reported on by more countries. Overall 84 countries reported on transboundary river and lake basins, representing 64% of their global area (UNECE and UNESCO 2018, p. 29). 61 countries provided estimates for transboundary aquifer basin areas, representing 48% of their global extent, depicted in Figure 44 (UNECE and UNESCO 2018, p. 30).

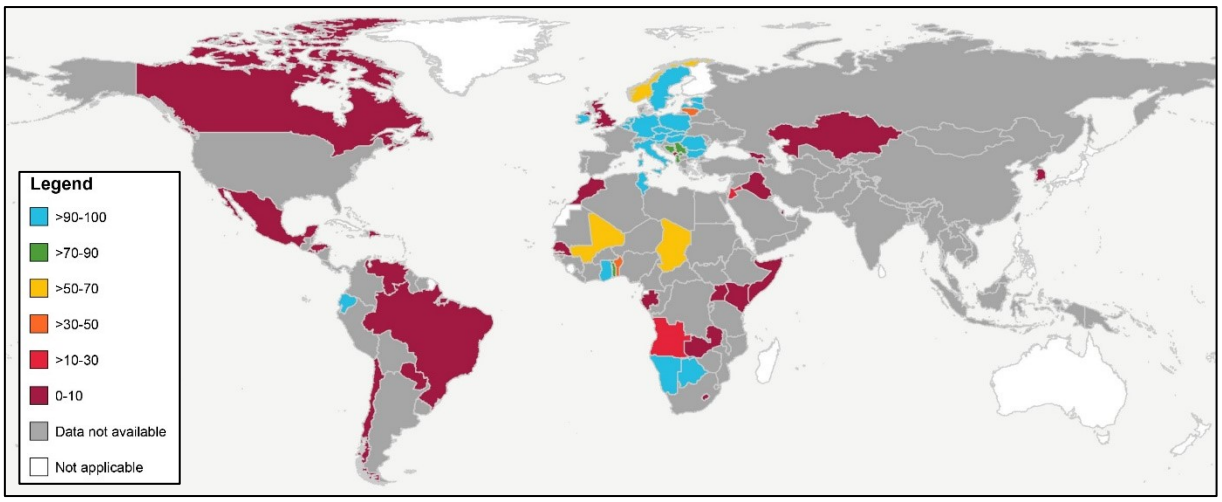


Figure 44 Proportion of transboundary aquifers with an operational arrangement for water cooperation in 2017 (UN Water 2019d)

Challenges

One challenge is to increase the number of countries reporting on arrangements in general and especially on arrangements for transboundary aquifer basin areas. A possible reason for having less data on this part of the indicator is the lack of data on delineation or incomplete data on aquifers. As a result, it may happen that in the literature there are cases of aquifers that have been researched in great detail, but no estimate has been calculated for that specific country. Originally, 107 countries

reported on this indicator. However, many countries still need clarification, which is why their estimates have not yet been calculated. A challenge is therefore to clarify questions prior to the next reporting cycle and to explain the methodology in detail to all relevant Member States (UNECE and UNESCO 2018, p. 23).

Another challenge arises from the fact that global data sources are partly used in parallel with country data and that their data are partly contradictory (UNECE and UNESCO 2018, p. 23). The same applies to data from countries that share a transboundary basin area. In the end, country level data are used, since monitoring is a country-led process, but the differences indicate that there is a need for clarification. Apart from this, the indicator itself is characterized by two limitations which can impair monitoring success. Firstly, only functioning arrangements are recorded, but not their results (UNECE and UNESCO 2018, p. 24). Under certain circumstances, existing structures have no positive effects. Secondly, only cooperation within official arrangements are monitored, not unofficial cooperation which might also be functioning.

Solution approaches

The discrepancies between the data of different countries on the same basin area can be discussed, but ultimately, they also show to what extent countries interpret the same situation, which allows insights into their national view. The unrecorded results can be examined by combining data from other indicators and therefore do not have to be explicitly included in the methodology. The decision to only include operational arrangements can be justified by the fact that informal cooperation does not represent the same degree of commitment.

To increase data availability the countries might mainly be in need of more time and capacity for data collection. As mentioned in the context of other indicators, the data on waterbodies, in this case on arrangements connected to them are probably not gathered at a central point but scattered throughout different institutions. Future reporting will show whether time and capacity are the main reasons for the currently low data availability or whether other factors impede the indicator's monitoring. However, the indicator currently got upgraded to TIER one, meaning that the data availability already surpassed the 50% of country coverage, required for TIER I classification.

The importance of this indicator can be comprehended when looking at the North-West Sahara Aquifer System (NWSAS), a transboundary aquifer system shared by Algeria, Libya and Tunisia. The implementation of a functioning agreement that focuses on data collection, sharing and forwarding to decisionmakers, has immensely improved the countries' knowledge of the aquifer system and enables the establishment of modelling tools and sound decision-making. A special feature in the context of this indicator is a gender-sensitive approach developed and implemented by UNESCO, which helps to find out (Central America, South Africa, Central Asia) whether fresh water procurement, distribution and ecosystem protection are carried out in gender-equal structures within three aquifers. (UNECE and UNESCO 2018, p. 34)

Overview

Both indicators are classified as TIER I indicators since November 2017 (IAEG-SDG 2019a, p. 17). Overall, the surveys of the 6.5 indicators offer countries the opportunity to determine, in which IWRM aspects or at which level transboundary arrangements there is still room for improvement. At

the same time, reporting requires a large amount of detailed data. While indicator 6.5.1 is the indicator for which the largest number of countries have reported in the last five years, the monitoring of indicator 6.5.2 show that an increase of data coverage is possible and as the reclassification illustrated is already successfully conducted since the last reporting cycle.

4.7 Challenges in monitoring target 6.6

The new indicator 6.1.1 measures the *change in the extent of water-related ecosystems over time* in order to monitor the target 6.6 *by 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes*. UNEP is responsible for its monitoring.

Data availability

The monitoring of indicator 6.6.1 is complemented by global Earth observation data. These are used to calculate the first sub-indicator s*patial extent of water-related ecosystems* and are already available for a large number of Member States. National data, on the other hand, which are required to determine the other 4 sub-indicators, are still incomplete and in some cases not available at all (UNEP 2018b, p. 14). The countries that have provided data on the indicator within the last 5 years are shown in the following Figure 45.

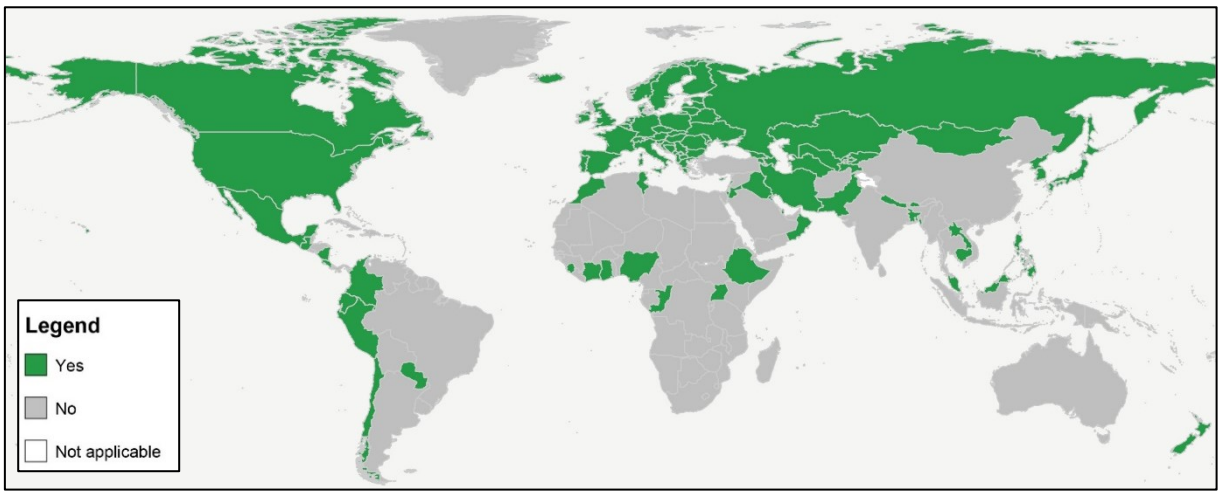


Figure 45 Countries that reported indicator 6.6.1 within the last 5 years (UN Water 2019f)

In 2018, 38 countries reported on indicator 6.6.1. 31 countries reported on *spatial extent*, 29 on *water quantity* and 32 on *water quality of water related ecosystems* (UNEP 2018b, p. 22). Earth observation data on the spatial extent of water-related ecosystems is available for more countries. The following figure depicts data from 2016.

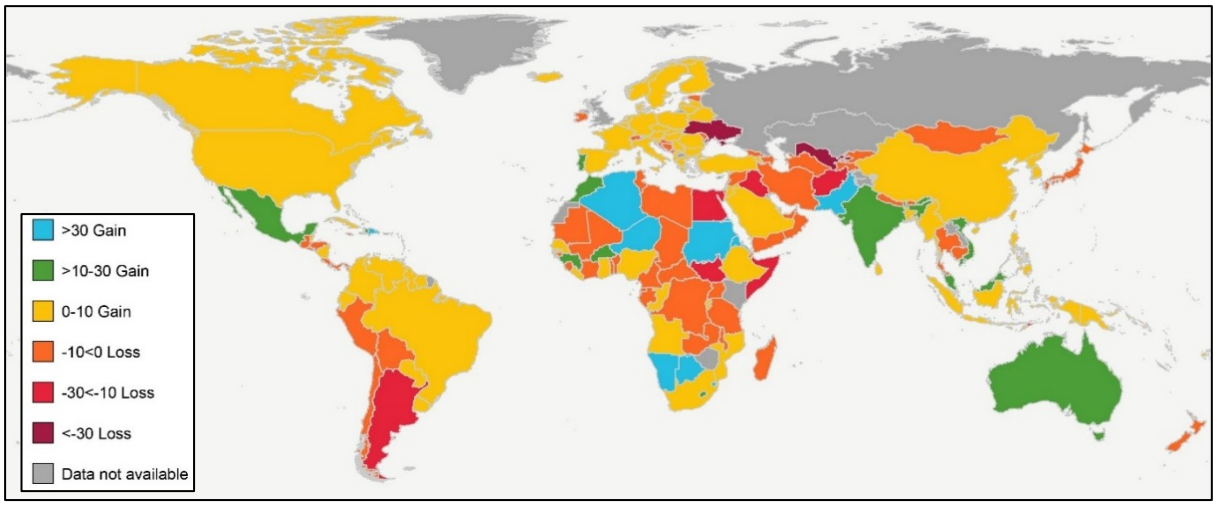


Figure 46 Spatial extent of water-related ecosystems from Earth observation – Lakes, rivers, estuaries and artificial waterbodies, change in extent from baseline 2001–2005 (%) (UN Water 2019b)

The data portal does not provide data on the sub-indicators *water quality of lakes*, *discharge of rivers and estuaries* and *water quality of water-related ecosystems*. Only for the sub-indicator *quantity of groundwater within aquifers* a map is available.

Challenges

The main challenges in monitoring this indicator are its novelty and complexity. Since it measures three different sorts of extent of waterbodies, namely quality, quantity and spatial extent, the indicator required data that goes back in time and allows an assessment of a water body's uninterrupted state. According to the different waterbody types river, lake and groundwater different measurements are necessary and feasible, resulting in a huge amount of data with different data collection methods for three parameters in several water body types for entire countries which poses an immense task for many countries. Additionally, those waterbodies might cover transboundary basins or are not easily accessible, which impedes sampling and measurements. (Huber 11/19/2019)

Due to the large amount of data to be collected, national capacities play a role, which makes it especially difficult for developing countries to collect them. During the test phase conducted in 2017, it became clear that very few countries have data on this indicator. Only 20% of the Member States provided data at that time, most of which were incomplete and of poor quality. For this reason, satellite-based Earth observation data were used to close these numerous data gaps. But even Earth observation data can't provide data on groundwater or river flow. At the beginning of 2020 the UNEP expects to have the data ready to send it to countries. This however might raise questions about data ownership and national capacity to work with the given data. (Huber 11/19/2019)

Especially groundwater seems to be one of the most challenging ecosystems in terms of monitoring. It is only possible to measure the extent and volume of groundwater bodies in a very localized way with is still expensive and not commonly done by countries. Hence there is no global data set for groundwater, although it is such an important resource. The indicators methodology describes measuring groundwater bodies through the level of groundwater within an aquifer as a facilitated way of groundwater monitoring, which still is complicated and expensive, but easier to accomplish as

measuring the aquifers thickness and storage ability. Despite this facilitation of measurement methodology, data on groundwater bodies is scarce. (Huber 11/19/2019; UNEP 2018b, p. 24)

Another challenging aspect that must be avoided is the joint representation of the spatial extent of artificial and natural waterbodies, since their development is often contrary and a joint representation is therefore of little significance (UNEP 2018b, p. 15).

Solution approaches

In 2017 the UNEP submitted two data sets to UNSD, including in-situ data of countries, and later complemented that by data on spatial extent of open waterbodies for 193 countries and a revision of the methodology. These submissions and revision lead to the indicator 6.6.1 being rated as a TIER I indicator. Unfortunately, that data is not represented in the data portal at the moment, but will be added next year. (Huber 11/19/2019)

Since 2018, data for new and lost waterbodies and seasonal data have been available as well. Data on vegetated wetlands and water quality has been in progress since 2019. As of 2019, data on spatial extent of artificial and natural waterbodies will be made available separately. Between 2016 and 2030, the aim is to achieve a higher spatial and temporal resolution than before and to be able to image cloudy areas through the combination of optical and radar satellites (UNEP 2018b, p. 33). In addition to technical and institutional development, more financial resources must be acquired in order to produce national data on water quality, discharges and quantity with the help of globally available data. Responsibility and coordination between institutions have to be established.

Overview

Indicator 6.1.1 is a new Tier I level indicator with a comprehensive and complicated methodology that still requires the support of the UNEP, but has already achieved an immense improvement in data availability. The next step will be sharing the newly gathered data with countries and working on increasing data availability. Looking at the target 6.6, there is a slight misalignment in the target and indicator terminology. While the target includes the protection and restoration of not only rivers, lakes and groundwater ecosystems, but also forests, wetlands and mountains, the indicator focuses on rivers, lakes and groundwater monitoring. The target's terminology originally comes from an alignment with the Aichi targets of the Convention on Biodiversity, in order follow the thought of using existing mechanisms, which include forests, wetlands and mountains. The monitoring methodology has to be understood as a progressive process that currently expects rivers and estuaries, vegetated wetlands, lakes and groundwater to be monitored but builds up to including, waterlogged forested areas and mountains in the future. Since even monitoring this fragment of the targets lead to many challenges, including more right from the start would be unreasonable. Especially because these other aspects are very hard to monitor themselves, as for example the Ramsar Convention on wetlands, trying to gather data on them for 45 years now, proofs. In addition to that the Convention on Biodiversity is under review, which means that the SDG framework itself in a way is under review. Due to its already established methodology in all of the Member States the target and indicator language, however, will remain the same. Another part of the target language, that is not covered by the indicator or its methodology, is measuring protection or restoration. This is mainly caused by the fact that decision makers are more interested in change over time that can

indicate deterioration, which in turn can be researched and addressed by specific action plans. This broader approach actually was meant to assess ecosystem health and act if the data indicates an unhealthy state. A future goal is monitoring the health of water-related ecosystems by using other variables such as bio-indicators. (Huber 11/19/2019)

4.8 Challenges in monitoring target 6.a

For monitoring the *expansion of international cooperation and capacity-building support to developing countries in water and sanitation-related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies*, the indicator 6.a.1 quantifies the *amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan*. The WHO and OECD are both responsible for monitoring the indicator which was already part of monitoring MDG target 8 D.

Data availability

The indicator 6.a.1 is applicable for 137 of the 193 Member States. About 71% of them reported on the indicator within the last five years as shown in Figure 47 (UN Water 2019e). In the latest data collection cycle in 2017 83 countries and 25 external agencies provided data.

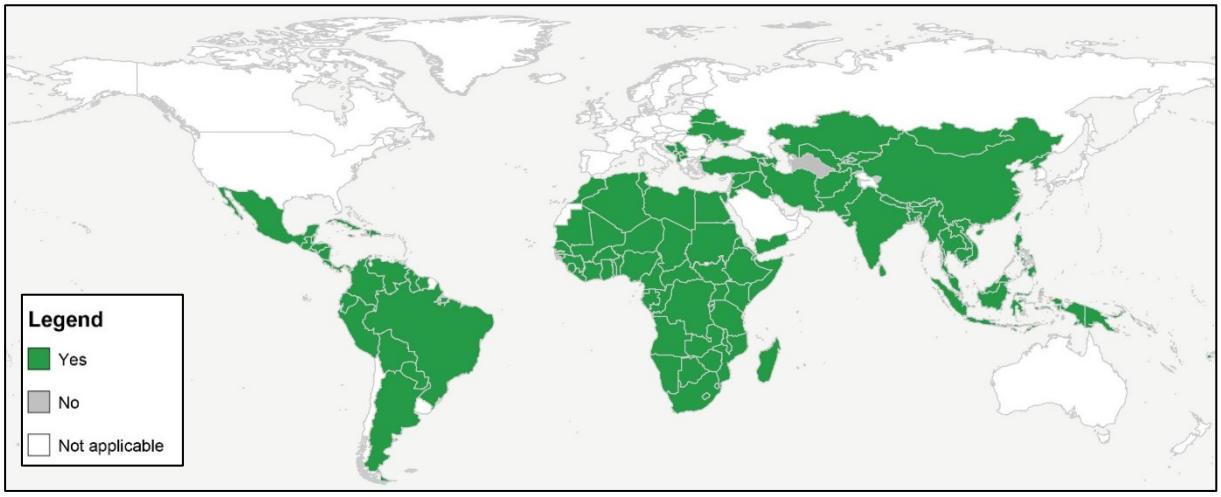


Figure 47 Countries that reported on the amount of water- and sanitation-related ODA received at least once during the last 5 years (UN Water 2019e)

Besides ODA received, the data portal also lists the national expenditures for a total of 14 different sub-areas of the water and wastewater sector that are collected in the context of the indicator. Among them are basic water supply and sanitation services, water resources conservation, river basin development, flood prevention, education and training in water supply and sanitation, hydroelectric power, water sector policy and administrative management, agricultural water resources and large systems in water supply and sanitation. With the exception of flood prevention and control, however, national estimates exist for all areas to varying degrees. Data on expenditure on river basin development and education and training in water supply and sanitation, for example, are available in fewer countries than on waste management and basic drinking water supply. However, for no country is it possible to present the annual expenditure for drinking water and basic

sanitation in millions of USD as a national estimate. The latest data is drawn from the data collection conducted in 2017, in which 83 countries and 25 external support agencies provided data.

Challenges

Challenges related to estimating indicator 6.a.1 mainly consist of data gaps, especially concerning a decisive aspect of its definition. Currently it is not possible to verify whether ODA is part of a government budget in all countries. The impact of international cooperation, however, which is not official is not monitored by the indicator. Those challenges have to be addressed when further shaping this indicator's scope. (UN Water 2018b, p. 95)

In addition, the methodology proposes two different sources of data for the nominator and the denominator which can pose a problem if the sources use deviating assumption on the included ODA figures. A country could for example state a value for WASH-related ODA in the government budget that includes ODA which is not part of the OECD-CRS estimation for the total WASH-related data. In this case the percentage would indicate a better picture of cooperation than it actually is. Another aspect that can distort the result, is the use of different timeframes to report aid flows such as fiscal years instead of calendar year. (GLAAS 2018a, pp. 9–10)

Solution approaches

To prevent these mistakes OECD provides GLAAS with details on their ODA figures so matching them with the country's answers can be carried out (GLAAS 2018a, pp. 9–10). By using TrackFin, the given data can be further disaggregated to the national, regional and local level, which can be especially important for countries with decentralized budget and finance systems (GLAAS 2018a, p. 10). By including the suggested additional indicators *amount of water and sanitation-related ODA channeled through treasury*, *total amount of water and sanitation-related ODA* and *Sanitation and Water for All (SWA) Collaborative Behaviors* the information content of the indicator would be increased so that an even more substantiated picture of current ODA in the water and sanitation sector would be produced.

