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Jay Rajapakse *Editor*

Safe Water and Sanitation for a Healthier World

A Global View of Progress Towards SDG 6

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Preface

The idea of the book took shape in 2019, following discussions between the editor and Professor Dick Fenner of Cambridge University, UK. The book proposal submitted to Springer Nature by the editor was enthusiastically approved by the internal board of Springer Nature in January 2020.

However, many unprecedented disruptions and long-term changes within numerous organizations during the COVID-19 pandemic led to some authors having to withdraw from the project. Grateful acknowledgement is made to the contributors for their collaboration in the preparation of this book.

I am grateful to Professor Fenner, who encouraged this project with his advice and kindly reviewed the chapters, with a concluding chapter for the book.

Particular thanks are owed to Dr. Brian Hudson of the School of Architecture and Built Environment, Queensland University of Technology, Australia, for helping me reformatting some of the contributions received from the authors.

Last but not least, I would like to acknowledge the support and words of encouragement by Professor Les Dawes and Dr. Craig Cowled of the School of Civil and Environmental Engineering, Queensland University of Technology, Australia.

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About the Editor

Jay Rajapakse is a Fellow of the Chartered Institution of Water and Environmental Management, UK, and is a Lecturer in the School of Civil and Environmental Engineering at Queensland University of Technology (QUT), Australia. Since joining QUT, Dr Rajapakse has successfully led two DFAT funded (Australian Aid) training and capacity building programmes in water and sanitation to water professionals for the Governments of Sri Lanka and the Solomon Islands. He was the project manager for the World Bank-funded first full-scale pebble matrix filtration plant constructed jointly with the National Water Supply & Drainage Board (NWSDB) of Sri Lanka. On gaining a doctoral degree in public health engineering, as a Dean's Scholar from University College London (UCL), he worked as a post-doctoral researcher in water treatment at UCL (UK-EPSRC) and at Imperial College London, jointly with Anglian Water Services Plc (Alton Water Treatment Works). He then worked as a project engineer for Salford Civil Engineering Ltd (SCEL, UK) for two years and subsequently joined the PNG University of Technology as a Lecturer in 1997 rising to be an Associate Professor in 2008. On leaving PNG, he obtained an MPhil degree in engineering from Cambridge University before joining QUT in 2010. Between 2005 and 2007, he won three competitive international awards for his work in Papua New Guinea: two from UNESCO-Daimler Chrysler (Water treatment solutions for remote communities, Mondialogo Engineering Award, Berlin 2005 and India 2007); and one award from the World Bank (Innovations in Water and Sanitation), Washington DC, in 2006. His current research interests include public health engineering (water and sanitation, filtration, pre-filtration, new filter media), stormwater treatment, low-cost, low-energy sustainable water treatment solutions applicable to remote communities and decentralised systems in developed and developing countries. He has over 50 peer-reviewed publications focusing on water and wastewater treatment, high turbidity problems, water-sensitive urban design (WSUD), waste recycling and new filter media published jointly with Seqwater, Logan City Council, Gold Coast City Council, NWSDB, University of Queensland, UCL, Cambridge University and others.

Introduction

1

Jay Rajapakse

The work presents a review of the global progress made and readiness of nations toward achieving Sustainable Development Goal 6 (SDG 6) on water and sanitation of the 2030 Agenda for Sustainable Development. It builds on the latest information provided by the UN System and other international organizations on data and statistics. The mix of authors for the detailed chapters are representatives of Government Ministries/Departments, international organizations, academia or senior professionals with subject expertise on SDGs and who are also highly knowledgeable in their respective regions, which will lend the book important credibility.

1.1 From IDWSSD to MDGs and SDGs

The International Drinking Water Supply and Sanitation Decade (IDWSSD), 1981–1990, emerged from a 1977 UN Water Conference, based on recommendations arising from the 1976 UN Habitat Conference. The objective of the Decade was to "provide all people with water of safe quality in adequate quantity and basic sanitation facilities by 1990." Much was accomplished, but the target of a safe water supply and adequate sanitation for all was not achieved. However, many useful lessons learned during the decade helped to guide work in this sector over the next several decades. Millennium Development Goals (MDGs) were identified following the UN Millennium Summit in 2000 and all 191 UN member states committed to help achieve the goals in the next 15 years. There were eight MDGs and 18 targets set to measure progress by the end of year 2015. The seventh MDG (MDG 7) "Ensure environmental sustainability" contained four targets (7A, 7B, 7C, and 7D). Target 7C was to "Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation."

In relation to MDG 7C, much progress has been made toward solving water and sanitation problems. According to the 2015 UN Millennium Development Goal Report, in 2015, 91% of the global population was using an improved drinking water source, compared to 76% in 1990, thus achieving the target. The proportion of people practicing open defecation has fallen almost by half. Globally, 147 countries have met the drinking water target, 95 countries have met the sanitation target, and 77 countries have met both (United Nations, 2015).

In 2015 the 8 Millennium Development Goals (MDGs) program ended, and a new post-2015 agenda for the next 15 years was adopted (2030 Agenda) by 193 countries. This comprised 17 Sustainable Development Goals (SDGs) and 169

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targets. These 17 SDGs (Fig. 1.1) address a wide range of issues such as eradication of poverty and hunger, health and well-being, quality education, gender equality, universal access to clean water and sanitation, and other desired improvements in the quality of life.

The MDG 7C laid the foundation for the new SDG 6: "Ensure availability and sustainable management of water and sanitation for all," which can be interpreted as "clean water and sanitation for all people." The SDG 6 has eight targets. These targets of SDG 6 are: (1) access to safe and affordable drinking water, (2) access to sanitation and hygiene and end open defecation, (3) improve water quality, wastewater treatment, and safe reuse, (4) increase water use efficiency, (5) integrated water resources management, (6) protecting and restoring water-related ecosystems, (7) expanding international cooperation and capacity building to develop water and sanitation-related activities, and (8) strengthening stakeholder participation of local communities in improving water and sanitation management.

There are 11 indicators associated with these targets to measure the progress of SDG 6 by the year 2030 or earlier.

Target 6.1: aims to achieve universal and equitable access to safe and affordable drinking water for all, while Target 6.2: aims to achieve access to adequate and equitable sanitation and hygiene for all and end open defecation by 2030. Target 6.1 is measured by Indicator 6.1.1—is the proportion of population using safely managed drinking water services. Target 6.2 is monitored using Indicator 6.2.1, having two components. Indicator 6.2.1a is the proportion of population using a safely managed sanitation services, and Indicator 6.2.1b is the proportion of population using a hand-washing facility with soap and water.

Target 6.3 aims to 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. Wastewater is "used water" from any combination of domestic, industrial, commercial or agricultural activities, and surface runoff or stormwater. Sewage (domestic wastewater or municipal wastewater) consists mostly of greywater (from sinks, tubs, showers, dishwashers, and clothes washers) and blackwater (the water used to flush toilets, combined with the human waste that it flushes away). Sewage and septage must undergo sufficient treatment before discharging into the environment (e.g. lakes, rivers, streams, ocean, soil) or further use (e.g. in agriculture). In South Asia there are millions of septic tanks and latrines, and uncontrolled septage dumping is threatening the

Fig. 1.1 Seventeen sustainable development goals

environment. This could undermine achievements related to "improved" drinking water systems such as protected wells, boreholes and public health. Planned actions in the much needed development process include the institutionalization of safety regulations and the development and promotion of sustainable innovations such as business models for safe resource recovery and reuse.

There are two indicators associated with Target 6.3. Indicator 6.3.1 is the proportion of wastewater safely treated and Indicator 6.3.2 is the proportion of bodies of water with good ambient water quality. According to the UN Water SDG 6 data portal at the global level, not enough country data were reported to estimate both of these indicators. For example, according to the latest data published in 2015 under Indicator 6.3.1, for USA, Canada, Australia, China, and Uganda reported 90%, 79%, 73%, 45%, and 4%, respectively, of the household wastewater were safely treated, yet no data were available under Indicator 6.3.2 for any of those countries. Countries like Russia, Sri Lanka, Ghana or Solomon Islands have no data under both indicators. Brazil has reported 34% and 74% under Indicators 6.3.1 and 6.3.2, respectively.

Target 6.4 aims to substantially increase water use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater. This is intended to substantially reduce the number of people suffering from water scarcity. In 2019 the Chinese government announced that it plans to comprehensively solve the problem of drinking water supply for 60 million rural people in 2020. Since 2014, 172 major water projects for water saving and water supply have been implemented. After completion, the annual agricultural water saving capacity will be increased by 26 billion cubic meters; the annual water saving capacity will be increased by 80.1 billion cubic meters.

Target 6.5 aims to implement integrated water resources management at all levels, including transboundary cooperation as appropriate. In Russia, opportunities and problems in the field of water resources are discussed with the aim of reducing pollution of water resources, increasing water use efficiency, and ensuring integrated water resources management (IWRM). Topics addressed include restructuring of information flows to meet modern requirements, information and scientific support for water management in the regions through innovation and digital technologies, and the role of housing and communal sector in achieving safe and affordable water and sanitation services. Under the Indicator 6.5.1, the degree of implementation of IWRM in Russia in 2017 was reported as 79% in the UN Water data portal.

Target 6.6 aims to protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes. Indicator 6.6.1 associated with this target tracks "the change in the extent of water-related ecosystems over time."

At the global level, the status of some of the available data for SDG 6 indicators tracking the progress for the period 2016–2020 is shown in Table 1.1. The lack of data for some of the indicators, even in 2021 is evident from this table.

Target 6.A aims to expand international cooperation and capacity building support to developing countries in water and sanitation-related activities and programs. These include water harvesting, desalination, water efficiency, wastewater treatment, recycling, and reuse technologies.

Target 6.B aims to support and strengthen the participation of local communities in improving water and sanitation management.

The two indicators associated with Targets 6A and 6B are Indicator 6.A.1 (International Cooperation) and 6.B.1 (Stakeholder Participation): Indicator 6.A.1 tracks the amount of water and sanitation-related official development assistance that is included in a government-coordinated spending plan.

On stakeholder participation, Indicator 6.B.1 shows the proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management. The figures for least developed countries (LDCs), Latin America and the Caribbean, sub-Saharan Africa were between 70% and 72%, similar to the global average of 70% in 2019. In the same year Oceania

Table 1.1 Global data (lack of) on SDG 6 indicators (source: https://www.sdg6data.org/). Accessed: 1 September 2021

Indicator	2016	2017	2018	2019	2020
6.1.1 Proportion of population using safely managed drinking water service	71%	72%	73%	74%	75%
6.2.1a Proportion of population using safely managed sanitation service	49%	50%	52%	53%	54%
6.2.1b Proportion of population using a hand-washing facility with soap and water	68%	68%	69%	70%	71%
6.3.1 Proportion of domestic and industrial wastewater flow safely treated					56%
6.3.2 Proportion of bodies of water with good ambient water quality					72%
6.4.1 Change in water-use efficiency over time	18%	18%	19%		
6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	18%	17%	17%		
6.5.1 Degree of integrated water resources management implementation		49%			54%
6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation					58%
6.6.1 Change in the extent of water-related ecosystems over time (km^2)	2727251				

(excl. Australia and New Zealand), Eastern Asia, Small Island Developing States (SIDS), Southeast Asia, and Central Asia reported 28%, 33%, 39%, 50%, and 67%, respectively.

1.2 Interlinkages Between 17 SDGs and 169 Targets

Although the 17 SDGs and their 169 targets cover separate and diverse elements, many of these goals and associated targets interact to make up a complex network of indivisible interlinkages.

Complex social systems sometimes exhibit counter intuitive behavior. A system thinking based analytical approach provides a framework within which such complex systems can be better understood.

SDG 6 on water and sanitation was found most suitable for the application of the systems thinking approach. This best describes the complex interrelationship between the anthropogenic and the natural water cycles, and the need for holistic and integrated policymaking to ensure availability of water resources that are vital for human, industrial and natural ecosystems. The provision of engineered ponds as environmental and ecological solutions in the anthropogenic urban water cycle and the interlinkage between SDG6 and some other SDGs is shown in Fig. 1.2.

To further illustrate the SDG interlinkages, a constituent part of SDG 6, Target 6.1 (Achieve universal and equitable access to safe and affordable drinking water for all) has direct interlinkages with 42 other targets from 16 of the 17 SDGs. Target 6.1 is directly influenced by 35 other targets and is a key influencer of seven other targets. Water forms a common link through several of the SDGs and water and sanitation (SDG6) has a very close link with human health and well-being (SDG3). Improved water quality and sanitation combats water-related diseases improve health and well-being. Target 6.1 is most strongly influenced by SDG 1 (Poverty Eradication); SDG 6 (Water & Sanitation); SDG 9 (Infrastructure & Industrialization); SDG 11 (Cities and Human Settlements); SDG 15 (Sustainable Use of Terrestrial Ecosystems); SDG 16 (Peaceful, Inclusive, and Just Societies with Accountable Institutions); and SDG 17 (Means of Implementation). Target 6.1 is also indirectly linked with another 38 targets.

Since SDG 6 involve complex interlinkages between other SDGs, unlike the MDG 7C, the SDG 6 cannot be achieved as a result of a single action such as constructing a standpipe or a septic tank. It requires considering the whole system rather than viewing the system as a mere assembly of isolated parts. They can only be achieved as a result of a series of actions within the system, over a period of time.

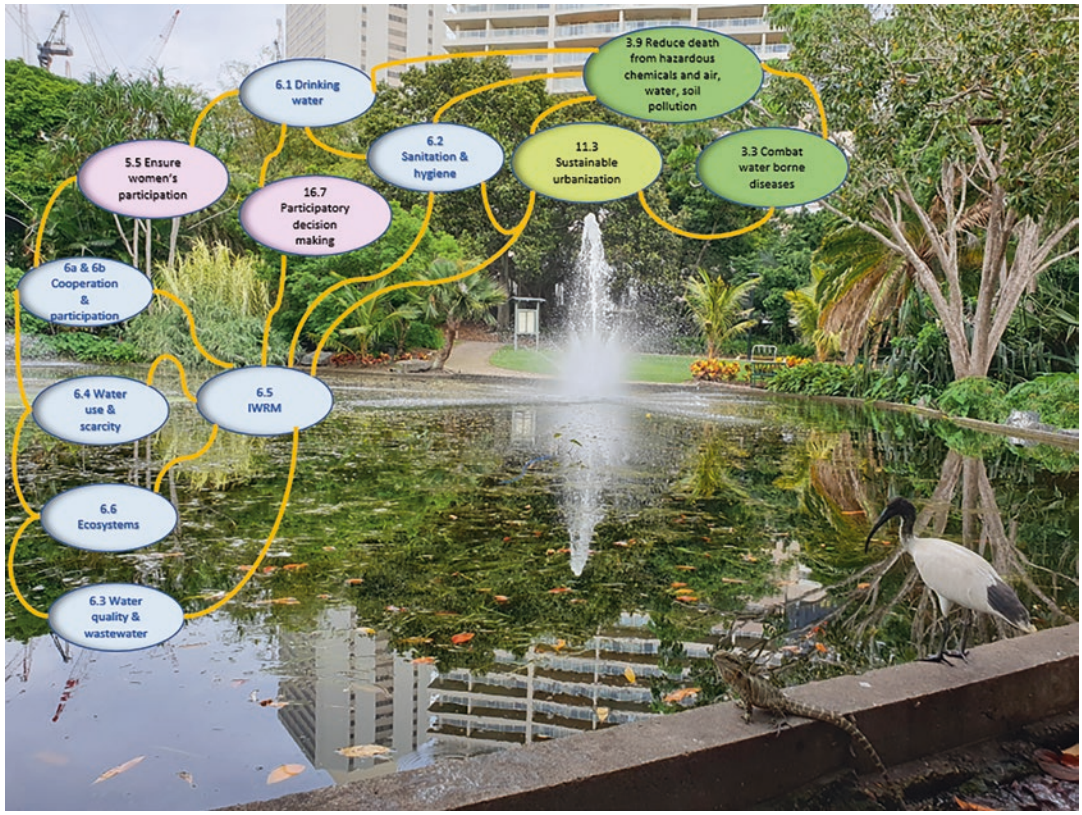

Fig. 1.2 The urban water cycle in the sustainable development goals

1.3 Chapter Contents

The themes of the chapters review the status of selected regions and countries in achieving the Sustainable Development Goal 6 (SDG6) with associated targets and indicators.

1.3.1 Chapter 2 Latin America

*(**Author affiliations:** Rio de Janeiro State University (UERJ-DESMA), Brazil; Pan American Health Organization (PAHO) Lima, Peru; Swiss Agency for Development and Cooperation (COSUDE), Lima, Peru; Minas Gerais Federal University (UFMG), Belo Horizonte, Brazil)*

This Chapter aims to analyze the possibilities and scenarios for specifically achieving the targets 6.1 and 6.2 on safe and affordable drinking water, and access to adequate and equitable and sanitation and hygiene for all in Latin America. Successful experiences of good progress in reducing open defecation in some Latin American countries are discussed, while emphasizing the need for better collaboration between governments and institutions responsible for WASH services. Authors consider that one of the main objectives of this chapter is to show how difficult it was for the countries to understand the need to move from the MDGs focus on quantity to the SDGs focus on quality in Water and Sanitation. Case studies from Argentina, Mexico, and Peru are presented. Some comparison of WASH services between Latin America and the Caribbean also discussed.

1.3.2 Chapter 3 Caribbean

*(**Author affiliations:** The University of the West Indies, St. Augustine, Trinidad and Tobago)*

This Chapter on the Caribbean seeks to investigate difficulties in achieving SDG 6 and propose measures to accelerate the Caribbean potential to stay on track to meet this goal by 2030. It cautions that the governments and policymakers of the Caribbean Region are concerned whether their countries will meet the target of SDG 6. It highlights the multiple anthropogenic pressures as well as climate change challenges Caribbean face in the provision of water and sanitation services. The impact of region's growing population as well as droughts, sea level rise, and hurricanes on water resources and sanitation services are discussed. Trinidad and Barbados were used as case studies with useful information to compare progress on contrasting water rich and water scarce islands. This Chapter also draws out some useful insights which may also be more generally applicable to other regions. Cost of water and sanitation facilities discussed.

1.3.3 Chapter 4 Africa

*(**Author affiliations:** The Sustainable Development Goals Center for Africa (SDGC/A) Kigali, Rwanda)*

The Chapter on sub-Saharan Africa highlights the ever-growing demand for water and sanitation services due to population increase, industrial development, and fast-growing urbanization, all creating pressure on utility services. Disparity between the rich and poor and the inequalities between rural and urban access to water and sanitation services in Africa are discussed. The climate, geological formation of the landscape, and pollution are discussed as the three significant factors that affect freshwater supply availability. The author cautions the extraordinary effort required by many countries in sub-Saharan Africa to achieve the target of at least basic water and sanitation services by the 2030 deadline.

1.3.4 Chapter 5: Ghana

*(**Author affiliations:** Ghana Outlook, a charity registered in the United Kingdom)*

This Chapter presents many problems, among others the tropical climate with extreme weather conditions that Ghana faces in the provision of safe water and sanitation facilities. It provides good detail on possible interventions and many practical insights into how success can be achieved to progress toward SDG 6 in remote areas. Important practical insights into the boreholes, latrines, and sand dams are presented, together with practical advice on the careful management of boreholes, operation of dry pit latrines, and how to enable access to safe water during the short but critical periods of labor-intensive farming. The Chapter demonstrates that successes largely gained by working closely with local community leaders and partner organizations.

1.3.5 Chapter 6 Russia

*(**Author affiliations:** Lomonosov Moscow State University; Ministry of Economic Development of Russia)*

The Chapter presents data on water reserves and discusses the integrated water management system in Russia. Success on equitable water and sanitation through improved coverage to both rural and urban areas, through the provision of piped water, sewerage, bath/shower, and hot water facilities are discussed. The coverage data on basic sanitation and hygiene facilities accessible to the populations and centralized wastewater disposal (sewerage) data are presented. Water scarcity problem and the need for improving water use efficiency are highlighted. The lack of investment in the country's water use and the need for introducing best available technologies (BAT) for transport, fishing, and hydropower sectors to rationalize the use of water resources are discussed. Finally, the importance of the protection and restoration of water-related ecosystems is highlighted.

1.3.6 Chapter 7 China

*(**Author affiliations:** Nankai University Binhai College, Tianjin, China; Tianjin University of Technology, Tianjin, China; Tianjin Polytechnic University, Tianjin, China)*

This chapter summarizes SDG6 under three headings: drinking water safety, environmental sanitation, and water resources management. Mainly employing the latest and most authoritative data, it summarizes China's plans and achievements for the successful completion of SDG 6. The differences between urban and rural areas are considered. Policies and regulations formulated in different years and the results achieved are discussed in detail. Water safety measures during COVID-19 outbreak are discussed. Finally, the projecting progress of SDG6 toward Agenda 2030 is presented.

1.3.7 Chapter 8 South Asia

*(**Author affiliations:** Ministry of Health and Wellness, Government of Alberta, Canada; Concordia University of Edmonton, Alberta, Canada; International Water Management Institute (IWMI), Sri Lanka; Tetra Tech ARD—International Development Group, Virginia, USA)*

This Chapter examines the current progress of SGD 6 targets among selected countries in South Asia. The selected counties are Afghanistan, Pakistan, India, Nepal, Bhutan, Bangladesh, and Maldives. The targets 6.1, 6.2 and 6.3 are discussed and specifically examine how these countries are working to achieve sanitation-related SDG 6 targets by 2030. Strategies that other countries can potentially adopt in achieving SDG targets are discussed. The problem of water stress in the region is discussed. The authors report a reduction in open defecation in the region, but slow overall progress toward SDG 6.

1.3.8 Chapter 9 Sri Lanka

*(**Author affiliations:** Colombo Municipal Council, Town Hall, Sri Lanka; National Water Supply and Drainage Board (NWSDB), Colombo, Sri Lanka; Queensland University of Technology, Brisbane, Australia)*

The Chapter reports the readiness of Sri Lanka to achieve SDG 6 targets in water and sanitation by 2030. This Chapter has a policy-based focus. It highlights the impact of an Australia Award Fellowship offered to water professionals at the transition from MDG to SDG period and how that program helped to lay a good foundation to establish the SGDs by identifying critical activities to be implemented to achieve safe water and sanitation targets. Government strategies to achieve SDG targets are discussed. Water supply and sanitation coverage data are presented with Corporate Goals of the NWSDB. The chapter contains informative figures and an interesting analysis of disruption caused by the COVID-19 pandemic supported by data.

1.3.9 Chapter 10 Solomon Islands

*(**Author affiliations:** Solomon Islands National University, Solomon Islands; Ministry of Health and Medical Service (MOHMS), Solomon Islands; Pacific Solomon Engineering and Consultancy Limited, Honiara, Solomon Islands)*

This Chapter starts with MDG era with baseline water and sanitation data and introduce the National policy development in facing SDGs during 2016–2030. These include Medium Term Strategy (MTS) 2016–2020 for building and upgrading physical infrastructure, alleviate poverty, improve provision of basic needs, and food security. Some water and sanitation targets not yet covered in National Development Strategy are discussed. The Rural Water, Sanitation, and Hygiene (RAWSH) targets

for 2024 on improved drinking water, free open defecation, and hand-washing with soap are considered too ambitious. Key constraints are discussed. National coverage data on water and sanitation for 2016–2020 are presented.

1.3.10 Chapter 11 Indigenous Populations of Some of the World's Wealthiest Nations

*(**Author affiliations:** Queensland University of Technology, Brisbane, Australia; Aurecon Brisbane, Australia)*

This Chapter covers the topic of water quality and health problems faced by remote Indigenous populations of some of the world's wealthiest nations. The situation in three developed nations, the United States of America, Canada, and Australia are discussed with two case studies for each country are presented. Appropriate water treatment technologies for remote communities are proposed to tackle the problem. One successful example of a new solar-powered water treatment plant comprising reverse osmosis (RO) and UV disinfection installed in the Northern Territory of Australia in 2019 is presented. Finally, some of the COVID-19 impacts on WASH services are discussed.

1.3.11 Chapter 12 Conclusions and Beyond 2030

*(**Author affiliations:** Cambridge University)*

The importance of considering interlinkages between SDGs is highlighted in attaining improvement toward one SDG by 2030. With respect to SDG 6, the interlinkages of SDG 6 and the targets of the other 16 SDGs using a comparative SDG targets matrix is explained using the causal loop diagram by Nikolova (2016). Then the Cernev and Fenner (2020) classification of the 17 SDGs into four distinct groups of "Outcome/foundational goals," "Human input goals," "Physical assets goals," and "Enabling goals" and the significance of the interconnectedness of these groups to safeguard the integrity of the whole system is discussed. Some of the key themes are analysed, contrasting the issues faced and approaches taken across regions. Finally, actions to accelerate the progress are discussed with the need for simplicity and fewer targets across fewer goals in any "New Agenda" beyond 2030 is proposed.

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2 The Objectives of Sustainable Development of Water and Sanitation in Latin America

Teofilo Carlos N. Monteiro, Hildegarde Venero, Rosa M. Alcayhuman, and Rodrigo Coelho de Carvalho

Abstract

This chapter aims to analyze the possibilities and scenarios for the fulfillment of the Sustainable Development Goals of Water and Sanitation in Latin America. To this end, an analysis is made of the transition from the MDGs to the SDGs, and the challenge that the new qualitative principles impose in the water and sanitation indicators of the Sustainable Development goals represents for closing the gaps. Along these same lines, the first results obtained for some Latin American countries of the estimation of indicators 6.1, 6.2, and 6.3a are presented, as well as the information gaps derived from this exercise, accompanied by a proposal to generate/obtain information to have good quality indicators. Additionally, successful experiences of elimination of open defecation are analyzed as part of the sanitation ladder. As well as the inequities in the access to these services are discussed as part of the problem that revolves around the fulfillment of the SDGs, this being in turn one of the main causes of the breach of human rights to water and sanitation.

Keywords

WASH indicators · Open defecation · Argentina · Peru · Mexico · Caribbean

2.1 Introduction

There are 17 Sustainable Development Goals (SDG) and 169 targets defined by the 2030 Agenda to encourage actions in critical areas of Global relevance, the Goal 6 is dedicated to ensure availability and sustainable management of water and sanitation for all. The Water and Sanitation Goal 6 and its targets promote an integral and compact vision, adopting the comprehensiveness of the water and sanitation cycle (World Health Organization, UNICEF, 2017). And as all the other goals, it emphasizes the need for an integrated work toward the social, economic, and environmental components.

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The Agenda 2030, in its Water and Sanitation Goal, is far more ambitious and represents a great step forward compared to the Millennium Development Goals (MDG). Instead of halving the gap of the global population without access, as the MDG did, the SDG 6 call for the achievement of universal access of Water and Sanitation. The SDG 6 also calls for an equitable access, which implies in reducing inequalities in service levels between the population subgroups, considering the multiples geopolitical contexts, globally, regional, national, and subnational layers.

This chapter aims to analyze the possibilities and scenarios for the fulfillment of the Sustainable Development Goals of Water and Sanitation in Latin America. To this end, an analysis will be made of the transition from the MDGs to the SDGs, and the challenges that the new qualitative principles imposed by the water and sanitation indicators represent for closing the gaps. Along these same lines, it will present the first results obtained for the estimation of the water and sanitation indicators in some Latin American countries, as well as the information of the gap derived from this exercise and the proposal to generate/obtain information to improve the quality of the indicators. Additionally, successful experiences of elimination of outdoor defecation will be analyzed as part of the sanitation ladder. Also, the inequities in service access will be analyzed as part of the problem that revolves around the fulfillment of the SDGs, this being in turn one of the main causes of the breach of human rights to water and sanitation. Completing this cycle, we will analyze the opportunities that the countries have to facilitate compliance with the SDGs. In this sense, a policy brief analysis will be recommended, as a way to promote and update the Sector Policy and National Plans to better represent and to align to the indicators of the water and sanitation sector, and to safely managed drinking water and sanitation services as described in the Sustainable Development Goals. In this way, the changes made will represent advances not only in coverage, but in quality and equity of these services in the Latin American countries.

2.2 Transition from the MDG to SDG

It is very important to include the MDGs in the discussion of this chapter to better understand the historical perspective and how the SDG's were built.

SDGs were designed based on the results and in the needed transition from MDGs. The SDG indicators related to water, sanitation, and hygiene become far more extensive and powerful than the related MDGs. While the MDG target (7c) aimed to halve the proportion of people without sustainable access to safe drinking water and basic sanitation, the SDG 6 aimed to ensure availability and sustainable management of water and sanitation for all. Therefore, instead of just measuring access to improved water and sanitation, although this was undoubtedly important, the new targets brought by the SDG 6 will also measure the quality of the service and product provided, and the fairness of distribution.