4.9 Challenges in monitoring target 6.b

The new indicator 6.b.1, defined as *proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management*, is meant to monitor target 6.b called s*upport and strengthen the participation of local communities in improving water and sanitation management*. Its custodian agency is the WHO.

Data availability

54% of Member States provided data on indicator 6.b.1 within the past five years as shown in Figure 48 (UN Water 2019c).

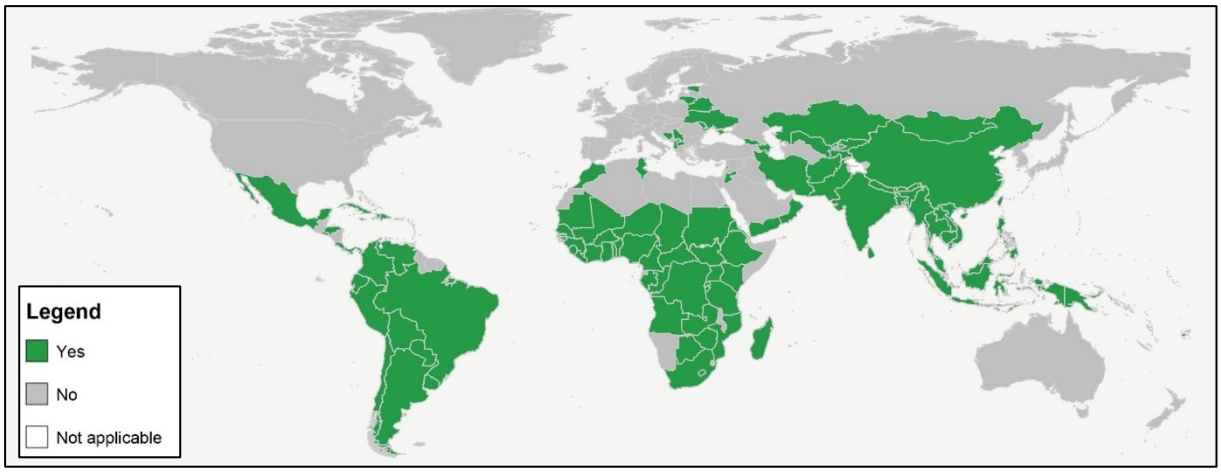


Figure 48 Countries that reported on indicator 6.b.1 at least once during the last five years (UN Water 2019c)

The indicator comprises data of the existence of procedures for participation of local communities in drinking water, sanitation, hygiene promotion and water resources planning and management and the extent of local community participation in those areas. Whereas the former information is gathered via a yes/no question format, the latter is rated as being high, moderate or low. The information of the existence of procedures is available separately for urban and rural areas for drinking water and sanitation and as national estimates for hygiene promotion and water resource for roughly the same amount of countries. As an example, the existence of procedures for participation in drinking water planning in rural areas is illustrated in Figure 49.

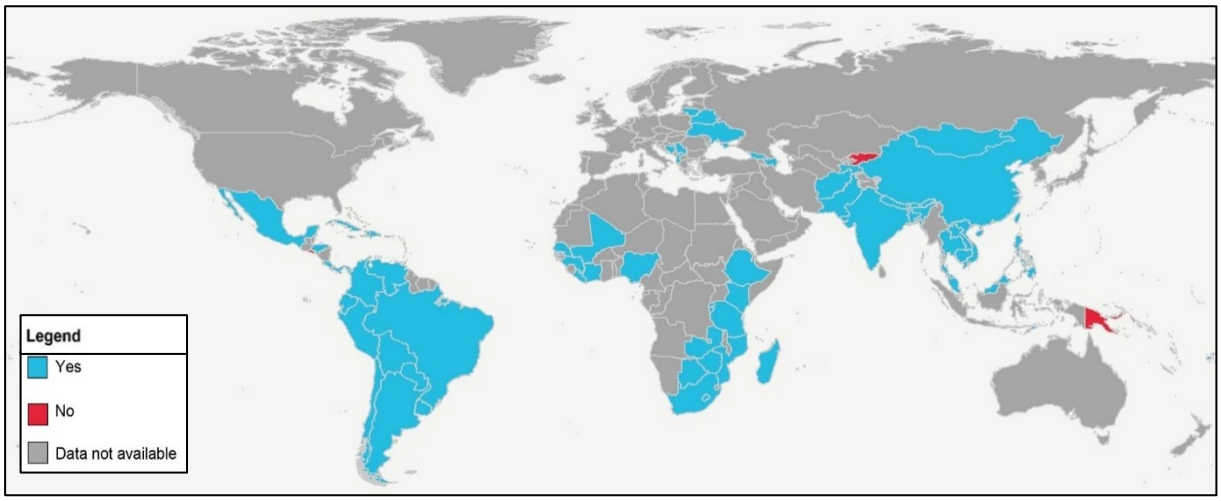


Figure 49 Existence of procedures for participation in drinking water planning in rural areas, data from 2017 (UN Water 2019c)

Data on the participation of local communities is available in the same form. Figure 50 displays the countries having available data on participation in sanitation planning in urban areas for 2017.

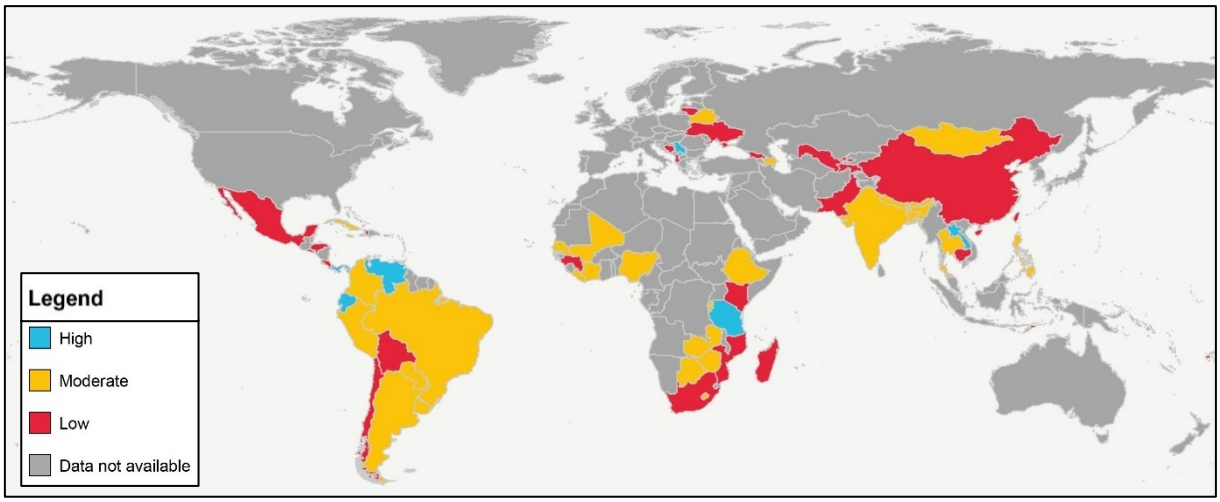


Figure 50 Extent of local community participation in sanitation for urban areas, data from 2017 (UN Water 2019c)

Data availability shows significant data gaps in many high-income countries in Europe and North America, as well as in all other regions except South America. The data sets derive from the last two GLAAS cycles and cover 110 countries (UN Water 2018b, p. 100).

Challenges

The main challenge are the big data gaps probably caused by the indicator's novelty. The systems to regularly and systematically collect this type of data at the local administrative data are not available at all countries yet (GLAAS 2018a, pp. 14–15). Another challenge of monitoring this indicator is its focus on the existence and therefore quantity of participation instead of its quality and outcomes. Also due to the big amount of GLAAS data on the WASH sector, other water-related sectors such as IWRM or agriculture are underrepresented at the moment (UN Water 2018b, p. 101).

Solution approaches

Data on IWRM was collected for the first time in the 2016/2017 data drive, however, the data was not sufficient for recognizing trends (UN Water 2018b, p. 101). Especially people working in agriculture should be better represented in the data, since they usually form water user associations (UN Water 2018b, p. 101). To address the fact that only quantitative data is required in the methodology, the indicator could be extended to include a qualitative component that is able to assess the effectiveness and relevance of the participation and thereby better reflect the objective of target 6.b which implies not only participation but also an improvement in water and wastewater management.

4.10 Discussion

The examination of the indicator-specific challenges shows that there are indeed general challenges which currently make the monitoring of several indicators more difficult. The main challenges in monitoring SDG 6 are related to either the indicator's novelty or difficulties concerning their methodologies' complexity. Several indicators are new and therefore the existing baseline reports represent the first effort in their monitoring process. This itself is challenging, since this first data collection includes identifying national data sources and establishing cooperation between national

institutions in addition to data collection and analysis. It can be said that generating data at all in this short time span and despite many countries' lack of capacity is a success. The SDG monitoring, however, requires an increase in national capacity, since both the number of indicators as well as their complexity present major challenges for many countries. Strengthening national monitoring systems and if necessary, clarifying the new indicators' methodologies are ongoing processes that the custodian agencies are working on.

In the light of the SDG's motto "leaving no one behind", representing even the smallest most vulnerable group of people is an important challenge that cannot entirely be ensured by simply increasing data availability. Generating data on these people is still a difficult task and has to be observed and especially focused on in the future. The aim must also be to better represent rural areas, less frequently used low-tech facilities or drinking water sources and generally the situation in low-income countries. The following figure underlines the low representation of the poor population in this case in low and middle-income countries. The monitoring column represents the percentage of countries that monitored the progress in service provision to their poor population for both sanitation and water services. Irrespective of the income group, only between 40% and 59% of countries usually monitor the poor portion of their population. It is noticeable that there is a correlation between the number of countries, the development of the service level of these population groups, and the funds available to them. Where monitoring takes place, more funds are made available to support it.

	World Bank income group	Number of countries	GOVERNANCE Policies and planes have specific measures to reach poo populations	MONITORING Progress in extending service provision to poor population is tracked and reported	FINANCE Specific measures in the financing plan to target resources to poor populations are consistently applied
SANITATION	All responding countries	74	74%	47%	19%
	Low income	15	73%	33%	7%
	Low middle income	29	66%	48%	10%
	Upper middle income	26	85%	58%	27%
WATER	All responding countries	74	74%	55%	27%
	Low income	15	73%	53%	20%
	Low middle income	29	66%	48%	14%
	Upper middle income	26	85%	69%	38%

80-100%
60-79%
40-59%
0-39%%

Figure 51: Percentage of countries implementing measures to extend services to poor populations (UN Water 2018b, p. 110)

Challenges related to difficulties in interpreting or implementing the indicator's methodologies were mentioned that became apparent when choosing national target values, disaggregating sectors or delineating waterbodies. Differing interpretation within the national context, however, can impede international comparability. In other cases, there are aspects of the indicators that are especially difficult to monitor in general or simply not part of an established data collection system and therefore usually not available on a national scale such as quantification of groundwater bodies or industrial wastewater flows. Also, the fact that federal states do usually not report all required data to a central database or institution, poses a challenge to a part of the Member States.

The aforementioned reasons for data gaps can largely be counteracted by increasing capacity and setting up the required monitoring structures, which of course takes time. The fact that all SDG 6 indicators are already classified as either TIER II or even TIER I level clarifies that there are no fundamental methodological problems and that the detected obstacles can only be classified as challenges not problems. Nevertheless, two questions have arisen in this context. On the one hand, it became clear that indicators that have reached the TIER I level still have to overcome challenges in their monitoring process. The meaning of the classification can therefore be misleading under certain circumstances. While this TIER system helps to constitute very clearly whether an indicator fulfils the desired effect and practicability for the purpose of which it is defined and thereby leads to an early on abandonment of indicators that proved to be impracticable, the achievement of the highest level does not mean that there are no challenges in the monitoring of an indicator and that an increase of its data availability isn't possible. In neutral terms the achievement of the highest TIER only illustrates that its data covers 50% of the relevant population which in a way contradict the SDG's principle of "leaving no one behind". However, this is only a tool of assessing the indicators usefulness. UN Water has set itself the goal of promoting national monitoring structures in a way that enables them to make good long-term decisions in the water and sanitation sector and to develop a solid database for this purpose. The monitoring of the 11 global indicators serves to promote this approach, but the UN agencies' tasks go far beyond mere reporting to the UN by also addressing the countries' priorities, monitoring a variety of other indicators and supporting countries in their national monitoring and also their achievement of sustainable development.

The second question that become apparent when analyzing the challenges in monitoring SDG 6 is whether the chosen indicators reflect all aspects of the associated targets. As described several times, there are methodological and capacity-related limits that justify the circumstance of not including all parts of a target's scope into the global indicators. Nevertheless, the fundamental question remains as to whether such uncovered partial aspects represent deficits in current monitoring. Only topics that are monitored can be addressed in a targeted manner. The deliberate omission of some target's aspects therefore amounts to a reduction in their chances of implementation. However, it has already been mentioned that Member States are free to implement such aspects within their national monitoring systems if they are of national importance. Also, some aspects of targets might be included in global monitoring in the future within advanced monitoring approaches, when the data availability of the current indicators has increased.

Data availability, however, has proven to be a useful measure for assessing monitoring success in this chapter, since the presence of national estimates is directly related to the success of implementing the indicator's methodologies. A larger number of national estimates therefore indicates less challenges in monitoring. To provide an overlook on the status quo on global monitoring the following Table 20 summarizes global estimates, TIER levels and the number of countries with current estimates for each indicator.

Table 20 Overview on SDG 6 indicators and their data availability and specifications (own representation, global estimates based on SDG 6 data portal)

Indicator (short form)	*TIER*	*Global estimate*	*Number of countries that have current national estimates*
6.1.1 Drinking water	*II*	*71%*	*117*
6.2.1 Sanitation/Hygiene	*II*	*45%/60%*	*92/78*
6.3.1 Wastewater	*II*		*(79 on domestic wastewater)*
6.3.2 Water quality	*II*		*(47 on parts of the indicator)*
6.4.1 Efficiency	*II*		*168*
6.4.2 Water stress	*I*		*(166 on EFR, 188 on other sub-indicators)*
6.5.1 Water management	*I*	*49%*	*172*
6.5.2 Transboundary	*I*	*59%*	*62*
6.6.1 Ecosystems	*I*		*(38 on parts of the indicator)*
6.a.1 Cooperation	*I*	*8.8b$*	*83*
6.b.1 Participation	*I*	*+*	*110*

For five of the 11 indicators there are currently no global estimates. The already increased data availability of indicators 6.4.1 and 6.4.2 since the baseline report however is not reflected in the data. It can be assumed that the data on these indicators will be sufficient to produce global estimates for the progress reports published in 2021. The other three indicators without global estimates are the indicators 6.3.1, 6.3.2 and 6.6.1, so mainly those indicators reflecting the environmental-focused approach of the SDGs. The variables required for monitoring those indicators are mainly those which are either not usually part of national monitoring systems or especially hard to generate, since they imply the collection of values such as in-situ data, data on aquifers or data on industrial wastewater flows.

One way to increase data availability, as already mentioned, is to expand the data sources and to support national capacity-building. In addition to national data sources such as administrative data, sector data, academic data, censuses and household surveys, regional and international sources can contribute to the data collection of some indicators. Using international sources, however, can be interpreted as weakening countries' data ownership and cause reporting of deviating data or misunderstandings between custodian agencies and national monitoring systems. In case of anticipating the use of international data the national focal points must be included in the process and always given the chance to review the data before publication. Aligning regional and national monitoring initiatives with the global indicator set can contribute to reducing countries' reporting burden.

When talking about capacity-building, enhancing national financial and human capacity is addressed. The custodian agencies support countries in finding donors or investors, give technical advice via workshops, meetings, online-courses, building a global database including best practices and thereby generating a knowledge platform that countries can use for orientation. Although there are many practical ways to support national capacity building, this remains a rather difficult solution to grasp, the success of which is only apparent with time. The use of further data sources always presupposes that the data used is aligned with the same monitoring objective and also requires communication and coordination structures, which still have to be created in several countries.

Overall, it can be stated that the task of monitoring to review the ongoing development processes is more successful with regard to some indicators in comparison to others, depending on the complexity and novelty of the indicator and the monitoring capacity of each country. The solution approaches that must be adapted to the national situation of each country in their concrete implementation. The preparation of the next progress reports will be based on greater data availability for some indicators that have been raised to a higher TIER level in the meantime. The examination of these reports in comparison to the baseline reports will clarify in retrospect how great the influence of novelty is today or whether other prevailing challenges play a greater role than assumed today.

The next chapter deals specifically with a regional instrument, the Protocol on Water and Health, which is closely linked to the objectives of SDG 6 in terms of content and can thus potentially lead to cooperation between their two monitoring systems.

5. Protocol on Water and Health

The scope of the Protocol on Water and Health overlaps with that of SDG 6. At the time this thesis was written, the fourth reporting cycle under the Protocol was evaluated, which was commissioned by the UNECE and carried out by the German Environment Agency and partly by the author of this thesis. In this sense, the following chapter will first present the basics of the Protocol on Water and Health and its connection to the Agenda 2030, in particular SDG 6. Subsequently, the approach and results of the analysis will be presented with a special focus on the challenges and problems that have arisen. The parameters will be compared to the indicators of SDG 6. The results are then compared to the most recent data published by the JMP in order to determine whether the same data is used. Concluding this chapter is a discussion of the comparison and the opportunities and benefits of integrating regional formats such as the Protocol into SDG 6 monitoring.

5.1 General information

The *Protocol on Water and Health to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes* is a legally binding agreement that was adopted by the third Ministerial Conference on Environment and Health in 1999 and entered into force in 2005. The Protocol aims to protect human health through simultaneously achieving the "prevention, control and reduction of water-related diseases" and implementation of sustainable water management in the WHO European region. It is ratified by 26 countries, covering 60 % of the region's population. (UNECE and WHO Regional Office for Europe 2016, p. 5)

The approach addresses stakeholders at national, transboundary and international level and at different sectors such as water, health, environment, agriculture and finance and encourages them to cooperate. The Protocols goals apply to surface freshwater, groundwater, estuaries, coastal waters of human use, enclosed waters for bathing, abstracted water, used for transport, treatment or supply and wastewater. (UNECE and WHO Regional Office for Europe 2019, p. 3)

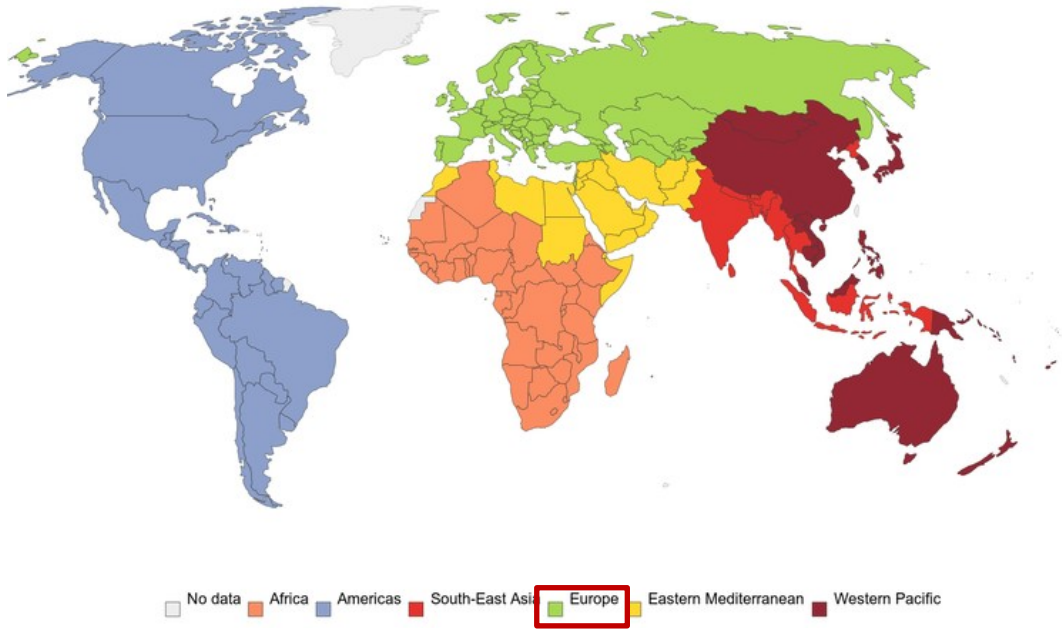


Figure 52 WHO regions in 2017 (Our World in Data and WHO 2019)

The secretariat of the Protocol is co-led by the UNECE and the WHO Regional Office for Europe. To coordinate support and promotion of the Protocol and related activities on the national level, national focal points were appointed (United Nations Economic and Social Council 10/18/1999, p. 20). Usually, there are two focal points, one in the ministry for water management or environment and one in the ministry for health (UNECE and WHO Regional Office for Europe 2019, p. 3). They coordinate target setting and reporting as well as sharing information, related to the Protocol, other countries, organizations and the general public (UNECE and WHO Regional Office for Europe 2019, p. 3). The overall implementation, the preparation of and reporting to the Meeting of the Parties and the review process is conducted by the Working Group on Water and Health.

The general goals of the Protocol are ensuring access to contaminant-free drinking water and sanitation, the protection of water resources and human health against water-related diseases and the implementation of a monitoring system for those diseases. Access to drinking water and sanitation within an integrated water management system is declared as the primary objective, since it implies the further objectives of sustainable water use, ambient water quality and protection of human health. To concretize these general provisions, the Protocol offers a list of target areas that each country is asked to nationally or locally establish and publish in their own version and complement them with prioritized and time-bound actions. Establishing national or local targets enables the countries to address their current level of performance and standards and describe concrete targets tailored to their needs and priorities, whilst including the Protocol's target areas. They are all somehow connected to the overarching goals of achieving access to drinking water and sanitation for everyone. (United Nations Economic and Social Council 10/18/1999, pp. 9–10)

While every country is obligated to produce a baseline analysis covering all target areas, national targets only have to concern those areas that are of national priority. If for example the access to drinking water reaches nearly 100%, a country does not have to set a national target in this area.

The first target area concerns the quality of the drinking water supplied that should be evaluated according to the WHO Guidelines for drinking water quality. To achieve access to drinking water and sanitation for everybody, the second target area attempts quantifying the area of territory, population sizes or proportions, served by collective systems. Alternatively, a country can include a target that addresses the improvement of collective systems aligned with its national needs. Also, the performance of collective systems and the quality of their management, possibly improved by applying recognized good practice, can be addressed in national targets. The same applies to the management of water resources and enclosed waters, usually used for bathing. The quality of waters used for human use such as drinking, bathing, aquaculture, production of shellfish can be reflected in another target.

Concerning wastewater and its treatment several aspects can be taken into account. The occurrence of discharges of untreated wastewater and untreated storm water overflows from treatment facilities, the quality of treated wastewater discharges into the environment, the disposal and reuse of sewage sludge and the compliance of quality of wastewater used for irrigation purposes with the WHO and UNEP Guidelines can be addressed in national targets. Moreover, the target areas identification and remediation of contaminated sites that threaten to rise water-related diseases and effectiveness of systems for management, development, protection and use of water resources can be dealt with at national level. Since the goal is to reduce water-related diseases, national targets can

concern the reduction of the scale of outbreaks and incidents, including the implementation of a national or local surveillance and early warning system. The last one of the target areas is the frequency of publications on drinking water and water resource quality, as well as on the quality of other waters, relevant to the targets.

The targets are periodically revised and therefore can be aligned with national and international targets or changed national priorities. The process of target-setting is illustrated in Figure 53. It includes several stages, beginning with the identification of relevant stakeholders and development of a coordination mechanism. After conducting a baseline analysis covering existing policies, laws and programs as well as the environmental and health related circumstances, the identified problems should be prioritized and the first draft of targets, actions and indicators can be developed. Hereafter the final agreements can be published and the program of measure implemented. The progress of implementation is monitored and may lead to a revision of the targets.

Figure 53: Target setting process (UNECE and WHO Regional Office for Europe 2019, p. 25)

To facilitate and support the national target setting process, the Task Force on Target Setting and Reporting was established in 2007. It develops guidelines and the format for reporting progress under the Protocol. Within this mandatory reporting exercise, the countries are asked to collect and evaluate data on their current progress concerning both their national targets and their achievements' effect on incidents and outbreaks of water-related diseases. Every three years their findings are compiled in national summary reports and send to the Meeting of the Parties of the Protocol. National data is then used to follow-up and review regional and global progress. The reporting cycle itself involves four stages. After launching the reporting exercise in form of a letter and the official reporting template, the reports have to be transmitted within a set timeframe, in order to ensure an analysis period of six months ahead of the reports' review at the Meeting of the Parties. (UNECE and WHO Regional Office for Europe 2019, p. 25)

A Compliance Committee was also established in 2007 and is obligated to control the Parties' compliance with the Protocol by considering submissions, referrals and communications from the

public and reporting on compliance with and implementation of the Protocol. It is also responsible for monitoring and since 2010 for country consultations that are conducted to facilitate the implementation of the Protocol. A concrete action of the Committee can be the support in finding donors or agencies or giving recommendations on specific implementation activities that are described in the program of work and cover for example the development of technical and political measures, good practices and capacity-building tools. The program of work is revised every three years by the Meeting of the Parties. (UNECE and WHO Regional Office for Europe 2019, p. 5)

5.2 Connection between the Protocol and SDG 6

When comparing the targets of the Protocol and SDG 6, their similarities are strikingly obvious. The Protocol addresses access to safe and sustainable drinking water and sanitation (SDG 6 Targets 6.1 and 6.2), comprising the entire water cycle, including water-ecosystems (Targets 6.4 and 6.5), reuse of sewage sludge and use of wastewater for irrigation purposes (Target 6.3), which are all part of the targets of SDG 6. Beyond that, the Protocol monitors WASH in schools and health-care facilities which is also part of the JMP's scope of work. Both the Protocol and the SDGs are approaches that concern the entire society and the entire government and follow the principles equity, prevention, safety and universality (UNECE and WHO Regional Office for Europe 2019, p. 12). In a way the Protocol is the precursor of SDG 6. It implemented a mechanism to define and revise national targets which qualifies it to translate the SDG 6 global targets into national contexts in a progressive manner. Hence the Protocol's experience can be very beneficial for the implementation of SDG 6 targets. Since one of the SDGs principles is to use existing structures and programs when possible, instead of building new systems, drawing from the Protocol's experiences, tools and data is a sensible and recommended approach. The aspects achieved by the Protocol which may be relevant for the implementation of SDG 6 are manifold. The Protocol offers lessons learned, best practices, a data pool on topics that are covered by the SDG 6 targets, approaches and tool (UNECE and WHO Regional Office for Europe 2019, p. 1). Two such approaches are, for example, the Water Safety Plan (WSP) and the Sanitation Safety Planning (UNECE and WHO Regional Office for Europe 2019, p. 1). In addition, a monitoring and reporting system was introduced within the framework of the Protocol that can be utilized for the monitoring of SDG 6. The results of monitoring in recent years can reveal persisting gaps or problem areas within the Protocol's implementation, thus providing starting points for the SDG 6 targets. SDG 6 implementation can also benefit from the fact that the Protocol follows an intersectoral and multi-stakeholder approach, thereby creating networking mechanisms as well as appointing focal points that enable the development of common strategies, sharing experiences and regional support, thus contributing to SDG 6.a. All these procedural similarities between SDG 6 and the Protocol, depicted in Figure 54, offer a range of possible synergies.

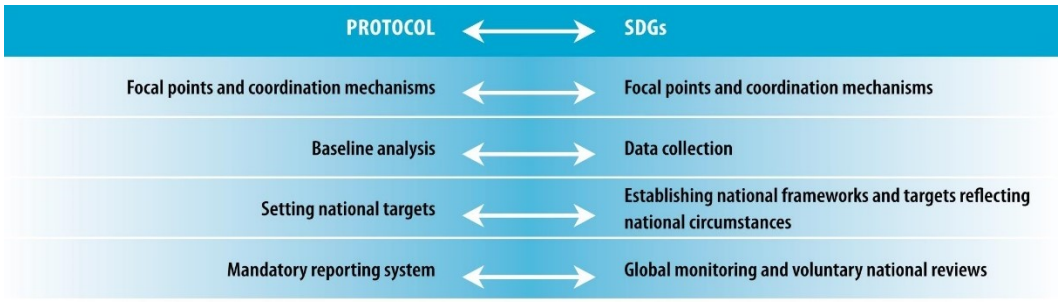


Figure 54: Parallels between the Protocol and the SDGs (UNECE and WHO Regional Office for Europe 2019, p. 12)

Aside from the many benefits, the Protocol's previous work offers in SDG 6 implementation, the Protocol can capitalize on the momentum of the SDGs to raise awareness for central WASH goals and possibly motivate more countries to ratify the Protocol (UNECE and WHO Regional Office for Europe 2019, viii). It should also be mentioned that the Protocol goes beyond SDG 6, as it will be effective after 2030 and is of legally binding nature. Therefore, a country's ratification of the Protocol represents a major step forward in the long-term sustainable development of water-related issues.

To achieve a joint implementation of the Protocol and SDG 6, the UNECE-WHO Regional Office for Europe developed a checklist, including eight points. At the beginning the focal points of SDG 6 and the Protocol should establish contact between each other. Then existing mechanisms that support intersectoral cooperation and coordination, have to be identifies and the mechanism most appropriate can be used thereafter. Alternatively, a new intersectoral mechanism for joint implementation can be developed or the different mechanisms be used but connected by communication channels. After deciding on the coordination, the Protocol's data should be used for reflecting the current status of target implementation whilst identifying problems, priorities and data gaps. Given this information the SDG 6 targets can either be developed in coherence with the Protocol's targets or joint targets for both SDG 6 and the Protocol developed. Following the target setting, action plans and implementation measures must be defined. The implementation itself can then be conducted with the help of existing tools and mechanisms of the Protocol's implementation framework. As a last step the monitoring and reporting process can be based on data collected within the Protocol's reporting system. (UNECE and WHO Regional Office for Europe 2019, p. 21)

An example of shared data use is the cooperation between the Protocol and the SDG 6 monitoring initiatives GLAAS and JMP. Both initiatives have already been using data collected by the Protocol. This approach is meant to avoid double collection and reporting and inconsistent indicators and information. (UNECE and WHO Regional Office for Europe 2019, p. 30)

5.3 Data analysis

As mentioned above, the Protocol on Water and Health implies the mandatory transmission of a report from every Party in a 3-year-reporting-cycle. By establishing this monitoring system, the Protocol facilitates an in-depth tracking of the countries achievements and obstacles and thereby an overview of the countries' current state of progress in reaching their targets. At the time of the constitution of this thesis the fourth cycle between 2017 and 2019 terminated. The fifth session of the Meeting of the Parties to the Protocol on Water and Health took place on 19-21 November 2019 in Belgrade, Serbia. According to the timeline for reporting the Parties requested to submit their reports 210 days prior to this date. Subsequently the given information is summarized and analyzed in terms of the status of implementation of the Protocol and compiled into a regional report. This cycle's regional report on the status of implementation of the Protocol is prepared by the German Environment Agency in Berlin. The currently used template for the fourth reporting cycle consists of seven parts and was already aligned with the global agenda. While Part 1 deals with general aspects related to coordination and publication efforts and Part 2 with concrete objectives, deadlines and their assessment of progress, Part 3 deals with common chemical and bacteriological parameters. Part 4 includes questions on monitoring systems for water-related diseases, while Part 5 addresses progress in other areas of the Protocol. Part 6 is a thematic part related to the priority areas of work under the Protocol. This includes the situation of WASH in schools and health-care facilities. The last

part asks for information on the reporting person. In the present reporting cycle 32 countries submitted summary reports, including the 26 Parties to the Protocol and six other countries. Within the scope of this thesis the analysis of Part 3 and Part 6 of the summary reports of the fourth reporting exercise was conducted. (UNECE 2018)

Since the aim of this thesis, however, is not analyzing the current state of implementation neither for SDG nor the Protocol, not the entire analysis but findings on the current reports data availability and challenges in reporting are focused on in this chapter. Beforehand the data types that were analyzed and their resemblance, potential of use for SDG 6 monitoring is assessed and modifications are defined. Concluding the chapter, the data reported by the Parties of the Protocol and SDG 6 data are compared in order to verify their assumed resemblance and make an assessment on whether the same data is used.

5.3.1 Data types of the Protocol's reporting template and their relation to SDG 6 indicators

Qualitative data

As described in chapter 6.2 data collected under the Protocol can potentially be used for monitoring SDG 6. The template involves several questions that either ask directly how a target contributes to achieving the SDGs or ask for numeric data that can be useful in the context of monitoring SDG 6 such as data on water quality. Part two of the template comprises questions on targets and target dates set and assessment of progress.

It covers the following twenty target areas (UNECE 2018):

- ***Access to drinking water***
- ***Application of recognized good practice in the management of enclosed waters generally available for bathing***
- ***Quality of waters which are used as sources for drinking water***
- ***Effectiveness of systems for the management, development, protection and use of water resources***
- ***Levels of performance of collective systems and other systems for water supply***
- ***Levels of performance of collective systems and other systems for sanitation***
- ***Quality of the drinking water supplied***
- ***Application of recognized good practice to the management of sanitation***
- ***Application of recognized good practices to the management of water supply***
- ***Occurrence of discharges of untreated wastewater***
- ***Access to sanitation***
- ***Occurrence of discharges of untreated storm water overflows from wastewater collection systems***
- ***Quality of discharges of wastewater from wastewater treatment installations***
- ***Disposal or reuse of sewage sludge from collective systems of sanitation or other sanitation installations***
- ***Quality of wastewater used for irrigation purposes***
- *Reduction of the scale of outbreaks and incidents of water-related disease*
- *Quality of waters used for bathing*
- *Quality of waters used for aquaculture or for the production or harvesting of shellfish*
- *Identification and remediation of particularly contaminated sites*
- *Additional national or local specific targets*

The target areas related to SDG 6 indicators are highlighted. Only five of the 20 target areas do not directly concern SDG 6 targets. In each target area, five identical questions are asked about the concrete targets and target dates, the actions taken, an assessment of the achieved progress, the contribution to fulfilling the 2030 Agenda or other global or regional commitments and lastly an

explanation, in case no targets were set. All of these questions can be relevant when implementing SDG 6, since the answers specify, how the existing targets can complement the SDG targets and also in which areas the Protocol's and SDG's implementation and monitoring overlap. The majority of countries specified which SDGs their targets affect. Most of them mainly described how the targets are linked to water and health- related SDGs 3 and 6, only two countries detailed affected subtopics.

Quantitative data

Chemical and bacteriological quality

Quantitative data that is of importance for SDG 6 monitoring is given in the parts three and six. In part three, the topics *bacteriological and chemical drinking water quality*, *access to drinking water and sanitation*, *water quality of freshwater resources* and *water use* are dealt with. *Bacteriological and chemical quality of drinking water* is a part of indicator 6.1.1 which estimates the proportion of population using *safely managed drinking water services* (UN Water 2017c, p. 8). One of the requirements of those services is that the drinking water is *free from fecal and priority chemical contamination* (UN Water 2017c, p. 8). The Protocol collects data on drinking water quality of supplied water, meaning mainly people who use water that is supplied by a centralized piped system. This however, means that the Protocol's data on water quality is only covering a certain proportion of the national population, while the data for SDG 6 monitoring aims for covering all types of water supplies.

Since the proportion of people, covered by the Protocol's data is quantified, the given data can be put into context concerning the overall population and compared to the JMP's data on *improved facilities* that are *free from contamination*. The collected data is supposed to include the *percentage of samples that fail to meet the national standard for E.coli, arsenic, fluoride*, *lead and nitrate* both in urban and rural areas as well as on the national level. The national standards might differ from the WHO guidelines which is why the Protocol's question prior to that asks whether WHO guidelines or national standards are used for data analysis. The data used by the JMP for evaluating bacteriological and chemical quality is drawn from sector data or in some cases from water analysis conducted during household surveys and measures drinking water quality as the proportion of the population that has access to drinking water free of contamination (WHO and UNICEF 2017c, pp. 48–49). Overall, the JMP can draw from the Protocol's data on the proportion using the central water supply and at least for this part of the population on the value for the sub-indicator free of contamination.

Access to drinking water and sanitation

Access to drinking water and sanitation is covered by the Protocol's reporting template in terms of urban, rural and total access and defining access either in the way the JMP does, or, when using a national definition, in specifying which of the four JMP requirements for safely managed services are nationally considered. The four requirements, a country can choose for defining its own definition of access are

- having an improved water source as per JMP definition,
- that is located on premises,
- available when needed or

- provides drinking water free from faecal contamination (UNECE 2018).

In terms of access to sanitation the three requirements are

- having an improved sanitation facility as per JMP definition,
- that is not shared and
- from which excreta is safely disposed in situ or treated off site (UNECE 2018).

Country data, based on the JMP's definition of access can directly be used by the JMP itself, the rest of the data can be used to identify the proportion of people using unimproved sources and to calculate estimates for each of the four parts of the indicators for drinking water and sanitation. Thus, it is possible to compare the data of the Protocol with the data of the JMP. However, the respective national definition of access must be observed and the respective equivalent value of the JMP ladder used. If, for example, the national definition includes the aspects improved source and accessible on premises, the value can be used for the basic level in the JMP report. However, if all three aspects of the safely managed indicator are part of the national definition, sharing data is possible.

Quality of surface waterbodies and groundwater

The indicator 6.3.2 measures the proportion of bodies of water with good ambient water quality. Within reporting for the Protocol, countries are asked to assess their surface waterbodies' ecological and chemical status and their groundwaters' quantitative and chemical status. The parameters used for SDG 6 monitoring are five chemical core parameters, when monitoring on level 1 and additional biological parameters, when monitoring on the advanced level 2. Both monitoring approaches aim for an assessment that classifies the waterbodies' chemical status as either good or poor. In case of indicator 6.3.2 the assessment depends on the percentage of samples that fail to meet target values that should be oriented at international standards (UN-Water, p. 7). The five core parameters, being measured, are dissolved oxygen, electrical conductivity, pH, orthophosphate and total oxidized nitrogen (UN-Water, p. 7). Only if at least 80 % of the entire monitoring data within a water body complies with the target values, it is classified as having a good water quality (UN-Water, p. 12).