The MDG drinking water target to halve the proportion of the global population without improved access to safe drinking water between 1990 and 2015, was met in 2010. This represented an increase in coverage from 76% to 88%. The percentage of the population without access to improved drinking water source reduced by more than 50% in Latin America and the Caribbean, and their MDG target was achieved ahead of time. As of 2015, about 95% of the people in Latin America and the Caribbean had achieved sustainable access to safe drinking water, meaning that the 91.5% MDG target had been surpassed.

In the other hand, the MDG target for halving the proportion of the population without sustainable access to basic sanitation between 1990 and 2015 was not completely achieved. During the MDG period, it is estimated that the use of improved sanitation facilities rose from 54% to 68% globally. But the global MDG target was 77%, and therefore it was missed by 9 percentage points, which represents almost 700 million people. Among the Latin America and the Caribbean

countries, a good progress was achieved, improving from 67% to 82% regionally, or 169 million people in average, who gained access to improved sanitation services. But the region MDG target of 83.5% was missed by just 1.5 percentage points. All these gaps, and the achievements from MDGs were important information used to build the SDGs.

The Agenda 2030 seeks to build on the gaps left by the MDGs but it is much more ambitious. The UN General Assembly resolution notes that the SDG targets are universally applicable to all countries and calls on member states to "leave no one behind." This chapter seeks to provide the most up-to-date overview of the SDG targets 6.1 and 6.2 and their implementation in the Latin America. These are the targets that more specifically emphasize the direct evaluation of drinking water and sanitation according with their indicators. The transition to SDG in water, sanitation, and hygiene represented a great step forward and its targets 6.1 and 6.2, described below, reflect all the main elements of the proposals agreed by the WASH sector stakeholders.

In result, the indicators for the targets 6.1 and 6.2 were, respectively, defined as proportion of the population using safely managed drinking water services and the proportion of population using safely managed sanitation services. These indicators represent a great challenge for the country's transition process from MDG to SDG because now they determined that safely managed drinking water and sanitation services will need to be adopted for all countries, also considering its equity and universality.

The Joint Monitoring Program from WHO and UNICEF (JMP-WHO/UNICEF), that includes 25 years of global WASH monitoring, build on its experience to learn how to translate the MDG database to these more comprehensive indicators. Therefore, the country's first challenges were to move from the numbers obtained with the previous water and sanitation MDG indicators to the more robust indicators described by the new SDG targets.

For the target 6.1, to achieve the safely managed water the countries will need to accomplish an improved water supply facility located on premises, available when needed, and free from contamination. In regard to the target 6.2, safely managed sanitation is associated to a private improved facility where fecal wastes are safely disposed on site or transported and treated off-site, plus an attached handwashing facility with soap and water to facilitate hand washing and improve personal hygiene.

These SDG criteria are also far more restrict, comparing to the former MDG indicators. In order to facilitate its understanding among the Latin American countries, PAHO's Regional Technical Team on Water and Sanitation (ETRAS) carried out three studies in three countries of the region: Argentina, Mexico, and Peru. The results are presented in the following session.

2.2.1 Baseline Studies of the WASH Indicators for Some Selected Latin American Countries

The PAHO/WHO ETRAS, the Regional Technical Team on Water and Sanitation, applied the methodology prepared by the WHO/UNICEF JMP Task Force on Methods (WHO/UNICEF, 2014) for estimating the indicators of SDG 6.1 and 6.2 in three countries, Argentina, Mexico and Peru.

The initiative to work with the countries to estimate the SDG of WASH, was born with the GEMI project in 2016 and adapted for by PAHO/WHO ETRAS (Monteiro et al., 2017) to estimate the SDGs in each country, it was necessary to work in coordination with all the institutions related to the provision, management, and regulation of water and sanitation services at the national level, as well as in urban and rural areas; in addition to influence the country formulation of the instruments and the modification of the formats of the surveys or information registration so they are aligned with the requirements of SDG 6.1 and 6.2. Once this monitoring system is capable of measuring the new SDG6 indicators, the next step will be to achieve the goals by 2030.

The three case studies of ETRAS-PAHO/WHO carried out in Argentina (PAHO/WHO

ETRAS, 2017a), Mexico, and Peru (PAHO/WHO ETRAS, 2017b) based on the JMP-WHO/UNICEF are presented below. Direct work with the countries made it possible to have access to the needed information to estimate the indicators 6.1.1 and 6.2.1, using the data from the countries official Statistical Institutes database and from data reported by the Water Sector governing body of each country.

The baseline analyses presented at Table 2.1 and Fig. 2.1 were made at national level in the case of Mexico and Peru, but in the case of Argentina, the estimate refers to the Autonomous City of Buenos Aires only (national data was not available at the time of the study). It is important to keep in mind that each country has its unique level of water and sanitation development, therefore the differences observed in the baseline figures presented at Table 2.1/Fig. 2.1 were expected. It is also important to note that there is a great difference between estimation of the SDG 6.1.1 (water) and 6.2.1 (sanitation) indicators. The main reason is that traditionally, countries are more developed in water services than in sanitation services. Therefore, a significant progress in the effective treatment of wastewater is required.

The exercise of working directly with the countries to obtain this information added an opportunity to discuss how to improve the monitoring and also to advocate to the country commitments to work toward the achievements of the goals.

Table 2.1 Baseline of ODS 6.1.1–6.2.1

Country	Indicator 6.1.1	Indicator 6.2.1
Argentina (Buenos Aires region)	83.9%	25.0%
México (Nacional)	66.1%	25.0%
Perú (Nacional)	42.0%	20–29%

Source: ETRAS OPS/OMS

2.2.2 The Case of Argentina

Sanitation statistics in Argentina reflects only data available from Buenos Aires Metropolitan Area, because data at the national, urban, and rural levels were not available when this study case was performed. The national surveys had a period of discontinuity, and the results were no longer published. The Secretary of Public Resources has been working on the establishment of a monitoring system at the national level, in which the governing body collects the information send by the Argentinian provinces. This system was not yet in place therefore monitoring national indicators was not possible at the time the study was performed.

The JMP-WHO/UNICEF organizes country files where the country information is published. In the Argentina country file, record information on WASH from 1991 to 2013 came from the National Household Expenditure Survey, IBNET (The International Benchmarking Network for Water and Sanitation Utilities), as well as the National Survey of Risk Factors. All these

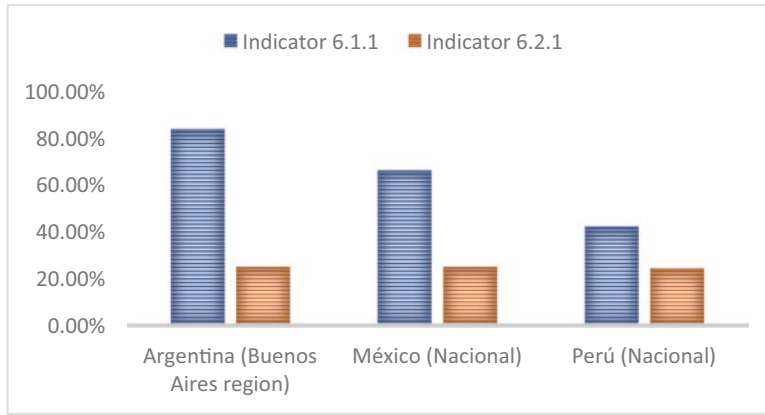

Fig. 2.1 Baseline of ODS 6.1.1–6.2.1

surveys record similar results. Improved sanitation is 97.6% (59.7% sanitation by sewage system and 22.6% sanitation by septic tank, and 15.6% from other types of sanitation), the rest of the 3.9% population accessing shared sanitation.

Regarding the drinking water data, the data source is the same, the coverage at the national level is around 90.1%, in which the connections inside the home are 89.9%. The remaining had unimproved or use of direct surface water sources without treatment.

Using the information available from previous years, the JMP-WHO/UNICEF makes estimates that allow for approximate figures on access to water and sanitation services. A noteworthy aspect is that given the scarce information available, the SDG 6.2.1 indicators cannot be estimated for the country, the urban and rural sectors. This does not mean that there is not a group of the population that has access to "safely managed sanitation," but rather that this group cannot be distinguished, because there is no information for it. In this sense, it is found in the population group that has "at least basic" sanitation, which represents more than 90% at the national level and in urban areas.

Sanitation

As previously mentioned, Argentina did not have statistics on the SDG indicator of Sanitation due to the lack of information. Although there was a group that had access to this service, was not possible to recognize what the percentages were. What was possible to known was that access to basic services is increasing, and 94.3% of the Argentinian population had access to a "at least basic service" in 2016 (Table 2.2). This includes the population that has a service that complies with SDG 6.2 but also a service of lower quality.

There is a variation on services provided when comparing the population of urban and rural areas, as can be seen in Tables 2.3 and 2.4. In the rural sector (Table 2.4), the percentage of access to sanitation is significantly lower, bordering 75% of the population in 2010 and 76.8% in 2016. Also, until 2014, there was a higher percentage of the population (7.7%), still practicing open defecation, compared to the national and

Table 2.2 Argentina sanitation: total

Year	At least basic	Limited service	Unimproved	Open defecation	Total
2010	92.6	2.9	2.6	1.9	100.0
2011	93.2	2.9	2.0	1.9	100.0
2012	93.7	2.8	1.5	2.0	100.0
2013	94.2	2.7	1.0	2.1	100.0
2014	94.2	2.6	1.0	2.2	100.0
2015	94.2	2.5	3.2	0.0	100.0
2016	94.3	2.5	3.2	0.0	100.0
2017	n.a.	n.a.	n.a.	n.a.	n.a.

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/arg)

Table 2.3 Argentina sanitation: urban

Year	At least basic	Limited service	Unimproved	Open defecation	Total
2010	94.4	2.9	1.5	1.3	100.0
2011	94.9	2.8	1.0	1.4	100.0
2012	95.4	2.7	0.5	1.5	100.0
2013	95.8	2.6	0.0	1.6	100.0
2014	95.8	2.5	0.0	1.6	100.0
2015	95.9	2.4	0.0	1.7	100.0
2016	95.9	2.4	0.0	1.7	100.0
2017	95.9	2.4	0.0	1.7	100.0

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/arg)

Table 2.4 Argentina sanitation: rural

Year	At least basic	Limited service	Unimproved	Open defecation	Total
2010	75.4	3.7	13.2	7.7	
2011	76.1	3.7	12.5	7.7	100.0
2012	76.8	3.7	11.9	7.7	100.0
2013	76.8	3.7	11.9	7.7	100.0
2014	76.8	3.7	11.9	7.7	100.0
2015	76.8	3.7	19.6	0.0	100.0
2016	76.8	3.7	19.6	0.0	100.0
2017	n.a.	n.a.	n.a.	n.a.	0.0

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/arg)

Table 2.5 Argentina water: total

Year	At least basic	Limited service	Unimproved	Surface water	Total
2010	98.5	0.0	0.9	0.6	100.0
2011	98.7	0.0	0.8	0.5	100.0
2012	98.9	0.0	0.6	0.5	100.0
2013	98.9	0.0	0.7	0.4	100.0
2014	99.0	0.0	0.6	0.4	100.0
2015	99.1	0.0	0.6	0.4	100.0
2016	99.1	0.0	0.6	0.4	100.0
2017	n.a.	n.a.	n.a.	n.a.	n.a.

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/arg)

urban areas. In Table 2.4, it is also possible to notice an increase in the number of "unimproved" sanitation system in the years of 2015 and 2016, probably related to the migration of the population practicing open defecation to the "unimproved" group.

Drinking Water

Regarding drinking water service, it is observed that there is greater progress than the one registered in the sanitation sector. More than 90% of the Argentinian population, located in urban and rural areas, has "At least one basic service." However, it is not possible to know again what percentage of the population has a "safely managed service" and comply with the SDG 6.1.1 indicator, therefore Argentina still does not have a baseline that allows to set the goals to be met in 2030.

In conclusion, the SDG 6.1.1 and 6.2.1 indicators on "safely managed water" and "safely managed sanitation" have not yet been estimated for the Argentina case. However, the information available show that for the total population in 2016 (Table 2.5) 99.1% of the population has access to at least basic water service, 0.6% is a "not improved" service and only 0.4% consumes "water superficial" without the guarantee that it is fit for human consumption.

In 2018, Argentina, with the technical support of PAHO/WHO, made an attempt to establish the baseline. However, national data was missing and there was only complete data available for the Autonomous City of Bueno Aires. Nevertheless, the exercise of collecting the data served to determine the information gap and encourage the government of Argentina to recreate a national information system, to be link and send information to the international information system JMP-WHO/UNICEF and allow it to determine the SDG targets 6.1 and 6.2 for this country. Until this information is obtained, the baseline cannot be established, and policies cannot be developed for this country to achieve the goals of the 2030 agenda (Tables 2.6 and 2.7).

Table 2.6 Argentina water: urban

Year	At least basic	Limited service	Unimproved	Surface water	Total
2010	99.3	0.0	0.6	0.1	100.0
2011	99.4	0.0	0.5	0.1	100.0
2012	99.4	0.0	0.4	0.1	100.0
2013	99.5	0.0	0.5	0.0	100.0
2014	99.6	0.0	0.4	0.0	100.0
2015	99.6	0.0	0.4	0.0	100.0
2016	99.6	0.0	0.4	0.0	100.0
2017	99.6	0.0	0.4	0.0	100.0

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/arg)

Table 2.7 Argentina water: rural

Year	At least basic	Limited service	Unimproved	Surface water	Total
2010	90.2	0.0	4.6	5.2	100.0
2011	91.6	0.0	3.6	4.8	100.0
2012	93.0	0.0	2.7	4.3	100.0
2013	93.0	0.0	2.7	4.3	100.0
2014	93.0	0.0	2.7	4.3	100.0
2015	93.0	0.0	2.7	4.3	100.0
2016	93.0	0.0	2.7	4.3	100.0
2017	n.a.	n.a.	n.a.	n.a.	n.a.

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/arg)

2.2.3 The Case of Mexico

Among the three countries studied, Mexico was the one that presented more completed statistical baseline data. CONAGUA, the Mexico's national water authority, is responsible for managing and protecting the country's water resources and keeps the registry of all information nationally provided in the sector. However, to correctly estimate the water indicator 6.1.1, it was also necessary to collect information from the health sector and this was obtained from COFEPRIS, the Federal Commission for the Protection against Sanitary Risks, linked to the Department of Regulation and Sanitary Promotion of the Ministry of Health.

Sanitation

As can be seen in Table 2.8, the number of Mexicans with access to *Safely Managed Sanitation Services* has increased, reaching half of the population (50.4% of the total in 2017), as decreased the percentage who had access to *Basic Sanitation Services*—40.8% of the total in 2017. A similar situation was observed in the urban areas, where in 2017 52.3% of the population had access to a service that complies with SDG 6.2.1 indicator and 45% had access to a basic sanitation service (Table 2.9).

The situation is different in the rural areas, where the percentage of *Safely Managed Sanitation Services* was not even measured (Table 2.10). This has been a constant in many countries, where the indicator 6.2.1 cannot be obtained, specifically for the evaluation of effective wastewater treatment for rural areas. The managers of the rural services generally do not record these statistics neither does the agencies nor the regulators. The result is that this important indicator is not available, precisely in the area with the highest percentage of inequities, when compared to the urban sector, and that requires that more work is done to reduce the gap.

Water

Regarding water, Mexico also registers an increased access toward the years and by 2017, 43% of the Mexican population had accesses to

Table 2.8 Mexico sanitation: total

Year	Safely managed service	Basic	Limited service	Unimproved	Open defecation	Total
2010	34.1	50.7	7.1	3.5	4.6	100.0
2011	36.3	49.5	7.0	3.2	4.0	100.0
2012	38.6	48.1	7.0	2.9	3.4	100.0
2013	40.9	46.8	6.9	2.6	2.8	100.0
2014	43.2	45.3	6.8	2.2	2.5	100.0
2015	45.5	43.9	6.8	1.9	1.9	100.0
2016	48.0	42.3	6.7	1.6	1.4	100.0
2017	50.4	40.8	6.6	1.3	0.9	100.0

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/table?geo0=country&geo1=MEX)

Table 2.9 Mexico sanitation: urban

Year	Safely managed service	Basic	Limited service	Unimproved	Open defecation	Total
2010	35.3	53.7	7.2	1.9	1.9	100.0
2011	37.6	52.0	7.1	1.7	1.6	100.0
2012	39.9	50.3	6.9	1.4	1.5	100.0
2013	42.3	48.5	6.7	1.2	1.3	100.0
2014	44.8	46.7	6.5	1.0	1.0	100.0
2015	47.2	44.9	6.3	0.8	0.8	100.0
2016	49.7	43.0	6.1	0.6	0.6	100.0
2017	52.3	41.1	5.9	0.4	0.3	100.0

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/table?geo0=country&geo1=MEX)

Table 2.10 Mexico sanitation: rural

Year	At least basic	Limited service	Unimproved	Open defecation	Total
2010	70.5	6.6	9.3	13.6	100.0
2011	72.3	7.0	8.7	12.0	100.0
2012	74.0	7.4	8.1	10.5	100.0
2013	75.7	7.8	7.4	9.1	100.0
2014	77.4	8.2	6.8	7.6	100.0
2015	79.1	8.6	6.1	6.2	100.0
2016	80.8	9.0	5.5	4.7	100.0
2017	82.4	9.5	4.9	3.2	100.0

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/table?geo0=country&geo1=MEX)

a safely managed water service at the national level that complies with the SDG 6.1.1 indicator (Table 2.11). However, most of the population (56.4%) continue to have access to basic services only. When analyzing the urban (Table 2.12) and rural (Table 2.13) areas, it is also possible to see that there was an increase on the percentage of access through the years, but the available data refers to *At least basic services*. Unfortunately, data were not available on drinking water quality to estimate the SDG 6.1.1 indicator in the urban case and in the rural case, therefore it was not possible to distinguish the percentage of the population that achieved a better quality of service.

2.2.4 The Peruvian Case

Sanitation

At the national level, data from 2017 show that 42.8% of the Peruvian population has a *Safely Managed Service* and a third (31.6%) accesses a *Basic Service*, but there is still 6.5% practicing

Table 2.11 Mexico water: total

Year	Safely managed service	Basic service	Unimproved	Surface water	Total
2010	41.3	54.4	3.2	1.1	100.0
2011	41.6	54.7	2.8	0.9	100.0
2012	41.8	55.0	2.4	0.8	100.0
2013	42.0	55.3	2.1	0.6	100.0
2014	42.2	55.6	1.7	0.5	100.0
2015	42.5	55.9	1.3	0.3	100.0
2016	42.7	56.2	1.0	0.1	100.0
2017	42.9	56.4	0.7	0.0	100.0

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/table?geo0=country&geo1=MEX)

Table 2.12 Mexico water: urban

Year	At least basic	Unimproved	Surface water	Total
2010	97.9	1.9	0.2	100.0
2011	98.2	1.6	0.2	100.0
2012	98.5	1.4	0.1	100.0
2013	98.8	1.1	0.1	100.0
2014	99.1	0.8	0.1	100.0
2015	99.5	0.4	0.1	100.0
2016	99.8	0.2	0.0	100.0
2017	100.0	0.0	0.0	100.0

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/table?geo0=country&geo1=MEX)

Table 2.13 Mexico water: rural

Year	At least basic	Unimproved	Surface water	Total
2010	88.4	7.3	4.3	100.0
2011	89.6	6.7	3.7	100.0
2012	90.7	6.2	3.1	100.0
2013	91.9	5.6	2.5	100.0
2014	93.1	5.1	1.8	100.0
2015	94.3	4.5	1.2	100.0
2016	95.4	4.0	0.6	100.0
2017	96.6	3.4	0.0	100.0

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/table?geo0=country&geo1=MEX)

open defecation (Table 2.14). A similar structure is found in the urban sector, however, the percentage of the population that accesses a *Safely Managed Service* is 8.4 percentage points higher than the national total (Table 2.15).

Among the Peruvians who lived in rural areas in 2017, 56.1% had access to At Least Basic Service and 18.8% continue practicing open defecation (Table 2.16). As it happened in Argentina and Mexico, in the case of rural Peru, it was not possible to determine what percentage of the population had access to *Safely Managed Service*, reducing the country capacity to reduce the gap in the place that need most. It is important to reinforce that wastewater treatment is the most important variable for this indicator and when this information is not available, the indicator cannot be estimated.

Water

The information available in Peru made it possible to determine the percentage of the population with access to *Safely Managed Services* for water. In this sense, the percentage of access was increasing and by 2017 approximately 50% of the population of Peru complies with the ODS for

Table 2.14 Peru sanitation: total

Year	Safely managed service	Basic	Limited service	Unimproved	Open defecation	Total
2010	28.8	41.9	9.2	9.2	10.9	100.0
2011	30.7	40.6	9.4	9.0	10.3	100.0
2012	32.6	39.2	9.7	8.9	9.6	100.0
2013	34.6	37.7	9.9	8.8	9.0	100.0
2014	36.6	36.2	10.1	8.7	8.4	100.0
2015	38.6	34.7	10.4	8.5	7.8	100.0
2016	40.7	33.2	10.6	8.4	7.1	100.0
2017	42.8	31.6	10.9	8.3	6.5	100.0

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/table?geo0=country&geo1=PER)

Table 2.15 Peru sanitation: urban

Year	Safely managed service	Basic	Limited service	Unimproved	Open defecation	Total
2010	34.9	43.8	11.0	5.8	4.5	100.0
2011	37.1	41.7	11.2	5.7	4.3	100.0
2012	39.4	39.5	11.4	5.5	4.1	100.0
2013	41.8	37.3	11.7	5.4	3.9	100.0
2014	44.1	35.1	11.9	5.2	3.7	100.0
2015	46.5	32.9	12.2	5.1	3.5	100.0
2016	48.8	30.6	12.4	4.9	3.2	100.0
2017	51.2	28.3	12.6	4.8	3.0	100.0

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/table?geo0=country&geo1=PER)

Table 2.16 Peru sanitation: rural

Year	At least basic	Limited service	Unimproved	Open defecation	Total
2010	45.0	3.5	19.9	31.6	100.0
2011	46.6	3.7	20.0	29.7	100.0
2012	48.2	3.8	20.1	27.9	100.0
2013	49.8	4.0	20.1	26.1	100.0
2014	51.4	4.2	20.2	24.3	100.0
2015	53.0	4.3	20.3	22.4	100.0
2016	54.5	4.5	20.4	20.6	100.0
2017	56.1	4.6	20.5	18.8	100.0

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/table?geo0=country&geo1=PER)

water, a percentage that rises by 8 percentage points when considering only Peruvians living in the urban sector. And more 40.8% of the population had access to a basic service.

However, at the same period, only 20.8% of the Peruvian rural population had access to *Safely Managed Services* for water. The majority of the rural population in Peru (54.8%) had access to *Basic Services*. It is important to highlight that, in the Peruvian case, the information was available through Survey of Strategic Programs and allowed to determine the SDG targets 6.1 and 6.2 (Tables 2.17, 2.18, and 2.19).

Conclusions of the Baseline Studies of the WASH Indicators of the Selected Countries

1. Preparing the baseline of SDG indicators for water, sanitation, and hygiene is an important and relevant task for the countries, because these studies help the countries and the international cooperation to determine the information gap that would impair to estimate the SDG indicators for water, sanitation, and hygiene. If a country cannot determine its current situation, it cannot set goals for the future and even less to achieve them by 2030. This is

Table 2.17 Peru water: total

Year	Safely managed service	Basic service	Limited service	Unimproved	Surface water	Total
2010	48.5	38.8	1.0	7.4	4.3	100.0
2011	48.8	39.1	1.0	7.1	4.0	100.0
2012	49.0	39.3	1.0	6.8	3.8	100.0
2013	49.3	39.6	1.0	6.5	3.6	100.0
2014	49.6	39.9	1.0	6.2	3.3	100.0
2015	49.8	40.2	1.0	5.8	3.1	100.0
2016	50.1	40.5	1.0	5.5	2.9	100.0
2017	50.4	40.8	1.0	5.2	2.6	100.0

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/table?geo0=country&geo1=PER)

Table 2.18 Peru water: urban

Year	Safely managed service	Basic service	Limited service	Unimproved	Surface water	Total
2010	57.9	36.0	0.9	4.7	0.5	100.0
2011	58.0	36.1	0.9	4.5	0.5	100.0
2012	58.2	36.2	0.9	4.3	0.4	100.0
2013	58.3	36.3	0.8	4.1	0.4	100.0
2014	58.4	36.4	0.8	3.9	0.4	100.0
2015	58.6	36.5	0.8	3.7	0.4	100.0
2016	58.7	36.6	0.8	3.5	0.3	100.0
2017	58.8	36.7	0.8	3.4	0.3	100.0

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/table?geo0=country&geo1=PER)

Table 2.19 Peru water: rural

Year	Safely managed service	Basic service	Limited service	Unimproved	Surface water	Total
2010	18.0	47.6	1.5	16.4	16.5	100.0
2011	18.4	48.6	1.6	15.7	15.7	100.0
2012	18.8	49.7	1.6	15.1	14.9	100.0
2013	19.2	50.7	1.6	14.4	14.1	100.0
2014	19.6	51.7	1.7	13.7	13.3	100.0
2015	20.0	52.8	1.7	13.1	12.5	100.0
2016	20.4	53.8	1.8	12.4	11.7	100.0
2017	20.8	54.8	1.8	11.7	10.9	100.0

Source: JMP-WHO/UNICEF (https://washdata.org/data/household#!/table?geo0=country&geo1=PER)

not a minor aspect, considering that all countries and stakeholders pledged to act in collaborative partnership to implement the Agenda 2030. The agenda calls for integration among nations, and pledges to *Leave No One Behind*. The targets are ambitious, and to achieve them it is important that countries keeping tracking of the gaps, the time and the resources to achieve the goals.

2. The 2021–2030 decade is called "the decade of action." In relation to WASH, the countries have to work to identify the gaps to achieve universal and equitable access to safe and affordable drinking water for all, and to achieve access to adequate and equitable sanitation and hygiene for all and end open defecation. And implement the necessary infrastructure for the population that lack these services, using the necessary mechanisms to provide the required service by 2030.
3. Lack of data can add an important delay to the process. The countries should not only rely on the international monitoring system such as the JMP-WHO/UNICEF, because it lags behind in updating them (currently it has data from 2017). The countries may have access to a greater number of sources of information and internal records. They can also improve

the way to gather information adapting the formats or, creating incentives for stakeholders related to the water, sanitation, and hygiene sector to update and improve their information systems and, most importantly, define local road maps to work toward to achieve the established goals for each targets.

4. The quality of water, free of microbiological and chemical contaminants, is a key information for the SDG indicator 6.1, but in general is missing in the countries. In the same way, the safe wastewater disposal measured by level of wastewater treatment is essential for the SDG indicator 6.2.1 and is frequently unavailable. Indeed, the access to these information depends on the country capacity to measure them, for being able to determine the goals, especially for the rural sector.
5. One of the normative principles of the SDG indicators for water, sanitation, and hygiene is related to inequities "for all," that is to say that the progress made in relation to access and quality of services must reach everyone, including sectors most disadvantaged, as is the case of dispersed rural areas, indigenous communities, low-income population, among others. In this sense, it is essential that in the strategies for compliance with the SDG targets 6.1 and 6.2, these disadvantaged areas are considered, more than in the traditional ones.
6. Finally, we must be clear that water and sanitation services are basic services, that by default we should all have and with the quality that allows better levels of well-being, however, countries prioritize other types of actions in their countries, In this case, we must not lose the opportunity to make a considerable improvement for the entire population, seeking to comply with the commitments implied by the 2030 agenda.

2.3 Open Defecation in Latin America and Caribbean Countries (LAC)

Open defecation refers to when people without sanitation are forced to defecate in the fields, forest, bushes, open bodies of water, beaches, and other open spaces. Defecating in the open creates undignified and unsafe conditions especially for women and girls, and results in a serious health risk especially for the most vulnerable, spreading diseases, and claiming lives unnecessarily. Ending open defecation has been identified as a top priority by United Nations since 2013 when the Deputy Secretary-General of the United Nations calls for Action on Sanitation that included the "Elimination of the practices of Open Defecation (OD) by 2025." And more recently, it was also included in the Agenda 2030 Declaration, Sustainable Development Goals (SDGs) particularly in the SDG goal 6, that seeks to guarantee clean water and sanitation for all, which involves ending open defecation.

According to the latest JMP-WHO/UNICEF report, in 2017, 15.6 million people in the Region were still practicing open defecation, the majority (72%) living in rural areas. Countries in LAC where OD is most widely practiced[1] are Haiti (19%), Bolivia (13%), and Peru (7%) accounting for over five million of open defecators. Table 2.20 shows countries in LAC practicing open defecation (percentage and number) in 2017.

The highest percentage of open defecators live in Haiti, where almost 19% of people are still practicing OD. Haiti also has the lowest coverage rates for improved water and sanitation services (65% and 35%, respectively). Meaning that almost four million individuals lacked improved sanitation services and of these, two million practice open defecation.

Table 2.20 Countries with population practicing open defecation, 2017

Percentage OD (%)	Haiti (19%), Bolivia (13%), Perú (7%), Nicaragua (7%), Honduras (6%), Guatemala (5%), Panama (4%), Granada (4%), San Vicente (3%) and Colombia (3%)
Numbers of OD (millions)	Brazil (5 mill.), Haiti (2 mill.), Peru (2 mill.), Colombia (1.5 mill.), Bolivia (1.5 mill.), and Mexico (1.2 mill.)

[1] WHO/UNICEF JMP data, 2017.

However, some countries in the Region have done very well in reducing OD. For instance, Mexico population that practiced OD droped from 10% to 1% between 2000 and 2017, respectively, other countries such as Uruguay figures droped from 2% to 0.5% and Ecuador from 14% to 2% over the same period. Despite on this good progress a challenge remains particularly for rural areas. The proportion of rural population practicing open defecation decreased from 20 to 6 between the period 2000 and 2017 in comparison to urban areas which percentages were down from 2% to 0.5%, respectively, showing how difficult to reach last mile.

Practicing open defecation also cause adverse health effects, being the most common cause of the diarrheal diseases that is exacerbated by the lack of safe water and sanitation. Diarrheal disease was the sixth cause of death in children under 5 years in the LAC region resulting in 580 daily deaths.[2] Furthermore, over five millions of children under 5 years in the region were stunted, among them half lived in South American.[3] The Global Burden of Disease 2016 estimated that the mortality rate attributed to unsafe water, unsafe sanitation, and lack of hygiene (WASH) in the Americas[4] was 2.3 per 100,000 populations. There are large inequities between the countries in the Region, where the mortality rate varied from 0.1 per 100,000 inhabitants in Trinidad & Tobago to 23.8 per 100,000 in Haiti. Other countries with higher mortality rate attributable to low coverage of WASH were at least four times lower that the rates of Haiti.

Therefore, to accelerate the ending of OD, it is necessary a clear understanding of what prevents and drives the transition from OD to using a basic sanitation.[5] According to Augsburg et al. (2015), cost was the main constrain to mitigate latrine adoption in both India and Nigeria, and finding ways to subsidies and access to credit are highly important to sustain sanitation services. In addition, Sanitation marketing,[6] an emerging field that applies social and commercial marketing approaches to scale up the demand of improved sanitation services, behavior change communication (BCC), and community led total sanitation (CLTS) are the three most likely joint strategies to enable communities, both rural and periurban to become completely OD-free.[7]

Thus, in conclusion, it is complex to define how to best move toward the elimination of OD in the region. One primary intervention is to ensure the universal access to toilets in each household, at least with a minimum level of sanitation that keeps excreta separated from human contact. But it is also important the inclusion and recognition of multiple and complex issues associated to open defecation, that varies from cultural preferences, to lack of resources. Political will is very important and needed at the highest level to positioned OD as a national development priority and to facilitate a better collaboration between governments and institutions responsible for WASH services. According to PAHO (PAHO/WHO ETRAS, 2019), an intersectoral collaboration beyond WASH is required to move from OD to the next steps in the sanitation ladder, including a global approach through joint plan and actions, innovative public–private partnerships, intersectoral alliances, innovative financing mechanisms and capacities to engage communities with sanitation and behavior interventions.

[2]World Health Statistics 2018: Disease burden and mortality estimates [website]. WHO-MCEE estimates for child causes of death 2000–2016. Geneva: World Health Organization (http://www.who.int/healthinfo/globalburden_disease/estimates/en/index3.html).

[3]World Health Statistics 2018: Disease burden and mortality estimates [website]. WHO-MCEE estimates for child causes of death 2000–2016. Geneva: World Health Organization (http://www.who.int/healthinfo/globalburden_disease/estimates/en/index3.html).

[4]EE.UU and Canada are excluded from this data.

[5]The elimination of open defecation and its adverse health effects: a moral imperative for governments and development professionals.

[6]WSP 2016. Sanitation Marketing Toolkit. Water and Sanitation Program, World Bank, Washington, DC. Available from: https://wsp.org/toolkit/toolkit-home (accessed 17 November 2016). WSP/MDWS.

[7]The elimination of open defecation and its adverse health effects: a moral imperative for governments and development professionals.

2.4 Inequalities in Access to Water and Sanitation Services in Latin America and the Caribbean

The 2030 Agenda for Sustainable Development was strongly aligned with the Human Rights principles of equality and non-discrimination, starting with the SDGs slogan: "leave no one behind." More specifically, aspects of the Human Rights to Safe Drinking Water and Sanitation (HRWS)—recognized by the United Nations in 2010 (United Nations General Assembly, 2010)—were incorporated in the Targets 6.1 and 6.2. However, despite the inclusion of concepts as quality, safety, equality, and affordability in the UN definitions, the indicators 6.1.1 and 6.2.1, proposed to assess and monitor progress toward these targets, do not properly capture all these dimensions. The expression "safely managed services," proposed to include in a synthetic way a set of these attributes, do not include equality and affordability in the access to WASH services. This omission should not compromise the efforts to incorporate these dimensions in the achievement of the SDG 6 in its fullness.

Ideally, the assessment of inequalities in the access to WASH services should be made according to the most recent methodology proposed by the Joint Monitoring Program for Water Supply, Sanitation, and Hygiene or JMP (WHO/UNICEF). In a 2017 report, JMP launched the official United Nations baseline for the global assessment and monitoring of Targets 6.1 and 6.2, based on a new conceptual framework (*2030 Agenda for Drinking Water, Sanitation and Hygiene in Latin America and the Caribbean*, 2020; WHO/UNICEF, 2017). JMP uses "service ladders" made up of five "steps" as a reference to assess, monitor and compare progress between countries and regions. Estimates of levels of access to services combine the classification of "facility types" ("improved" and "unimproved") with some attributes related to services. From the highest to the lowest level of access to services, the categories proposed are "safely managed," "basic," "limited," "not improved," "open defecation," (in the case of the "sanitation ladder"), and "surface water" (in the case of the "drinking water ladder"). Unfortunately, few countries have available information to measure access to services at this level of detail, especially disaggregated data that allows comparisons between subnational spaces and between subgroups of the population.

The lack of quality and availability of updated information is the biggest challenge in addressing inequalities in the access to WASH services. That said, the concept of "at least basic" services is frequently used by JMP when there is no sufficient data to distinguish "basic" and "safely managed" services (the two highest "steps" of the "ladders"). The "at least basic" level corresponds to the second-highest level of the ladder ("basic") and includes the population that meets the criteria of the first level ("safely managed"). Besides that, it is important to search for alternative data sources with information related to WASH services, even if not directly related to the JMP conceptual framework. This section, heavily based on the PAHO report "*2030 Agenda for Drinking Water, Sanitation and Hygiene in Latin America and the Caribbean: A Look from the Human Rights Perspective*" (Pan American Health Organization, 2020), includes data from different sources in order to create the broadest overview possible with the most recent data available. Besides JMP estimates (available at www.washdata.org), it was used data from different Multiple Indicator Cluster Surveys (MICS/UNICEF) (Martel, 2016), Demographic and Health Surveys (DHS/USAID) and, most importantly, microdata from several demographic censuses collected, harmonized and provided by the IPUMS-International project, coordinated by the Minnesota Population Center (Ruggles, 2018). The use of these databases allowed many disaggregation but it is important to highlight that they do not refer to the same year, which requires some caution in the analysis (the years to which the data refers are informed along the text).

2.5 Regional Inequalities in Latin America and the Caribbean

As shown in Fig. 2.2, there are significant inequalities in the access to drinking water between Latin American and Caribbean countries

Fig. 2.2 Proportion of population using at least basic drinking water services (first map) and sanitation services (second map), 2015. (Reproduced from PAHO, 2020. Source: WHO/UNICEF/JMP, 2017)

(LAC) and even greater disparities in what regards sanitation services. According to JMP estimates (World Health Organization and UNICEF, 2017), in 2015, the Caribbean countries as a whole showed the lowest level of access to at least basic services of drinking water and sanitation (86% and 71%, respectively), followed by the Andean countries (95% and 82%), North and Central America (97% and 86%), and the South Cone (98% and 89%).[8] Even within these blocks, there is a great heterogeneity: in North and Central America, while the population of Costa Rica had nearly universal access to at least basic drinking water services, the neighboring country Nicaragua presented a much lower coverage, of 82 percentage points (p.p.). In what regards at least basic sanitation services, in the Caribbean block, while Cuba, French Guiana, and Puerto Rico had access levels exceeding 90 p.p., Haiti had only 31 p.p., the lowest among all LAC (the same applies to at least basic drinking water services). On the other extreme, Chile was the only country with almost universal coverage of both services.

2.6 Inequalities in the Access of Water and Sanitation Services and Facilities by Different Population Subgroups

Since the beginning of this century, significant advances in the access to water and sanitation services in Latin America and the Caribbean were made. From 2000 to 2017, coverage of safely managed drinking water services rose from 56% to 74% of the population and the access to safely managed sanitation services went up from 12% to 31% (WHO/UNICEF/JMP, 2017). Nevertheless, significant inequalities remain hidden in the aggregated data and the differences between certain population subgroups within LAC countries can far exceed the disparities between them. The following analyses, besides using JMP estimates, use two census

[8]This division of Latin America and the Caribbean in "subregional blocks" is the same proposed by JMP (WHO/UNICEF, 2017).

variables (Ruggles, 2018) to evaluate inequalities in WASH services: access to piped water and to sewerage or septic tanks.[9] It is worth remembering that facility type is the first classification criterion used by JMP to define the service level in the drinking water and sanitation ladders. Among these facilities, the inequalities observed in the access to sewerage or septic tanks were systematically greater than those observed in the access to piped water.

The differences between urban and rural areas are one of the most studied and well-known forms of inequality in the access to WASH services. According to JMP estimates, in 2017, the gap in the access to safely managed drinking water services exceeded 40 p.p. between urban and rural areas in Latin America and the Caribbean (the coverages are respectively 82 and 41 p.p.). In 2015, while the countries of the South Cone, Belize, and some Caribbean islands (such as Martinique, United States Virgin Islands, Barbados, Saint Lucia, and Guadeloupe) had nearly universal access to improved drinking water facilities, the Andean countries presented high inequality levels between urban and rural areas, with gaps ranging from 17 to 23 p.p. The only country to present a worst performance than these was Nicaragua, with a difference of almost 30 p.p. between urban and rural areas. In what regards sanitation, in all Latin America and the Caribbean, almost 9% of the rural population have no access to sanitation facilities (practicing "open defecation") compared to less than 1% of the urban populations in 2017.[10] In 2015, the access to improved sanitation facilities varied widely within blocks and countries. In the Caribbean, for example, while some islands (such as Puerto Rico, Aruba, Grenada, and the British Virgin Islands) had almost universal coverage and, consequently, almost no inequalities, Haiti presented a much lower coverage and a much larger gap between urban and rural areas (respectively 34 and 19 p.p.). In Brazil, besides the low level of overall coverage, the difference between urban and rural areas reached 36 p.p., the largest gap among all countries considered.

The differences between urban and rural areas can be partially justified due to the scale gains in the implementation of services in more densely occupied areas, typically urban. However, inequalities by color, race or ethnicity have no other justification besides being one of the most well-known grounds of discrimination (besides that, the interweaving of these characteristics with socioeconomic status must be taken into account). The differences in the access to piped water between white and non-white people (which includes black, mixed race, indigenous, Asian, and other classifications) reached substantial gaps in some countries as Colombia and Jamaica, respectively, a 22 p.p. (in 2005) and 18 p.p. (2001). In the former, the non-indigenous population had a coverage of piped water almost 43 p.p. higher than the indigenous populations, a difference that exceeds 30 p.p. also in Panama (2010) and Paraguay (2002). The differences between the white and non-white populations in the access to sewerage or septic tanks are even greater, reaching 39 p.p. in Jamaica (2001)—the worst position among all countries considered. Despite being a much smaller difference, the gap between white and non-white people exceeded 16 p.p. in El Salvador (2007) and Brazil (2010).

Among socioeconomic aspects, "education" is one of the most studied. This dimension was addressed through the variables "household head educational attainment" (four different and harmonized levels) and "literacy." In eight of the 15 countries analyzed according to the first criterion, the differences in the access to piped water between residents of households where the "household head" had full university education was more than 20 p.p. higher than of the residents of households where the "household head" have less than primary education. In Paraguay (2002), Nicaragua (2005), and Bolivia (2001) these differences exceed 42 p.p. In nine of 16 countries analyzed, the difference in the access to piped water between the illiterate and the rest of the population was higher than 10 p.p., reaching a

[9] "Sewerage" is used here as an equivalent to "sewage systems."

[10] There are no JMP estimates available regarding the access to safely managed sanitation services in rural areas for 2017.

gap larger than 20 p.p. in Nicaragua (2005), Panama (2010), and Peru (2007). In what regards the access to sewerage or septic tanks the differences observed between the two extreme categories (residents of households where the "household head" had full university education against less than primary education) were, again, even more profound. Of the 13 countries considered, seven had a gap larger than 43 p.p. In Bolivia (2001), Nicaragua (2005), and El Salvador (2007) the differences are striking, around 70 p.p. In seven of the 15 countries analyzed, the gap between the illiterate and the rest of the population was higher than 20 p.p., reaching 44 p.p. in Panama (2010). Even in the South Cone, where countries such as Uruguay (2011), Chile (2002), and Argentina (2010) presented relatively low levels of inequality, the difference between the literate and the illiterate in Brazil reached 25 p.p. in 2010.

Figure 2.3 uses data provided by JMP to show differences in the access to at least basic services of drinking water and sanitation by wealth quintiles.[11] The access levels tend to grow sharply according to wealth in several countries, especially in what regards sanitation services, as the coverage of at least basic drinking water services was not only higher but also more egalitarian. Thus, data suggests a high vulnerability of the poorest, as the poorest quintiles had a much lower coverage of both services in comparison with the wealthier segments of the population. Apart from these general trends, the situation of the countries is diverse: once again, Haiti (2012) stands out negatively and, in what regards sanitation, the access to at least basic services in this country was relatively low even for the wealthier quintile (the same can be said about Bolivia (2008) and Honduras (2012)). In the other countries, in contrast, the wealthier quintile had nearly universal access to both services. As might be expected, the contrast with the poorest segment is substantial in almost all countries considered but, even between the poorest quintiles, there are significant inequalities: In Colombia (2010), Panama (2013), Dominican Republic (2014), Guyana (2014), and El Salvador (2014), the difference between the lowest quintile (Q1) and the subsequent one (Q2) was higher than 15 p.p., reaching 38 p.p. in Suriname (2011).

Although inequalities in the access of WASH services usually takes into account household variables, one way of assessing sex and age differences is by analyzing the person in the household responsible for the burden of collecting water when it is not available on premises (one of the main criteria used on the drinking water service "ladder"). As shown in Fig. 2.4, the proportion of the population without water on premises is extremely high in some countries, as Peru (2012), El Salvador (2014), Honduras (2012), and Jamaica (2011). In these cases, more than 10% of the population did not have water on the household, lot or land, reaching almost a fifth of the population in Peru (2012). Figure 2.3 also indicates the sex and age profile of the main person responsible of collecting water. In half of the countries considered, adult women were the majority group. Considering only countries where at least 4% of the population had no water on premises, Peru (2012) had the highest proportion of adult women responsible for water collection—more than 70%—followed by Honduras (66 p.p.) which also presented the highest proportion of children (under 15 years old) responsible for fetching water (15 p.p.).

While inequalities in the access to WASH services and facilities can reach profound gaps, the chances of deprivation can steeply increase when disadvantageous characteristics associated with lower access to basic services overlay at the same groups. That is why is so important to consider intersecting forms of inequality (Aleixo et al., 2016; Butts and Gasteyer, 2011) to explore how certain populations segments are particularly vulnerable and at a profound disadvantage

[11]The variable "wealth" is a measure of socioeconomic status introduced in the late 1990s DHS editions, also used in the MICS and by JMP itself, in an adapted manner. It is a composite measure regarding the living standard of households (household services and possessions, such as televisions, bicycles and construction materials). As the wealth index originally includes variables related to drinking water and sanitation facilities, JMP uses a "restricted" version of the wealth index to disregard these variables and avoid tautologies (for more details, see Martel, 2016).

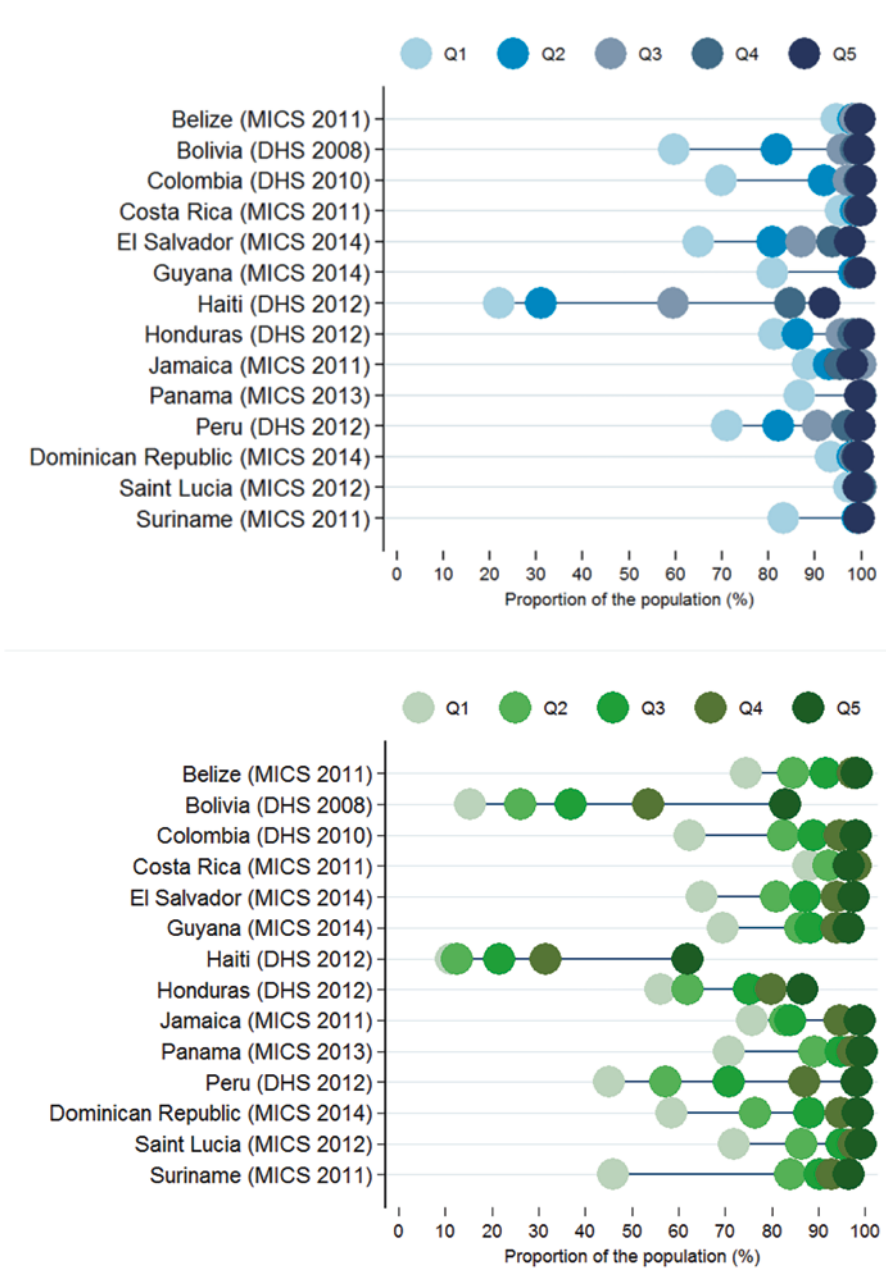

Fig. 2.3 Proportion of population using at least basic drinking water and sanitation services by wealth quintiles. (Reproduced from PAHO, 2020. Source: WHO/UNICEF/JMP, 2017)

in comparison to others (Queiroz et al., 2020) (as shown in PAHO, 2020). To illustrate this point, the effects of combined inequality-related criteria were analyzed by comparing two antagonistic population profiles with regard to susceptibility to deprivation to WASH services: the *black rural population living in households headed by persons with less than primary education completed* and the *white urban population living in households headed by persons with higher education completed*. The access to piped water and to sewerage or septic tanks by these

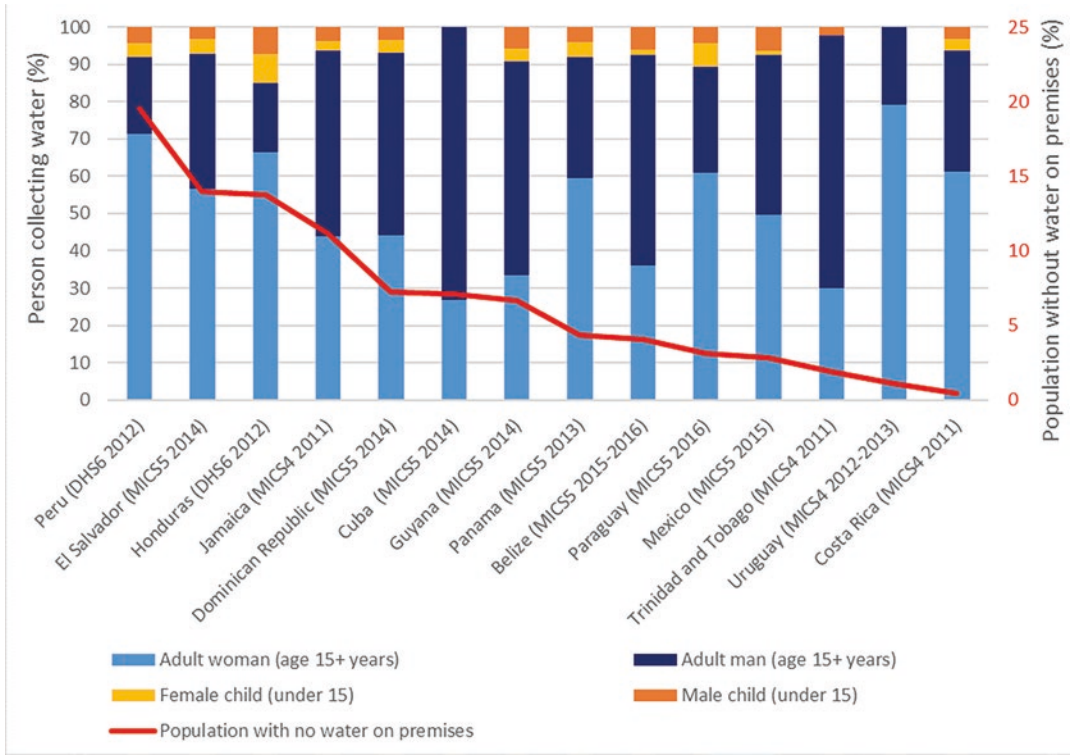

Fig. 2.4 Proportion of the population without water on premises and person collecting water. (Reproduced from PAHO, 2020. Source: DHS and MICS (Note: No distinction was made in Cuba between the children' sex (people under 15 years old), which totaled 0.1%)

two subgroups were computed using census microdata from the IPUMS-International project for the few countries[12] with available data to conduct this analysis (which requires the disaggregation of variables regarding access to facilities by residence in urban or rural households, color or race and "household head educational attainment"). Despite data limitations, it was possible to represent at least one country from each one of the Latin American and Caribbean subregional blocks.

In what regards access to piped water, the less vulnerable group had nearly universal access—higher than 99%—while the access of the more vulnerable group varied from 36% to 84%. The greatest gap was observed in Colombia (2005), where this difference was greater than 62 p.p., followed by El Salvador (with 57 p.p. in 2007) and Ecuador (with 54 p.p. in 2010). Costa Rica (2011) showed the lowest level of inequality, although the difference between the two groups was still 15 p.p. Differences in the access to sewerage or septic tanks were even higher: apart from Costa Rica (2011), the difference between countries was greater than 64 p.p., reaching a 91% gap between the more vulnerable and the less vulnerable group in El Salvador (2007). These sharp discrepancies show that the consideration of each criterion separately can lead to an underestimation of the degree of deprivation of WASH services and facilities and how this methodology can complement traditional analyses of inequalities. However, it is important to stress that the two groups do not encompass the entire population and this methodology should be used as a complement of single-criteria analyses.

[12]Access to piped water: Colombia (2005), El Salvador (2007), Ecuador (2010), Jamaica (2001), Brazil (2010), and Costa Rica (2011); Access to sewerage of septic tanks: El Salvador (2007), Ecuador (2010), Jamaica (2001), Brazil (2010), and Costa Rica (2011).

2.7 Comparison of the Degree of Social-Spatial Inequality in the Access to Water and Sanitation Between LAC Countries

In order to evaluate and compare countries in terms of the intranational degrees of social-spatial inequalities in the access to WASH services, a synthetic indicator was used at the 2020 PAHO report—the "inequality factor," computed with the most recent data provided by the JMP and by the IPUMS-International project. The inequality factor, based on multiple criteria,[13] was calculated by means of logistic regression in which the binary response variables are *piped water within the household* (against no piped water) and access to sanitation via *connection to sewerage or septic tank* (against absent or other types of facilities). The explanatory variables cover different dimensions of inequality (according to availability by country): *rural-urban status, geographic region* (according to the administrative subdivision adopted by the countries), *race*, *indigenous status*, *household head educational attainment*, and *literacy status*.

The data available allowed the computation of the inequality factor for 20 countries, in what regards water supply services, and for 16 countries, in what regards sanitation services. Again, results indicate great regional heterogeneity. The inequality factor computed for water supply services varied from 1.0% in Argentina, where no significant differences were observed between the selected subgroups, to 41.0% in Haiti, where access was exclusive only for certain population subgroups. In comparison, the values of the inequality factor regarding sanitation services were greater in all countries (except for Uruguay, where both values were low). This indicator also varied more widely, ranging from 0.3% for Uruguay to 45.5% for Nicaragua. Regionally, this methodology showed that the most unequal LAC countries in terms of access to water and sanitation facilities and services were Bolivia, in the Andean Block; Paraguay, in the South Cone; Nicaragua, in North and Central America and Haiti, among the Caribbean countries (in what regards drinking water services, because this country had no sufficient data to address inequalities in the access to sanitation facilities). A limitation of this approach is that the response variable for water supply reflects the existence of infrastructure and not necessarily if water is available when needed or free from contamination. Additionally, the variations in census dates (which are significantly outdated for some countries) compromise direct comparisons.

2.8 Affordability

Measuring affordability is one of the most challenging aspects in the assessment and monitoring of inequalities in the access to WASH services. It is explicitly mentioned in the definition of target 6.1, although the same does not apply to the target 6.2, from the perspective of the Human Rights to Safe Drinking Water and Sanitation (HRWS), it should also be taken into account. The difficulty to characterize and define parameters for the evaluation of affordability issues and the lack of data are two of the most methodological challenges regarding this dimension (Brown and Heller, 2017). In order to outline a combined evaluation for both water and sanitation services, the analysis made in PAHO (2020) focused in the poorest segments of the population (more specifically, the four poorest deciles) and standardized the consumption level,[14] in order to make direct comparisons viable.

[13] The inequality factor was used in PAHO (2020) and QUEIROZ et al. (2020) to adjust levels of access to WASH services based on the degree of inequalities—the greater the inequalities between different population subgroups, the greater the decrease in the access index. This new methodology, a novelty in the WASH sector, was inspired by the Human Opportunity Index methodology (Barros, 2009), originally created to measure inequality in opportunities to access basic services. For more details on this methodology, see PAHO, 2019 and Queiroz et al. (2020).

[14] A high level of per capita consumption was adopted (monthly consumption of 5m³) to generate a safety margin for the evaluation and due to the fact that water consumption is quite high in several regions of Latin America and the Caribbean.