The Protocol asks countries to assess the water quality on the basis of national systems of water classifications, resulting in percentages of waterbodies or volume of water falling under each class. The question is divided into a section for countries that follow the European Union Water Framework Directive classification and one for other countries. The former offers the classifications, used by the framework. The ecological status of surface waterbodies is classified as high, good, moderate, poor or bad, the chemical status however, is either considered as being good or poor. The status of groundwater has to be provided in terms of good and poor chemical and quantitative status. (UNECE 2018)

The sharing of the data obtained from the Protocol in this case requires that the waterbodies extent is defined in the same way and that the same core parameters and value targets are used. An examination of the national metadata can indicate whether this is the case.

Water use

Another question that covers the content of an SDG 6 indicator, requires information on the water exploitation index at country level for the three sectors agriculture, industry and domestic. The Protocol inquires quantitative data in form of the mean annual abstraction of freshwater by sector divided by the mean annual total renewable freshwater resource at the country level, expressed in percentage terms. (UNECE 2018)

The SDG 6 monitoring involves an indicator on change in water-use efficiency (6.4.1) that is calculated for three economic sectors according to their ISIC codes and the level of water stress, measured through freshwater withdrawal as a proportion of available freshwater resources (6.4.2) (FAO 2018b, XII). The water use efficiency, as determined by the indicator's methodology, is a value that reflects each sector's and the total national economy's dependence on water resources and is given as USD per m^3 (FAO 2018b, XII). The calculation of this value requires data on the gross value added by the respective sector in USD and the volume of water used within the sector in m^3 (FAO 2018b, p. 6). The level of water stress, as calculated by the SDG indicator, factors in the volume of total renewable freshwater resources (TRWR), the total freshwater withdrawal (TWW) by the sectors and the environmental flow requirements (EFR) in km^3/year (FAO 2018a, XII).

A difference between the Protocol's and the SDG's approach can be the definition of economy sectors. The SDG clearly follows the ISIC code and offers a precise classification of sectors into agriculture, MIMEC and domestic. The Protocol's definition is based on the three sectors agriculture, industry and domestic with no precise definition of implied subsectors. Disaggregated metadata could be an option to either ensure that the countries definitions match the ISIC code or identify data that can be modified to serve the SDG's needs. The Protocol's data on sectoral water withdrawal can be useful for calculating indicators 6.4.1 and 6.4.2 depending on its definition. If the use of non-conventional water sources such as treated wastewater, desalinated water and drainage water are implied, the data can be directly used for indicator 6.4.1. In order to use it for calculating indicator 6.4.2 only the conventional water sources should be considered.

WASH in schools and health-care facilities

In part 6 of the Protocol's reporting template the countries are asked to provide data on water, sanitation and hygiene in institutional settings. In detail it asks for information on the proportion of schools (primary and secondary) and health-care facilities that provide basic WASH services. Basic services are defined as per JMP definition. If a country provides data not compliant with the JMP definitions, it has to indicate its alternative categories. The required data is the same data the JMP collects so a separate collecting is not necessary.

Overview

Overall the Protocol does not request metadata but estimates and in some cases the source of the given data. So, the data that is interesting for SDG monitoring and that can potentially be shared for both monitoring processes are the underlying metadata. To harmonize the required data, for SDG 6 and the Protocol monitoring, the Protocol's template can still be modified regarding certain questions. However, it should be taken into account that some of the Protocol question exceed the SDG's scope and a harmonization might reduce the data's information value.

When comparing the Protocol's and the SDG 6 indicators' definitions for monitoring similar data there are some differences that could be reduced in order to facilitate using the same metadata for both monitoring formats. With regard to the recording of the bacteriological and chemical quality of the drinking water, the same parameters are already used, so that no modification is necessary here. Although it is important to check which part of the population is covered by the data. If only people using piped water supplies are included, it represents only a part of population and hence a part of data required to monitor SDG 6.1. The same applies to access to both drinking water and sanitation. In case of using national definitions a disaggregated presentation of metadata by the single sub-indicators would be helpful for its use in SDG 6 monitoring.

The quality and quantity of rivers, lakes and groundwater are specified in the Protocol in the form of various categories, which are not further defined, making the use of the SDG indicator *good ambient water quality* more difficult. Adaptation of these questions to the national ambient water quality and its definition chosen for 6.3.2 monitoring would enable the common use of data. The question on the water-exploitation rate is a mixture of the SDG indicators *change in water-use efficiency over time* and *level of water stress: freshwater withdrawal as a proportion of available freshwater resources*, which leads to the fact that the countries can only partially use the already available data on SDG 6.An adaptation to one of the two indicators or the separate query of both indicators would have to be considered in the sense of simplified reporting.

Comparing the required data clarifies that both formats use similar data, so that the data can be shared to some degree. The structures implemented for data collection should be used in both monitoring processes in order to minimise costs and effort. For this purpose, it is possible to modify the template in the described way. However, the scope of the information collected by the Protocol should not be diminished. There is no counterpart within the scope of SDG 6 monitoring to query water-related diseases for example. Concerning this subject, the monitoring therefore exceeds the SDG 6 monitoring. The associated metadata for determining the values reported in the template is not available to the author of this thesis. Therefore, only a comparison between the reported data is possible. In this sense only the direct comparison of data on access to drinking water and sanitation and WASH in schools and health-care facilities is possible. For comparing data on ambient water quality and water use additional information on the data reported for the Protocol would be required.

5.3.2 Methodology of analysis

The task of analyzing and summarizing the 32 country summary reports in accordance with article 7 of the Protocol on Water and Health created by the Joint Secretariat to the Protocol on Water and Health was conducted in a non-standardized way.

The first step in the analysis of Parts 3 and 6 was to transfer the country reports to an Excel spreadsheet. In the second step, the data were displayed graphically using a tableau. Here, a tableau project was created for each sub-question and different presentation methods were selected, depending on the anticipated information content. With the help of these visualizations, a text summary was created from which several pieces of information could be extracted. In addition to the results and continuations compared with the latest available data, data availability and quality was assessed. By presenting the change compared to previous reporting cycles, the development of parameters was is examined.

5.3.3 Data availability

Since the detailed results do not directly contribute to the scope of the thesis, they can be found online under the link given in Appendix F. The data availability, however, is an aspect that is interesting in the light of the previous chapters and is briefly described.

The majority of the countries describes how their targets contribute to fulfilling the 2030 Sustainable Development Agenda. While most of the countries which answer the questions only refer to the sustainable development goals (SDG) most clearly linked to the topic of water and health, namely SDG 3 and SDG6, others like Estonia and Romania provide a detailed description of how and why the targets contribute to fulfilling the individual subtopics of the respective SDGs.

Overall, almost 20 of the targets set within the Protocol are related to WASH either in schools or in health care facilities, which corresponds to the specifications in part 6 of the reporting format, concerning WASH in institutional settings. The World Health Assembly resolution on Drinking-Water, Sanitation and Health (WHA72.7,20192019) stresses the importance of safe drinking-water, sanitation facilities and adequate hygiene practices in health care facilities, prevention of waterborne disease and protection of high-risk communities. It urges countries to highlight safe drinking-water, sanitation and hygiene as the basis for primary prevention in their national strategies. Many countries reporting under the Protocol incorporated this urgency: a major part of the countries provides basic water, sanitation and hygiene services (WASH) in schools and especially in health care facilities.

Regarding access to water and sanitation, the analysis shows that data is often unavailable for the whole population in reporting countries. In many cases, if data is available for both urban and rural areas, it indicates that rural areas continue to have lower access to safe services as compared to urban areas, and that access to sanitation lags behind access to drinking water. Overall the data reveal improvements especially in access to sanitation compared to the previous reporting cycle.

The data on the quality and quantity of surface waterbodies and groundwater display a mixed picture. While there are still several countries defining over 50% of their surface waterbodies' status as either bad or poor, the bigger share defines them predominantly as having good and high or at least moderate status. Concerning the chemical status of surface waterbodies and groundwater, the data clearly display a superior number of countries reporting a predominantly good status. The same applies to the quantitative status of groundwater. Some countries did not provide any information on the questions on the status of surface waters and groundwater bodies at all, while others did not evaluate all waterbodies. The data on water use were less clear since several countries did not provide the type of information that was asked for. Not all countries adhered to the desired percentage, but some also gave absolute values, which reduces the comparability of data. A comparison between countries and in some cases over time is not possible. However, there are more countries reporting a decrease of water exploitation than an increase since the previous reporting cycle. None of the sub-questions concerning common indicators were answered by all 32 reporting countries as shown in Figure 55. Data gaps in the form of missing answers and/or insufficient details exist for example on year specifications. As a lack of differentiation between data for urban and rural areas impede the evaluation of available data, countries that have not done so yet are encouraged to report segregated data for urban and rural areas. Particularly regarding chemical and bacteriological

quality of drinking-water, only few countries provided differentiated data for urban and rural areas. The answers to the sub-question on water use varied a lot. Not all countries adhered to the desired percentage, but some also gave absolute values, which reduces the comparability of data. Some countries did not provide any information on the questions on the status of surface waters and groundwater bodies at all, others did not evaluate all waterbodies.

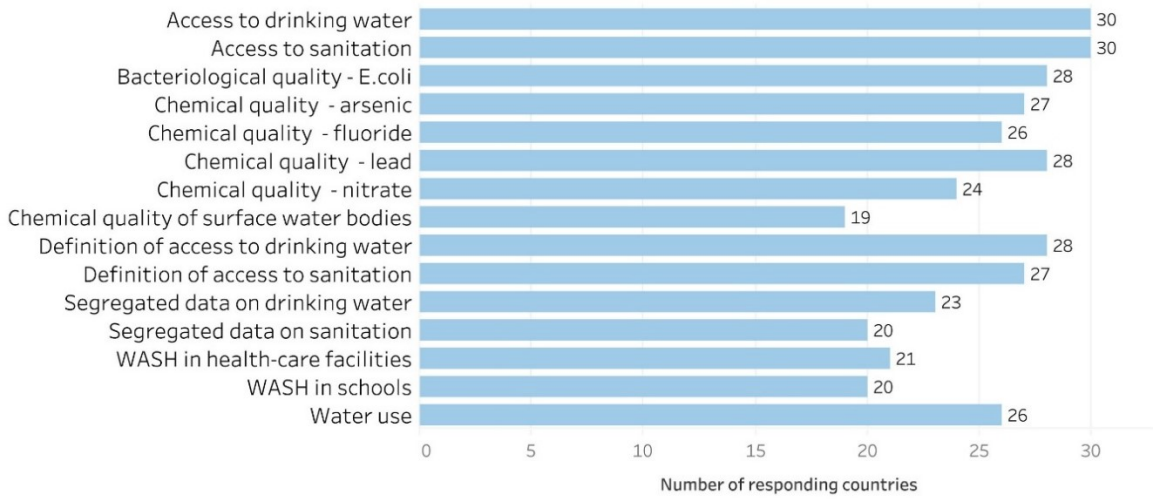


Figure 55 Number of responding countries on each question (own representation)

In the following chapter, a part of the numeric data is compared to the latest data collected by the JMP.

5.4 Comparison between data reported for the Protocol and the latest JMP progress reports

After examining the degree of resemblance of data collected for the Protocol' reporting and the SDG 6 monitoring, data are compared in this chapter. The aim of this comparison is to determine whether the monitoring programs use the same data, accordingly the countries submit the same data and save resources by identifying these synergies. The earlier comparison of used data but also the results of analysing the countries' reports indicate that only a comparison of data on WASH in schools and health-care facilities and access to drinking water and sanitation is sensible. The reports used for this comparison are therefore as follows:

- Progress on household drinking water, sanitation and hygiene I 2000-2017 SPECIAL FOCUS ON INEQUALITIES (data from 2017) (WHO and UNICEF 2019d)
- Progress on Drinking Water, Sanitation and Hygiene 2017 Update and SDG Baselines (data from 2015) – only for countries, who reported data from 2015 as latest data (WHO and UNICEF 2017a)
- DRINKING WATER, SANITATION AND HYGIENE IN SCHOOLS Global baseline report 2018 (WHO and UNICEF 2018b)
- WASH IN HEALTH CARE FACILITIES Global Baseline Report 2019 (WHO and UNICEF 2019e)

5.4.1 Access to drinking water and sanitation

To compare the data on access to drinking water and sanitation of the Protocol with data from the JMP progress report, it is necessary to look at the national definitions of access, given in the Protocol. Besides countries that comply with the JMP definition and claim to have used JMP data, there are countries that provide national data and define their basis via checkboxes. The following table shows the countries' definitions of access to drinking water as given in their country reports and the chosen equivalent values of the latest JMP report for the sake of the comparison. Depending on the definition, the value chosen from the JMP report was either the value given for *safely managed* or *basic services*. In case of the countries that do not provide an information on their definition of access, the JMP that were closer to the values given in the country reports were chosen for the comparison. It is important to note that this is a classification based on assumptions. In order to validate these assumptions, the countries would have to be asked about their definition and the values they provide in their country reports. Since this procedure cannot be carried out within the framework of the thesis, the following explanations are based on assumptions, the results of which must be critically questioned. In particular, it must be noted that in some cases the compared country values do not originate from the same year, but usually differ by one year, and in some cases by two years. The values of the JMP are all dated 2017. In order to better interpret the comparison, the countries whose values given in the Protocol are older than those of the JMP report are highlighted in dark red. The countries whose protocol values are newer than those of the 2017 JMP report are highlighted in blue. Although it cannot be assumed that the difference of one year is the sole reason for a large difference between the two data, small differences may nevertheless be justified.

Table 21 Definition of access to drinking water given by the countries in the Protocol and equivalent value in JMP report (own representation)

Definition of access to drinking water in Protocol	***Countries***	***Equivalent value in JMP report***
JMP Estimates	*Croatia, Czechia, Estonia, Georgia, Germany, Republic of Moldova, Serbia*	*Safely managed*
National estimates:		
Definition same as safely managed	*Latvia, Lithuania, Romania, Spain*	*Safely managed*
Improved source, on premises and free of contamination	*Azerbaijan, Finland*	*At least basic service*
Improved source and on premises	*Albania, Hungary, Serbia, Norway*	*Norway, Serbia - At least basic service* *Albania & Hungary – safely managed*
On premises, available when needed and free of contamination	*France*	*Safely managed*
Improved source	*Armenia, Belgium, Israel, Netherlands, Portugal, Slovenia*	*At least basic drinking water*
No further definition	*Belarus, Luxembourg, Ukraine*	*Safely managed*
No cross at all	*Bosnia and Herzegovina, Malta, Russian Federation, Slovakia, Switzerland, Uzbekistan*	*Bosnia and Herzegovina, Malta, Slovakia - Safely managed* *Russia Federation Switzerland - At least basic services*

The following figure illustrates a comparison between the values of the countries that chose a definition best compared to the JMP's definition of safely manged.

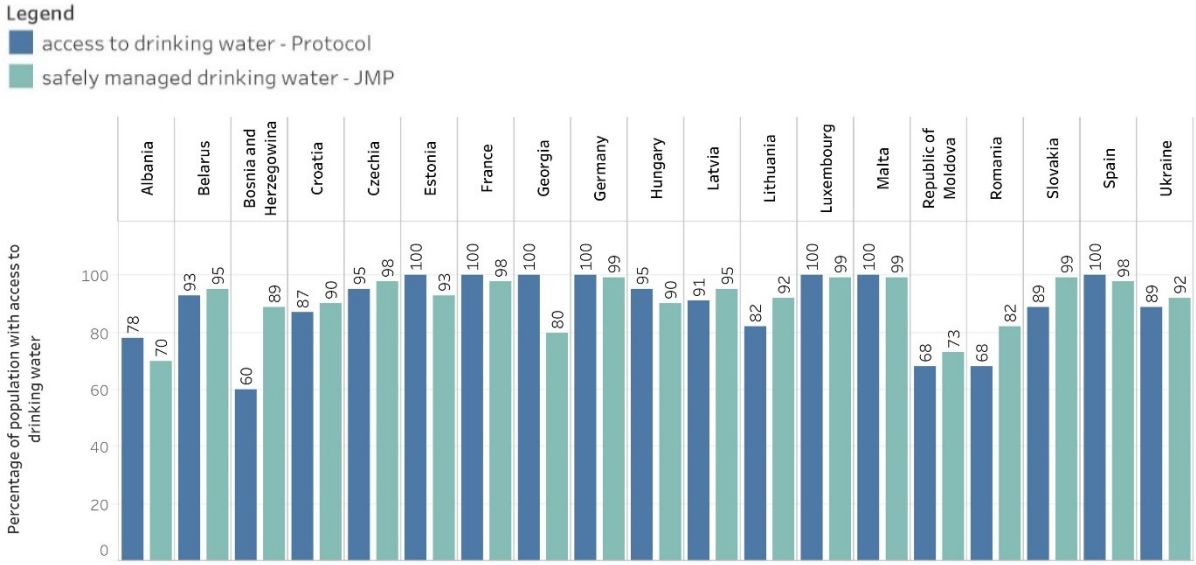


Figure 56 Comparison between the Protocol's data on the percentage of population with access to drinking water and the JMP's data on safely managed drinking water services (own representation)

The comparison shows that the values used in the country reports for the Protocol and the presumably equivalent values selected from the latest JMP report differ for all countries. There are some deviations, which are only 1-3%, but also, as in the case of Bosnia and Herzegovina, a deviation of 29%. The x-axis is the value given in the Protocol and the bars indicates the positive or negative deviation of the JMP value from the Protocol value. A positive value indicates, that the JMP value exceeds the Protocol value, while a negative value illustrates the opposite.

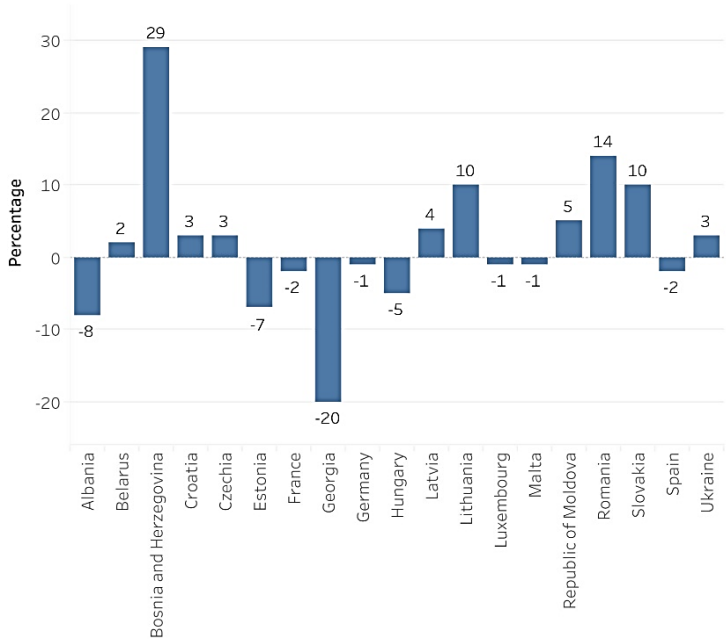


Figure 57 Deviations of the JMP's percentage of population with access to safely managed drinking water services from the countries' values provided in the Protocol's country reports (own representation)

The discrepancies can be explained by the fact that the countries' definition of safely managed do not match the definition of safely managed of the JMP or that other data and calculation methods were used. The proportion of countries providing a higher value in the Protocol as given in the JMP report is equally high as the proportion for which the JMP's value exceeds the Protocol's value. It is, however, notable that there are some countries which only minimal deviations and some with deviations is in the double digits.