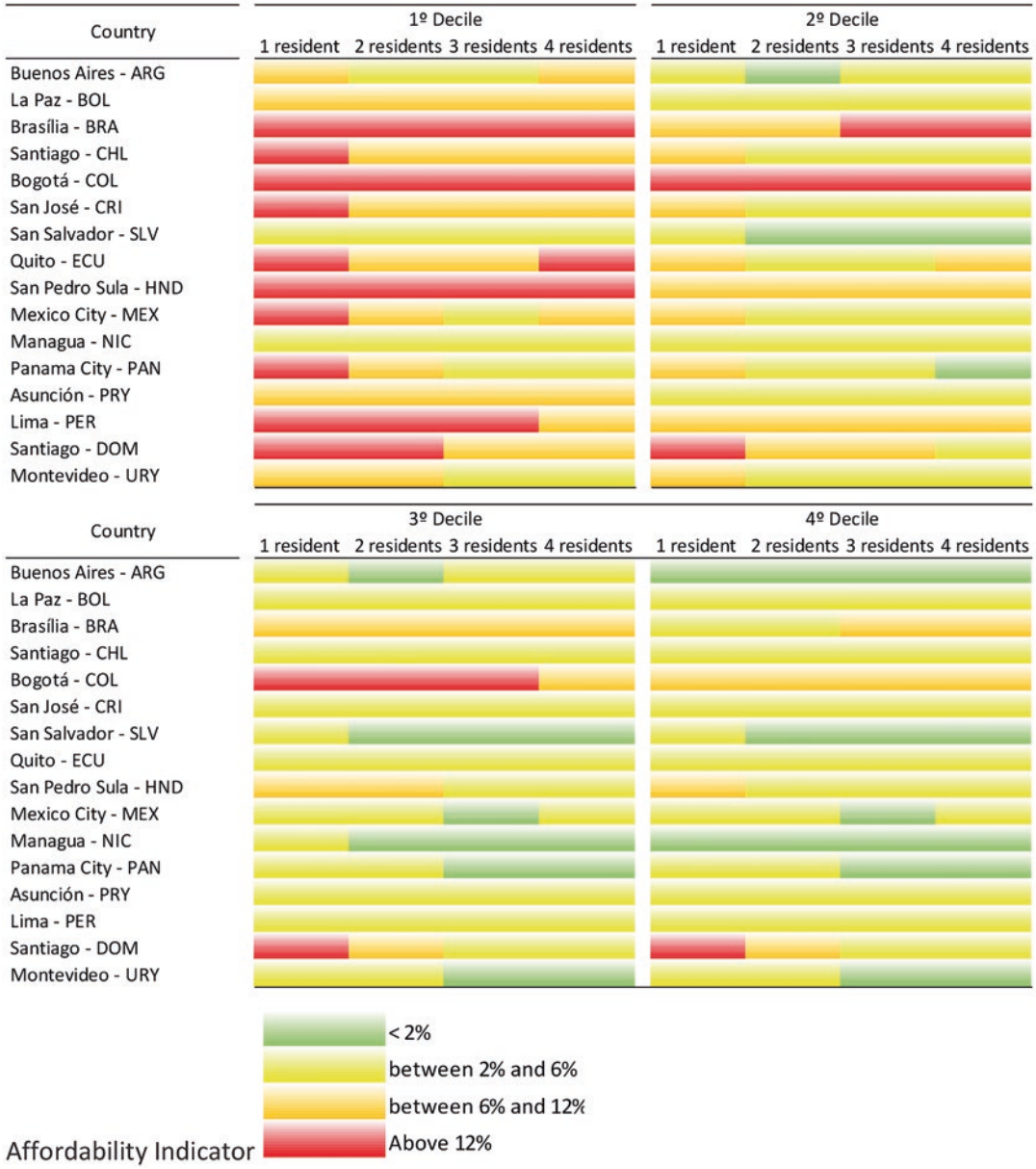

Fig. 2.5 Affordability indicator by income deciles and number of household residents. (Reproduced from PAHO, 2020. Source: Based on IBNET and SEDLAC, CEDLAS and The World Bank, 2017)

The "affordability indicator"[15] shown in Fig. 2.5 is basically a measure of household income impairment, i.e., the relation of expenditure on water and sanitation services and household income. Even considering only capitals of some countries, the application of these innovative methodology shows that this issue cannot be ignored, as all capitals analyzed presented some degree of affordability problems. As expected, the poorest decile had the lower potential affordability, but it is important to mention that the application of social tariffs, discounts or subsidies were not considered. The chart indicates an over-

[15]The International Benchmarking Network for Water and Sanitation Utilities (IBNET) was used for the estimation of expenditure on water and sanitation services (https://www.ib-net.org/) and the Socio-Economic Database for Latin America and the Caribbean (SEDLAC—CEDLAS and The World Bank) was used for estimating household income (May 2017 version).

all trend of greater income impairment in households with fewer residents and lower income impairment as consumption increases. These variations can be explained by the tariffs structure, generally composed by an initial block of consumption followed by progressive subsequent ones (there is a great variability in the definition of the initial block and the progressivity).

A high-income impairment with drinking water and sanitation services is observed in different countries and is especially evident in Brazil and Colombia. The former was one of the few countries where income impairment grew accordingly to the number of household residents, due to the high progressiveness of the rate. Considering the tendency of the poorest households to have more residents, this is a worrisome situation. High-income impairments were also observed in Honduras, Dominican Republic, and Peru. On the other extreme, El Salvador and Nicaragua had the lowest values.

In a similar effort, a study made by (Smets, 2017) showed that the affordability indicator (expenditure divided by income) in Latin America and the Caribbean varied between 4% and 12% for the poorest quintile of the population connected to a network. Additionally, affordability estimates provided in the 2017 JMP report (in this case, based on household expenditure instead of income) shows that Latin American and Caribbean populations have an income impairment higher than 5% (WHO/UNICEF, 2017). Worldwide, only Central and Southern Asia presented higher values. Although direct comparisons between the methodologies are not possible, there is some convergence in these values, indicating that affordability is a pervasive problem in LAC countries. It is worth mentioning that all these estimates do not include informal providers or self-service, only populations connected to water and sanitation networks—the most burdened by water and sanitation expenditures. Nevertheless, as the levels of access to formal WASH services increases in countries with low coverage as Haiti and Nicaragua, the income impairment can also be expected to grow.

2.9 Conclusion

The 2021–2030 decade is called "the decade of action." The baseline studies of the WASH indicators in countries are very important to review and revise the achievements and the gaps. The results empower the country capability to determine its current situation and to set goals for the future and to achieve the 2030 agenda. However, we identified a lack of data that can add an important delay to the process. Key indicators for the SDGs are missing in some countries, such as the measurement of quality of water, free of microbiological and chemical contaminants (a key information for the SDG indicator 6.1.1) and the safe wastewater disposal, measured by level of wastewater treatment (essential for the SDG indicator 6.2.1). In addition, the efforts to achieve the SDG 6 in its fullness must comprise all dimensions established in the UN definitions for the Targets 6.1 and 6.2, including equality and affordability, not included in the SDG indicators. Some countries rely on the international monitoring system to achieve their data, and this can add a delay. Therefore, it is important that they also develop their own systems.

The SDG indicators were built to reduce inequities, therefore any progress made in relation to access and quality of services must reach everyone, with special attention to underserved and disadvantaged sectors. These include dispersed rural areas, indigenous communities, low-income populations, among others, that need to be incorporated. Despite the strong disparities in the access to WASH services observed between countries and regions of Latin America and the Caribbean (especially regarding sanitation services), it was shown that subnational inequalities can be even greater. Besides, taking into account the access levels of the most vulnerable groups, the proper evaluation and monitoring of inequalities require the consideration of intersecting forms of inequality, that puts certain segments of populations at a profound disadvantage in comparison to others. Water and sanitation are basic services that, by default, need to be available to anyone and the Agenda 2030 is an opportunity to make a considerable improvement for the entire population.

Open defecation (OD) is another important problem in the region because it provides a serious health risk and creates undignified and unsafe conditions, especially for women and girls. Ending OD has been identified as a top priority by United Nations since 2013. To move forward and achieve the SDG 6, it will be necessary:

1. National political will to position end OD as their development priority and to facilitate a better collaboration between governments and institutions responsible for WASH services.
2. A primary intervention to ensure the universal access to toilets in each household, at least with a minimum level of sanitation that keeps excreta separated from human contact.
3. Recognition of multiple and complex issues associated with cultural preferences and lack of access to resources.
4. A global approach through joint plan and actions, innovative public–private partnerships, intersectoral alliances, innovative financing mechanisms and capacities to engage communities with sanitation, and behavior interventions.
5. Updating and expanding databases (such as the MICS and DHS) to include all the information required to calculate the access to safely managed drinking water and sanitation services in accordance with the new criteria proposed by JMP (WHO/UNICEF, 2017), including disaggregated data for different population subgroups and small areas.
6. Definition of conceptual and methodological standards to address the challenges regarding the evaluation and monitoring of the affordability dimension, including the provision of data (e.g., on social tariffs and household income impairment with WASH services).

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3 Safe Water and Sanitation for a Healthier Caribbean

Michelle Mycoo

Abstract

The challenge of meeting the United Nations Sustainable Development Goal 6, especially given climate change, disaster risks, poverty, and the economic disruption caused by COVID-19, is a major concern of Caribbean governments and policymakers. Anthropogenic pressures along with climate change impacts are significantly affecting water and sanitation services. Several Caribbean islands are already experiencing water insecurity arising from climate change and variability impacts on their freshwater resources. Paradoxically, many countries, with a few exceptions, have sufficient water resources to meet demand. A critical issue is that existing infrastructure, management, and institutional frameworks that should close the supply–demand gap are obsolete. In several countries water management institutions have not been substantially transformed for over 60 years. Growing demands for wastewater management due to population increase along with the inability of the Region's governments to modernise sewerage treatment facilities have undermined efforts to ensure sanitation for all by 2030. Economic disruption from COVID-19 is expected to slow and divert investment in water and sanitation improvements to other critical sectors. This paper seeks to investigate difficulties in achieving Goal 6 and propose measures to accelerate the Caribbean potential to stay on track to meet this goal by 2030. Trinidad and Barbados were used as case studies. Although they differ from each other in several respects, for this reason these case studies allow salient lessons to be distilled and help craft key recommendations that would have applicability to a wide cross-section of Caribbean countries.

Keywords

Caribbean SIDS · Trinidad & Barbados · SDG6 performance · Water stress · Covid-19

Safe Water and Sanitation for a Healthier Caribbean: SDG 6, COVID-19, and Climate Change using Trinidad and Barbados case studies. https://wateractiondecade.org/wp-content/uploads/2018/03/UN-SG-Action-Plan_Water-Action-Decade-web.pdf. KEY TO INTRODUCTION TO CONTEXTUALISE. ALSO SEE ACTION: VERY COMPREHENSIVE FOR SDG 6

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3.1 Introduction

Caribbean Small Island Developing States (SIDS) as signatories to the United Nations Sustainable Development Goals (SDG) accepted the challenge of providing access to clean water and sanitation as a basic human right of all citizens. Studies have underscored that natural characteristics are a key determinant of water resource availability in SIDS. For instance, the different geographies of SIDS in the Caribbean Region result in some islands being water resource rich in stark contrast to others that suffer from water scarcity. Climate change and variability are also impacting on their freshwater resources (Nurse et al., 2014) though their risk profiles vary across the Region (Nguyen and Robinson, 2019; Rhiney et al., 2018; Taylor et al., 2018). Temperature changes can also have severe impacts on water supply. With a warming of 1.5 °C or less, freshwater stress on small islands would be 25% less as compared to 2.0 °C (Hoegh-Guldberg et al., 2019). Additionally, the projected length of seasonal dry periods and frequency of droughts are expected to increase (Gohar and Cashman, 2016) and these changes may impact on the hydrologic cycle. Yet, anthropogenic pressure is a major challenge to water resources in the Region. Associated changes are population growth, rapid urbanisation, and land use changes that have impacted on groundwater recharge, water pollution, and flooding which collectively compromise access to clean water and sanitation. Paradoxically, many Caribbean countries, with a few exceptions, have sufficient water resources to satisfy demand. However, the infrastructure, management, and institutional frameworks to close the supply–demand gap are lacking (Cashman, 2014; Mycoo, 2007 & 2018).

In several Caribbean states water management institutions and arrangements have not altered substantially for over 60 years and this is most obvious in the sectoral approach to water management (Cashman, 2012; Mycoo, 2018). Most Caribbean SIDS rely on the command and control approach to water management, which focuses on building infrastructure to increase water storage during periods of abundant rainfall, and to maintain supply in response to droughts (Belmar et al., 2015). This approach promotes a top-down, scientific approach to planning, where experts are perceived as capable of making objective decisions based on sufficient evidence and a high degree of certainty about outcomes (Belmar et al., 2015). Government control using this water management approach is reliant on its political/policy capacity to make informed and rational decisions and its administrative capacity to execute these decisions. The command and control approach, however, produces negative results where excessive political interference occurs.

The provision of sanitation services is severely hampered by limited infrastructure investments, inadequate institutional capacity to govern the sector, and a lack of political will among Caribbean governments to ensure sanitation goals remain high on the development agenda. As a result, the health of population living in some of the Region's SIDS, especially those that reside in poorly serviced informal settlements is threatened. Additionally, limited sewerage treatment has polluted water sources and damaged sensitive ecosystems such as coral reefs, which many countries are dependent upon for tourism.

Before the COVID-19 pandemic Caribbean SIDS were making some progress in fulfilling SDG 6 notwithstanding that climate change, socio-economic inequalities, and weak governance systems threatened to undermine efforts to succeed in meeting this goal by 2030. In light of economic disruption and threats to human health and well-being presented by COVID-19, fulfilling SDG 6 and its multiple targets between 2015 and 2030 is expected to be a major concern of Caribbean governments. Some researchers have already begun to call for the SDGs to be revisited and the achievable targets prioritised (Naidoo and Fisher, 2020). Pre-existing issues such as anthropogenic pressures, weak governance, and climate change now require re-imagining future efforts to achieve SDG 6 in a post-pandemic era. Despite double exposure to external economic and environmental shocks, ultimately the broader goal of a safer, healthier world for all remains paramount.

This chapter seeks to investigate current barriers encountered by Caribbean SIDS in meeting SDG 6 and propose measures that can help them meet the targets of this goal. Key questions that the chapter attempts to answer are: (1) Can Caribbean SIDS meet SDG 6 by 2030? (2) What barriers are stopping these territories from meeting the targets associated with SDG 6? and (3) What enabling factors can be recommended to find accelerate efforts to meet this goal by the end of the decade? Trinidad and Barbados are used as selected case studies to fulfil these research objectives. The two case studies were chosen to highlight salient differences in water resource availability as well as similarities or differences in management approaches to water and sanitation service provision, from which lessons and good practice may be distilled and mainstreamed into Caribbean governments' efforts to achieve SDG 6.

Existing difficulties experienced by the selected case studies in meeting SDG 6 are first presented. This is followed by a discussion, which compares and contrasts the performance of the selected countries' performance in fulfilling SDG 6. Recommendations are then articulated for policies and technologies which may help Caribbean SIDS stay on the pathway to meeting SDG 6. Lastly, key conclusions are presented.

3.2 Background: Water and Sanitation Sector in the Caribbean

Compared to the Millennium Development Goals (MDGs), Sustainable Development Goals (SDGs) are considered broader, deeper, and far more ambitious in scope than the MDGs and are geared towards achieving global sustainable development (Purvis et al., 2019).

Water-related challenges, including limited access to safe water and sanitation, increasing pressure on water resources and ecosystems, disasters and an exacerbated risk of droughts and floods, have received increasing attention in the global development arena (UN, 2018a). The UN declared that water is critical for sustainable development and the eradication of poverty and hunger, and is indispensable for human development, health, and well-being. It set 17 SDGs which consists of 169 global targets, relating to development outcomes and means of implementation, for the period 2015–2030. The SDGs are strategically designed to balance the social, economic, and environmental dimensions of sustainable development. The 2030 Agenda further seeks to realise the human rights of all, and to achieve gender equality and empowerment of all women and girls. This ambitious universal agenda is to be implemented across the globe taking into account the perspectives and needs of all stakeholders based on a collaborative partnership. Water is at the heart of recent milestone agreements such as the 2030 Agenda for Sustainable Development, the Sendai Framework for Disaster Risk Reduction 2015–2030, and the 2015 Paris Agreement (UN, 2018b).

The Caribbean Region is on track to achieving SDG 6 which relates to universal access to basic drinking water services by 2030 (UN, 2018a). For many Caribbean countries, improved water supplies and sanitation coverage exceed 90%. The central issues are not so much associated with the universal provision and access to water services, though this does remain a concern, they are related to service efficiency and infrastructure maintenance and operation (Cashman, 2012; Mycoo, 2018). Challenges confronting the water sector include inappropriate governance arrangements, deficient legislation and regulation, ageing infrastructure, high levels of unaccounted for water, concerns over potable water quality, and poor infrastructure management (Cashman, 2012; Mycoo, 2007 & 2018; Schneiderman and Reddock, 2004). Scores on operating efficiency revealed that Barbados, Jamaica, and Trinidad and Tobago scored 2, 1, and 1, respectively, out of a range of 1–5 where 4 indicated a high level of success and 0 a low level of success (K&M Advisors, 2019) (Table 3.1).

Water governance in the Region is quite complex and the existence of a water policy does not necessarily mean it is effective. Many challenges arise because of the limited resources and capacity of SIDS; they often need external funding,

Table 3.1 Utility gaps for water supply services in selected Caribbean countries

Utility	Coverage	Service quality	Operating efficiency
WSC (Bahamas)	2	3	3
BWA (Barbados)	4	2	2
BWS (Belize)	3	4	4
GWI (Guyana)	2	1	TBD
NWC (Jamaica)	2	2	1
SWM (Suriname)	2	3	TBD
WASA (Trinidad and Tobago)	3	3	1

Note: Harvey Balls are round ideograms used for visual communication of qualitative information. They provide a range from 1 to 5 to show the extent to which each data point applies. A 4 indicates high level of success and a 0 indicates low level of success
Source: K&M Advisors, 2019

technical and human capacity to formulate, and implement policies (UNEP, 2012). In some countries, traditional or customary land usage can also hinder the implementation of water policies (Gheuens et al., 2019) as is often the case where family lands and squatting occur. Furthermore, Caribbean SIDS score low or medium-low on the degree of implementation of Integrated Water Resources Management Policy (IWRM) (UNEP, 2018). Only Cuba has a high score in providing an enabling environment for IWRM, including the institutional capacity, stakeholder participation, availability of management instruments, and financing to facilitate implementation.

Climate change poses a major challenge to the Region's freshwater systems especially in islands already experiencing water scarcity (Schewe et al., 2014; Holding et al., 2016). In small islands population growth, urbanisation, and tourism already place pressure on limited freshwater resources and in some cases water demand already exceeds supply. For example, Barbados is utilising close to 100% of its available water resources and St. Lucia has a water supply deficit of approximately 35% (Cashman, 2014). In Jamaica, the ability of rainwater harvesting to meet potable needs between the 2030s and 2050s will be reduced based on predicted shorter intense showers and frequent dry spells (Aladenola et al., 2016). Areas where a freshwater lens is thinner are most likely to be impacted by multiple climate stressors. These locations tend to be in coastal zones where population is likely to be most concentrated (Holding et al., 2016).

Achieving health and sanitation face challenges given events associated with climate change such as hurricanes and storms which disrupt water and sanitation services. These extreme events can cause disease outbreaks, as occurred when outbreaks of cholera occurred in Haiti following Hurricane Matthew (Raila and Anderson, 2017; Hulland et al., 2019).

Throughout the Region the provision of infrastructure for wastewater services lags behind drinking water services. The centralised sewerage system in the Caribbean is not extensive and the majority of households rely on septic tanks such as in Jamaica, the Bahamas, St. Lucia, St. Vincent and the Grenadines, Guyana, and Suriname (K&M Advisors, 2019). It is estimated that 20% of the wastewater produced in the Caribbean is collected and only 5% of the total wastewater is treated and disposed of appropriately (Pemberton, 2013). Approximately 85% of wastewater entering the Caribbean Sea remains untreated (UNEP, 2010). Most Caribbean SIDS already have a moderate to high risk for groundwater pollution not only because of poor sewage treatment but also because of seawater intrusion, agricultural chemicals, and other types of waste (Kaly et al., 2002) (see Table 3.2). This is indicative of difficulties facing the scale of investment in much needed sewerage infrastructure (UNEP, 2010). In addition to the financial constraints, other barriers include inadequate legal and regulatory frameworks, fragmented approaches to and responsibility for wastewater management, and limited technical and operational capacity,

Table 3.2 Risk for groundwater pollution in Caribbean SIDS

Country	Eutrophication	Risk of Salinisation
Antigua and Barbuda		High
Bahamas		High
Barbados		Low
Belize		High
Cuba		High
Dominica		High to very high
Dominican Republic		High
Grenada	Yes	Medium
Guyana		Yes
Haiti	Yes	Yes
Jamaica	Yes	Medium
Saint Kitts and Nevis		Low
Saint Lucia		High
Saint Vincent and the Grenadines		Yes
Suriname		High
Trinidad and Tobago	Yes	High

Source: Adapted from K&M Advisors (2019)

knowledge and awareness of low-cost treatment technologies (UNEP, 2010).

According to the 2018 Sustainable Development Goal 6 Synthesis Report on Water and Sanitation (UN, 2018a), major knowledge gaps exist among countries with less than 50% of the data required to track the progress of all SDG 6 targets. Many Caribbean countries contribute to these gaps and a study was commissioned in 2019 to examine ways of monitoring SDG 6 through improved data acquisition (Roopnarine et al., 2019).

The following section of this chapter examines the performance of the selected case studies in meeting SDG 6 using available empirical evidence.

3.3 Current Performance in Meeting SDG 6: Trinidad and Barbados

The Caribbean's performance in meeting UN SDG 6 will be discussed in this section using the main targets and related indicators as discussed in Chap. 1. The eight main targets in relation to SDG 6 that form an essential part of the discussion are: 6.1 Drinking water; 6.2 Sanitation and hygiene; 6.3 Water quality and wastewater; 6.4 Water use and scarcity; 6.5 Water resources management; 6.6 Water-related ecosystems; 6.7 International Cooperation and capacity building; and 6.8 Stakeholder participation.

3.3.1 Trinidad

Trinidad is a water resource rich island due to its proximity to the Inter-Tropical Convergence Zone in addition to climatic, hydrological, and geological characteristics. The island has a tropical, warm, and humid climate. Its renewable freshwater resources are an estimated 3800 million m^3/year. Meteorological data showed that between 1996 and 2016 precipitation decreased and temperature rose which may be attributed to climate change and variability. Though in recent years water resources have declined in the dry season, the country is not water stressed like some of its Caribbean counterparts. The following sub-sections review its performance and obstacles to meeting SDG 6.

SDG 6.1 Universal and Equitable Access to Affordable Drinking Water

According to SDG 6.1 by 2030 there should be universal and equitable access to safe and affordable drinking water for all. The proportion of the population using safely managed drinking water services is the indicator used to measure SDG 6.1 In the Trinidad context the official government data reveals that 95% of the population has access

to potable water and this has been so over the last 5 years. Access to potable water is high for both urban (97%) and rural (93%) households (Food and Agricultural Organisation, 2015).

The level of service is either pipe borne water supply, which comprises of in-house connections, and standpipes used mainly by informal dwellers and poor households. Despite the high percentage of persons receiving pipe borne water a major downfall is the unreliability of water supply in many parts of Trinidad as this has consequences for access to safe drinking water. The Water and Sewerage Authority (WASA) in 2019 reported approximately 54% of the population received a 24-h service daily. WASA provides a scheduled water service to the remaining 46% of domestic users many of whom store water in tanks and other water containers on days when water is not transmitted and distributed by WASA.

Potable water supplied via standpipes to informal settlements is safe because it undergoes treatment before distribution by the water authority. However, some poor households rely on rainwater harvesting to meet their domestic needs (Peters, 2015). These households do not enjoy access to safe water provided by WASA and must rely on their individual water purification efforts to ensure water is fit for drinking.

Although the pipe borne supply is treated in accordance with the standards set by the World Health Organisation for drinking water, and a 100% access to safe drinking water is often reported in official reports, there is an increasing trend among households to purify water by boiling and/or using water filters. In addition, more domestic users are purchasing bottled water than in previous decades because of scepticism surrounding the water quality provided by the water authority. Moreover, potable water quality is compromised if water is left in storage tanks for several days. The private sector has stepped in over the last decade and a half to meet a growing demand for bottled water while simultaneously gaining large profits from state failure to supply a regular water service.

As noted, the UN states that the major goal of SDG 6 is to provide safe and affordable drinking water for all by 2030. In determining if Trinidad will attain this goal by 2030, it is important to assess if the water service provided is affordable for domestic consumers. A key objective of Trinidad's water policy is that of equity which is based on the annual rateable value of property and not household volumetric consumption. In theory, the flat rate is linked to property values to vary consumption charges with the income of the consumer. However, the use of flat-water rates as a method of achieving equity has difficulties in practice. Trinidad's water service is one of the most highly subsidised in the English-speaking Caribbean, but WASA's fee structure is highly regressive, in that the percentage of income paid in water rates, declines with rising income levels. The last domestic water rates were increased was 1993. Furthermore, the failure to update property values has resulted in water rates not reflecting the true economic cost and inflation of water production and distribution costs. Domestic consumers pay among the lowest water rates in the Caribbean. Comparing Trinidad and Tobago's average residential water tariff to that of other Caribbean territories, the Castalia Strategic Advisors Benchmarking Report of November 2018 found that domestic consumers were charged the lowest at US$ 0.31/m^3 as opposed to Curacao at US$ 3.05, The Bahamas at US$ 2.78, Antigua at US$ 2.52, Jamaica at US$ 1.95, and Barbados at US$ 1.84.

SGD 6.2 Sanitation and Hygiene

It is stated in SDG 6.2 that by 2030 the aim is to achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations. Indicator 6.2.1 used to measure achievement in meeting SDG 6.2 is the proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water. Presently there is unequal access to central sewerage facilities in Trinidad, although within the

Region it has the highest level of access to such service. However, the level of access to an in-house pipe connection is 93% thereby facilitating handwashing and overall sanitation, hygiene, and health.

WASA provides wastewater services to 48% of the population (WASA, 2020) and the remainder of the population relies on private package treatment plants, septic tanks (46%), soakaways and pit latrines (6%). Access to wastewater services differs among urban, suburban, and urban areas. The population of Greater Port of Spain Metropolitan Region has by far the most access to sanitation and hygiene. Approximately 77% population of the capital city of Port of Spain and close to 40% of other main urban regions such as Diego Martin and San Juan/Laventille are connected to the central sewerage system (WASA, 2016). In urban, suburban, and peri-urban settlements approved by the planning agency, some houses are not connected to the central sewer systems and rely on private sewage treatment plants and septic tanks. However, quite frequently privately-operated plants are malfunctioning and poorly maintained in the absence of enforcement by inspectors of the Public Health Department. Public health is therefore threatened by malfunctioning private package treatment plants.

The proliferation of informal settlements has also impacted on sanitation and health. An estimated 85,000 squatter households currently exist of which approximately 55,000 households occupy lands belonging to the state and an additional 30,000 households have encroached on private lands. Applying a conservative average household size of six persons in these settlements, it can be extrapolated that approximately 37% (510,000 persons) of the country's total population of 1.4 million persons may be squatting. Based on such data, a significant percentage of the country's population is living in illegal housing not built in accordance with health and safety standards. Sanitation facilities are rudimentary for 37–47% of the population posing a health risk to inhabitants, especially women, children, the elderly, and sick persons. Earlier research on Trinidad found that women in underserved communities spend much time collecting water for domestic use (Mycoo, 1996; Schneiderman and Reddock, 2004). Additionally, there are health consequences of nutritional deficiencies and the burdens associated with travelling further to collect water. Carrying heavy loads over long periods of time causes cumulative damage to the spine, neck muscles, and the lower back, leading to early ageing of the vertebral column.

COVID-19 poses a significant challenge to low-income households in adhering to the sanitation protocols, especially those living in informal settlements where pipe borne water and sewage disposal facilities are lacking. In such settlements water shortages make it difficult to sanitise living spaces and practice safe personal hygiene to reduce the chance of virus transmission.

SDG 6.3 Water Quality and Wastewater

UN SDG 6.3 seeks by 2030, to improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse. The main threats to Trinidad's water quality are uncontrolled point waste discharges especially from industries and domestic sources and high levels of erosion in the upper reaches of watercourses. Pollution of surface water impacts on the production of potable water. In-stream problems due to pollution are further exacerbated during periods of low flows when the dilution effect is at its lowest.

Using SDG 6.3.1 which measures the proportion of wastewater safely treated it can be said that over the next 10 years much improvement is needed to achieve this goal and target. As noted, 48% of households has access to central sewerage treatment facilities and together with weak enforcement of regulations governing the disposal of hazardous waste from industries and the agricultural sector much more effort is needed to reduce pollution. An estimated 60% of water supplies is drawn from surface water sources such as rivers which are polluted and compromise water quality as well as impact on costly purification methods. The government indicated that at least 75% of households and other such entities would be connected to the central sewerage system by

the year 2020. It is off target in meeting SDG 6.3.1 and high levels of expenditure will be necessary to meet this target in the remaining decade.

SDG 6.3.2 uses the indicator proportion of bodies of water with good ambient water quality to measure SDG 6.3. Reports reveal that surface water sources constitute the country's main source of water (60% or 65%) yet the quality of the surface water resources is deteriorating in many places, as evident by high levels of biological oxygen demand, bacterial content, turbidity, and the presence of chemical pollutants in rivers. These land-based pollutants undermine efforts to attain SDG 6.3. Pollutants are penetrating the Caroni River Basin, the country's largest river basin, and invading the largest watersheds which contain the major river systems and their associated wetlands. All rivers and streams flowing through urban areas are heavily polluted while most industries outside the sewerage system discharge semi-treated or untreated waste directly into rivers or into the sea. Major threats to the management of watersheds and freshwater are quarrying, deforestation, housing on steep slopes, annual bush, and forest fires and indiscriminate unplanned construction such as squatting. These factors cause high levels of soil erosion, surface water run-off in the upper parts of watersheds, and flooding in the low-lying coastal plains. Untreated sewage from informal settlements, pesticides, and fertilisers from agricultural use also pollute surface water. Collectively these drivers cause a decrease of percolation, reduced aquifer replenishment and contamination of freshwater sources.

Most aquifers, in the absence of thick overlying clay layers, are vulnerable to contamination originating from hazardous waste dumps, underground fuel storage tanks, untreated sewage, and industrial effluents. Although there has been no recent major incident of groundwater contamination, intermittent high levels of nitrates were detected in three sub-aquifers of the Northern Gravel System. Other pollutants were also found in groundwater along the country's main urban corridor called the East-West Corridor. The levels pose no immediate danger, but this indicates that there is a trend towards increasing health risks.

Legislation such as the Water Pollution Rules 2001, generated under provisions of the Environmental Management Act Chapter 35:05 is aimed at mitigating water pollution. However, a major challenge facing the Environmental Management Authority (EMA) is its inability to detect the source of pollution of major rivers. Consequently, the EMA's capacity to monitor and enforce these rules upon polluting industries is severely diminished. Furthermore, The Town and Country Planning Division is unable regulate built development in accordance with legislative provisions because it is hamstrung by a lack of human resource capacity to monitor development within watersheds and to enforce site development standards that strengthen water management.

SDG6.4 Water Use and Scarcity

According to SDG 6.4 by 2030, countries should substantially increase water use efficiency across all sectors to ensure sustainable withdrawals and the supply of freshwater to reduce the number of people suffering from water scarcity. Trinidad is currently performing poorly in attaining SDG 6.4 and outdated water policy retards possibilities of achieving water efficiency.

The SDG 6.4.1 indicator used to determine if SDG 6.4 can be achieved is the implementation of measures to change water use efficiency over time. A review of empirical evidence found that water use is inefficient in Trinidad. Available data show that in 2010 it cost US$ 64 to produce a cubic metre of water, which was far higher than most other Caribbean islands with the exception of Antigua and Barbuda. More recent reports revealed that approximately 50% of water produced is lost because of poorly maintained pipelines or old pipelines which are more than 80 years old and date back to the colonial era in some sections of the main cities and other urban centres (WASA, 2016). The extent of unaccounted for water (UFW) from pipeline leakage remains a dilemma of the water authority because of its inability to increase expenditure on pipeline repair and replacement. Furthermore, the extent of UFW could be higher because of the growing number of squatter households accessing state-

provided water supplies through illegal water connections. Table 3.3 summarises reasons for technical losses.

Water consumption levels continue to be high in contrast to other Caribbean SIDS because of comparatively low water rates and non-metered consumption. Water wastage is high among domestic consumers and the agricultural sector, but commercial and industrial user charges are more in alignment with production costs, which curbs excessive consumption. In the Trinidad context pricing reform and behavioural change have long been recommended to address high levels of current water use inefficiency (Mycoo 2007 and 2018; Virgie and Gaskin, 2010).

SDG 6.4.2 Level of Water Stress: Freshwater Withdrawal as a Proportion of Available Freshwater Resources

Long-term annual renewable surface water resources are estimated at 3740 million m^3, of which 3600 million m^3 are available in Trinidad. Long-term average annual renewable groundwater resources are estimated at 614 million m^3, of which 545 million m^3 are in Trinidad. Considering an overlap between surface water and groundwater resources of 514 million m^3, the total Internal Renewable Water Resources (IRWR) are estimated at 3840 million m^3/year. Expressed per capita, the surface water availability in Trinidad and Tobago is approximately 2200 m^3/year per person. The total renewable water resources are 2805 m^3 per capita (2017) and estimated water withdrawal is 286 m^3 per capita (2011). The international criterion for water scarcity is less than 1000 m^3/year per person so by international standards, Trinidad and Tobago is not a water stressed country. Trinidad has a low level of water stress in that between 2000 and 2017 freshwater withdrawal as a percentage of available freshwater resources has been consistently the same at 20%.

Table 3.3 Factors contributing to technical losses in Trinidad (Source: WASA, 2016)

There are several factors that contribute to leaks. These include:
1. Cyclic loading of the system.
2. Soil movement and conditions.
3. Pipe condition, corrosion of pipes both internally and externally.
4. Poor quality materials, fittings, and workmanship.
5. Traffic loading, effects of vibration, and high loading caused by heavy machinery.
6. Aged infrastructure.

SDG 6.5 Water Resources Management

The assessment of water resources management revealed that Trinidad and Tobago performed poorly in the degree of implementation of IWRM with a score of 23 out of a range of 0–100. The country scored 13 in financing, 33 in management instruments, and 29 in institutions and participation out of a range of 0–100 (see Fig. 3.1). Achieving SDG 6.5.1 by 2030 relates to implementation of integrated water resources management at all levels but this remains a challenge without political will.

A major concern of the agencies involved in preparing the draft IWRM plan of 2017 was that this plan like its predecessors would remain as a paper plan. Consequently, the draft plan provides detailed recommendations for policy implementation, review and revision, and a governance framework to support IWRM. A water resources management authority with fiscal autonomy was highly recommended to operationalise the goals of the plan.

SDG 6.5.2 relates to the proportion of transboundary basin area with an operational arrangement for water cooperation. The IWRM plan for the country states *inter alia* that water resources will be managed based on integrated river basin management with a continued and deliberate effort to maintain and restore ecosystem functioning within catchments and the coastal and marine ecosystems with which they are connected. However, no data was available for this indicator and steps are needed to improve monitoring.

SDG 6.6 Water-Related Ecosystems

For the purpose of monitoring SDG 6.6, the period 2001–2005 has been defined as the baseline, from which changes are measured. The data revealed that the spatial extent of lakes, rivers,

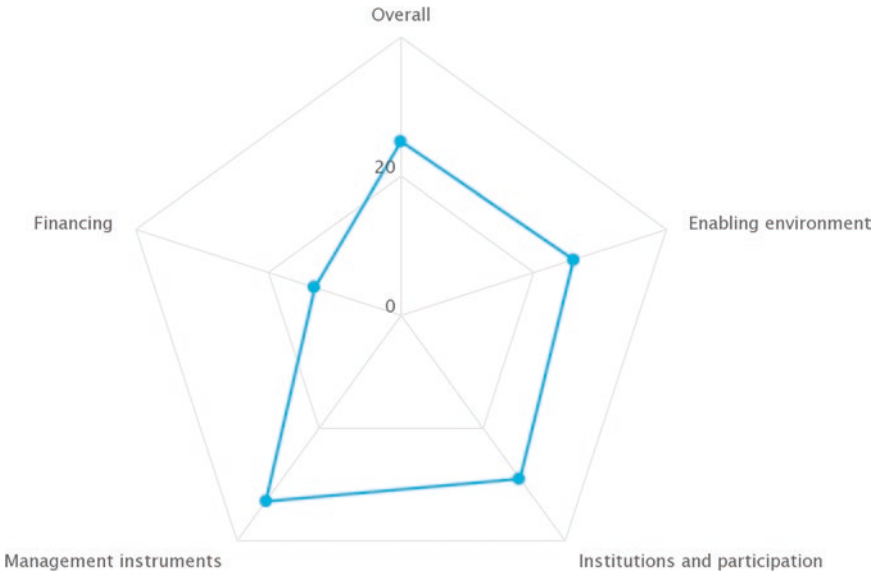

Fig. 3.1 Degree of IWRM implementation in Trinidad and Tobago (2017), score range (0–100) by dimension. (Data source: UNEP. Exported from UN–Water https://www.sdg6data.org on 12 August 2020)

estuaries, and artificial water bodies using the baseline (2001–2005) was 13 km^2 and the latest 5-year period (2011–2015) was 13 km^2. However, change in extent compared to the baseline was a loss of 3%. The country's environmental management policies are not stringently enforced to ensure the protection and restoration of water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes by 2030 which compromises the achievement SDG 6.6.

SDG 6.a International Cooperation and Capacity Building

SDG 6.7 places emphasis on international cooperation and capacity building in several aspects of water and sanitation related activities, *inter alia*, water harvesting, desalination, water efficiency, wastewater treatment, recycling, and reuse technologies. Trinidad continues to build capacity in water harvesting techniques through community-based projects funding under United Nations Development Programme Global Environmental Facility-Small Grant Programme (UNDP GEF-SGP). Over the last decade, the government has secured loans from the Inter-American Development Bank for water management efficiency and wastewater treatment to ensure improved water and sanitation for all. Some of these projects are not fully operational and much more effort is required to enhance water efficiency, recycling and reuse technologies in all sectors. The level of UFW remains as high as 50% which calls for both technical training for improved leakage detection and the acquisition of new technology to stem UFW.

SDG 6.b Stakeholder Participation

The Regulatory Industries Commission provides an opportunity for stakeholder engagement in tariff setting. Additionally, participation in the preparation of the Draft IWRM plan was broad based and included state agencies, the business sector, and civil society.

3.3.2 Barbados

Barbados is one of the highest-ranking water scarce countries in the world falling within the top 15 globally. Its per capita water use exceeds available water resources. Groundwater accounts for the largest proportion of the island's water

resources because the limestone cap, which covers 86% of the island, is highly permeable, allowing for a well-developed aquifer system. Droughts have plagued the country over the last three decades. A notable one was the 1 in 100-year severe drought which occurred in 1994–1995 which left over 3000 households without water on a regular basis and caused the public hospital to experience water shortages (Cashman, 2014). This event marked the turning point in the country's water policy in that a desalinisation plant was built and universal metering was embarked upon to reduce water wastage. In the last decade, however, dependency on tourism for revenue has resulted in satisfying the water needs of hotel sector as a priority, but the hotel sector uses almost three times more water than households (756 L per capita per day versus 240 L per capita per day) (Charara et al., 2011). Tourism's impact on water supply to the population led to policy revisions aimed at encouraging water recycling and conservation in the sector. The ability of the country to achieve SDG6 and its targets within the context of these challenges is discussed in the following sub-sections.

SDG 6.1 Universal and Equitable Access to Affordable Drinking Water

Barbados is well on track to achieving SDG 6.1 as available data revealed that in 2017 an estimated 99% of the population of Barbados' received drinking water and therefore had almost universal access to potable water. Additionally, 97% of the population had at least a basic drinking water service and 96% of the population received piped water directly to their homes, while the remaining population has access from public sources.

In keeping with SDG 6.1, Barbados is likely to achieve an affordable drinking water supply for all its citizens by 2030. The pricing policy adopted is a block tariff structure aimed at ensuring that the basic needs of the poor are met at minimal cost. Currently, the Social Welfare Department covers the cost of water bills for the indigent and aged poor to address equitable access to drinking water. Residential users currently pay US$ 1.84/m^3.

SDG 6.2 Sanitation and Hygiene

SDG 6.2 goal is that by 2030 there is 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. The country is performing very well in achieving SDG 6.2 according to UNDP data, which showed that 99% of the population of Barbados in 2017 had access to an improved sanitation service, and this has been improving since the turn of the century. Nevertheless, much improvement is necessary in the treatment of sewerage as the percentage of urban sewerage presently treated is less than 8%.

Indicator 6.2.1 used to measure achievement in meeting SDG 6.2 is the proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water. Barbados is likely to achieve this aspect of SDG 6 by 2030 as the data revealed that in 2017, an estimated 97% of the population had access to a safely managed sanitation service. Furthermore, although data is lacking on the percentage of population with hand-washing facilities with soap and water at home, it can be extrapolated that this is high given that 96% of the population receives a pipe borne water service to their homes.

Nurse et al. (2012) noted in their earlier research on Barbados that the individual and localised character of wastewater management challenged authorities to effectively control the nature and volume of discharges, particularly because of their weak enforcement capacity. They further observed that regardless of the type of improved sanitation that was envisaged for the island, the system often functioned poorly, provided low levels of treatment such as primary treatment which could not handle all biota, including bacteria, and discharged partially treated effluent off-shore via pipelines or inadvertently into the marine zone via seepage. The decision to build centralised sewerage systems was driven more by the impact of sewage on coral reef health and its implications for the survival of the tourism sector rather than public health considerations (Nurse et al., 2012).

Two municipal wastewater treatment plants, the Bridgetown Sewage Treatment System (BSTS) and the South Coast Sewage Treatment System (SCSTS), and several private package treatment plants service Barbados. The South Coast Sewerage System, commissioned in 2003, is an advanced preliminary treatment plant. Additionally, planning is at an advanced stage for the construction of a third wastewater treatment facility along the West Coast.

SDG 6.3 Water Quality

Barbados faces a difficult road ahead to meet SDG 6.3 especially since it relies on groundwater aquifers as its main source of water which is threatened by weak land use management. As a result, all drinking water is currently treated by disinfections including chlorine gas. Moreover, the island has designated five Groundwater Protection Zones to control groundwater quality. Zone 1 has stringent regulations on built development and land uses near public supply wells while zones closer to the coast have fewer restrictions. This approach has failed to protect coastal waters from land-based pollutants and groundwater supplies from chemical contamination (Government of Barbados (GOB), 2019). However, pollution of the limited available groundwater resources could result in a reduction of the available freshwater resources, and an increase in the number of persons without access to safe and affordable drinking water (GOB, 2019). The Draft Amended Physical Development Plan of 2017 recommended revised land use zonings to address this critical issue of groundwater supply protection.

SDG 6.4 Water Use and Scarcity

According to SDG 6.4 by 2030, countries should substantially increase water use efficiency across all sectors over time, ensure sustainable withdrawals, and supply of freshwater to address water scarcity and reduce the number of people suffering from water scarcity. Approximately 90% of Barbados' groundwater resources are used for public water supply (Cashman, 2014). In 2017, Barbados' renewable water resources were 280 m^3 per capita and water withdrawal was an estimated 293 m^3 per capita. The island is water stressed but there has been improvement since 2000 with the available data in 2014 revealing that 88% of available freshwater resources was withdrawn. Droughts associated with climate change raises water security concerns as households, schools, and businesses are increasingly impacted by inadequate supply in recent years. During the last quarter of 2015, daily water outages severely impacted the lives of many women, the elderly and children. For the women affected, it meant a return to harvesting water to undertake their daily household chores, such as cooking and cleaning. Some schools were closed due to the on-going water shortage. Furthermore, given a reliance on groundwater for food production, urban use, and environmental needs, higher food prices are expected in the future if informed management and policy implementation is not put in place to manage groundwater in the short term, even with modest climate change threats (Gohar et al., 2019).

Water scarcity is being tackled through the Town and Country Planning regulations which makes it mandatory that households build cisterns for water storage. Any building erected after 1996 must provide a rainwater storage tank to capture water for secondary or non-potable uses. Residential structures with 139–279 m^2 of roof area require 13,638 L (13.6 m^3 tank); a residence greater than 279 m^2 of roof area requires a tank of 27,300 L (27.3 m^3), and all commercial and industrial buildings require a tank with a volume computed on the basis of 193 L/m^2 of roof area (Hutchinson, 2010). Additionally, rainwater harvesting must adhere to these guidelines.

To build resilience of domestic potable water reliability to supply interruptions, the Barbados Water Authority created the personal tank programme (PTP) in 2016. The PTP offers a tank solution to customers either for free or as a 5-year interest free hire purchase agreement. The system comprises a 400-gallon tank, 0.6 HP pump, concrete base, and plumbing fittings. By July 2018, the PTP installed 50 free and 215 purchased systems (Issacs et al., 2019). Eighteen of the 50 free

systems remain in-operational due to the inability of programme participants to afford the unexpected/non-advertised plumbing and electrical works (Issacs et al., 2019). To avoid pump electricity costs (US$ 35/month), programme participants store standing water in the tank (potentially stagnant) and take water directly from the utility supply. At least 30 purchased systems store water in this non-flow through design mode.

The lack of water increases health risks and has already led to some minor health challenges in Barbados. While rainwater storage has been promoted as an adaptation strategy to address water scarcity, the risk of vector-borne diseases increases dramatically. It resulted in higher instances of dengue across the Barbados, which has the highest rate of dengue in the Americas (Wilson Center, 2013).

SDG 6.4.1, which addresses water efficiency, was analysed in the context of Barbados. Available data revealed UFW was approximately 60% in 2016 (GOB, 2019). An earlier study revealed UFW comprised under-reading by domestic metres (50%), bulk production metres (15%), and bursts and leakage (40%) (Halcrow, 2010). BWA's non-revenue water (NRW) level estimated for the entire island is 43% of potable water supplied with 7% commercial losses and 36% real losses.

SDG 6.5 Water Resources Management

Barbados needs to improve IWRM according to the statistics available to ensure that it fulfils SDG 6.5 by 2030. As shown in Fig. 3.2, on a scale of 0–100 to measure degree of implementation of IWRM, Barbados scored 40 in degree of integrated water resources management, 30 in finance and an enabling environment, 48 in institutions and participation, and 50 in management instruments .

SDG 6.6 Water-Related Ecosystems

For SDG 6 monitoring, the period 2001–2005 has been defined as the baseline, from which changes are measured. For Barbados, the change in the spatial extent of rivers and artificial water bodies compared to the baseline is a 10% loss of water-related ecosystems. This is three times higher than that for Trinidad over the same period.

SDG 6a International Cooperation and Capacity Building

SDG 6.7 places emphasis on international cooperation and capacity building in several aspects of water and sanitation related activities, *inter alia*, water harvesting, desalination, water efficiency, wastewater treatment, recycling, and reuse technologies. The European Union and CAF-Development Bank of Latin America are financing Barbados' efforts to improve water supply and reduce water losses which includes providing technical expertise to assist the country in re-engineering the water sector. Between 2007 and 2010, the BWA spent between US$ 7.5 million and US$ 9 million annually on replacing and installing new mains. The Government also invested US$ 1.2 million in research to inform future decisions on water supply network rehabilitation and upgrading. The US$ 50 million Water and Sanitation Systems Upgrade Project, funded by the Inter-American Development Bank is addressing some fundamental needs in water resources management under the following three components: (1) institutional strengthening through reorganising and modernising the Authority, (2) rehabilitation of the potable water supply, and (3) development of a wastewater treatment action plan.

SDG 6b Stakeholder Participation

Barbados has performed well in terms of the existence of procedures, laws, and policies to engage local communities in planning water and sanitation services. The level of stakeholder participation is high. The process of policy formulation is generally conducted through the work of a committee of experts and stakeholders. This is an initiative aimed at involving all major stakeholders in the decision-making process. The Barbados Water Authority (BWA) was an active participant in the work of the National Commission on Sustainable Development and provided information on water resources and recommendations for conservation activities for inclusion into the National Policy on Sustainable Development.

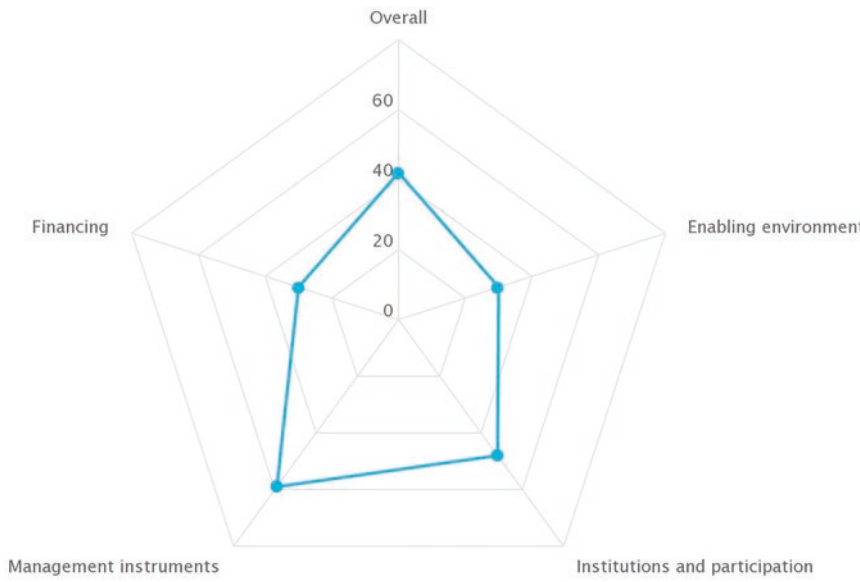

Fig. 3.2 Degree of IWRM implementation in Barbados (2017), score range (0–100) by dimension. (Data source: UNEP. Exported from UN–Water https://www.sdg6data.org on 12 August 2020)

There is an appeals process under the existing BWA Act for conflict resolution.

3.4 Discussion

Trinidad and Barbados are signatories to the UN SDG 6, and it is therefore necessary to gauge if they are on track in meeting the goal of ensuring the availability of potable water and sustainable management of water and sanitation for all their population by 2030. As noted earlier, the two case studies provide a contrast between a water resource rich island and a water scarce island. A summary of their performance in meeting SDG6 is provided in Table 3.4.

The comparative analysis of both case studies provides the basis for guiding other Caribbean SIDS in determining what measures are needed to get them on track in meeting SDG 6 by 2030 and beyond. At the same time, it is necessary to discuss emerging issues, which may derail their efforts to achieve SDG 6 by 2030 and onwards. On the one hand, the health and safety of SIDS populations are paramount concerns, and on the other hand, climate change, associated natural hazards, and COVID-19 pose serious challenges in keeping them on track to meet SDG 6 by the end of this decade. Nevertheless, these challenges may also present opportunities for transformation in water and sanitation service delivery.

3.4.1 Access to Potable Water

As the data showed, by 2030, both Trinidad and Barbados are expected to be well on track in fulfilling SDG 6.1. They have been able to achieve near universal and equitable access to affordable drinking water. An estimated 95% and 99% of the population of Trinidad and Barbados, respectively, have access to potable water. Potable water is a basic human need and the respective governments have ensured that the health and safety of their people are not compromised.

3.4.2 Affordability and Equity

In addressing social equity and affordability of water, the governments of Trinidad and Barbados heavily subsidise domestic water users. The two countries are therefore fulfilling SDG 6.1 in that the majority of their populations pay very low

Table 3.4 Performance of Trinidad and Barbados in meeting SDG 6 targets using indicators

Target SDG 6 and indicators	Trinidad	Barbados
SDG 6.1. Drinking water: Proportion of population using safely managed drinking water	95%	99%
SDG 6.2. Sanitation and hygiene: Proportion of population using safely managed sanitation services including handwashing facility	93%	97%
SDG 6.3. Water quality and wastewater: Proportion of wastewater safely treated. % households with access to central sewerage	48%	8% of urban areas
SDG 6.4. Water use and scarcity: Water use efficiency		
Unaccounted for water	50%	60%
Level of water stress: Freshwater withdrawal as a percentage of available freshwater	20%	80%
SDG 6.5. Degree of Implementation of IWRM: Score 0–100	23	40
Financing	13	30
Management instruments Institutions and participation	33	50
	29	48
SDG 6.6. Change in freshwater ecosystems over time	3%	10%
SDG 6a. International cooperation and capacity building: Water and sanitation overseas development assistance	Loans from Inter-American Development Bank	Loans from CAF-Development Bank of Latin America and European Union
SDG 6b. Stakeholder participation	Regulatory Industries Commission facilitates stakeholder participation in rate setting	Barbados Water Authority enables stakeholder engagement

Source: Author, 2020

water tariffs. Interestingly, the method of water pricing differs but water remains subsidised; Trinidad's domestic users are un-metered in contrast to Barbados' households that are metered. Throughout the Caribbean Region, affordability is a politically sensitive issue and it is likely that subsidised water tariffs for domestic users will remain. Water rates in Trinidad and Tobago rank among the lowest in the Caribbean, which is made possible by large government subsidies as a result of its oil wealth. The government provides an annual subsidy of US$ 294 m (TT$ 2 billion) to the water utility (Attzs, 2020). However, heavy subsidisation has failed to provide domestic users on the whole, and in particular poor and rural households, with a reliable water service and broader water coverage and it has resulted in inefficient water usage and wastage. Furthermore, underpricing of water significantly affects WASA's financial viability and sustainability (Mycoo, 2018).

Although Trinidad is rich in water resources reliability of service remains a major issue for households. In contrast, Barbados as a water scarce country has fewer disruptions in water supply. Approximately 54% of Trinidad's population receives a 24-h 7-day supply whereas all households in Barbados receive an uninterrupted supply of water, except during droughts. Financial and management challenges encountered by Trinidad's water utility, made more complex with state interference in its operations, have resulted in inefficiencies that make it harder to increase water rates to offset improvement costs because justification for rate increases must be simultaneously matched by service improvement.

3.4.3 Level of Service Provision, Sanitation, and Hygiene

The two case study islands are performing extremely well in fulfilling SDG 6.2 and are well on track to maintain this achievement by 2030 once there is no economic disruption. The level of service provision is very high in both countries therefore ensuring that households have access to

hand-washing facilities to ensure that sanitation and hygiene are available to the majority of the population. Approximately 95% and 96% of households in Trinidad and Barbados, respectively, receive in-house pipe borne water. Furthermore, households living in Trinidad's informal settlements have access to standpipe services which are highly state subsidised in the amount of TT$ 33–75 per quarter.

Despite high levels of service provision, the pandemic of 2020 raised new concerns among Caribbean governments especially because COVID-19 has exposed inequalities in Caribbean societies in almost all sectors, not least of which are health and sanitation. The safety protocols called for access to water for handwashing and sanitising household spaces. Trinidad households affected by a disruption in water service requested truck-borne water from the water utility. Moreover, in Trinidad, persons living in informal settlements with limited access to in-house pipe connections also asked for water from the utility. Health and sanitation should not be jeopardised in these islands and therefore more spending will be necessary to provide coverage to the remaining 5–6% of their respective populations living without access to in-house connections.

3.4.4 Water Quality and Pollution

Much improvement is needed over the next 10 years to ensure that both islands achieve SDG 6.3 which seeks to improve water quality by reducing pollution. Trinidad's reliance on surface water has made its water supply vulnerable to uncontrolled point waste discharges especially from industries and domestic sources and high levels of erosion in the upper reaches of watercourses. Weak enforcement of land use and environmental management regulations is a major contributor to surface water pollution which impacts on potable water production. In addition, the low coverage of central sewerage system services to settlements results in less than desirable wastewater treatment. A wastewater treatment plant is scheduled for completion before 2030. Barbados relies on ground water supplies, but aquifers are subjected to contamination from land-based pollutants. Steps have been taken to improve the possibility of meeting SDG 6.3. The Draft Amended Physical Development Plan has re-zoned previous Ground Protection Zones and a third wastewater treatment plant is scheduled for construction before 2030.

3.4.5 Water Use and Scarcity

The two case studies are impacted by inefficient water management which contributes to water scarcity and an unreliable water supply. Their ability to achieve SDG 6.4.1 by 2030 is unlikely unless drastic measures are implemented to significantly reduce water leakages. As noted earlier, Trinidad's level of water loss is significant with approximately 50% of water produced lost because of poorly maintained pipelines or old pipelines that are more than 80 years old. This level may be even higher than estimated due to the increasing number of unregistered consumers, namely squatters who are recorded on WASA's consumer database. Available data for Barbados revealed a similarly high UFW of 60%. As a result of water leakage Barbados has had to increase the level of withdrawal from groundwater aquifers, which is unsustainable and has caused it to be water stressed. Much more investment is needed for upgrading pipeline infrastructure in both case studies to reduce water loss. In the case of Trinidad, universal metering, infrastructure upgrading, and monitoring of illegal connections are key measures urgently required to improve water efficiency and use if it is to be on track in meeting SDG 6.4 by 2030.

3.4.6 Water Resources Management

A comparison of the two case studies highlighted that Trinidad is showing a weaker performance in IWRM in contrast to Barbados. Trinidad performed poorly in the degree of implementation of IWRM with a score of 23 out of a range of 0–100 whereas Barbados scored 40. Trinidad scored 13 in financing and Barbados' performance was

twice better with a score of 30. Furthermore, Trinidad had a lower performance in institutional capacity and coordination and stakeholder participation with a score of 29 in contrast to Barbados with a score of 48. Moreover, Trinidad scored 33 in the use of management instruments compared with Barbados, which had a higher score of 50. Although both countries are not on track as yet to meeting SDG 6.5, the weak performance of Trinidad when compared to Barbados in IWRM translates into the former having to take urgent steps to implement the Draft IWRM plan if it is to be on schedule in meeting SDG 6.5 by 2030.