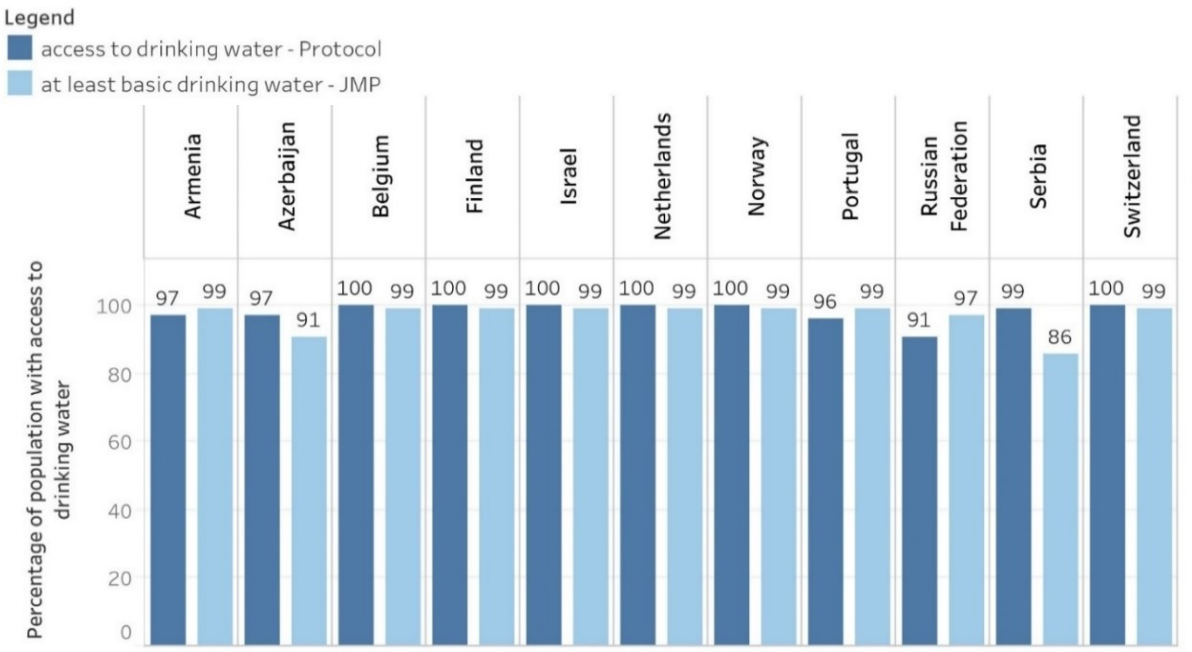


Figure 58 Comparison between the Protocol's data on the percentage of population with access to drinking water and the JMP's data on basic drinking water services (own representation)

Figure 58 presents the rest of the countries, whose definition is compared to the JMP's definition of basic services. Therefore, their values given in their country reports are compared to those JMP values. Again, the all values show deviations. However, most of them are relatively low. In 6 countries the values only differ by 1%. Overall the Protocol value more often exceeds the JMP value for basic services. When taking a closer look to the eight countries whose Protocol value exceeds the JMP value, six of them provided values newer than 2017. Assuming that there has been an increase in access, these deviations are plausible. Therefore, is possible, that those countries use the same data for both monitoring exercises. However, these countries all a high percentage of population with access to drinking water services. The deviation of 1% can also mean, that the value given in the Protocol does simply not reflect the 1% not having access or uses different calculation methods that lead to an overestimated less accurate value.

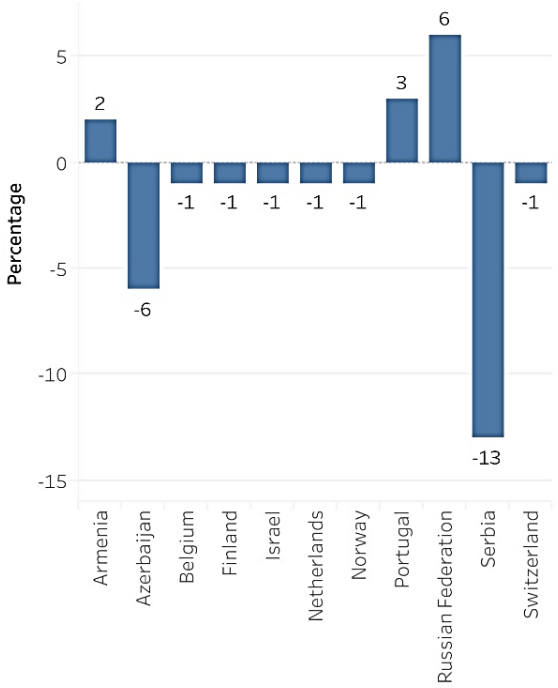


Figure 59 Deviations of the JMP's percentage of population with access to basic drinking water services from the countries' values provided in the Protocol's country reports (own representation)

Slovenia and Uzbekistan did not provide current data within their country reports. Hence, they are not reflected in the comparison of access to drinking water services.

In the case of access to sanitation, the same procedure is followed. The following table shows the assignment of the Protocol's data to JMP definitions. Again, Slovenia and Uzbekistan are excluded.

Table 22 Matching of data given in the Protocol and the JMP reports (own representation)

Definition of access to drinking water in Protocol	***Countries***	***Equivalent value in JMP report***
JMP Estimates	*Belarus, Croatia, Czechia, Estonia, Georgia, Germany, Serbia, Ukraine*	*Safely managed* *Georgia, Serbia - At least basic fits better*
National estimates:		
Definition same as safely managed	*Finland, France, Latvia, Lithuania, Netherlands*	*Safely managed*
Improved source facilities, not shared	*Albania*	*Safely managed*
Improved facilities, safely disposed	*Azerbaijan*	*Safely managed urban*
Improved facilities	*Armenia, Belgium, Israel, Norway, Portugal, Republic of Moldova*	*At least basic sanitation*
No further definition	*Hungary, Luxembourg*	*At least basic sanitation*
No cross at all	*Bosnia and Herzegovina, Malta, Romania, Russian Federation, Slovakia, Spain, Switzerland*	*Bosnia and Herzegovina, Romania, Spain, Slovakia safely managed, Malta, Russian Federation, Switzerland at least basic sanitation*

Figure 60 shows the comparison of those countries whose definitions equal the JMPs definition of safely managed sanitation services.

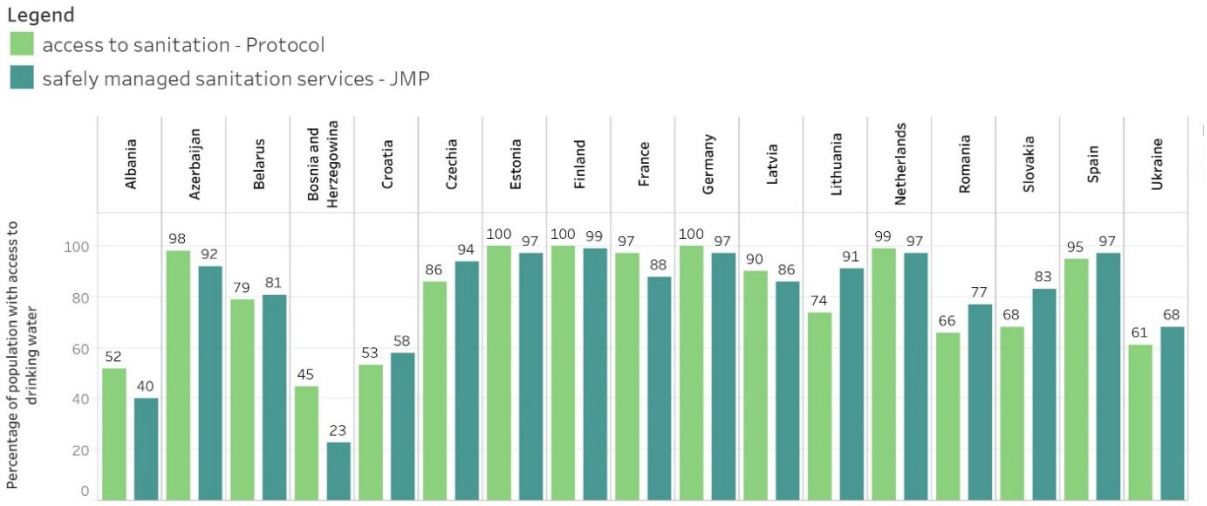
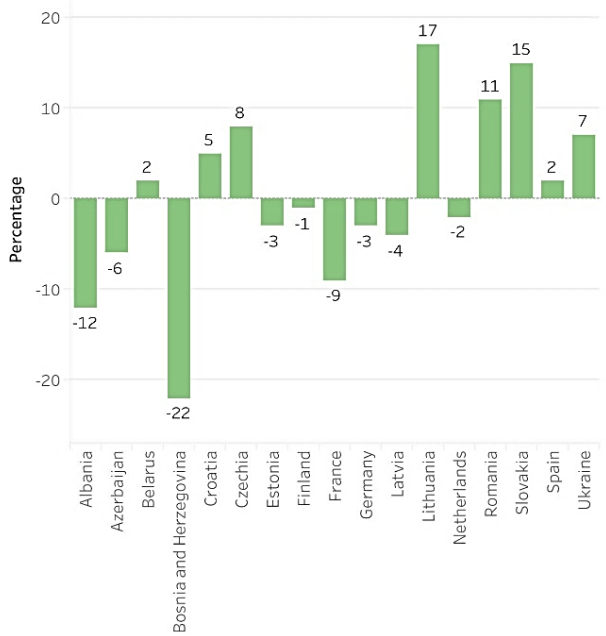


Figure 60 Comparison between the Protocol's data on the percentage of population with access sanitation and the JMP's data on safely managed sanitation services (own representation)



The comparison illustrates that there are deviations between one and 22%. There are five countries with deviations over 10%. As in the case of drinking water, there is no trend on whether the JMP or Protocol values are higher. Four countries whose protocol data is newer than the JMP specifications and which nevertheless have lower values are included. At this point it can be assumed that other methods and or data were used to calculate the estimates, as previously mentioned for drinking water services.

Figure 61 Deviations of the JMP's percentage of population with access to safely managed sanitation services from the countries' values provided in the Protocol's country reports (own representation)

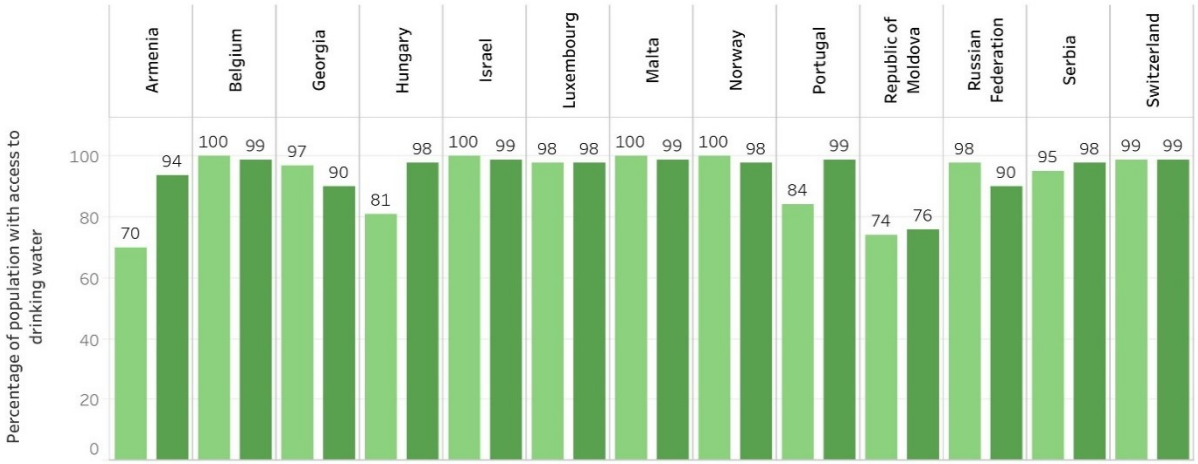


Figure 62 Comparison between the Protocol's data on the percentage of population with access to sanitation and the JMP's data on access to basic sanitation services (own representation)

The comparison of the rest of the countries with the JMP's data on the percentage of people with access to basic sanitation is illustrated in Figure 63 and Figure 62. Seven of the 13 countries shown a deviation between zero and 2%. However, there are three countries whose JMP value was over 10% higher than the value given in the country reports for the Protocol. In these cases, the data does obviously not reflect the same definition of access or the same part of the population.

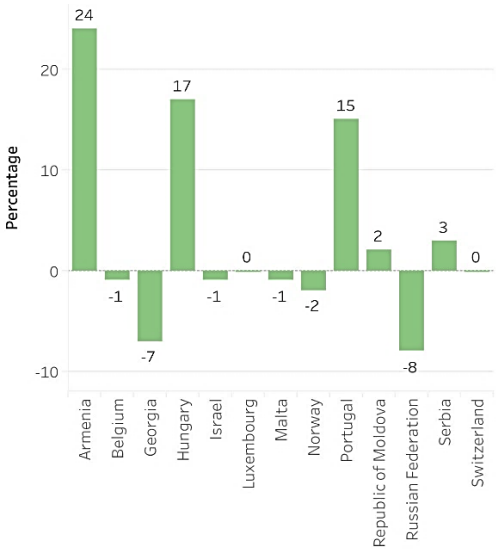


Figure 63 Deviations of the JMP's percentage of population with access to basic sanitation services from the countries' values provided in the Protocol's country reports (own representation)

5.4.2 WASH in health-care facilities and schools

The comparison of the values for access to WASH in health-care facilities and schools does not require an interpretation of definitions given in the Protocol's reporting template. Both the Protocol's reporting template and the JMP data refers to basic services. Figure 64 depicts the comparison between the countries' data for health-care facilities, including access to basic hygiene, drinking water and sanitation services. Overall four of the countries that reported on the Protocol had data on access to WASH in HCF and an equivalent value in the JMP's latest progress report on WASH in HCF. The following figure only shows the three countries for which deviations occurred. The fourth county, Lithuania, showed no deviations but 100% for all three types of services and in both the Protocol and the JMP's data. The comparison of the other three countries' values show deviations in case of Czechia's data on basic sanitation services, Serbia's data on basic hygiene services and all three types of basic services in Armenia.

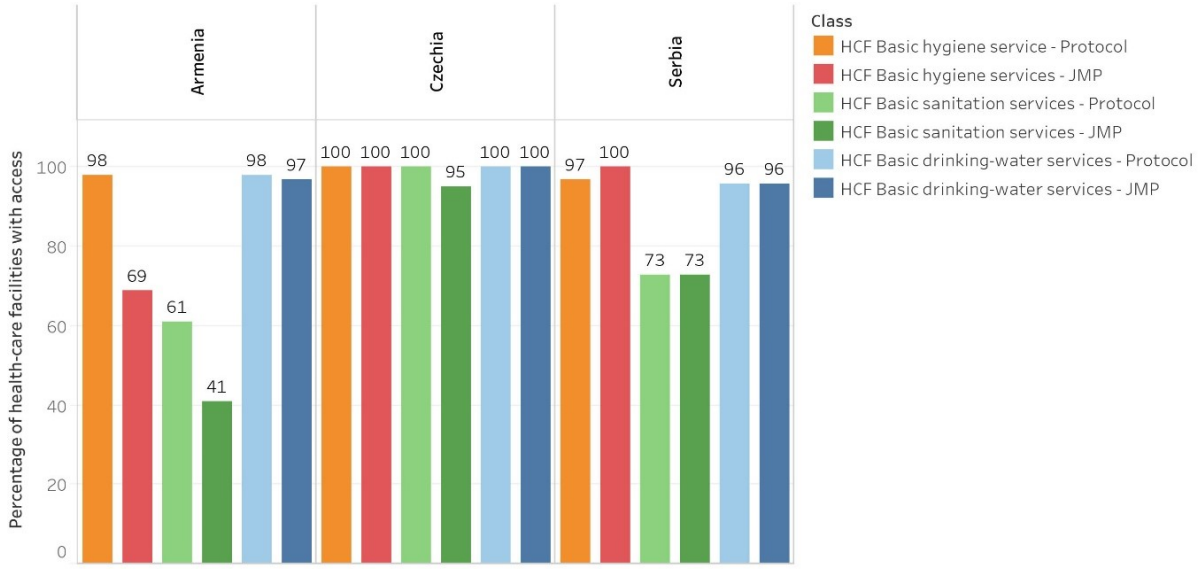


Figure 64 Comparison between the Protocol's data to the JMP's data on the percentage of health-care facilities with access to basic services

The reason that only such comparisons are possible is that there is no data in the JMP report on some countries that have indicated values in the Protocol. This may also be due to the fact that this report refers to 2016 data. The data of the Protocol are mostly much younger and originate either from 2017, 2018 or 2019. In the 3 countries for which the comparison is available, the data of the Protocol are dated 2017 in the case of Serbia and 2018 in the case of the other two countries. In the case of Czechia and Armenia, the temporal difference can explain the higher values of the Protocol data. Serbia's younger hygiene services company may be explained by the fact that in the meantime a larger amount of data has been generated, which has led to the value being corrected downwards.

A comparison of Protocol and JMP data on WASH in schools is possible for 17 countries. In 13 of them the values reach 100% for all three types of services and both reporting systems. Figure 65 depicts the four countries showing deviations. Again, the latest JMP data on the subject is dated 2016, while the data the countries provided in their country reports for the Protocol is dated either 2017 (Hungary, Serbia) or 2018 (Republic of Moldova, Czechia).

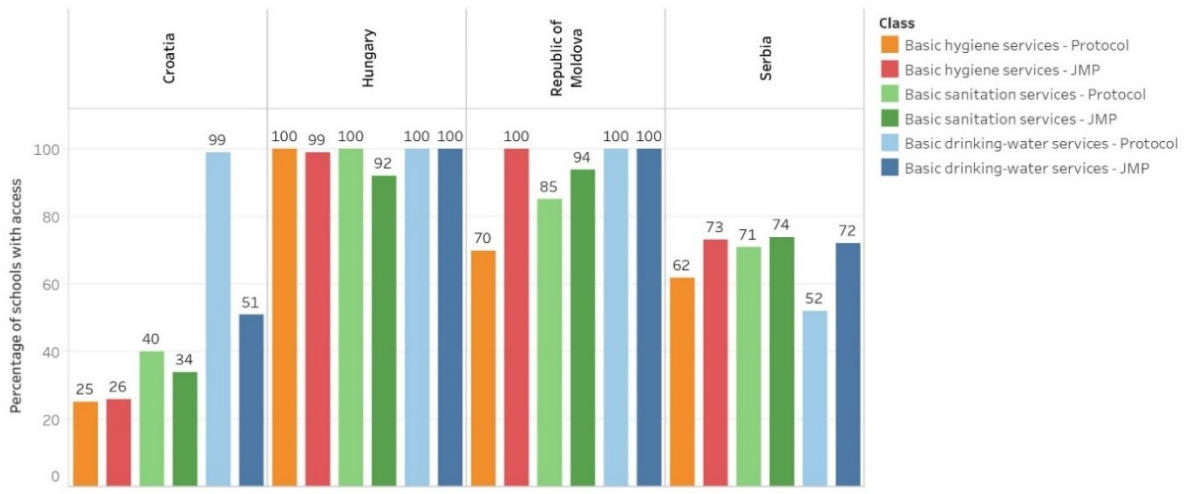


Figure 65 Comparison between the Protocol's data to the JMP's data on the percentage of schools with basic services

The values provided in Serbia's and the Republic of Moldova's country reports for the Protocol are significantly lower than the JMP's values from 2016. A possible reason for that can be an increase in data availability enabling the data to reflect a more distinct view of the actual situation. The deviations shown by Hungary can be caused by an actual increase in basic services. The data on Czechia, however, shows an increase in access to basic drinking water of 49%, nearly doubling the value within two years. An increase of this proportion seems unlikely and indicates that the data provide for the Protocol and in the JMP's report do not reflect either the same level of service or use very different methods of calculation.