3.4.7 Water-Related Ecosystems

For Barbados, the change in the spatial extent of rivers and artificial water bodies compared to the baseline is a 10% loss of water-related ecosystems which is three times higher than that for Trinidad (3%) over the same period. Although SDG 6.6 has no direct bearing on safety and sanitation, there is an indirect correlation between loss of freshwater ecosystems such as rivers and groundwater aquifers that can lower the population's access to potable water. Damage to watersheds due to land cover changes related to increasing urbanisation and pollution of surface and groundwater sources from agricultural pesticides and sedimentation degrade water-related ecosystems have occurred. Weak enforcement of environmental and land use planning laws erodes Trinidad and Barbados' potential to stay on course in meeting SDG 6.6.

3.4.8 International Cooperation and Capacity Building

Over the last decade, both governments have secured loans from lending agencies for water management efficiency and wastewater treatment to ensure improved water and sanitation for all. Some of these projects are not fully operational and have been plagued by delays. This component is integral to the achievement of SDG 6.2 by 2030. Trinidad's utilisation of the IADB's loan to construct a modern wastewater treatment plant will improve its chances of meeting its SDG 6.2 target. The funding Barbados received in 2020 from the CAF-Development Bank of Latin America and the European Union for improvement of its drinking water system is a step in the right direction.

3.4.9 Stakeholder Participation

Stakeholder involvement in policymaking and decision-making in the water and sanitation sector is in the need of strengthening in both countries. Moreover, there are other activities such as land use planning and environmental management which impact on SDG 6. Participation of a broad range of stakeholders in consultations related to these activities would help improve the possibility of attaining water and sanitation goals by 2030. The engagement of the business sector and civil society is likely to facilitate compliance with regulations on water pollution and water use efficiency.

3.5 Recommendations

If Caribbean SIDS are to stay on course in achieving SDG 6 the barriers faced in transforming water and sanitation services must be dismantled. Recommendations are advanced in this section to provide Caribbean SIDS with potential measures for staying on track to achieve SDG 6.

The Region has near universal access to potable water, but this very good performance in meeting target SDG 6.1 can change with double exposure; if COVID-19 proves to be an insurmountable challenge to increase infrastructural investment and if climate change exacerbates water scarcity. Most scenario studies reflect that SIDS in the Caribbean can expect less precipitation in future years (Nurse et al., 2014). Droughts have been increasing in the Region so that a concerted effort is needed to curb excessive water consumption and minimise pipeline leakages. Reduced water usage calls for a water pricing method, which is reflective of production and

transmission costs and water scarcity, while simultaneously ensuring that the objective of equity in access to potable water is guaranteed. Fiscal measures such as incentives for adopting water saving devices may also help reduce wastage. Additionally, technological changes are fundamental to addressing pipeline leakage. Technologies for leakage detection such as Geophones, Hydrophones, Infrared Thermography, and Ground Penetrating Radar should be adopted. Furthermore, investments in pipeline replacement and upgrading will be key to tackling water loss from pipelines.

Of all the regions, the Caribbean SIDS have the highest debt percentage (76% of their GDP in 2014) (Gheuens et al., 2019). In the past decade, debt levels have continued to grow. In the past decade, debt levels have continued to grow. High debt levels pose a challenge as they limit the capabilities of SIDS to invest in better infrastructure to enhance their resilience and to further their development (Gheuens et al., 2019). Economic disruption arising from COVID-19 will further diminish state revenue and lead to investment delays. A prioritisation of spending on water infrastructure is therefore critical and requires strong financial management.

Growing trends in flooding as well as storm and hurricane damage have disrupted water supplies from reservoirs across the Caribbean. Stricter watershed management is key to reducing sedimentation of water reservoirs which occurs during the rainy season and especially in the aftermath of storms and hurricanes. Several Caribbean islands with assistance of agencies such as the UNDP Global Water Partnership and the European Union have developed IWRM plans. Implementation of IWRM plans and policies is paramount. As the two case studies revealed a more robust land use planning framework is integral to the mitigation of flooding, water resource loss, and water pollution. This requires enforcement of land use planning regulations such as restrictions on building in hilly areas as is utilised in Trinidad or land use zoning regulations as used in Barbados. Another option is the use of market incentives to encourage compliance with these rules. The latter can include tax subsidies to promote re-afforestation aimed at sediment control which lower water treatment costs.

At the regional scale, Farrell et al. (2007) predicted that Caribbean SIDS faced many challenges, and with the additional threats posed by climate change, management of water resources on Caribbean islands will become more difficult due to the complex interactions between the various threats. Sea level rise and droughts arising from temperature increase and declining precipitation can have severe impacts on freshwater resources. Mitigation will require more water resources personnel, knowledge of existing resources including economic valuations of resources, and appropriate management strategies and policies.

A more robust water governance framework is recommended to help Caribbean islands to meet SDG 6. Although several countries have been making strides toward attaining SDG 6, retaining a command and control approach allows for political interference in day-to-day operations and water pricing. State subventions leave too much opportunity for political intervention in the decision-making of water authorities. A fiscally autonomous water agency is integral to the sustainable management of water resources, safe water supplies, and improved sanitation and hygiene. Independent regulatory commissions and broad stakeholder engagement are pivotal to curbing excessive state involvement in water service delivery.

Back in 1999, the Inter-American Institute for Cooperation on Agriculture highlighted the lack of water professionals in the Region, but capacity building among water professionals has improved significantly in the last two decades. As a regional university, The University of the West Indies has strengthened capacity through the M.Sc. Water and Wastewater Management Programme. However, this programme is no longer offered although its delivery in the future should be revisited given the importance of SDG 6 to the Region. The Caribbean Water and Wastewater Association has been contributing to on-going training of pro-

fessionals and its efforts should be strongly supported by Caribbean governments. Much work still needs to be done in capacity building activities in implementing IWRM, water, sanitation, and health service delivery, water integrity, use of national risk profiles and risk assessments, water governance and strengthening of institutions, and through financing mechanisms. To enable informed decision-making, over the next decade activities will also have a focus on strengthening access to a range of reliable water data, by scaling up underutilised, cost-efficient, and new methods of collecting data including remote sensing techniques, as well as making data more accessible and open to enable its effective use to model and plan for future scenarios.

The UN (2018) recommends stepping up international and regional cooperation and collaboration in science, research, and innovation for the sustainable development of water resources at the local, national, and regional levels, including through public–private and multi-stakeholder partnerships, and on the basis of common interest and mutual benefit. In keeping with the UN's (2018) recommendations throughout the Region it is important to facilitate access to knowledge and the exchange of good practices; improve knowledge generation and dissemination, including new information relevant to water-related SDGs; pursuing advocacy, networking and promoting partnerships and action; and strengthen communication actions for implementation of the water-related goals.

COVID-19 threatens to throw Caribbean countries off track in meeting SDG 6. Economic disruption has been severe in the Region as SIDS are extremely vulnerable to external shocks due to their small open economies. This has consequences for their ability to fulfil SDG 6. Infrastructural investments in water and sanitation will need to be revisited in light of pressing priorities to develop stimulus packages for the business sector to re-engage as partners in economic recovery and transformation. Investment trade-offs may become necessary to cope with the devastating economic impacts of the pandemic.

3.6 Conclusion

Caribbean SIDS were making progress toward attaining some aspects of SDG 6 prior to COVID-19. Despite experiencing climate change impacts such as drought, as the selected case studies demonstrated, near universal access to potable water and equity has been guaranteed as a result of highly subsidised water provision by governments. If the Region is to make even greater strides in meeting SDG 6 it will need to overhaul the management approach currently in use. Greater fiscal and management autonomy of water and sewerage service providers has been overlooked by Caribbean governments, which have treated water more like a social good rather than an economic one. Paradoxically the Command and Control Approach, excessive political interference and state paternalism have together undermined the quality of service to domestic consumers. While there is no single panacea to address the difficulties faced by Caribbean countries in meeting SDG 6 because they are all distinct in terms of water resource availability based on their unique geographies, the fiscal and management approaches they have adopted are quite similar as the case studies showed. Too much focus on a supply-led response to meeting basic water needs, instead of a demand management response, has compromised the ability of Caribbean islands to achieve more of the SDG 6 targets. A range of options for improving performance in meeting such targets exists. These can be distilled as best practices in formulating a plan at the country level to forge ahead in meeting SDG 6 by 2030 and beyond. COVID-19 and climate change combined may have fast tracked innovative ideas to finally confront weak management in water and sanitation. Double exposure to external economic and economic shock, though they threaten the Caribbean's survival in the future, can positively transform how Caribbean SIDS tackle issues of access, affordability, equity, economic efficiency, environmental sustainability, and stakeholder engagement aimed at meeting SDG 6. Crises often present opportunities for transformation and innovative ways of achieving SDG 6 in the Caribbean can be realised.

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4 Safe Water and Sanitation for a Healthier World: A Global View of Progress Towards SDG 6- Africa

Tekalign Tsige Sahilu

Abstract

Among the world's regions, sub-Saharan Africa is lagging in progress in achieving the SDG 6 targets of universal access to water and sanitation. If sub-Saharan Africa continues with the current pace of progress, achieving the targets by 2030 are unlikely. Various challenges contribute to the slow pace of progress of the access to water and sanitation by the sub-Saharan Africa population. The author categorizes the challenges under two interlinked areas, physical water scarcity and economic water scarcity. The physical water scarcity refers to a lack of available water resources, and the economic water scarcity refers to limited water access resulting from insufficient financial resources. An in-depth analysis of the economic scarcity reveals a significant financing gap in Africa to meet the universal coverage of water and sanitation. The study proposes various options for financing mechanisms to close the gap. The conclusion is that African countries need to put an extraordinary effort into increasing the water and sanitation services' annual coverage rate to achieve the SDG 6 targets by 2030.

Keywords

Sub-Saharan Africa · Monitoring progress · Challenges · Population · Water stress · Financial stress

4.1 Introduction

Article 31 of the 2010-UN resolution recognizes everyone's right to clean and accessible water, adequate for the health and well-being of the individual and family. No one shall be deprived of such access or quality of water due to individual economic circumstance. In general, the "rights to water" refer to the citizens' moral or legal entitlement over getting water in adequate quantity and quality. It can be a fundamental right for a specific country or human rights when it refers to worldwide acceptance.

As a human right, the UN resolution reminds the member states to avail clean and safe water in adequate quantity to all the citizens, irrespective of the economic status, whether a rich or poor person. The provision of sufficient and clean water to people entails costs. The aging of infrastructure exacerbating water loss, climate change affecting the quality and quantity of water, increasing costs of services, materials and equipment, and supplying clean water is getting more expensive across many countries. And hence paying for water is understandable and unavoidable. As a fundamental right, governments should not

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deny citizens access to clean water due to their economic status. But it does not mean providing the services free of charge. We need to understand that setting water tariffs and charging low-income residents more than they can reasonably afford to pay is violating the people's human and fundamental rights. To make the water tariff affordable to the citizens, many African governments subsidize water and sanitation services targeting low-income residents.

African countries have recognized water as a fundamental right and contribute to achieving efficient and equitable economic growth. The countries have stated in their constitution about providing water to the citizens as fundamental rights. For instance, Kenya's Constitution (2010) [1] says every person has the right to clean and safe water in adequate quantities. The Constitution of the Federal Democratic Republic of Ethiopian (1995) [2] articulates that to the extent the country's resource permit, policies shall aim to provide all Ethiopians access to public health and education, and social services (clean water, housing, food, and social security). The Constitution of the Republic of South Africa was promulgated by President Nelson Mandela on December 18, 1996, and came into effect on February 4, 1997. Section 7, under the Bill of Rights, states "the rights to food, **water**, health care and social assistance, which the state must progressively realize within the limits of its resources" [3].

In some countries, such rights are shown in national policies and strategies. For instance, in Rwanda, the National Policy & Strategy for Water Supply and Sanitation Services (2010) gives direction to the Water Supply and Sanitation Sector (WSS) to endeavor that all population groups, including vulnerable households, children, elderly and disabled persons benefit from its interventions. Rwanda's water and sanitation policy gives due attention to affordability and considers the specific needs of the disadvantaged population groups.

As part of fulfilling their commitment to supplying clean water to the citizens, African nations have planned to implement internationally agreed programs each, 2000–2015 the Millennium Development Goals (MDGs) and 2016–2030 the Sustainable Development Goals (SDGs).

This study aims to examine Africa's readiness and progress in meeting the SDG 6 targets. The approach or methodology of the analysis profoundly depends on secondary data sources. The author likes to remind the readers that lack of data in general and up-to-date data is the main limitations of the African water and sanitation sectors to make a comprehensive analysis and reach concrete conclusions.

The Africa continent is divided into five sub-regions, North, Eastern, Southern, Western, and Central. For data collection and reporting purposes, some international organizations like the World Bank categorize the Northern African countries with the Middle East and treat the rest of the sub-regions under one category called sub-Saharan Africa. Except for Sudan, most of the Northern Africa countries are at an advanced stage of the universal access to water and sanitation. Therefore, the challenge is with sub-Saharan Africa, which is the focus of this study.

4.2 From MDGs (2000–2015) to SDGs (2016–2030) in Africa

During the MDG era, in sub-Saharan Africa, where the initial water coverage had been low, the population's proportion with access to an improved drinking water source increased by 20 percentage points, despite significant population growth. However, sub-Saharan Africa is one of the regions that remain furthest behind improved sanitation facilities. Between 1990 and 2015, the population's proportion using an improved sanitation facility increased only from 24% to 30% [4].

The MDG Report 2015[5] highlighted some critical challenges that we need to consider during the SDGs. The report indicated that the MDG experience exposed the data challenges facing national statistical systems and underscored the importance of strengthening statistical and analytical capacities. Analyzing the future SDG program, the report said that the data requirements

for tracking SDG progress would be greater than those for the MDGs, reflecting the SDGs' broader scope and the emphasis on disaggregation of data.

Regarding water and sanitation, the report noted the progress on access to safe drinking water in the continent has been steady; however, many countries are experiencing water stress, which is likely to be exacerbated by climate change. As water use for irrigation and other agricultural purposes increases, countries need to introduce more efficient water management systems.

Under the SDGs, the water and sanitation have been established as one of the 17 goals. The establishment of SDG 6, *Ensure availability and sustainable management of water and sanitation for all,* reflects the increased attention on water and sanitation issues in the global political Agenda [6]. The targets associated with the SDG 6 are described in the UN report [7]. Among the targets, the two most critical elements are Target 6.1 (access to universal and equitable access to safe and affordable drinking water for all) and Target 6.2 (access to adequate and equitable sanitation and hygiene for all and end open defecation, paying particular attention to the needs of women and girls and those in vulnerable situations). We have translated the indicators of these two targets to mean, in all African countries by 2030:

- 100% of the population use safely managed drinking water services, one located on-premises, available when needed, and free from contamination.
- 100% of the population use safely managed sanitation services that a household does not share with other households and where excreta are safely disposed of in situ or transported and treated off-site, including a hand-washing facility with soap and water.

In addition to SDG 6, basic services also are included as targets of SDGs 1(ending poverty) and SDG 11 (cities and human settlements). SDG 1 target 1.4 includes having equal **access to basic services** by all men and women, particularly the poor and vulnerable, with the related indicator of the population living in households with access to basic drinking water, sanitation, and hygiene. The inclusion of basic services among SDG 1 targets implies its direct impact and contribution of safe drinking water and sanitation in ending poverty. One of the targets (11.1) of SDG 11 is to ensure access for all to adequate, safe, and affordable housing and **basic services** and upgrade slums. Under this target, the basic services element implies the need to acquire houses with sufficient and affordable drinking water and sanitation.

While discussing Africa's water and sanitation services, another consideration is the Africa Union Agenda 2063. On the occasion of celebrating the founding of the Organization of African Unity (OAU) in May 2013, Africa's political leadership took stock of past achievements and challenges and rededicated itself to its socioeconomic and political transformation. In this regard, the Assembly requested elaborating a forward-looking 50-year continental framework, namely Agenda 2063.

The AU Agenda 2063 was adopted in January 2015, in Addis Ababa, Ethiopia by the 24th African Union (AU) Assembly of Heads of State and Government. The Agenda has seven aspirations with related goals and priority areas elaborated into five implementation plans of 10 years each. The first 10 years plan that covers 2014–2023 is under implementation [8].

The *Aspiration, Goal,* and Priority Area where the target for safe drinking water and sanitation included are the following:

- *Aspiration 1: A prosperous Africa based on inclusive growth and sustainable development.*
- *Goal 1*: *A High Standard of Living, Quality of Life and Well-Being for All Citizens.*
- *Priority Area: Modern and Liveable Habitats and Basic Quality Services.*
- *Target safe drinking water and sanitation* (*First Ten Years Plan): to reach nine out of ten persons (90% coverage) by 2023.*

The water and sanitation service levels of African people are found at different stages. The Joint Monitoring Program (JMP) of WHO/UNICEF defines different services levels known as "ladders." The JMP ladders, as shown in Box 4.1, help the African countries to understand and plan the water and sanitation targets to achieve by 2030.

According to the JMP ladders, the safely managed water and sanitation services (SDG 6.1 and 6.2 targets) are the highest services standards. However, looking at the progress achieved so far, and the future trend based on the historical data, many countries in Sub-Sahara Africa may not be in a state of achieving even the target of at least basic water and sanitation services by 2030.

Box 4.1 The Joint Monitoring Program (JMP) Ladders

Drinking water	Sanitation
Safely managed	
Improved water source located on-premises, available when needed and free from contamination	Facilities not shared with other households and where excreta are safely disposed in situ or transported and treated off-site
Basic	
Improved source, the collection time is not more than 30 min for a roundtrip, including queuing	Improved facilities not shared with other households
Limited	
Improved sources, collection time, exceeds 30 min for a roundtrip including queuing	Improved facilities shared between two or more households
Unimproved	
Unprotected dug well or unprotected spring	Pit latrines without a slab or platform, hanging latrines or bucket latrines
Surface water	*Open defecation*
Directly from a river, dam, lake, pond, stream, canal or irrigation canal	Disposal of human faces in fields, forests, bushes, open bodies of water, beaches, and other open spaces or with solid waste

4.3 Sub-Saharan Africa Situation in Access to Basic Drinking Water and Sanitation

As per the World Bank data [9] as of 2017, sub-Saharan Africa was the lowest in terms of the population's proportion with access to basic drinking water and sanitation services compared to the rest of the world (Table 4.1). While the basic drinking water services coverage was above 90% for all the world regions, it was 61% for sub-Saharan Africa. Likewise, the access to basic sanitation of sub-Saharan Africa was the lowest (31%) followed by South Asia (59%) while the rest of the world regions had coverage in the range of 84–100%. This situation is a clear manifestation of unequal access to basic services among the world's regions, sub-Saharan Africa being underprivileged. In actual figures, in 2017, more than 400 million and 700 million sub-Saharan Africa people did not have at least basic water and basic sanitation services, respectively.

In sub-Saharan Africa, the ever-growing demand for water and sanitation services due to population increase, industrial development, and fast-growing urbanization have created pressure on providing adequate services by the utilities. Consequently, the service providers/utilities could not meet the growing demand, resulting in inefficiency as expressed in terms of the quality of the service provisions and lack of inclusiveness. There is a disparity between the rich and poor in Africa. The low-income people access small quantities and low-quality water and sanitation but relatively pay per unit more than the rich. In sub-Saharan Africa, statistics show significant inequalities between rural and urban access to water and sanitation services. For instance, in 2017, of Africa's total population, 60% was rural and 40% was urban. However, according to the World Bank [10], the rural population with access to water was 51%, and access to sanitation was 29%. On the other side, the urban population with access to water was 86% and with access to sanitation was 54%. We can see the disparity between rural and urban Africa by looking at urban to rural ratio without access

Table 4.1 People using at least basic drinking water and basic sanitation services by the regions of the world (% of the respective population), 2017

	Basic drinking water			Basic sanitation		
Region	Total	Rural	Urban	Total	Rural	Urban
World	90	81	96	73	59	84
East Asia and Pacific	93	86	98	84	74	89
Europe and Central Asia	98	97	99	97	93	98
Latin America and Caribbean	97	87	99	87	68	91
The Middle East and North Africa	94	87	97	91	81	94
North America	99	97	100	100	100	100
South Asia	92	91	96	59	53	71
Sub-Saharan Africa	61	46	84	31	22	45

Source: The World Bank Open Data, https://data.worldbank.org/indicator/SH.STA.SMSS.ZS

to the basic services. For every person without safe drinking water in urban areas, there were five unserved people in rural areas. Also, for every person without improved sanitation services in urban areas, there were two unserved people in rural areas. In addition to other factors, the presence of such inequalities between urban and rural Africa in access to water and sanitation services attribute to the lack of institutional capacity to design and implement a proper policy and strategy.

Furthermore, within urban areas, disparities in access to basic water and sanitation exist between the affluent communities and slums or peri-urban areas, mostly deprived of such basic amenities in terms of quantity and quality standards. Unavailability of data of access to the basic services by income group or by the type of settlements (slum and affluent) could not allow us to look at the disparity between the rich and the poor. However, the likelihood of lack of access to either drinking water or improved sanitation services by the low-income or poor people in Africa is significant, which is the sign of lack of inclusiveness.

In line with Agenda 2063, the Africa Union produced the first continental report on the implementation of the program in February 2020 [11]. The report indicated a modest performance at a continent (from 68.4% in 2013 to 77% in 2019) registered to increase access to safe drinking water. Based on the reported coverage rates, we have estimated that of the total population of Africa (about 1.308 billion [12]) more than 300 million people were excluded from accessing safe drinking water in 2019. The report did not include information/ data on the progress of access to basic sanitation.

4.4 The Progress of Sub-Saharan Africa in Meeting the SDG 6 Targets by 2030

Based on the baseline data (2017) of basic water and sanitation coverage of sub-Saharan Africa, the author tried to look at the future, 2030, under two scenarios. The first scenario assumes that the sub-Saharan African countries exert extraordinary efforts to meet the SDG targets of universal coverage (100%) of the population by 2030. To reach the full coverage by 2030 and take 2017 as the baseline, sub-Saharan Africa needs to achieve an average annual increase of coverage of 3.9% for basic water and 9.4% for basic sanitation. With these growth rates, it is possible to ensure no one will be left behind (universal access to water and sanitation of Africa's people) by 2030.

The author also considered the business-as-usual scenario, which assumes no significant change. The historical average growth of the rate of increase in access to both drinking water and sanitation will continue. In other words, it means that the historical trend of the annual rate of growth of access to water and sanitation between 2010 and 2017 will continue up to 2030. Accordingly, the finding is that the average yearly rate of change of access for basic water was 1.4%

and for basic sanitation was 1.5% for the years 2010–2017.

Figure 4.1 shows the population coverage levels of the basic water and sanitation services per annum for the years 2018–2030 under the two scenarios, SDG target and business-as-usual paces of progress. Under the SDG targets scenario, the level of coverage for both water and sanitation will reach 100% by 2030. However, under the business-as-usual scenario, sanitation and water coverage will get 38% and 73%, respectively, by 2030.

Table 4.2 describes the population to be served and unserved in figures under the two scenarios described above. Under the SDG target scenario, the total sub-Saharan population of close to 1.5 billion will access basic water and basic sanitation services by 2030. Sub-Saharan Africa can achieve this full coverage by increasing drinking water access for about 846 million and to sanitation for about 1.2 million between the years 2018–2030. In the business-as-usual scenario, the population with access to water is about 444 million and to sanitation is about 238 million. Given the total population of about 1.5 billion by 2030, then the business-as-usual scenario will leave more than 402 million without safe drinking water (at least basic water services) and 922 million people without improved sanitation (at least basic sanitation services) by 2030.

4.5 The Challenges of Water and Sanitation Sectors of Africa

For African people, obtaining clean and safe water is the fundamental right. And providing clean and safe water to the population is a constitutional obligation of the government. Accordingly, people have the privilege of demanding for the service. However, expanding water and sanitation service to cover all populations requires significant resources (material/human/financial). Securing the resources needed has remained to be the challenge and beyond the capacity of many African countries. Consequently, the progress of achieving the targets remained to be quite an important challenge during the MDGs as well as during the ongoing SDGs.

Various factors contribute to the low level of access and unequal distribution of water and sanitation services among Africa's population. We can categorize these factors into two-physical water scarcity and economic water scarcity.

The physical water scarcity refers to a lack of available water resources resulting from natural and human-made factors. The economic water scarcity refers to limited water access resulting from insufficient financial resources to access, store, and distribute the water for different uses.

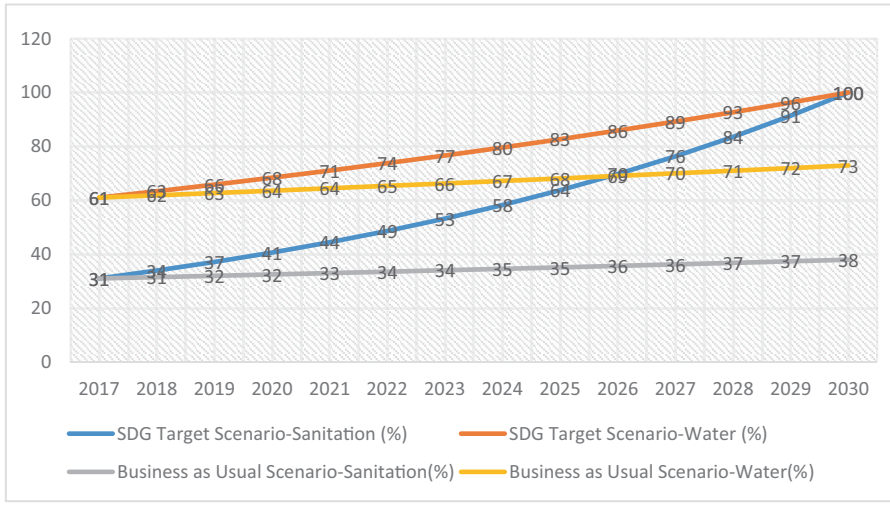

Fig. 4.1 Progress towards achieving the SDG 6 targets

Table 4.2 Estimation of the population to be served by 2030 under two scenarios

Baseline sub-Saharan Africa population (2017)	1,050,000,000	
Projected population (2030)	1,486,456,544	
Sector	**Water**	**Sanitation**
Population served in % (2017)	61	31
Population served in figures (2017)	640,500,000	325,500,000
Meeting the SDG target progress scenario		
Population should be served between 2018 and 2030	845,956,544	1,160,956,544
Total population served by 2030	1,486,456,544	1,486,456,544
Population will be unserved by 2030	–	–
Business-as-usual progress scenario		
Population to be served between 2018 and 2030	443,791,851	238,385,047
Total population served by 2030	1,084,291,851	563,885,047
Population that will be unserved by 2030	402,164,693	922,571,498

Source: Author's forecast based on the historical trend of rates of increase of the World Bank data of 2010–2017

4.5.1 The Physical Water Scarcity

The familiar water supply sources are surface water (lakes and rivers) and groundwater (aquifers). These sources mainly depend on rainwater. Also, some countries use seawater through the means of desalination.

The three significant factors that affect freshwater supply availability are climate, the geological formation of the landscape, and pollution or contamination. With climate change, the rainfall pattern in many parts of the world, particularly Africa, is unpredictable. The climate change can cause low levels of rainfall in which less water is available to feed the rivers and lakes or recharge the groundwater. The increase of temperature due to climate change can lead to water evaporation from the surface water, making less water available for use.

The nature of the geology influences the surface and groundwater resources. As rainfall flows down to the rocks beneath the ground, permeability or impermeability of the rocks of the area contributes to groundwater or surface water formation. Areas with permeable rocks have the potential of groundwater sources, while areas with impermeable rocks are sources of surface water.

Pollution affects places with either plenty or even scarce water resources and can make it unsafe to use. There are various water pollution sources, including sewage and wastewater from industries, institutions, hospitals, commercial settings, and households. In such cases, the surface water is more susceptible to pollution than groundwater. However, we cannot rule out the presence of some pollutants that can travel down into the ground and contaminate the groundwater. Due to over-abstraction, the seawater's intrusion into the underground can be a common source of contamination of the groundwater in islands and coastal areas. It is common in gold mining places to observe surface water-polluting (rivers and streams) by pollutants of uranium, arsenic, and sulfuric acid.

Growing populations, rising incomes, and expanding cities will converge upon a world where water demand increases exponentially, while supply becomes more erratic and uncertain [13]. Only 2.5% of the world's oceans and seas harness freshwater, salts concentration of less than 1 g/L. However, 70% of fresh water is frozen as eternal ice. Only less than 1% of freshwater can be used for drinking [14]. Consequently, we can reach a situation where the available fresh water on the earth cannot meet the increasing water demand, leading to a critical shortage of water or severe water scarcity. Like a shred of evidence, based on the World Bank open data sources, we have looked at the historical (1962–2012) trend and forecasted the future trends (up to 2052) of the per capita internal renewable freshwater at the world level and some selected regions of the world. Figure 4.2 shows the historical trend of the renewable internal freshwater resources per capita from 1962 to 2012 of the

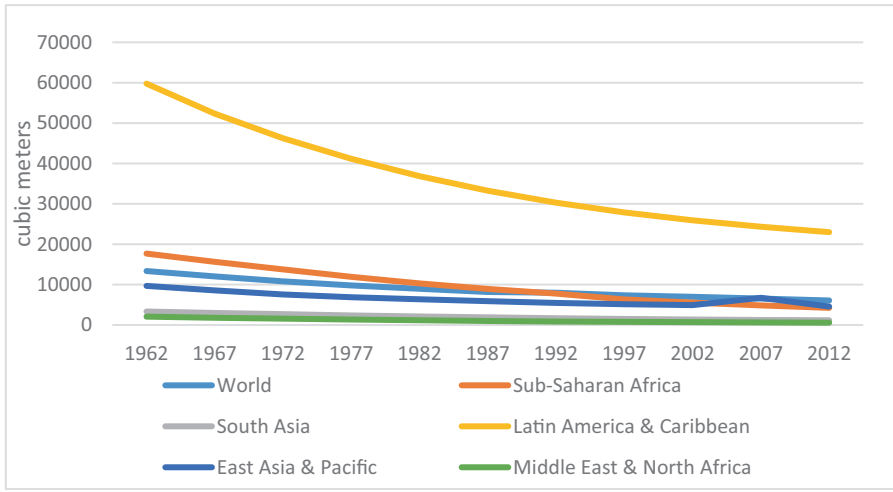

Fig. 4.2 Renewable internal freshwater resources per capita for the world and selected regions (1962–2014). (Source: Graph constructed by the author based on the World Bank Open Data https://data.worldbank.org/indicator/ on renewable internal freshwater resources per capita)

whole world and selected regions of the world. With a cumulative average decline rate of 1.56% per year, the per capita internal renewable freshwater, which was 13,365 cubic meters globally in 1962 reached 6074 cubic meters in 2012. It is about a 55% decrease in 50 years.

The average rate of decline of the per capita internal renewable freshwater from 1962 to 2012 was the highest in sub-Saharan Africa (−2.82% per year) followed by the Middle East and North Africa (−2.54%/year). For sub-Sahara Africa, the per capita renewable internal freshwater, which was 17,686 cubic meters in 1962 had reached 4244 cubic meters in 2012, which was about 76% decrease in 50 years.

The future is worrying much if the trend continues the same way. Assuming no change of factors affecting the per capita freshwater levels, and applying the annual average decline calculated for the period 1962 to 2012 for the future, in 2052 the renewable freshwater per capita reaches 1355 cubic meters for sub-Saharan Africa (SSA) and 3232 cubic meters for the world as a whole. The lowest rates will be the Middle East and North Africa (MENA) with 205 cubic meters per capita, followed by South Asia 510 cubic meters per capita. Figure 4.3 shows the forecast (2013–2052) for the whole world and selected regions. Typically, the trend sends a message of the level of water stress and acute water shortage that many countries of the world will be facing unless far-reaching solutions are put in place as early as possible. The forecasted levels of per capita of freshwater shows that some regions, including sub-Saharan Africa, will be affected drastically. Under such circumstances, it is hardly possible to think of the countries and regions' economic growth and development, which will lead to an increasing level of poverty and catastrophe in all forms.

Looking at Africa critically, both water scarcity and quality have remained challenges with a detrimental impact on economic growth, health, and food security. As per Africa water vision report [15], 10 African countries experienced water scarcity in 1995. The countries were Algeria, Burundi, Cape Verde, Djibouti, Egypt, Kenya, Libya, Malawi, Rwanda, and Tunisia. Projections indicate that the situation will worsen by 2025, 14 countries will suffer water scarcity, and a further 11 countries will suffer water stress. In a few years, at the current rate of increase in water demand, almost all sub-Saharan African countries will be below the level at which water supply is enough for all. Even worse, most of them will be in a state of water stress or scarcity.

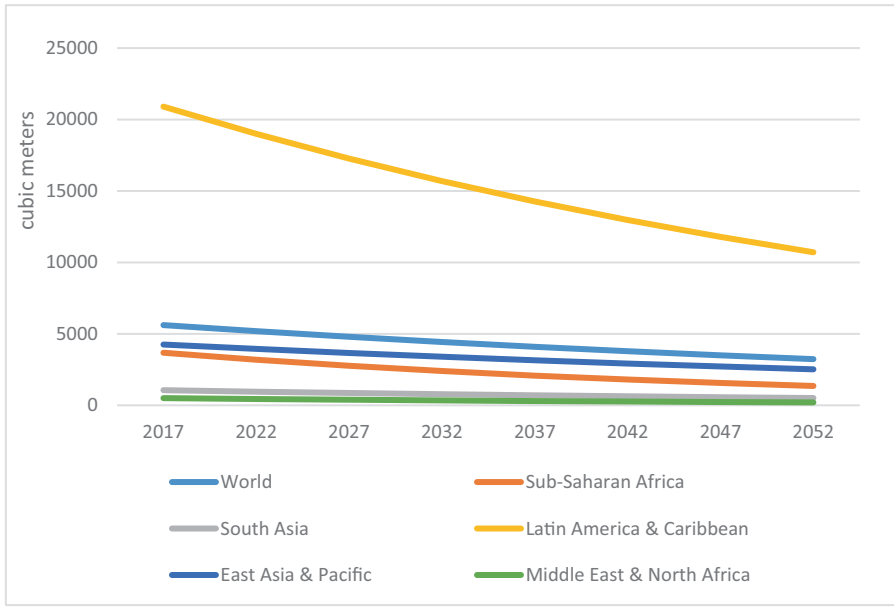

Fig. 4.3 Forecast of internal renewable freshwater per capita by selected world regions. (Source: Forecast made and graph constructed by the author based on the World Bank Open Data of 1962–2012 on renewable internal freshwater resources per capita as shown under Fig. 4.1 above)

Africa's water resources are being degraded due to high demand and untreated wastewater entering the environment from industry and domestic sources. Adaptation and water resources planning is difficult, as many African countries have no established water quality monitoring programs. Most rivers and watercourses are non-gauged, and the rural and peri-urban water supply are not considered an essential part of most water treatment systems. Water pollution statistics are limited as adequate analytical laboratories are scarce. There has been a lack of focus on water as a critical resource, and therefore, this sector has seen substantial under-investment. Above all, the absence of a structured framework for water governance is hindering effective water management [16].

One of the technical challenges of the African countries is the high non-revenue water (NRW). It represents water that has been produced and is "lost" before it reaches the customer (either through leaks, through theft, or through legal usage for which no payment is made). For instance, as per the International Benchmarking Network (IBNET) report [17], in 2017, countries with more than 40% NRW included Zambia (49%), United Republic of Tanzania (47%), Rwanda (43%), and Mozambique (42%).

African utilities are not invulnerable to the impact of climate change. The degradation of the ecosystem and the various activities within the watershed (agriculture as an example) significantly impact the water resources and affect water quality and quantity. Also, contamination of water in the source and distribution system and the growing water scarcity and lack of water reuse and conservation are factors that are contributing to the challenges of meeting the SDG 6 targets in Africa.

4.5.2 The Economic Water Scarcity

Costing of the Basic Water and Sanitation Services

Estimating the costs is an integral part of the planning and mobilizing resources to reach the SDG 6 targets by 2030. It is challenging to come with the near to actual estimates of the costs needed to achieve the targets. However, a study

sponsored by the World Bank indicates that meeting the WASH-related SDG targets will require considerably more capital resources in all regions. Still, in sub-Saharan Africa, the requirement is 2.0% of the Gross Regional Product, which is by far higher than other regions of the world. This amount was estimated to be 0.58% of GRP in Northern Africa, ranging from 0.15 in Eastern Asia to 0.85 in Southern Asia [18].

Alternatively, we can use the per capita costs to estimate the total water and sanitation costs to serve the additional population. Accordingly, we have collected secondary data on costs from reliable sources. We used the technical paper by Guy and Mili [19] on the costs of meeting the 2030 SDGs target as the primary source to estimate the per capita costs of water and sanitation. The author provided the total population to be served by 2030 and the related capital costs per year. We used this information to arrive at the total capital cost required for 15 years period. We divided this total by the total population to be served to arrive at the per capita capital costs under the lower, baseline and upper estimates. Table 4.3 shows the results.

The estimation of the additional population to be served under the two scenarios (Table 4.2) and the per capita capital costs (Table 4.3) have helped us to arrive at the total capital costs of the water and sanitation for sub-Saharan Africa (Table 4.4). As per the estimation, the total capital costs range from US$21 billion (lower estimate) to US$67 billion (upper estimate) for the basic water services and from US$153 (lower estimate) to US$238 billion (upper estimate) for basic sanitation services. The baseline estimate (average) of total capital costs of basic water services is about US$40 billion, while that of basic sanitation is US$196 billion. The total capital costs of basic sanitation are almost five times that of basic water's total capital costs.

The comparison of the additional population to serve under the SDG scenario is almost double than the additional population to serve under the business-as-usual scenario. For the SDG scenario, the total capital costs (investment requirements) for basic water range from US$20 billion for a low estimate to US$65 billion for an upper estimate and basic sanitation from US$148 billion for a low estimate to US$230 billion for an upper estimate. The baseline estimates are US$38 billion and US$190 billion for basic water and basic sanitation, respectively. For the business-as-usual scenario, the total capital costs (investment requirements) for basic water range from US$10 billion for a low estimate to US$34 billion for an upper estimate and basic sanitation from US$30 billion for a low estimate to US$47 billion for an upper estimate. The baseline estimates are US$20 billion and US$39 billion for basic water and basic sanitation, respectively. The comparison between water and sanitation shows that on the average (baseline estimate), the basic sanitation costs are almost five and three times higher than the capital costs of basic water services for the SDG scenario and business-as-usual scenarios, respectively.

The sum of total capital costs of basic water and basic sanitation under the SDG scenario is about US$169 billion for lower, US$228 billion for the baseline, and US$295 billion for the upper estimates. In the case of the business-as-usual scenario, the sum of total capital costs of basic water and basic sanitation for lower, baseline, and upper estimates are US$ 41 billion, US$59 billion, and US$81 billion, respectively. Considering the baseline estimates as average figures, then we can conclude that meeting the SDG targets (universal coverage of drinking water and sanitation) for Africa requires a total budget of US$ 228 billion.

The estimated capital costs of the basic services do not include operation and maintenance costs. Taking into account about 30% (that is commonly used for planning purposes) of the total capital costs to cover operational and maintenance costs, then we can adjust the complete budget requirements to be close to US$300 billion.

The total capital costs that we estimated are aggregate figures for sub-Saharan Africa. Therefore, we need to use the information with caution due to many uncertainties in the underlying data and methodological choices. Consequently, to get more reliable and closer to actual cost figures, each country needs to do own

Table 4.3 Cost data of water and sanitation to reach the additional population from 2016 to 2030

	Basic		Safely managed	
Description	Water	Sanitation	Water	Sanitation
Population to serve by 2030 (millions)[a]	2278	3448	4531	5309
Capital costs $billions per year				
Lower estimate	3.6	29.4	8.6	31.5
Baseline estimate	6.9	37.6	19.5	49.3
Upper estimate	11.6	45.6	32.5	77.2
Total capital costs $billions (15 years)[b]				
Lower estimate	54	441	129	472.5
Baseline estimate	103.5	564	292.5	739.5
Upper estimate	174	684	487.5	1158
Per capita capital cost ($)[c]				
Lower estimate	23.71	127.9	28.47	89
Baseline estimate	45.43	163.57	64.56	139.29
Upper estimate	76.38	198.38	107.59	218.12

Source:
[a]The Water and Sanitation Program of the World Bank Technical Paper prepared by Guy Hutton, and Mili Varughese (January 2016) entitles The Costs of Meeting the 2030 Sustainable Development Goal Targets on Drinking Water, Sanitation, and Hygiene
[b]Author's calculation (the capital costs per year times 15 years–the SDG period)
[c]Author's calculation (the total capital costs (15 years) divided by the total population to serve by 2030)

costing studies based on the local unit costs, which depend on the level of services to be achieved and the mix of technologies. Countries should need to conduct an in-depth analysis of the specific factors that influence costs such as securing bulk water, providing wastewater drainage and sewerage systems, and defining effective behavioral change programs to reach and sustain hygienic practices. Also, the costs need to be disaggregated by rural, urban and peri-urban settlements.

Since the beginning of 2020, in the fifth year of implementing the SDGs, the unforeseen pandemic of COVID-19 has shocked the world. Based on the pace of progress before COVID-19, we were apprehensive about achieving the SDGs targets of basic water and sanitation services in 2030 by many African countries. On top of the slow progress, the COVID-19 pandemic started and spread all over the continent. This pandemic has resulted in another harmful impact on the African economy in general and the SDGs' implementation and achievements in particular. More than ever, developed countries are needed in meeting their commitments to providing 0.7% of gross domestic product as official development aid. However, there is a concern that the developed countries that have been harshly hit by the pandemic will continue to struggle to maintain their problems instead of supporting the African countries. Accordingly, this new incidence can harm financial flows from north to south, affecting the programs' implementation. Therefore, financial resources will continue to be the significant challenges and constraints to fulfill African countries' commitments to meet SDG 6 targets.

Given this fact, African countries have no choice than focusing on their resources. They need to put extraordinary efforts in raising money from domestic sources to finance the SDGs of water/sanitation and modern energy. The next sections of this chapter will give due consideration to the SDG 6-Water and Sanitation financing for African countries.

Sources of Finance

The sources of finance for water and sanitation sector of developing countries include overseas development assistance, loans, grants, international private sector investments, investments by the domestic small-scale private providers, public sector expenditures, and individual household and community contributions.

Table 4.4 Total capital costs to serve the additional population from 2018 to 2030 of sub-Saharan Africa under the two scenarios

Description	Category	Basic water	Basic sanitation
Additional population to serve (2018–2030)- SDG target scenario	Population	845,956,544	1,160,956,544
Additional population to serve (2018–2030)- Business-as-usual scenario	Population	443,791,851	238,385,047
Per capita capital cost ($)	Lower Estimate	23.71	127.9
	Baseline estimate	45.43	163.57
	Upper Estimate	76.38	198.38
Capital costs-investment Requirement (million US$)-SDG target scenario	Low Estimate	20,057.63	148,486.34
	Baseline Estimate	38,431.81	189,897.66
	Upper Estimate	64,614.16	230,310.56
Capital costs-investment Requirement (million US$)-Business-as-usual progress scenario	Low Estimate	10,522.30	30,489.45
	Baseline Estimate	20,161.46	38,992.64
	Upper Estimate	33,896.82	47,290.83

Source: Author's calculation based on the data provided in Tables 4.2 and 4.3 above

Historical data (Table 4.5) shows that the funds to cover the capital expenditure of water and sanitation sectors of the developing countries came mainly from individual households (46%) followed by the Official Development Assistance (27%) and public sector/government budget (23%).

While financing the water and sanitation capital expenditure in developing countries has mixed or hybrid sources, the financing of operation and maintenance costs is covered by the consumers (individual households) through the water tariffs. Also, households are covering the expenses on personal/private connections of water and wastewater.

The aggregate data on annual Water, Sanitation, and Hygiene (WASH) expenditure by financing sources of ten selected African countries between 2015 and 2019 (Table 4.6) also shows a similar financing pattern. Of the ten countries' total expenditure, 44% came from individual households, 24% from external sources, and 16% from the government budget. The external sources mainly include funding from development agencies (bilateral, multilateral, and NGOs).

Table 4.5 Financial flow to the water and sanitation of sub-Saharan Africa (average for the years 2001–2006)

	US$ billions per year	% of the respective category	% of the total
Operation & Maintenance (O&M)			
Public Sector	3.06	100%	40%
Capital Expenditure (CapEx)			
Public Sector	1.06	23%	
Official Development Assistance (ODA)	1.23	27%	
Non-OECD Financiers	0.16	3%	
Private Sector	0.01	0%	
Household self-finance	2.13	46%	
Total CapEx	4.59		60%
Total (O&M + CapEx)	7.65		

Source: David Hall and Emanuele Lobina, March 2012, Financing water and sanitation: Public Realities, Public Service International Research Unit (PSIRU), www.psiru.org) as cited from The World Bank-AFD 2010 report on 'Africa's Infrastructure

Financing Gap

In sub-Saharan Africa, there has been always a financing gap of the water and sanitation investment. In many African countries, the total budget that is required by far exceeds what is available. We have taken a sample of ten African countries (Table 4.7) to look at the financing gap for developing the water and sanitation program. In 2017, except for two countries (Guinea and Mauritania), all eight countries had budget deficits ranging from 35% for the United Republic of Tanzania to 97% for Côte d'Ivoire. We estimated the overall average available budget of the total requirement for all the ten countries to be 64%, meaning that there was a shortfall of 36%.

The implies that most of the sub-Saharan Africa countries could not meet the growing demand of the population for basic water and sanitation services. This deficit is due to the gap between the total amount of money required (demand) and the total budget available (supply) both from external and internal sources. Several factors contribute to the financing gap and affect the financing of African countries' water and sanitation programs. Among others, the low level of budget allocation by the national governments, the declining trend of grant financing from donors, the ability of people to pay for services, and the weakening performance of the revenue-generating capacity of the utilities or service providers can be sited as the main factors contributing to the challenges of financing the water and sanitation sector in Africa. Additional factors that create the financing gap in Africa include rapid rates of population growth**,** rapid urbanization, and economic development in all areas that require water and sanitation as primary inputs, and growing water scarcity and increasing costs of infrastructure investment,

The financing gap has remained to be a hindrance to the realization of universal access to water and sanitation in sub-Saharan Africa. Notably, due to the lack of infrastructure development and institutional capacity, the financial requirements are high in developing countries.

Table 4.6 Annual WASH expenditure (US$ millions, constant 2017 US$)

Country	Year	Expenditure	By source of funding			
			Households	Government	External	Repayable
Burkina Faso	2015	265.1	185.1	13.9	53.1	13.0
Kenya	2016	427.3	197.6	92.9	33.6	103.2
Lesotho	2018	113.4	17.4	33.4	62.2	0.5
Madagascar	2017	22.9	9.5	3.6	9.8	
Malawi	2018	42.1	9.2	19.8	0.5	12.6
Mali	2015	248.0	192.5	16.6	37.8	1.1
Mauritania	2017	99.4	1.5	15.0	25.2	57.7
Mozambique	2017	170.4	40.0	5.0	57.4	68.0
Senegal	2016	415.3	209.7	94.5	21.7	89.5
Zambia	2019	346.9	92.6	45.2	209.1	
Total		2150.9	955.0	339.9	510.3	345.6
Share (%)			44%	16%	24%	16%

Source: UN-Water Global Analysis and Assessment of Sanitation and Drinking Water (GLAAS) 2019 Report

Table 4.7 Funding gap to reach national targets

Country	Annual need (US$ millions, constant 2017 US$)	Available (US$ millions, constant 2017 US$)	Share (available to annual need)
Burkina Faso	229.9	122.1	47%
Burundi	16.8	5.1	70%
Côte d'Ivoire	27.4	0.9	97%
Ghana	1202.7	303.5	75%
Guinea	41.2	62.3	0%
Madagascar	169.3	23	86%
Mauritania	114.4	116.6	0%
Senegal	818.1	278.4	66%
Togo	146.7	9.4	94%
United Republic of Tanzania	237	154.2	35%
Total	3003.55	1075.49	64%

Source: UN-Water Global Analysis and Assessment of Sanitation and Drinking Water (GLAAS) 2019 Report

In sub-Saharan Africa, the central governments' budgets cannot close the gap at the scale required. Most of the national governments consider the water and sanitation services as fundamental rights of their people that directly and indirectly impact the economic development of African countries. However, in terms of national budget allocation, the sector may not be their top priority. As evidence, we can compare the aggregate national budget allocation of 48 African countries among three sectors, transport, energy and water for the years 2014–2018. The national governments budget allocation among the three sectors (transport, energy, and water) during the past 5 years (2014–2018) indicates that the transport sector was the top priority followed by energy (Table 4.8). The water sector's share out of the national budget allocation of the 48 African countries from 2014 to 2018 was 18%, which was below the share of transport (61%) and energy (21%).

One of the reasons for the low level of national budget allocation to the water sector compared to energy and transport is that the African governments consider water and sanitation services as the issues of local government instead of the national government. This government's position emanates from the fact that transport and energy sectors have a catalytic role in supporting the national economic development by linking different districts or areas within the country. These two sectors also play the role of regional economic integration by connecting other countries within a region. Consequently, the two sectors have relatively higher potential than the water and sanitation sectors in attracting the private capital and stimulating foreign direct investment (FDI).

Also, most of the sub-Saharan Africa courtiers' water and sanitation utilities lack resources to fund the water and sanitation projects directly from annual revenues. Due to various reasons, most of the African utilities have a weak financial capacity. The water and sanitation tariffs fail to

Table 4.8 National Government Budget Allocations by Sector ($bn), 2014–2018

Sectors	2014	2015	2016	2017	2018	total	Share (%)
Transport	17.6	12.9	16.3	20.1	19.6	86.5	61
Water	5.1	3.5	6.1	5.9	5.6	26.2	18
Energy	7.5	4.8	4.4	5.6	7.7	30.0	21
Total	30.2	21.2	26.8	31.6	32.9	142.7	100

Source: The Infrastructure Consortium for Africa: https://www.icafrica.org/en/topics-programmes/spending-by-african-governments-on-infrastructure/

reflect the actual costs of the services. The tariffs are set to cover operation and maintenance costs but not the full costs (exclude capital costs). The utilities depend on government subsidy and/or donors' grant to cover capital costs or investment to develop the infrastructure. Mainly the tariffs incorporate the utilities' inefficiencies such as high non-revenue water (NRW) and low efficiency of bill collections. Besides, the local and national governments consider water tariffs as sensitive matters. As a result, the national governments are reluctant to do the timely review and adjustment of the water tariffs to reflect the services' increasing costs through time.

The fast-increasing demand for the water and sanitation services fuels the ever-increasing demand for investment and hence the inflow of financial resources. However, the multilateral institutions and donor agencies lack the resources to fill the formidable financing gap. When examining the past 10 years (2008–2018), the per capita net Official Development Assistance (ODA) received by sub-Saharan Africa has shown a declining trend (Table 4.9). It implied that the net ODA increase during the period could not match the sub-Saharan Africa population growth. Even though the net ODA received figures are for the total economy, we consider that the trend is the same for sub-Saharan Africa's water and sanitation sector. Due to ever-increasing investment costs in the water and sanitation through time, the per capita costs also assume an increasing trend. Consequently, the per capita costs exceeded the per capita ODA received and resulted in the financing gap of investment in sub-Saharan Africa's water and sanitation sector.

As previous data showed, the private sector's role (domestic-based private operators and International private sector) in financing the water and sanitation sectors of developing countries was negligible (Table 4.5). This outcome was contrary to the expectations of international financiers. Still, there is no evidence to argue that the private sector has a noticeable contribution to investing in developing countries' water and sanitation sector, particularly Africa. David and Emanuele [20] indicated that since 1990 the central model promoted by the World Bank and other international agencies has been of the private water company investing, developing, and operating water and sanitation services in middle- and low-income countries. It is now generally agreed that this experiment has failed to generate significant amounts of private investment and that there has been almost universal public resistance to private companies.

Another area that we need to explore is the role that development banks or commercial banks have played in raising the financing for Africa's water and sanitation sector. Financing the water and sanitation through bank loans is a marginal option. Government banks have limited resources, and private commercial banks will not provide long-terms loans, even for the most creditworthy projects. These banks' deposits are not of sufficiently long maturities, and the risks involved render them unwilling to lend without public guarantees [21]. Furthermore, commercial financing requires the creditworthiness of the utilities. The creditworthiness is linked to the performance efficiency of the utilities, which is still the critical challenge of many utilities in Africa (high NRW, low collection efficiency rate, and negative balance sheet).

As the historical data proved (Table 4.5), the lions' share of the water and sanitation sector's financial investment came from the households self-financing. However, in Africa's poverty

Table 4.9 Net Official Development Assistance received sub-Saharan Africa

Year	Billion (US$)	Population (Billion)	Per capita ODA received US$)
2008	40.255	0.82	48.92
2010	44.363	0.87	51.05
2012	46.764	0.92	50.96
2014	46.46	0.97	47.95
2016	44.314	1.02	43.32
2018	50.33	1.08	46.69

Source: The World Bank Open Data, https://data.worldbank.org/indicator/SH.STA.SMSS.ZSTh
The per capita rates are calculated by the author based on the available ODA received and population data

level, the willingness and ability of people to pay for water and sanitation services is a big challenge to support the internal revenue generation capacity of the utilities and hence to cover the costs. It is hardly possible for the poor to afford the full cost recovery tariff rates. As a result, in most African countries, the investment or capital cost that they need for the development of the infrastructure is covered through government subsidy or donors' grant. Accordingly, the water tariffs that target the poor are "social tariffs" and are set profoundly to cover operation and maintenance costs only under subsidizing the capital costs.

However, we cannot rule out situations where the subsidy or social tariff fails to benefit the poor. The poor people who have no access to the municipal water system buy water from private vendors at a higher price than the rich people who have access to the municipal water network. Under such circumstances, these poor people are not benefiting the social tariff, which is against the principle of subsidizing the poor.

Given the challenges of financing the water and sanitation sector in Africa as discussed above, then the main questions remain to be as follows:

- What kind of financing strategy can lead African countries towards long-term solutions?
- What options of financing mechanisms are available to support meeting people's right to clean drinking water and basic sanitation?
- What African governments should do to improve the utilities' performance to increase the financial capacity to extend services to the urban poor?
- What can be the role of different stakeholders, including the government, in assisting the service providers in delivering services to the poor in recognition of water and sanitation as the fundamental right of people?
- What is an innovative financing mechanism available to take out Africa's water and sanitation sector from the current challenges?

The next sections of the chapter will attempt to explore some possible means of financing the water and sanitation sector of Africa.

Closing the Financing Gap

Africa needs to consider various ways of financing of the water and sanitation sector. Above all, the strategy needs to focus on bringing together all the stakeholders, profoundly the water and sanitation sector professionals and financial experts, to find Africa's sustainable financing system. Working in isolation of the sector professional may not help eliminate the water and sanitation sector challenges of Africa. The policy decision-makers of Africa need to believe that investments in the water and sanitation are prerequisite to deliver on the Sustainable Development Goals (SDGs), particularly on SDG 6 ensuring availability and sustainable management of water and sanitation for all.

The solution to close/narrow the financing gap required to look at deep and further explore areas to increase the inflow of financial resources into Africa's water and sanitation sector. There is a need to consider the traditional as well as new financing systems. Continuing mobilizing bilateral and multilateral aid or grant is very important. Reports indicate the declining trend of such

aids to the Water and Sanitation sector. The sector partners and professionals need to convince African politicians to ensure that bilateral and multilateral aid should increase instead of declining.

Reallocation of public sector resources, including domestic resource mobilization and effective allocation of these resources for achieving water and sanitation targets and other social and sustainable development agendas is crucial. This approach entails strengthening the fiscal capacity of national governments, through good governance and tax reforms.

Household self-financing in the water and sanitation sector includes personal investments in septic tanks, hand-dug wells and latrines. On the other hand, community investments refer to investments that the community makes towards a collective scheme. Studies have shown that local communities place water supply and sanitation among the highest priorities. However, Africa's poverty levels are obstacles to raise the required level of financial investment by the people to bring the change at scale. Therefore, getting the public's necessary level of investment in Africa's water and sanitation sector without ending poverty is unthinkable. We believe that achieving the goal of ending poverty in Africa will enable people to increase investment in the water and sanitation sector.

Africa is in serious trouble as debt burden grows. As per the World Bank [22], by the end of 2018, external debt among sub-Saharan African countries grew faster than in other regions: Over half of the region's countries have seen their external debt stocks double. The servicing of debt absorbs budgetary and foreign exchange resources, hampering the government's ability to fund the social expenditure programs, including the water and sanitation sector. The problem has been worsened with the case of COVID-19. Therefore, launching a debt relief program for heavily indebted poor African countries will support their struggle to finance the SDGs, including SDG 6-ensuring water and sanitation for all.

The rapid urbanization rate in Africa requires an immense financial investment of infrastructure development, including water and sanitation infrastructure. Accordingly, establishing and strengthening municipal fiancé system can be seen as a development strategy to address the financing gap. We can consider the use of domestic capital markets to finance infrastructure requirements as one of the opportunities. Long-term debt from capital markets represents the most promising source of financing for municipal water and sanitation. Development and commercial banks can play a crucial role. In this line, the local government capacity to generate a commercially viable project stream is essential to access domestic capital markets for water and sanitation finance. The commercial viability of the water and sanitation projects entails the performance efficiency of the utilities. The urban utilities are required to demonstrate, among others, acceptable levels of technical and financial performances. The donor community's commitment to supporting Africa's national governments in increasing technical and institutional capacity of the urban utilities and making them creditworthy is critical.