5.5 Discussion

The attempt of comparing the data provided by countries within the current template for reporting to the Protocol and the latest JMP reports on WASH in households, schools and health-care facilities faces several obstacles. First of all, the compared data does not always originate from the same year. Moreover, the JMP's estimates are produced in a certain way following calculation rules that might not be the same as the countries used when providing an estimate for the Protocol. In addition, the data reported in the template depends on the reader's interpretation as well as national definitions and standards which can deviate from the JMP's approach. In order to enable a more detailed comparison metadata on both the Protocol's and the JMP's reports would have to be provided. In regard to all of that difficulties the given comparison has to be handled with caution. However, the comparison reveals that although there are values on WASH in schools that are consistent, when looking at the data on access to drinking water and sanitation there are no identical values and even large deviations in the double-digits. When suggesting that the definitions of access chosen in the country reports are equal to the JMP's definitions of safely managed and basic access, these deviations cannot only be caused by the data's differing time references but indicate that not all countries reported the same data for both reporting formats. Since the goal of this comparison was to find out whether the efforts of aligning the Protocol's template led to a reduction of national monitoring efforts, though the opportunity of using the collected data for both the Protocol and the SDG 6 monitoring, the result suggests that this is not the case for all countries. The analysis of the template's and the SDG 6 indicators' similarities demonstrates that there are still possibilities of further aligning the template to the indicator's methodologies.

6. Conclusion and outlook

This thesis provides an overview of the methodologies and challenges of monitoring SDG 6 three years after its adoption.

The scope, complexity and integrated approach of the SDGs undoubtedly exceed the objectives of the MDGs. A major difference between the two development agendas is that the SDGs apply to all Member States, not primarily to developing countries. SDG 6 comprises numerous targets addressing the entire water cycle and includes several new targets and therefore indicators that were not part of the MDG's agenda such as several targets focusing on the environmental dimension of sustainability. It is a complex goal that can benefit all of the other 16 SDGs and is becoming increasingly relevant through observable ecological and societal change. The indicators of SDG 6 are equally complex as those targets and their monitoring requires a variety of different data and data sources.

In general, monitoring aims to provide information on progress in the achievement of defined goals. The monitoring of SDG 6 is conducted through collection and analysis of data for 11 global indicators to generate a solid and reliable database for decision-makers and investors, so they can initiate targeted interventions to accelerate development progress. In addition to those 11 indicators countries can implement national indicators reflecting their prioritized targets by surpassing the global indicators' scope. These national targets are not necessarily reported to the UN agencies and used to provide national governments with information, while the global indicators rather aim at international parties such as the High-level political forum, international banks, agencies and NGO's. The monitoring of the global SDG 6 indicators is organised under the umbrella of the Integrated Monitoring Initiative under the auspices of UN Water. The Initiative's approach includes supporting countries in their national data collection, analysis and reporting as well as decision-makers and other stakeholder to use the collected data in a way that fosters sustainable development. The IMI coordinates the three initiatives JMP, GEMI and GLAAS which are responsible for global monitoring. Within these initiatives, various UN agencies are assigned to monitor individual SDG 6 indicators and are therefore referred to as their custodian agencies. Their work comprises the development of indicator-specific methodologies, supporting their implementation at the national level and gathering and analysing national data in order to regularly report them in the form of national, regional and global estimates. The chosen methodologies are described in chapter 2. The selected indicators are continuously assessed by the IAEG to one of 3 tiers and thus evaluated in their effectiveness and practicability. 7 out of the 11 SDG 6 indicators are new, which means that the existing data originate from a first baseline report. Such a first collection of data includes the identification of data sources and the implementation of national structures for regular collection and coordination as well as determination of national focal points. Therefore, the first reporting exercise is possibly the most difficult one.

Challenges that occur in the monitoring of SDG 6 are therefore largely associated with the novelty of these indicators. The given time period for data collection and analysis was too short for many countries in order to implement such a comprehensive new process. In addition, many countries could not provide sufficient technical, human and financial capacity. These challenges are identified as main obstacles within the latest data collection in many countries. Besides, there are of course indicator-specific challenges, such as a large number of sub-indicators, parameters that are very

complex in their collection process or data that are difficult to gather due to fragmented availability. Misinterpretations of methodologies or decentralised data availability in federalised states have also made previous monitoring processes more difficult. However, the identified challenges must be seen within the overarching phased approach of the IMI. The phase between 2015 and 2018 was dedicated to generate a global baseline. The phase currently conducted aims to build national ownership by strengthening national monitoring systems through capacity-building, fostering of interministerial and intersectoral cooperation and harmonization of global and national monitoring initiatives. In that context, identifying the challenges was a process anticipated by the IMI in order to target them effectively throughout the second phase which is devoted to supporting countries to build data ownership.

Independently of this, the analysis of the current monitoring processes has also shown that there are parts of the SDG 6 targets that are not reflected in the corresponding indicators. Several targets show slight discrepancies between the definition of the targets and the indicators, so that parts of these targets are not included in the methodologies of the indicators and thus not considered part of the global monitoring. Examples for that are the reuse and recycling of wastewater and the aspects of protection and restoration of water-related ecosystems as defined in targets 6.3 and 6.6. This circumstance can be explained by recapitulating the indicator's development process and the scope of Agenda 2030. Basically, the indicators represent the result of international negotiations that were conducted with the attempt of meeting all countries requirements. Hence, it is not surprising that the indicators really reflect the lowest common denominator of the globally discussed indicator definitions. Also, considering that the Agenda 2030 contains 221 other indicators in addition to these 11 indicators, it becomes clear why the creation of further indicators or the expansion of already complex indicators is not in the sense of the UN Member States. Instead, countries whose capacities allow it, may include these parts in their national indicators. As mentioned before the custodian agencies' task of reporting these 11 indicators is only a small fraction of their work. They also monitor aspects of the targets, that exceed the indicators' scope such as WASH in schools and health-care facilities which is monitored by the JMP.

In line with the IMI's planned phase of increasing national ownership and capacity, the solutions for increasing data availability in the future consist of precisely these aspects. Supporting national capacity-building through further workshops, meetings and eLearning courses as well as advice concerning acquiring financial capacity has to be continued. The identification of new data sources through harmonization of regional or national initiatives with the global agenda and the modification of survey formats are further approaches to increase data availability and thus strengthening monitoring.

One example of such a regional initiative and potential data source is the Protocol on Water and Health. Since the Protocol's and the SDG 6' targets coincide with each other concerning multiple aspects, aligning their monitoring could benefit both the data availability for SDG 6 as well as the Protocol's success through capitalizing on the SDG's momentum. The fourth reporting template that was the basis of this year's country reports on the status of implementation of the Protocol was intended to be aligned to the SDG 6 monitoring methodologies. However, analyzing the template's questions revealed that there are still options for improvement through slight modifications which could facilitate the common use of data. The comparison of data reported within this template format and the latest JMP data on access to WASH in households, schools and health-care facilities

suggests that the countries provided differing data for each format. It should be noted that this comparison is based on several assumptions and affected by obstacles such as the remoteness of metadata, possibly use of differing methodologies and definitions and the fact that the reports provided data covering deviating years. Nevertheless, the comparison illustrated that reporting conducted for the Protocol can benefit SDG 6 monitoring and possibly even increase that potential by implementing the suggested modifications.

Difficulties that have arisen in the preparation of the thesis include the different densities of information on the challenges of the various indicators. While there is a lot of information on challenges concerning indicators 6.1.1 and 6.2.1 and at least one assessment of the 7 new indicators within their baseline reports, there is less information available on challenges concerning indicators 6.a.1 and 6.b.1. Since the interviews also do not contain any findings about these indicators, significantly less information on these two indicators is given in chapter 4. In addition, the analysis of the country reports on the status of implementation of the Protocol carried out for the German Environmental Agency does not entirely fit into the scope of this thesis, since its core consists of the examination of the monitoring process itself, not its status of implementation. Therefore, the resulting regional report is linked to in the appendix, but not specifically addressed within this thesis. Nevertheless, the examination of the Protocol and the comparison of the analysis' results with latest data published by the JMP revealed interesting findings. However, in order to conduct a more exact and comprehensive comparison, both reports' metadata would have to be examined.

Overall the tasks of describing the SDG 6 indicators, their monitoring methodologies and challenges as well as possible solutions were carried out. Though, it is difficult to assess the above-mentioned solution approaches, as these are structural measures, such as capacity-building, whose success or failure only become apparent within future monitoring activities. The comparison of the current data availability with the progress reports planned to be published in 2021 will provide information as to whether the mentioned solutions were sufficient and feasible and whether other yet unrecognized challenges in monitoring will remain. Until then, following the status of the SDG 6 indicators' tiers can provide information on whether data availability increases. A further interesting examination of SDG 6 monitoring could be an analysis of other national and regional instruments and their current state of alignment to the global agenda. For this purpose and probably also for an even more detailed presentation of challenges in the national data collection process, individual countries with low data availability could be focused on. Unfortunately, these studies exceed the scope of the thesis.

In conclusion, it remains to be said that the current monitoring results show obvious data gaps that need to be closed as soon as possible, since a solid database is a fundamental prerequisite for the implementation of the SDG 6 targets. Especially the goals for which data availability is particularly low must undergo a significant increase in data availability in the following years, as they include the quality and quantity of freshwater resources, changes in water-related ecosystems and treatment of wastewater, which are of high importance in achieving sustainable development. The already increasing availability of data and the committed work of the UN agencies, as well as the already increasing national awareness of the importance of monitoring present a number of positive developments on the basis of which a strengthening of monitoring can and must be achieved in the following years.

Appendix

A. MDG Indicators

Millennium Development Goals (MDGs)	
Goals and Targets **(from the Millennium Declaration)**	**Indicators for monitoring progress**
Goal 1: Eradicate extreme poverty and hunger	
Target 1.A: Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day	Proportion of population below $1.25 (PPP) per day Poverty gap ratio Share of poorest quintile in national consumption
Target 1.B: Achieve full and productive employment and decent work for all, including women and young people	Growth rate of GDP per person employed Employment-to-population ratio Proportion of employed people living below $1.25 (PPP) per day Proportion of own-account and contributing family workers in total employment
Target 1.C: Halve, between 1990 and 2015, the proportion of people who suffer from hunger	Prevalence of underweight children under-five years of age Proportion of population below minimum level of dietary energy consumption
Goal 2: Achieve universal primary education	
Target 2.A: Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling	Net enrolment ratio in primary education Proportion of pupils starting grade 1 who reach last grade of primary Literacy rate of 15-24 year-olds, women and men
Goal 3: Promote gender equality and empower women	
Target 3.A: Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015	Ratios of girls to boys in primary, secondary and tertiary education Share of women in wage employment in the non-agricultural sector Proportion of seats held by women in national parliament
Goal 4: Reduce child mortality	
Target 4.A: Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate	Under-five mortality rate Infant mortality rate Proportion of 1 year-old children immunised against measles
Goal 5: Improve maternal health	
Target 5.A: Reduce by three quarters, between 1990 and 2015, the maternal mortality ratio	Maternal mortality ratio Proportion of births attended by skilled health personnel
Target 5.B: Achieve, by 2015, universal access to reproductive health	Contraceptive prevalence rate Adolescent birth rate Antenatal care coverage (at least one visit and at least four visits) Unmet need for family planning
Goal 6: Combat HIV/AIDS, malaria and other diseases	

Target 6.A: Have halted by 2015 and begun to reverse the spread of HIV/AIDS	HIV prevalence among population aged 15-24 years Condom use at last high-risk sex Proportion of population aged 15-24 years with comprehensive correct knowledge of HIV/AIDS Ratio of school attendance of orphans to school attendance of non-orphans aged 10-14 years
Target 6.B: Achieve, by 2010, universal access to treatment for HIV/AIDS for all those who need it	Proportion of population with advanced HIV infection with access to antiretroviral drugs
Target 6.C: Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases	Incidence and death rates associated with malaria Proportion of children under 5 sleeping under insecticide-treated bednets Proportion of children under 5 with fever who are treated with appropriate anti-malarial drugs Incidence, prevalence and death rates associated with tuberculosis Proportion of tuberculosis cases detected and cured under directly observed treatment short course
Goal 7: Ensure environmental sustainability	
Target 7.A: Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources Target 7.B: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss	Proportion of land area covered by forest CO2 emissions, total, per capita and per $1 GDP (PPP) Consumption of ozone-depleting substances Proportion of fish stocks within safe biological limits Proportion of total water resources used Proportion of terrestrial and marine areas protected Proportion of species threatened with extinction
Target 7.C: Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation	Proportion of population using an improved drinking water source Proportion of population using an improved sanitation facility
Target 7.D: By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers	Proportion of urban population living in slums
Goal 8: Develop a global partnership for development	
Target 8.A: Develop further an open, rule-based, predictable, non-discriminatory trading and financial system Includes a commitment to good governance, development and poverty reduction – both nationally and internationally Target 8.B: Address the special needs of the least developed countries Includes: tariff and quota free access for the least developed countries' exports; enhanced program of debt relief for heavily indebted poor countries (HIPC) and cancellation of official bilateral debt; and more generous ODA for countries committed to poverty reduction	*Some of the indicators listed below are monitored separately for the least developed countries (LDCs), Africa, landlocked developing countries and small island developing States.* <u>Official development assistance (ODA)</u> 8.1 Net ODA, total and to the least developed countries, as percentage of OECD/DAC donors' gross national income 8.2 Proportion of total bilateral, sector-allocable ODA of OECD/DAC donors to basic social services (basic education, primary health care, nutrition, safe water and sanitation) 8.3 Proportion of bilateral official development assistance of OECD/DAC donors that is untied 8.4 ODA received in landlocked developing countries as a proportion of their gross national incomes 8.5 ODA received in small island developing

	States as a proportion of their gross national incomes Market access
Target 8.C: Address the special needs of landlocked developing countries and small island developing States (through the Program of Action for the Sustainable Development of Small Island Developing States and the outcome of the twenty-second special session of the General Assembly)	8.6 Proportion of total developed country imports (by value and excluding arms) from developing countries and least developed countries, admitted free of duty 8.7 Average tariffs imposed by developed countries on agricultural products and textiles and clothing from developing countries 8.8 Agricultural support estimate for OECD countries as a percentage of their gross domestic product 8.9 Proportion of ODA provided to help build trade capacity
Target 8.D: Deal comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long term	Debt sustainability 8.10 Total number of countries that have reached their HIPC decision points and number that have reached their HIPC completion points (cumulative) 8.11 Debt relief committed under HIPC and MDRI Initiatives 8.12 Debt service as a percentage of exports of goods and services
Target 8.E: In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries	8.13 Proportion of population with access to affordable essential drugs on a sustainable basis
Target 8.F: In cooperation with the private sector, make available the benefits of new technologies, especially information and communications	8.14 Fixed-telephone subscriptions per 100 inhabitants 8.15 Mobile-cellular subscriptions per 100 inhabitants 8.16 Internet users per 100 inhabitants

B. SDG targets and indicators

https://unstats.un.org/sdgs/indicators/Global%20Indicator%20Framework%20after%202019%20refinement_Eng.pdf

C. 26 Indicators produced by the JMP

Water	The proportion of the population that uses...
W_1	improved drinking water sources
W_2	piped improved drinking water sources
W_3	non-piped improved drinking water sources
W_4	unimproved drinking water sources
W_5	no drinking water facility (surface water)
W_6	improved water sources exceeding 30 minutes collection time (limited drinking water services)
W_7	improved water sources not exceeding 30 minutes collection time (basic drinking water services[2])
W_8	improved water sources which are accessible on premises
W_9	improved water sources which are available when needed
W_{10}	improved water sources which are free from contamination
W_{11}	safely managed drinking water services[3]
Sanitation	**The proportion of the population that uses...**
S_1	improved sanitation facilities
S_2	improved sanitation facilities connected to sewers
S_3	improved sanitation facilties connected to septic tanks
S_4	improved pit latrines or other on-site improved facilities
S_5	unimproved sanitation facilities
S_6	no sanitation facility (open defecation[4])
S_7	improved sanitation facilities which are shared (limited sanitation services)
S_8	improved sanitation facilities which are not shared (basic sanitation services[2])
S_9	sewer connections where wastes reach treatment plants and are treated
S_{10}	on-site sanitation facilities where wastes reach treatment plants and are treated
S_{11}	on-site sanitation facilities where wastes are disposed of in situ
S_{12}	safely managed sanitation services[5]
Hygiene	**The proportion of the population that has...**
H_1	a handwashing facility on premises
H_2	a handwashing facility on premises with soap and water available (basic handwashing facility[2,5])
H_3	a handwashing facility on premises lacking soap and/or water (limited handwashing facility)

Figure 66 26 indicators produced by the JMP (WHO and UNICEF 2017a, p. 4)

D. Interview transcripts (Note: This chapter was edited after the submission to the university.)

a. Dr. Richard Johnston and Francesco Mitis (JMP)

L. H.: In your opinion, what is the primary purpose of monitoring? Does it serve different purpose today than during the MDG era?

R. J.: I would say that there's a global monitoring that we do and then there's national and sub national monitoring that countries do and that the SDGs are a commitment made by countries. So, the primary purpose should be for countries to have a better picture of their own sectors and progress towards the targets that they have committed to. Local and national monitoring promptly needs to have a lot more resolution and granularity and detail than global monitoring, the kind of stuff that we do because you can only aggregate up and standardize a small number of parameters. So I would say that for the global indicators and the reporting the objective is really to have comparable data with consistent terms and definitions and methods to allow comparison and to allow aggregation of data from individual countries up into regions or global estimates and also to allow comparison over time, even within one country or amongst different countries. So, for all of that comparability, the global indicators are really focused on having consistent indicators and definitions and methods. But for the national level and sub national level, really comparability with other countries is of secondary importance. So often the national monitoring indicators would be more numerous, uh, but they also might use different terms or methods or definitions than the global ones.

L. H.: Would you agree that monitoring contributes significantly to facilitating and accelerating development progress?

R. J.: I think that if you're not monitoring, things are less likely to advance and that holds whether they're national indicators or global indicators. I think the decision makers and the users of data are different. Obviously, the national monitoring systems feed international decision makers, so annual budgets, strategic plans or sector investment plans all need to be grounded in some kind of assessment of where the country is and where it's headed with the rates of progress. The global data that we generate is probably less used by national decision makers because they have their own national sources of data that they rely on and are more comfortable with. So, I think probably the global data are more used by multinational or international actors such as development agencies.

We certainly know that bilateral aid agencies draw upon the data used by the JMP and GLAAS when they make decisions about how to allocate their resources. Also, we know that NGOs do a similar exercise. So, some of the big water NGOs definitely draw upon our data when they're deciding which countries to work in or what type of activities to support in different countries. I think the shift to the SDG agenda has also pulled a lot of those international actors along to these new service levels that are measured with the SDG indicators. For example, topics as drinking water quality, waste water treatment or management of onsite sanitation are focused on more than during the MDG period. And we definitely see partners, whether they're development agencies or NGOs, reorienting their support to countries to include explicitly those new SDG elements.

L.H.: How were the drinking water, hygiene and sanitation ladders created?

R.M.: Originally there were only two ladders. The hygiene ladder was added a couple of years ago and historically also the drinking water and sanitation that were different before. All the information to calculate the proportion of population using safely managed drinking water and sanitation before the 2017 report was not collected and the indicator didn't exist. So basically, until the end of the millennium development goal era the ladders for drinking water included improved water that means every kind of water source excluding surface water, unprotected wells and unprotected springs. Even though there were some adjustments, some things were considered unimproved before like bottled water and purchased water, while now they are improved. This ladder has been changed with the SDG area. We still have surface water. We still have unimproved water. And then we have improved water that's now divided into three additional rungs of the ladder. The first one is called limited. That means improved water with a round trip to the water source, including queuing more than thirty minutes. Basic is the same, but within 30 minutes and the very new one is safely managed that means basic level plus other things. The other things are the three kind of new information that we collect in the SDG era. That means drinking water quality related to microbiological contamination, so *E.coli* and chemicals and we consider arsenic and the fluoride and that's the first part of the indicator. Second part to the indicator is accessibility, so if it's on premises, third part of the indicator is available when needed.

That part of the indicator is quite difficult to compare across countries. It should rather be water sufficiency when needed, but we don't always use the same kind of questions in the household survey. Sometimes it's number of hours with water availability, the number of days per week, if it's a continuous service or the appearance of interruptions. The minimum of these three indicators

applied to the basic level gives us the safely managed drinking water services. We can calculate it only if we have at least two of these three indicators. But one of the two needs to be water quality.

Regarding sanitation, the situation is even more complicated. Open defecation is still the lowest possible state. We still us the categories unimproved and limited which means improved but shared sanitation service among different families or households. Basic sanitation service stands for improved but not shared. To calculate safely managed sanitation, we need to make some distinctions. We need first to understand if a country is offsite dominant or onsite dominant. Offsite dominant means that among the improved sanitation services, sewerage connections are prevalent compared to the sum of septic tanks and improved latrines. If this is the situation, we can calculate safely managed sanitation calculating the people with sewage as well as the wastewater treatment level. We need data not only from household surveys that can give us how many families have sewage, but also from other sectors that can be ministry of environment or sanitation utilities since we need to understand the level of wastewater treatment. The multiplication of the two gives the safely managed sanitation indicator due to the offsite part. The remaining part is the onsite sanitation to which we apply the same treatment rate that we are for offsite sanitation. Usually we don't have detailed data on septic tanks emptying, transport and containment.

Safely managed sanitation is given by the offsite part plus the onsite part that it safely disposed in-situ or safely treated, emptied and treated. For that we need data on containment or septic tanks or latrine emptying and treatment. In case there is data on these types of sanitation, we need additional details on the type of disposal such as its location and treatment. If we don't have anything telling us what's happening to septic tanks and latrines, we cannot calculate this indicator. This is one of the huge data gaps that we have because to have information on the containment of septic tanks or latrines, inspections, emptying is quite difficult. Some high-income countries offer very high detail data on that, but in case of low-income countries, you need to go through household surveys.

The hygiene ladder was introduced in the 2017 report and contains the three ranks, having no hand washing facility, having a facility, but without either water or soap which is categorized as limited and the basic category that is a facility with water and soap, that can be fixed or mobile. Back in 2011, the JMP began preparing for the post 2015 period. We convened a bunch of working groups in water sanitation, hygiene, equity and non-discrimination to review the existing indicators of the MDGs and to analyze what had worked well, but what was missing and what could be added to compose more thorough targets and indicators for post 2015. Each of those four working groups met over more than a year and came up with proposals such as the handwashing indicator. Then those four separate proposals were merged into one overall proposal that was fed into the larger global processes: UN Water at that time was also coordinating amongst the other sectors about what else should go into water.

Should it be a wash goal or should it be a big water goal? How that should all fit together. They made a technical proposal, but that also fed into a larger political process. Within the UN General Assembly, there was the open working group, which was a group of countries that were very influential in shaping what came to be the SDGs. They were the ones who actually took those proposals and other proposals and ended up coming up with the six technical goals or six technical targets and the two means of implementation targets of SDG 6. They took some of what we had recommended from those technical working groups, but they were also trying to reduce the number

of indicators and targets. They compressed a lot of what we had suggested into just a smaller number of indicators.

L.H.: How exactly can one imagine the setting of the global SDG targets and indicators? Were there ultimately democratic votes? Has this process been political, or primarily technical, practical or something else?

R. J.: There was a member state led process, so it was a political process. And again, there were different groups involved. There was a group called the sustainable development solutions network. SDSN led by Jeffrey Sachs had one idea for how the whole SDG framework should be organized. It turns out that the open working group design was the one that was adopted in the end. But in the end, of course, there were countries within the UN who were arguing for or against different aspects. Some of the high-income countries didn't particularly like the open working group structure or some of the indicators. But in the end the “Transforming our world” document was universally adopted by all member states. So, you could say that in the end they all came to an agreement even if they weren't perfectly happy with every aspect of the framework.

L.H.: Working with such a huge amount of different data sources, how often do data contradict each other and how is this handled?

R. J.: I guess we have two methods. One is that we collect as much data as we can find, summarize it all and extract the relevant bits, trying to match them to these global indicators and standard terms. We put those all in our country excel files. In most cases we will use them all. We'll put them all in a model of just simple linear regression and draw a line through them which allows us to use all data points. Sometimes we will put a data source in the country file, but we will decide not to use it, not to include it in the regression. We call that turning off that data point which can be done for a number of reasons. One reason for data to be unusable can be the way that the data were collected. Maybe the categories don't match the global categories closely enough or there was a technical problem with that data collection. Sometimes we hear from the national authorities that a particular survey was unreliable. Another reason can be that the teams weren't trained well or there was some miscommunication. If the national authorities and especially the national statistical office tells us not to use a data point then we don't use it. Sometimes data are not representative of the entire country. So especially there's a lot of data about utilities, but sometimes utilities only cover a small proportion of the population, so we can't use it to generate a national estimate.

L.H.: What are the new challenges in monitoring the SDGs compared to monitoring the MDGs?

R. J.: I think the higher levels of service and also smaller populations because most of the data on these higher levels of service, if you think about drinking water quality or wastewater treatment, they come from formal systems, which do not cover entire populations. So even in the highest income countries, there'll be 5%, 10%, 15% of the population who have a private well or a private septic tank that is not captured by the official statistics. We face real data gaps for those populations. I think we end up overestimating safely managed services because we'll take the numbers from the utilities that cover 80% of the population and we'll apply that to a hundred percent of the population. But actually the 20% who have private wells have bigger water quality problems than the people who have municipal pipe systems.

L.H.: How do you assess the development of regional capacities for data collection? Have there been significant improvements in data availability and/or quality since 2015? Are there still data gaps and how can they be closed?

R. J.: That is a real challenge for both low-income countries and high-income countries. That links to the SDG message of leaving no one behind because we would really like to know those most marginalized, most disadvantaged populations. What are their services like? I think that's probably the biggest generic challenge. As far as specific technical information, onsite sanitation is a big data gap Even if it is formal and there is some data on those systems, those tend to be collected at a very local scale such as a municipality and is not necessarily available at the national level or in public data sources that we draw upon. Especially in federated states like Germany, Switzerland, Australia or Canada the data is available at state level but never at the national capital level.

F.M.: For instance, for the calculation of drinking water quality in Canada, I yet have to go through all the provinces, all the States who are building huge files collecting data that are not available at central level. The workload is immense when there are 9, 10, imagine 40 States. If the United States provide data like that, there are 50 individual data sets which is tough and one of the bigger problems. Data on septic tanks in the US, for example, are only available on state level, not nationally. The second aspect I would like to add is data restriction which people often ignore. On hygiene there is practically no data for high income countries just because that type of data is not measured at all in household surveys since hygiene requirements are assumed to be fulfilled in these countries. You think that there is a hand washing station with water and soap everywhere.

And sometimes we also discuss with countries saying, of course these kinds of aspects are obligatory. Whenever you build a house in those countries, you have to build a bathroom with a handwashing station. Still we need the numbers, we need the legal obligations. If you have a look at the report and you look at the map for hygiene and WASH in facilities, you see that all the high income countries are grey, because there is no data and we will have to start in the future some proxy to fill this gap, like presence of a bath or a shower. There are things like that we have to discuss.

R. J.: Francesco and I work primarily on target 6.1 and 6.2 but I should also mention that the WHO collaborates with UN Habitat to monitor target 6.3. at its indicator 6.3.1 around safely treated wastewater. A lot of the same challenges we have mentioned about onsite sanitation apply to indicator 6.3.1. But target 6.3 goes a bit further than target 6.2 and it really attempts to measure the amount of wastewater generated at households. What we would really like to know is the volume of water going into and coming out of households but those data are very scarce. Also, we would like to know, not only whether wastewater is reaching a treatment plant that nominally provides secondary treatment, but actually the quality of the treatment.

In order to qualify as safely treated wastewater, we need to know if the treatment plant’s effluent is actually meeting the criteria that the it was designed for. Those data are also hard to generate. Target 6.3.1 includes data on industrial wastewater which is handled by UN Habitat. The big challenge is collecting data from all of the small industrial facilities that produce some kind of hazardous waste such as whether they have a permit, discharge into a sewer or into the environment.

L.H.: Have you reviewed the monitoring itself since 2015?

R. J.: So far, we haven't rigorously done that. We do keep track of our data coverage so we measure the amount of countries and population that we have data for, for the indicators and also the sub indicators. There is a table in the annex of our 2019 report that shows the data coverage by SDG region also for urban and rural areas. Basically, for the basic indicators we have a data coverage of 99% but for the safety managed indicator the coverage is significantly lower, in case of onsite sanitation it is very low. Since we've now made two reports, our plan is that in 2023, we put out household reports every two years. So far, we have published the 2019 report and we will put out another one in 2021. In 2023, we have reached the midpoint of the SDGs, we are planning to have a statistics report, as well as a report on the progress in monitoring where we will look more in depth at the countries' monitoring abilities. At that point we will probably evaluate the availability of datasets, data gaps and possibilities to fill those data gaps. It still feels like it's early days in the SDGs. I would say that we are at a stage now where countries are familiar with the indicators. There is a lot of effort right now to do baseline surveys and fill data gaps. So, I think countries are making efforts and maybe the best indicator of the monitoring's success is how many additional estimates we are able to get with each new report. I am also interested to see how this data coverage increases over time.

At the global level, we have about 50% data coverage for the safely managed indicators. For the indicator access to drinking water we have data for 51% of the global population, but less than 50% of the countries. Whereas for sanitation, especially for sewered sanitation, we have data on more than 50% of the countries, but less than 50% of the population. We are trying to get above 50% for both of them. Maybe in the next report we can do that through data of bigger countries such as data on access to safely managed drinking water for China or safely managed sanitation for India where we have data for rural areas, but not for urban areas. If we could get that type of data, suddenly we would have a much higher data coverage.

b. Interview with Will Reidhead (UN-Water)

L.H.: What are your tasks in monitoring SDG 6? When and how was the IMI developed? What can you tell me about GEMI, JMP or GLAAS?

W.R.: First of all, there is no GEMI anymore. It used to stand for something, but for a number of years it doesn't really stand for anything anymore. GEMI was an initiative created in 2014 to advance the new seven indicators under goal six. The new indicators being the ones not included in JMP or GLAAS. GLAAS is kind of the other end of the cycle, which deals with the indicators 6.a and 6.b, which measure the inherent conditions. The initiatives JMP and GLASS are older and were well established. GEMI was created to promote the newer indicators, which are kind of in the middle of the cycle such as the indicators 6.3.1 to 6.6.1. It did its job for a few years and in a sense the newer indicators have caught up with the JMP and GLAAS indicators. As far as we are talking about the 11 global SDG 6 indicators, JMP and GLAAS are completely under the same umbrella as the former indicators. So, all 11 indicators now get treated the same and the name of the initiative is just the Integrative Monitoring Initiative. The JMP is part of the IMI and its indicators go well beyond just those two global indicators. Examples for that are the JMP's additional indicators WASH in schools and WASH in healthcare facilities. GLASS goes beyond 6.a and 6.b and even GEMS/Water, which is the custodian for 6.3.2 go beyond that. They collect a lot more data on water quality, than one single indicator could cover.

L.H.: As far as I understood, WASH in schools and health-care facilities is covers a part of the request to leave no one behind. Why is it not part of SDG 6 monitoring?

W.R.: It is definitely part of achieving 6.1 and 6.2. There is no question about that. And you are absolutely right, it is part of leaving no one behind. But if you look at the actual definition of the indicator and the way it is calculated as a single figure per country, this aspect is buried in there, but not disaggregated as such. There is not enough data to calculate regional estimates for watching healthcare facilities, it is more of a case study, but not actually a part of the global indicator calculation.

L.H.: Do you think WASH in schools and HFC might become an indicator someday?

W.R.: No, I'm actually quite certain they will not. The IAEG does not want to apply more indicators since there are over 230 global indicators. We recognized early on that there is no single UN agency on water, so we have to coordinate 31 different agencies who have bits and pieces of data on water. That also reflects the water cycle diverse disciplines. The SDG 6 targets capture kind of all the different parts of the water cycle which means that we deal with a lot of different stakeholder organizations. This is why the idea of integration across these different disciplines is really key because otherwise you have people making policy decisions on drinking water having no links to water quality. Each target links to the other targets in very important ways. So, the idea of the goal itself and the idea of this integrated monitoring initiative is to capture these interrelationships.

L.H.: How does data exchange between initiatives like JMP and GLAAS work? Is there a common platform for meeting or data exchange?

W.R.: We are funded as a project by Germany, Switzerland, Netherlands, and now hopefully Austria will be coming on board. I am the coordinator and we have a coordinator from each of the eight different UN agencies who are the custodians for those 11 indicators acting as the project team. We have a steering committee, which is separate to the coordination team, which takes strategic decisions. Then we have a strategic advisory group of external experts. We interact very frequently and talk about methodologies and data collection. The SDG 6 synthesis report is one of our joint products. The actual sharing on technical discussions doesn't happen as much as it could because we are focused on implementing our work plans. We talk about how we can collect data together and how to minimize the burden on countries. Phase one was really about implementing the methodologies and generating the indicator baselines. Now in phase two there will probably be more learning and collaboration on the data itself. For example, we did not concern ourselves much on the topic gender during phase one, but now we are kind of developing a joint work plan for how we can capture a gender sensitive analysis for different indicators and what that might look like across the goal. This approach might result in tools or analytical briefs on gender in water and sanitation related goals which would be an intellectual product of the initiative of integration across the agencies.

L.H.: Are there any current research projects or new monitoring approaches that are being tested?

W.R.: As I was saying, phase one was primarily dedicated to testing and methodologies. All of our indicators now are tier one and tier two while none of them are being under methodological scrutiny. Of course, there will always be tweaks and improvements, but I would say that with the exception of indicator 6.3.1 on industrial wastewater, none of the indicators are under significant

development anymore. But you know, for example with the JMP, the topic WASH in health care facilities, was an innovation. They are trying to find new ways of mainstreaming person observation data on wetlands extent into national monitoring processes. There are ongoing innovations on data collection such as citizen science data.

L.H.: In your opinion, what is the primary purpose of global monitoring?

W.R.: The Agenda 2030 likes to say that we have these global indicators that were developed by Member States, which is technically true since the IAEG is a state body for Member States. Yet I would say almost by definition if you have to create an indicator on some parameter that is relevant to all member countries, or as many as possible, you are going to have to sink down to a relatively low common denominator which limits its value to countries. There is a tradeoff between global comparability and the national relevance. The big global indicators are really meant to stimulate a discussion in these high-level processes like the high-level political forum and to show how the world is developing the agenda in its entirety. They help countries to compare themselves to their neighbors, I think there's a bit of a friendly competition that is stimulated by these sorts of numbers. I think at the global level the value is to mobilize finance and to drive countries forward in a friendly competition sort of way. But what we are trying to do at the same time is to make these indicators relevant to countries. These are just 11 indicators, but they are on the country level part of the national monitoring system. When we do our capacity building, we try to balance the strict interpretation of this methodology as written up on paper, with how that would be fitting into the national policy making. Each indicator has, depending on the custodian agency, some flexibility. They don't have to be measured exactly the same way. It's up to the agency to decide what kind of tolerance they have for country variability. In the end which data points are accepted to go into the global database is really based on the dialogue between the custodian agency on the country. There is a bit of a negotiation. We try to make it as nationally relevant as possible whilst ensuring global comparability.

The integration at the country level is really important which is why we extensively help countries to build up their own intersectoral monitoring teams including one or more experts for each of the global indicators. These intersectoral monitoring teams can be dealing with a hundred indicators, with the eleven just being a subset. We have seen that these global indicators can actually act as a lever to get a country interested in it and into providing support for the country monitoring more holistically.

L.H.: Would you agree that global monitoring contributes to facilitating and accelerating development progress?

W.R.: I would say that is for sure though it varies enormously by country. The European countries, of course have very strong monitoring systems since they have lasted a long time and these indicators are almost always a step down for them. They provide data just to be a good global citizen. They understand the value of this global agenda. But on the other extreme, you have countries in Africa and Asia that have no water and sanitation monitoring system. For these countries collecting data for the global indicators is actually much more than they have been doing. Which is why they find it quite useful to have the global indicators in their processes. And, as I mentioned, having to do this global monitoring is mandatory. If they have signed up to the Agenda 2030, they have to generate this data. Having the UN agencies providing support is a really great way to start that

conversation on water and sanitation monitoring in these countries. In these countries the indicators are actually pledged to kind of proceed for more evidence-based water and sector policies.

L.H.: Some high-income countries don’t provide data on hygiene services for example. Why do you think it is important that they do, despite their argument of already having high standards anyway?

W.R.: This is interesting since I am living in Switzerland and they have kind of the same argument. We have almost perfect data coverage on many of these indicators and they argue whether is it really worth the effort to get the last 10 to 1% of the population that is not reflected in the data. In numbers we are still talking about, hundreds of thousands or possibly in other countries millions of people who don't have access to the ideal amount of hygiene and many of them are kids. It's still worthwhile. The further you are along that curve, the harder it gets to gain the data. They are the ones that are most deeply hidden and that is where you really need the monitoring data because otherwise you don't know where they are.

L.H.: Do you think there are options to monitor high-income countries in a more efficient way?

W.R.: There could be and coming back to why WASH in schools is not part of the main calculation that is because it doesn't necessarily benefit from a national monitoring program. There are more targeted ways to get information than having a national household survey. That is also why global monitoring is not a single bullet. National monitoring systems tend to be a lot more flexible and result in higher resolution than a global monitoring does.

L.H.: What happens if a country does not provide the mandatory data?

W.R.: Nothing happens. Generally speaking, no one is refusing the monitoring principles. The reason countries are not providing data is because they either don't know about it or they just don't have the capacity. It is our job to support those countries. Normally if we offer our support, countries start to monitor the indicators. But there are no penalties at all. The worst that can happen is that a country’s international reputation is affected for not providing data. In the data portal for example you will see how many indicators each country has recorded on in the last five years.

L.H.: What are the challenges in monitoring SDG 6?

W.R.: That's an interesting question. I mean my day to day challenges are basically project management challenges. The only real limits that we have in terms of the success of getting the data is just how much time and capacity we have to support countries. If a country doesn’t have the data 9 times out of 10, if we can engage them and give them different types of support, then they will provide data and knowing people aren't slamming the door on us, it's just either they don't know or they're not able to provide data until they get our support. In principle, if we have enough time and enough resources on our own side, we can probably generate 100% data coverage.

The methodologies have been designed with the idea of a monitoring ladder. The monitoring ladder has affected the way we measure the same indicator in different ways that vary in their level of robustness and therefore the level of cost. The bottom rung is existing data that doesn't require additional work. The more robust the data set get, the more expensive it becomes. Over time the goal is to wander up that ladder.

We designed it so that everyone can at least achieve the bottom rung. In a way we have designed our outreach so that there shouldn't be challenges. We have built it into our DNA to deal with that sort of challenges. Having the data portal itself was an interesting experience because now for the first time UN Water is using maps, which includes the tricky task of choosing borders. Azerbaijan for example complained that the land area we have chosen for their country snapshot is off by 4 million hectares and that's because of their dispute with Armenia. I had a similar conversation with Morocco raising an issue about what we said on the data status of the Western Sahara region, which is disputed territory. Those sorts of issues are challenges. Another challenge can be the definition of indicators. We had a lot of discussion about indicator 6.4.1 and how we define water use efficiency because a lot of countries switch the defined numerator and denominator. Sometimes countries don't agree with the methodology and then there is a range of political issues that the UN itself is concerned with but it is not really a monitoring problem. Basically, the tiering system's advantage is that is clarifies whether the indicator is going to be doing its job or not. In some cases, we couldn't prove to our peers that a chosen methodology is the right one, which meant that a certain indicator did not overcome tier three and got dropped which basically is what just happened to a couple of indicators in the last IAEG meeting. An indicator that reached tier two but not the generating of enough data points, showing that the indicator in question wasn't as practical, as it should have been can't lead to regional and global estimates. This situation finally leads to gaps in the database.

The tiering system incentivizes people to define methodologies and provide the capacity to get the data since the absence of these kind of efforts become visible through the system. In fact, that's what is really interesting for indicator 6.2.1 which was a new indicator. It started out very slowly but the UN organization in charge took the countries feedback seriously and tried to make the data more usable for them. From then on, the data coverage ion that indicator increased and at the last IAEG meeting, it has reached TIER I which is defined as data coverage for 50% of a region's countries and 50% of the population of that region.

L.H.: So basically, having data covering 50% of the world population is the goal of global monitoring?

W.R.: No, but that aspect leads us back to the difference between what the official intention of the indicators is and what they actually are. Theoretically we can get away with only having data for half the world. Through the distribution by the right regions and having half the data points we could still have estimates for the whole world. But what does that mean for the other half being not represented in these numbers? They're being left behind. We as an initiative take that seriously. We recognize that it is not just about the SDG database. It's really about building the capacity of countries to do evidence-based policy making on water and sanitation. These global indicators are just a means of promoting that goal. I think that's probably true for the other goals as well since the UN agencies are not just devoted to reporting to the UN. They genuinely have a mandate to support countries.

c. **Interview with Stuart Crane (UNEP)**

L.H.: What are your tasks in monitoring SDG 6?

S.C.: My job is to coordinate the three indicators 6.3.1, 6.5.1 and 6.6.1. The way that the custodian ship works is that we have the responsibility to help countries with monitoring reporting and

internally as UNEP being sort of the environmental arm of the UN. We have picked up the environmental indicators. WHO and UNICEF dealt with WASH for a long time so it is a little bit more in their mandate. I mention that because they are kind of new to UNEP and to countries and that's a really important point when it comes to some of the challenges. The environmental dimension of the SDGs is new and so it is hard for all of us to sort of figure out what's exactly the right indicator data to collect and to report. My job is to internally coordinate those three indicators and externally between UNEP and the other seven agencies that work on the joint program. It is very much focused on indicator 6.6.1 since we have indicated teams for indicator 6.3.2 on water quality and indicator 6.5.1 on IWRM.

L.H.: Let’s start with indicator 6.6.1 then. So far there is mainly globally available Earth observation Data for this indicator but big data gaps in national data. Do you think the novelty of this indicator is the reason for these data gaps? What other challenges do you face in monitoring 6.6.1?

S.C.: It's definitely partly due to its novelty. Another way of thinking about that is that we don't know the true answer. Different countries have reported different challenges. There are some common challenges. One of them I've already mentioned, is that it's new. The second one is that the indicator 6.6.1 is complicated and it's not just a single number that we're asking for. Actually indicator 6.6.1 tries to measure a change in the extent of water over time, which means that you have to go back in time to a place where ecosystems were untouched or uninterrupted so that when you are trying to protect or restore them, your restoring them back to a place in time where it was highly functional.

That means you need data across quite a long period of time. That's one element which is quite hard. The second element that's quite hard is that we talk about a change in extent. The word extent is a little bit confusing and it means three things. It could be a change in extent of water quality, a change in water quantity/volume or its spatial extent. Hence there are three sorts of measures of extent for different types of water related ecosystem. For example, you can't really measure the spatial extent of groundwater, but you can measure a change in volume in groundwater. Depending on the different water bodies that you are measuring, you are actually trying to measure a different type of extent. To measure all of these parts of extent for all types of water related to the ecosystem is overall a challenging task.

Another challenge is that unlike many of the other indicators, these indicators deal with water-related ecosystems hence systems that operate at a sub national level. They have their own spatial area and they tend to fall within water basins, some of them cover transboundary basins. Their monitoring includes monitoring various, very localized waterbodies over a long period of time. Not all of these waterbodies are highly accessible and it's not easy to get in-situ or ground based measurements or any of those measures for all of your water bodies. It's incredibly challenging, although that's what we're asking for.

While developed country may have done this to a certain extent because they probably are interested in understanding how much water they have for various water security reasons like sustaining domestic supply, sustaining agriculture or sustaining energy. Basically, there's a sector

driven need to obtain that information, not the SDGs. It tends to be like this in some of the developed countries that have that level of investment to apply and start monitoring. But if you do not have those resources, such as many developing nations, then establishing these monitoring systems is quite time consuming and expensive. Indicator 6.6.1 has many components to it that require significant resources, a quite significant technical understanding and volume of data and therefore a capacity to monitor and report on the indicator.

That's what we tried to in 2017. Between the periods of 2014 and 2017, we wrote an indicator monitoring methodology that was very country driven since SDGs are intended to be led by countries. Less than a quarter of all UN Member States, about 20% of them were able to provide data. The data was very scattered and it was of very poor quality. So, for example one country might say, I've got some information on river flow data for one river for the last three years and some information on water quantity in just one lake. This first data reporting cycle also showed that the fragmentation of the data within a country was a challenge.

We had a technical help desk set up. We had a team of people who were calling countries to make sure they understood everything and tried for a whole year to get data from countries. It was an intensive process and after that we still only had 20% of countries able to provide data which is why we then turned to a satellite-based earth observation, remote sensing to fill that data gap. That was the most logical alternative which also presented itself with some new challenges, that I can foresee, but we haven't heard the feedback from countries yet. We are now in the process and my job is right now working with all the space agencies such as NASA and ESA. I am in contact with the European Commission, with the Japanese space agency, with Google and we are generating data on different waterbodies. Several systems are segregating between lakes and reservoirs and wetlands and mangroves. Some information is not able to get, for example, you can't get river flow data and groundwater data from space. But I hope we will have this data by February 2020 and be able to share it with countries next year. That of course throws up a different set of problems around ownership of the data and whether there's capacity to receive that data and to act on the data.

L.H.: So basically, the quality and quantity data still have to come from national data sources?

S.C.: Yeah that's right. So actually, there's two data sets that will come from national monitoring. One is stream flow or volume of rivers and one is groundwater. Right now, we cannot get them from other sources but in the future, I suspect we will be. Early next year, all of the UN agencies under this Joint UN SDG 6 program that we're working on called the IMI will be requesting data from countries, but in the case of 6.6.1, we will be sharing the Earth observation data and then also requesting data on rivers and groundwater.

L.H.: At the moment the methodology includes the measurement of the level of groundwater within an aquifer, not the aquifers thickness or storage ability. Is that an intended simplification in order to facilitate the monitoring?

S.C.: Yes, that is correct. Groundwater is notoriously hard to monitor and in fact nobody has succeeded so far. There are whole institutions that exist to try and measure groundwater and it can be done in a very localized situation, but there is no global data set that exists on groundwater. Governments still really don't know how much water is underground. It's always an estimate and we

really don't understand the full scale or volume of water contained within aquifers, unless you put a lot of money into Institute measurements. So again, it's a similar situation where many of the developed nations have the required resources and groundwater is a very prevalent means of providing water to the population.

But many nations don't have that kind of data since the measurement is really difficult and hence expensive. What we tried to do in the first round was to give countries a more complicated methodology but no data came back at all. We then simplified the monitoring methodology to just take a measure of level. But that is by far not perfect at all. I think though that getting at least this data is better than nothing. Specifically, in the case of groundwater the information we have is so little globally. We really don't know much about it and yet the resource is so valuable to us. It's something we need to start a conversation on and we can only do so if we have a baseline of information. We are trying to start simple. I think that will lead us into a better place, particularly with interested donor organizations who might be willing to then look at a trend in groundwater and maybe we can give it a bit more of the attention it deserves. In my own opinion groundwater could almost become an indicator on its own due to its enormous value.

L.H.: When looking at target 6.6, it also includes the improvement of forests, mountains and wetlands. However, they aren't specifically mentioned in the indicator's methodology. Are they included in Earth observation data or are they not monitored at all?

S.C.: There is a slight misalignment in the target terminology and the indicator terminology. The reason for that is that the interagency expert group on SDGs tried to ensure that existing monitoring mechanisms were used to the benefit the SDGs. In this case, the convention on biodiversity already provides data on this target. That is where the target terminology actually comes from. It's actually in alignment with the convention's targets of Aichi 2020 which include the consideration of forests and mountains.

When we tried to convert that into water-related ecosystem types, it becomes a little bit harder. We haven't removed it, but the monitoring methodology at the indicator level doesn't include them right now. To include those ecosystems is a progression that we would need to build up to. Right now, the indicator includes wetlands which is hard to generate as well. If you look at the Ramsar Convention on wetlands, which has been around for almost 50 years they have very, very little data. Even they are not able to distinguish between different types of wetlands. It is very difficult to monitor wetlands, but it doesn't mean we shouldn't attempt it. We will, but we'll do it in a progressive manner. The goal is to include wetlands and forested areas that are heavily waterlogged and mountainous areas that act as water towers in the future. Currently we're trying to build up to that.

Another valuable point that's worth mentioning on indicator 6.6.1 is its original intention. The reason it's got all of these multifaceted parts to it is that although the target says we need to protect and restore water-related ecosystems, there is no notice of measuring protection or restoration in the indicator. It's more valuable for decision makers to see how a water resource is changing over time and then ask for possible reasons and apply more context specific actions that would protect the services the water related ecosystem provides to society. This is a slightly different way of looking at it, but it's a very important take and that's why the indicator is designed the way it is.

This leads to a broader approach, which the indicator doesn't fully cover in its current version. The original idea was to think about ecosystem health, about how to picture it and what relates to ecosystems as being healthy or unhealthy and therefor their need of protection or restoration. When you think about ecosystem health a little bit more, it broadens the scope of the indicator and then the consideration of water towers and saturated forests makes sense.

L.H.: Is indicator 6.6.1 a Tier I level indicator?

S.C.: Yes, that is right. We actually submitted two sets of data at the end of 2017 to the United Nations Statistics Division where all the SDG data was held. The data we sent was in-situ data that countries had sent to us. We also collected some data on the spatial extent of open waterbodies and ended up having data for 193 countries which we sent that to them. We revised the monitoring methodology and started to incorporate a bit more of these observations. After that it went back to the interagency expert group and the IAEG approved the indicator as Tier II. They took their own revision again a few months later and upgraded it to a Tier I.

L.H.: So there actually is data, covering over 50% of the world? Why is it not displayed at the SDG 6 data portal?

S.C.: This is an issue with the SDG 6 data portal. The process of data collection comes ideally from countries to the custodian, then gets forwarded from the custodian to the UN Statistics Division where it gets reported as official data. Since many countries did not report national data on spatial extent it is not represented on the SDG 6 data portal. Which means that the data portal is not the best place to assess the data on 6.6.1. Next year we'll have more Earth observation data which will be accurately represented on the SDG 6 data portal. But right now, it's a little bit misleading.

L.H.: What are the main challenges in monitoring indicator 6.3.2?

S.C.: There are two issues, two major challenges. For 6.3.2 you need a national monitoring program in place that monitors those waterbodies to collect in-situ data on water quality. There is a level of investment that has to happen to have this kind of monitoring program which is one of the challenges. Lots of countries haven't invested in monitoring programs, so they don't have a full set of data. The second issue is the definition of good ambient water quality and bad ambient water quality and the task of setting a threshold. The five core parameters that are measured in 6.3.2 vary in different parts of the world since natural levels of them vary. It becomes very difficult to set a global threshold value. which is why the monitoring methodology encourages countries to set their own threshold value. But in doing that, it makes the methodology a bit more complicated. You need countries to set this threshold value and also measure those parameters. Setting this threshold itself involves similar challenges as mentioned before. It includes the decision of what time scale to use when defining good ambient water quality. If you just go back 15, 20 years it’s entirely possible that the lake in question has high levels of one of those parameters during that entire period and therefore you're setting a threshold value based on a historic value that might already be quite high due to natural conditions that have changed since then.

I guess, there's one last aspect which is worth adding on indicator 6.3.2. These five chosen parameters are really only the lowest common denominator. Actually, there is a lot of debate around

the fact that to evaluate water quality you need far more parameters. Take faecal coliform as an example. Many waterbodies are polluted with sewage and yet the indicator doesn't measure that. It's a little bit complicated to do so. And so, the monitoring methodology had to come down to this small number of core parameters, in order to ensure global comparativeness. Ideally there would have to be many more parameters, but it's not possible for all countries to take that on.

d. Interview with Riccardo Biancalani (FAO)

L.H.: What are your specific tasks in monitoring?

R.B.: I am the coordinator of the monitoring of target 6.4 and the two indicators. The target 6.4, has been assigned to the FAO as custodian agency. I think, you know, at this point that each indicator has a sort of tutor in a way that is called custodian and FAO is the custodian of 21 indicators. Among those there are the indicators 6.4.1 and 6.4.2. What we do is to define the indicators and the monitoring methodologies. Although the official methodology is established and we are refining the methodology somehow, continuously both in terms of refining the explanations of the parameters and the national generation of data. A part of refining methodologies is deepening the methodology, for example, by indicating how to disaggregate the methodology; in our case by economic sectors or by territorial disaggregation for example. These are ways of improving the methodologies.

These are all things that are done in the context of the integrated monitoring initiative. Another subject of our work is to collect the data. We do a quality check of the data and report it, to disseminate those data. The process of collecting, checking and disseminating is done through the AQUASTAT database. We have dedicated staff who is doing specifically this. The third part of our work is capacity development. We support countries in increasing their capacity of collecting, reporting and using the data and in producing data for the indicators and the indicators themselves. This is done through a number of tools. We have distant tools such as Skype conservations and conversations like this one and emails, but also eLearning courses.

So, there are two courses for the moment on the FAO website, one for 6.4.1 and one for 6.4.2 that everyone can register for. They are now online only in English, but we have already the Spanish, French and the Russian versions for indicator 6.4.2, which I hope will be online soon. We are also organizing physical workshops or face to face meetings at regional or sub-regional level. At these meetings we invite representatives of five to 10 country to discussions and training, but we offer meetings at country level. There are several tools that we are using for supporting countries according to their needs and their requests. Of course, nothing is mandatory.

L.H.: What challenges are you facing in monitoring indicator 6.4.1?

R.B.: One of the main challenges is linked to the complexity of the indicator. It's a very complex syndicate that puts together economic aspects, agronomic aspects and hydrological aspects. There are several inputs and so the output is a bit complicated. In addition, it's a new indicator, so there is no experience by anyone opposing us. Fundamentally the meaning of the 6.4.1 is to understand that if the economic growth of a country can potentially be constraint by a lack of water resources. But it will take some time until we can really make use of this kind of information and also until being sure that this indicator will provide this kind of information. Indicator 6.4.1 is defined as the change in

water use efficiency although very often it is called water use efficiency, so even in the name of the indicator makes clear that you need to have a time series of data in order to generate it. Only once we have this kind of data, we will be able to apprise and to appreciate the actual meaning and significance of the indicator. So, the difficulties are fundamentally for now the complexity and still the lack of data.

L.H.: What challenges do you face in monitoring indicator 6.4.2?

R.B.: Fundamentally it is a more straightforward environmental indicator where we consider water that we take from natural sources and compare it with water that we have in terms of renewable water resources. It originates from the previous millennium development goal initiative. But the difference is that in the SDGs, we also consider environmental flow and therefor the fact that we cannot use the entire water available in environmental sources such as rivers, lakes or groundwater. We need to reserve part of this water for the functioning of the environment. Therefor the indicator's denominator says "renewable water resources minus environmental requirements". This new aspect, in short EFR, is the indicator's novelty and is meant to monitor the sustainability of water abstraction. It's important to consider that environmental flows are not absolute in the sense that we are not talking of a conservation parameter. Depending on a country's chosen water management the level of EFR that have to be met varies. Of course, this has a limit and we have guidelines on these limits that are available in our website.

L.H.: The indicator is TIER I, but on the data portal there is no global estimate. Is there not enough data on EFR?

R.B.: That is not correct. We have data on EFR for the whole world. The data is published on our website, on AQUASTAT and also on the SDG website. The data was generated through studies that have been done by the international water management Institute. They did a first round of estimation several years ago. In our first issue of the data, we used those estimations. One year ago, they issued a new system to assess the worldwide environmental flows. So, we have revised all our estimations following this new approach. The data that you find now includes EFR data from this new system which is called GEFIS. We have sent to each country their data so they can study it. The use of GEFIS is not mandatory for countries. So, they may have their own estimations. In this case, the countries should be in condition to give explanation on how they do their estimation. And of course, these estimations need to be reasonable.

L. H.: So, the data is just not transmitted to UN Water yet?

R. B.: For a number of reasons linked to the transmission of data from us to UN Water, our data are not on the portal but on our website. So, if you go on our page, there you find the data.

L.H.: The target itself contains the aspect of lowering the number of people affected by water scarcity. However, this is not a part of the indicator's methodologies. Is that aspect monitored?

R.B.: No, it's not monitored. Unfortunately for the overall worldwide monitoring of the SDGs in principle each target should have had only one indicator. So, in our case, we have two indicators. We have pointed out that the target has three parts and we have only two indicators. We would need to

have a third indicator, but the third indicator had not been accepted fundamentally because they don't want to have an increasing number of indicators. We think that it could exist as an indicator at the national level and at the regional level. So, groups of countries could agree and get this specific indicator. This is something we are loosely working on now.

D. Core questions on drinking water source

W1. Main drinking water source			
What is the **main** source of drinking water for members of your household?	Piped water		
	Piped into dwelling	11	>>W5
	Piped into compound, yard or plot	12	>>W5
	Piped to neighbour	13	>>W4
	Public tap / standpipe	14	>>W4
	Borehole or tubewell	21	>>W3
	Dug well		
	Protected well	31	>>W3
	Unprotected well	32	>>W3
	Water from spring		
	Protected spring	41	>>W3
	Unprotected spring	42	>>W3
	Rainwater collection	51	>>W3
	Delivered water		
	Tanker-truck	61	>>W4
	Cart with small tank / drum	62	>>W4
	Water kiosk	72	>>W4
	Packaged water		
	Bottled water	81	>>W2
	Sachet water	82	>>W2
	Surface water (river, stream, dam, lake, pond, canal, irrigation channel)	91	>>W4
	Other (specify)	96	>>W3

Figure 67 Example of core questions for drinking water (WHO and UNICEF 2018a, p. 8)

E. Link to access the regional report on the status of implementation of the Protocol

https://www.unece.org/fileadmin/DAM/env/documents/2019/WAT/11Nov_19-21_MOP5PWH/Official_docs/ECE_MP.WH_2019_4_Regional_report_status_of_implementation_ENG.pdf

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