Africa has quite a significant number of professionals and businessmen living and working abroad, mainly western countries. Suppose there are proper coordination and lobbying mechanism. In that case, this workforce can serve as the source of finance and knowledge to support Africa's development initiatives, including water and sanitation program. A good example is the prime minister of Ethiopia's initiative in establishing the Ethiopian Diaspora Trust Fund (EDTF) through a fundraising program of one dollar per person per day approach. Among the five projects funded by EDTF is the Promotion of Safe Water Supply, Hygiene and Sanitation - for hard-to-reach communities using renewable energy in Afar and Tigray Regions. The EDTF is an exemplary approach for African countries in sourcing finance to support the water and sanitation sector.

Suitable debt instruments for African water and sanitation utilities that can provide Capital to an entity that promises to repay the Capital over time can be an option. National governments or municipalities can issue revenue bonds to utilities to finance the construction or extension of water and sewer systems. Interest and principal payments on the bond are derived from the revenue

to be generated by providing water and sanitation services to the customers. Accordingly, the more the income that the utility generates from the services, the faster it pays the interest and principal on the bond. This performance of increasing revenue from the service can be achieved by increasing the number of customers connected to the water and sanitation network (improving the service coverage) and improving the bill collection efficiency rate, without increasing the tariffs.

Above all, Africa needs to bring on board the private sector to finance the water and sanitation sectors. We need to further investigate why the private sector is not attracted to invest in the water and sanitation sector than other sectors, such as the energy sector. Is there a lack of conducive or enabling environment for the private sector's engagement in investing in Africa's water and sanitation sector? Is there a lack of information for the private sector where and what to invest, including the return on investment? Is the private sector consider investing in the water and sanitation sector of Africa as a risk? Are African government sensitive to allow the involvement of the private sector in the water and sanitation? We need to address all such questions to boost the private sector's engagement in financing water and sanitation services in Africa.

Convergence, a global network for blended finance [23], argues that by using catalytic Capital from public or philanthropic sources to scale-up private sector investment in developing countries, blended finance has the potential to result in as much as a tenfold increase in investment.

Convergence generates blended finance data, intelligence, and deal flow to increase private sector investment in developing countries. It believes that the traditional development aid from public and philanthropic sources is not enough to realize the SDGs, which face an annual $2.5 trillion funding gap.

Blended finance is not an investment approach, instrument, or end solution. It is a structural approach. Convergence identifies four common blended finance structures:

- Concessional Capital: Public or philanthropic investors provide funds on below-market terms within the capital structure to lower Capital's overall cost or provide an additional layer of protection to private investors.
- Guarantee/ Risk Insurance: Public or philanthropic investors provide credit enhancement through guarantees or insurance on below-market terms.
- Technical Assistance Funds: Transaction is associated with a grant-funded technical assistance facility that can be utilized pre- or post-investment to strengthen commercial viability and developmental impact.
- Design-Stage Grants: Transaction design or preparation is grant-funded (including project preparation or design-stage grants).

As per Convergence, sub-Saharan Africa has been the most frequently targeted region in blended finance transactions among the world regions. In recent years, we have seen Asia emerge as a frontier for blended finance. Energy has been the most frequently targeted sector in blended finance transactions, followed by financial services.

Inopportunely, the water and sanitation sectors were not among the priority sectors of the Convergence blended finance in sub-Saharan Africa. OECD affirms that blended finance has not reached scale in the water and sanitation sector. A more incredible evidence base is needed to understand better the current applications as well as the potential of blended models in the water and sanitation sector [24].

Among the four blended finance structures recommended by Convergence, the Technical Assistance Fund looks appropriate to Africa's Water and Sanitation utilities. Through the fund, it will be possible to increase their performance and make them more efficient in service delivery, contributing to the strengthening of their commercial viability.

4.6 Conclusion

As per the UN resolution, everyone has the right to clean, accessible, adequate, and affordable water. As a fundamental right, every country citizen should not be denied access to clean water due to their economic status.

Sub-Saharan Africa achieved the MDG targets for water but not for sanitation. The MDG experience highlighted the data challenges facing national statistical systems and underscored the need to strengthen statistical and analytical capacities during the SDGs. The MDG assessment also indicated the water stress that many countries were experiencing with the likelihood of being exacerbated by climate change.

Under the SDGs, the water and sanitation have been established as one of the 17 goals, reflecting increased attention given to the sector in the global Agenda. Besides the UN SDGs 2030 agenda, the Africa Union Agenda 2063 included the targets for safe drinking water and sanitation under Aspiration 1, Goal 1 and priority area of "Modern and Liveable Habitat and Basic Quality Services."

During the second year of the SDG, Sub-Sahara Africa was the lowest among the world regions in terms of the population's proportion with access to basic drinking water and sanitation services. Within sub-Saharan Africa, a wide gap was observed between the rural and urban populations. The rural population was categorically underprivileged in terms of access to such basic services compared with the urban population.

The author's analysis of Africa's readiness in achieving the SDG 6 targets entails two scenarios, working towards the SDG 6 targets (universal coverage rate of increase) and the business-as-usual (the continuity of the historical rate of increase). Under the SDG targets (universal coverage) rate of increase, the access to drinking water and sanitation services will reach 100% by 2030. Under the business-as-usual rate of increase, the coverage by 2030 will be 73% and 38% for water and sanitation, respectively.

Expanding sub-Saharan Africa's water and sanitation services require quite significant resources (material/human/financial). However, securing these resources has remained a critical challenge for sub-Saharan Africa. We can categorize these challenges under physical and economic water scarcity. The physical water scarcity refers to a lack of available water resources profoundly due to natural and human-made factors. The economic water scarcity refers to limited water access resulting from insufficient financial resources. An in-depth analysis of the financial resources reveals a significant funding gap to meet the SDG 6 targets of universal access to water and sanitation services of sub-Saharan African countries. Accordingly, the study has recommended various financing options that African governments and all the partners need to consider and apply to close the financing gap for the continent's water and sanitation programs. Above all, the conclusion is that African countries need to put an extraordinary effort into increasing the annual coverage rate of the water and sanitation services to achieve the SDG 6 targets by 2030.

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5 Sustainable Safe Water and Sanitation Interventions in Remote Parts of Ghana

John S. Walker

Abstract

The role of a small non-government organisation (NGO) is significant in bringing safe water and sanitation to subsistence farming communities in remote parts of Ghana. The experience of the charity Ghana Outlook, a small NGO based in the United Kingdom working with small Ghanaian NGOs, illustrates how genuine involvement of beneficiaries, throughout the development and implementation of interventions, leads to successful outcomes. The process builds community ownership of the intervention. The community will lead at problem definition stage and their views will be decisive in the choice of intervention. They will provide unpaid labour to construct latrines, wells or sand dams and will nominate personnel to be trained in routine maintenance. They will enhance a borehole's sustainability by carefully managing extraction of water.

Important practical insights into the design and construction of boreholes, latrines, and sand dams are presented, together with practical advice on the careful management of boreholes, operation of dry pit latrines and how to enable access to safe water during the short but critical periods of labour-intensive farming.

For safe water projects, two indicators of performance are presented. First, does it give everyone enough safe water for basic, daily needs? Second, does it relieve the burden of responsibility, borne by women and children, to provide water? Examples are given on how to measure the indicators.

Keywords

Remote Ghana · Water carrying · Cultures & traditions · WATSAN interventions · Limited funding · NGO

5.1 Water and Sanitation in the Rural Parts of Ghana

5.1.1 The Scene

The West African Republic of Ghana (Fig. 5.1), with area about 240,000 km^2 and estimated 2020 population 31 million is about the size of the United Kingdom but with less than half its population. Some 43% of the population lives in rural areas and is engaged in agriculture (Ref. 1). The climate is tropical with average temperatures in the lower 30s throughout the year and generally high humidity nationwide. Seasonal heavy rain-

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Fig. 5.1 Ghana. (Sources: https://en.wikipedia.org/ and https://www.google.com/)

fall occurs everywhere but the far north is semi-arid, having only a short annual period of rain.

Throughout the country it is commonplace for rural communities to be accessed only on foot or by motorcycle but most are linked to sealed roads by rough tracks suitable for 4-wheel drive vehicles. Sometimes more than 2 h are needed to cover the off-road part of the journey.

In rural areas, obtaining water in sufficient quantity to meet personal needs, including drinking, cooking, and washing, is a daily challenge. There is no piped water and, unless a community has been provided with an intervention to give regular supplies, foraging for water, mainly by women, is the only option. Traditional water sources are likely to be unsafe, being rivers, streams, ponds, and swamps. Some interventions such as dugouts, hand dug wells, and a number of boreholes have become contaminated. Most of the 20 million population in rural parts do not have access to safe sanitation, perhaps six million practising open defecation (Ref. 2).

Access to water is especially difficult in the semi-arid far north of the country where severe and widespread drought is a recurring phenomenon throughout the Upper East and Upper West Regions. There are at least six and up to eight consecutive months between October and May without rainfall. The dry conditions are exacerbated in December and January by the Harmattan winds which carry sand and dust from the Sahara. The natural vegetation is grassland and savannah; trees are drought resistant varieties including baobab, acacia, shea nut, and mango.

The population in the far north, the context for much of the experience described here, is estimated at 2.2 million (Ref. 3). More than 70% live in rural communities, most small subsistence farming communities of 300–1200 people. Farms are small, being owned, and operated by single families or family clusters and growing mainly millet and sorghum. Most families rear goats and keep chickens and guinea fowl; some also graze cattle and sheep.

An obvious consequence of the semi-arid climate is that water, safe or unsafe, becomes increasingly scarce as the drought continues. Houses do not have piped water and because most communities do not have a borehole or other water-providing intervention, more and more time is spent, mainly by women, searching for water. They walk to find streams, ponds, and swamps which can be several kilometres away and shared with domestic and wild animals. As these traditional sources get smaller and eventually disappear as extraction and evaporation continues, the women must scoop and dig down into dry stream and pond beds to find water.

A further consequence is a short annual farming season with timeslots available for ploughing, planting, and harvesting so small that the entire able population of communities must focus on these activities at critical times. If they do not do so, harvests will be meagre and, for remote communities of subsistence farmers, without access to markets or the ability to purchase, the situation would be dire.

In contrast, a short rainy season presents swollen streams which overrun their banks; ponds and swamps are replenished and surface water is plentiful. Water collection remains essential but is an easier task and takes less time. Some families will temporarily reduce their need to walk for water by channelling rainwater from their roofs into containers.

Every village is unique but a common feature is a large area of bare earth, usually empty apart from dwellings; there are no vehicles, little evidence of possessions and no toys. At the centre will be a sala (a building with no walls but having a thatched or sheet roof) which provides shade for activities including meetings of chief, elders, and community members. Sometimes the sala is supplemented by a large spreading mango or acacia tree, its shade used for similar community purposes.

Widely separated houses or clusters of several houses are another common feature of villages; houses are single roomed, single storey, adobe (mudbrick) dwellings. Roofs are, in the west, predominantly pitched and clad in thatch or corrugated sheet and in the east are, by tradition, flat and covered with adobe. Each house is occupied by one family, often with around ten members. The houses of closely related families are clustered to enable sharing of tools, kitchens, rudimentary toilets and to facilitate pooling of labour, including water collection. They also provide a secure compound for animals, growing vegetables, and storage.

An electricity supply network is being introduced and many communities now have electricity, but it is unusual for individual housing units to be supplied.

Individual houses do not have toilet facilities of any sort. Separate urinals for men and women are common within family house clusters and some have an outside dry pit latrine. Villages usually have urinals for community use, separate ones for men and women. Latrines for community use are rare, so that in the majority of situations, there is no alternative to open defecation or dig-bury. Schools have urinals but dry pit latrines are by no means universal. Hand washing is not always possible and soap is unlikely to be available.

For long periods each day, villages are sparsely occupied with only the pre-school children, people too old to work and the sick; able bodied women will be absent collecting water and men will be either working on their farms or, in the dry season, will have travelled to the south or elsewhere in search of work.

Some communities have their own primary school, often with an associated kindergarten. Others share with neighbouring villages as is the norm for junior high and senior high schools. In common with the communities which they serve, schools do not have piped water.

5.1.2 The Daily Burden of Water Collection

Water is a precious commodity. Throughout rural Ghana and around the year, women can be seen collecting water, usually in groups and often walking several kilometres and carrying it back. Children, girls and boys, will accompany them if distances are short. Men do take part on occasion but, by tradition, water duty falls to women (Fig. 5.2). Typically, the mother of a family will have the responsibility for ensuring her family has enough water. Sometimes a group of women from a house cluster will together take responsibility to collect for all residents of the cluster, but

Fig. 5.2 Water carrying in Ghana

people are generally unwilling to share water with those outside their cluster.

The duty to collect water is onerous and time consuming, exampled here for a family of ten. If each member is to have 15 L every day as a minimum quantity to meet basic needs, the family's 150 L total requirement means that eight bowls, each of 20 L capacity, have to be filled every day and carried back to the family. The water collection duty usually takes place in daylight shortly after daybreak and before dusk every day, periods when children can help before or after school, at least when the source of water is nearby. The schedule may also allow some time for women to do other things, including domestic work and helping the men on the family farms.

The most common vessel used to carry the water is the 20 L metal bowl, so chosen for its relative ease of being carried on the head over distances, leaving both hands free and enabling a baby to be carried in a sling on the back (Fig. 5.3). Smaller bowls are sometimes used, especially by children. Clearly, the large bowls are heavy when full so group members will assist each other to lift full ones up onto the heads of carriers. Small bowls are used for filling. Plastic Jerry cans of 20 L capacity are also used but they are more difficult to carry on heads so are more commonly used when distances are short or when water has to be carried longer distances by donkey, bicycle or pick-up.

Every year in the far north, as drought advances, natural water sources either shrink or disappear. As they do so, the ever-decreasing available water either becomes stagnant, with more concentrated pollution, or becomes evermore difficult to find by scooping or digging into dry stream beds. In the long dry season, water is hard to find and difficult to access (Fig. 5.4) and at these times animals become stressed, and the scarce water becomes a magnet for them. Women may have to walk further to find water and then may have to scoop or dig it from streambeds. The major activity becomes that of sustaining the community with sufficient water for drinking, cooking, and hygiene. Those women not involved in this activity have little to do beyond tend goats and chickens. Water borne diseases increase as the quantity of water reduces its quality becomes less safe. Illness puts additional strain on the water taskforces and, consequently, children are regularly called upon to collect water rather than attend school.

Fig. 5.3 Baby in a sling on the back to carry water

Fig. 5.4 Digging into dry stream beds during drought

In the wet season, however, rivers and ponds become swollen and water lies on the ground in a proliferation of ephemeral pools. As the heavy rains coincide with the short farming season, people are able to save time by collecting water on the way to and from their farms. Farming is only possible in the wet season and, because the

season is short, there is an over-riding need for every able person to lend a hand to cultivate the family farms. Inevitably, the acute demand of farming depletes the water-collecting taskforces and obtaining the minimum volume of water for the family becomes less certain. Nevertheless, it is fortunate that rain quickly replenishes the natural water sources, creates others, and swiftly fills family tanks built to store rainwater channelled from roofs.

In schools, the responsibility for supplying the daily needs for water falls mainly on the pupils, both girls and boys of at least primary school age. Before lessons begin, groups of girls and boys will meet at a stream or water hole to collect water and carry it to school.

When a borehole intervention has been made, women of the community continue to have responsibility to collect water from it. Instead of foraging for water, they walk to the borehole, wait their turn in a queue, fill their containers and then carry them back to their homes (Fig. 5.5). The activity continues to be a mainly early morning and late afternoon duty but will generally take less time in addition to obtaining safer water.

Fig. 5.5 Women waiting for their turn around the borehole

Fig. 5.6 Rainwater harvesting

5.1.3 Interventions

Government and non-government organisations (NGOs) in Ghana, often in bilateral partnership with foreign NGOs, have endeavoured over many years to address the widespread need for access to safe water. By far the most common intervention, and perceived as the most effective, is the borehole. Unfortunately, they are not a panacea and abandoned boreholes, evidenced by unused hand pumps, are a common sight. The range of interventions made to date in the north of Ghana is extensive and the most common are listed here with comment.

Rainwater Harvesting Systems are in common use at institutional buildings, notably schools. Such buildings are mostly single storey and have a large footprint covered by a large area roof (Fig. 5.6). Gutters, made of bamboo, plastic or galvanised steel sheeting are fixed to the eaves and channel rainwater into downpipes made of similar materials, connecting to a tank at ground level, supported by a sturdily supported plinth. Tanks, sometimes linked together, are usually of black plastic (polytank) of 5000 L or 10,000 L volume and fitted with a faucet from which water can be drawn for handwashing, irrigation, and other usage. Common failures are due to inadequate foundations of the plinth, bearing in mind that full tanks of these sizes weigh 5 or 10 tonnes and ground bearing-capacity is substantially reduced in the rainy season, when saturated. Some older tanks remain, made of ferro-concrete but these are subject to cracking if even minor subsidence occurs.

Smaller scale rainwater harvesting is used for private dwellings, particularly those with roofs made from steel sheeting. Tanks with volume

circa 200 L made of ferro-concrete, recycled oil drums or other containers are used.

In all cases, the tanks require annual cleaning, usually using a chlorine-based germicide/fungicide. Storm damage to improvised gutters and downpipes is common, as is the inability of schools and households to pay for materials to carry out repairs. The roofs and gutters become soiled over the dry season and the first flush carrying the first rains should be discarded; this can most easily be achieved by including a hinged section in the downpipe, thereby creating a temporary bypass.

Hand Dug Wells are a traditional intervention and are common throughout the region. For practical and safety reasons they need to have a minimum diameter 1.0 m to permit digging by hand and they are rarely more than 30 m deep. They will usually have a windlass (bucket and rope over pulley or pole) or a hand pump, which is safer.

Wells are rarely productive throughout the year in the far north. As drought progresses, groundwater levels drop and yield diminishes. The available water becomes increasingly unpalatable due to stagnation or increased concentration of dissolved minerals. As they dry up, they become a refuge for amphibians, notably frogs. Consequently, hand dug wells can lie unused for several months every year and sometimes used only as a last resort. Many have been abandoned permanently.

Scoop Holes are common features along the beds of ephemeral streams. In the long dry season streams sink below ground and people leave scoop holes after digging into the stream bed to obtain water. As the drought continues, ever deeper excavation is required.

Dugouts are much bigger and permanent holes dug by communities, usually in or near stream beds and made in an attempt to make a permanent, safer, source of water. The source of retained water can endure through the dry season but the water can become stagnant and they are dangerous to use. Drowning, particularly of children, is an all too frequent tragedy.

Gravity Systems require piping, tanks, construction, and fencing and are rarely used in Ghana, particularly in the north, where the terrain is predominantly flat.

Tube Wells can be drilled to great depth in soft ground, using sludging and auger methods. However, they require skilled, specialist drillers so they are few in number.

Boreholes with Hand Pumps are the most common intervention and are sunk within the community as near to the centre as other considerations permit. Women walk to the pump from their houses, join a queue and then pump water into their containers before carrying it back home (Fig. 5.7a). The procedure in almost every case saves considerable time compared with the erstwhile situation of collecting from natural sources. Unfortunately, there are many abandoned examples; the cause being either over-enthusiastic pumping as the yield falls and/or inadequate depth of drilling. More details on this topic are given later.

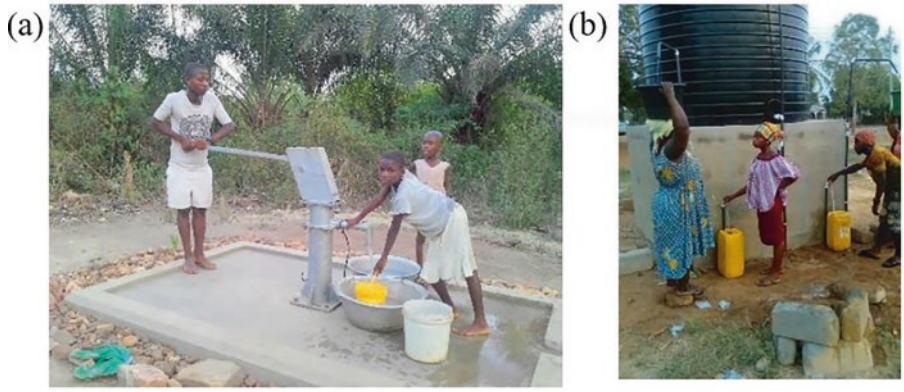

Fig. 5.7 Boreholes with (**a**) hand pumps (**b**) motorised pumps

Fig. 5.8 The only sand dam in Ghana

Boreholes with Motorised Pumps are becoming more common as electricity power distribution extends. Such pumps have a tank at surface or elevated level, typically 10,000 L capacity, which feeds a bank of faucets at various levels which enable easy filling of containers during water collection (Fig. 5.7b). Collection takes less time and queues are shorter; they are less easily damaged by over-enthusiastic pumping. Nevertheless, the required electrical power comes at a cost, the motor must be maintained and the operation of the borehole must be managed to that the aquifer can recharge following water extraction.

Sand Dams are potential low cost, sustainable interventions. They are potentially feasible across seasonal sand-laden streams, have banks on both sides and have a deep sandy bed on an impervious layer of rock, clay or shale. There is only one sand dam in Ghana, located at Kpaloworgu in Upper West Region (Fig. 5.8).

5.2 Action for Sustainable Development Goal 6

5.2.1 A Daunting Task

The United Nations Sustainable Development Goal 6 is to ensure availability and sustainable management of water and sanitation for all by 2030. Targets within the goal include giving everyone access to safe water and reducing the burden of responsibility, borne by women to provide water. The goal also includes reducing the incidence of disease caused by ingestion of unsafe water.

In Ghana, some 70% of the population lives in rural communities, in our experience mostly in villages of 200 to 1200 people. Piped water is available only within larger townships; the others, including all rural areas, at best rely on boreholes, small dams, wells, and dugouts within their communities. Others not so fortunate have to collect water from available natural sources including rivers, streams, ponds, and swamps; in the north of the country many of these dry up during the long annual drought.

Government agencies in Ghana are actively working towards achieving SDG6. Their intervention programmes are largely to provide rural communities with manually pumped boreholes but the effectiveness of programmes is hampered by limited resources of finance, local expertise, specialist equipment for drilling and personnel to supervise and measure outturn. There is much to be done via bilateral aid and co-operation, and by non- government organisations (NGO). The latter are numerous and active throughout most of the country but the well-known larger international NGOs do not operate in the more sparsely populated and semi-arid Upper West and Upper East Regions, the poorest regions and also the driest.

The task faced by small NGOs is daunting. In only the far north, about 1.5 million people live in small rural communities of average size 600; this equates to 2500 borehole interventions being needed to bring safe water to all. It is believed that government agencies, using a World Bank loan, have recently completed 250 boreholes (Ref. 4) and perhaps a similar number have been sunk by local, small NGOs. If this is the case, it suggests there are still 2000 boreholes, or similar interventions, required to bring access to safe water for some 1.2 million people in the far north.

To achieve this number of borehole interventions by 2030, thereby meeting an SDG6 target at local level, is a daunting task if it must be taken on by small NGOs only. Drawing on the experience of Ghana Outlook, which is perhaps similar

to many other small NGOs operating in the sector, ten boreholes in 1 year with total cost US$50,000, is a very tall order and is at the limit of the project management and supervision capability of the charity and its Ghanaian partner.

5.2.2 Small NGOs Can Make a Difference

Perhaps typical of the endeavours of foreign NGOs, Ghana Outlook, although having operated in Ghana for many years, has done so only in Regions where it has trusted, small but competent, Ghanaian NGOs, and individuals. Without such partners, the charity would be ineffective. Over the years, Ghana Outlook's method of operation has evolved through experience. In 2020, with only five members, all of whom are volunteers, it has delivered ten boreholes, two dry pit latrine blocks and four school and agricultural support projects.

The proven successful method of working has four key elements.

Needs are identified by listening to community leaders and members, seeking clarifications, and posing suggestions.

Appropriate interventions target the needs explained by the community. Ideas are developed together, forming projects which will be owned, valued, operated, and cared for by the community.

Bespoke, multi-faceted, yet uncomplicated interventions evolve which work with tradition and culture rather than aim to change them.

Operation sustainability is maintained by setting thresholds consistent with a culture of personal ownership of projects, and which ensures that fundraising and management capacity is not exceeded.

Local Partners In the Upper West and Upper East Regions, one partner is Coalition for Change, a small NGO with four members specialising in safe water, dry season livelihood, and agriculture. Another small NGO partner in the far north is Sahara Advocates of Change, which brings further expertise in safe water, sanitation, dry season livelihood and empowerment of women. Further south, operating in Central, Eastern, Greater Accra, and Volta Regions our partner is the Presbyterian Relief Service and Development agency, a larger NGO but with three personnel acting directly as partners to Ghana Outlook on safe water and sanitation intervention projects.

Partners bring essential skills and attributes to an intervention team; knowledge of language, culture, climate, regulation, consultation requirements, contractors, prices, and banking. They have the ability to encourage and nurture honest descriptions of need and honest ideas about solutions. Partners also have stewardship of project funds and provide records with transparency.

Partners are the interface between the beneficiaries and Ghana Outlook. Over time they gain an in depth understanding of the needs of a community, mutual trust develops based on respect for knowledge and skills on both sides. Team working leads to identification of appropriate interventions and agreed expectations of outcomes.

The local partners will have heard about or seen evidence of a community need and will have responded initially by seeking a meeting with the chief and elders of the community, also the headteacher of the school if the need relates to the school. The partners will ask to talk about the community's problems, what factors lead to the problems and what ideas they have about solutions. They will ask about what has been tried before and will guide the discussion towards candidate interventions by describing a range of measures which the community may have heard about. Site visits will be required, notes taken and sketches made.

Basic information will be obtained at the meeting, through further discussion and by observation. It will include community size, school size and type, number of households, distribution of dwellings (widespread may not be suitable for a borehole in the centre), location of latrines and urinals, water collection procedures, who collects the water and when, typical water carrying ves-

sels, current sources of water, shared sources with animals, distances to water sources, dry season occupations and incidence of water born disease. Partners will sometimes ask for further information to be obtained and made available.

If a particular type of intervention is agreed in principle, the next steps will be explained. First the case for the intervention, including how it was arrived at and with a budget estimate, will be presented to Ghana Outlook for consideration. If accepted, the project's implementation will be dependent upon the community agreeing to a memorandum of understanding (MOU) and an indication of the timing of implementation will be given if possible.

It will be explained that Ghana Outlook's projects are of the self-help type. Materials and local specialists, not available free of charge to the community, will be paid for as project costs using funds raised in the UK and sent to the partner who will purchase materials and procure the services of specialists, if required. Materials could be cement and timber and specialists could be a mason and a carpenter.

The MOU to be signed by the partner and by the community, usually by the chief or an elder on his behalf, will confirm that the agreed intervention will be provided and that the community will give the following undertakings:

- to take ownership of the intervention,
- to take care of and protect the intervention. Ghana Outlook rarely plans to provide further funds for routine repairs and maintenance,
- to store the materials and keep them safe and in good condition,
- to nominate people from the community to be trained by specialists provided by the partner, for example mixing and placing concrete, maintaining a hand pump, and managing a borehole,
- to help provide and collect specified data and information before, during, and after implementation,
- to provide labour free of charge and as agreed, when needed and in sufficient numbers during construction and for future routine maintenance,
- to raise and set aside funds for maintenance and operation, for example, by charging families a nominal sum for water from a borehole in order to pay for its maintenance,
- to establish an Intervention Management Committee with a Chairman to manage the operation of the project, to keep records of water collections (by whom, quantity and when), to charge fees for use of water, to receive the fees and keep good records, to arrange for routine maintenance and to pay for it from the fees,
- to confirm that they understand the project and how it will be installed and operated.

Experience suggests that agreements made between chiefs and elders and the partners on behalf of donors, subsequently documented in an MOU and duly signed, are adhered to and can be long lasting.

The partner will report on implementation of the project, its commissioning and its outcomes. Together with Ghana Outlook, they will analyse its impact and identify lessons learnt. Much of this will be quantified based on measurements but, of at least equal importance will be the users' perception of success or otherwise; its benefits, its disbenefits and how it could be improved.

5.2.3 Measurable Indicators of Outturn

Evaluation of safe water and sanitation interventions requires measurable indicators. The objective of the exercise is to estimate the extent to which the intervention adds towards SDG6. Three key outturns related to SDG6 are: first, the extent to which people receive access to safe water; second, the extent to which illness from water borne diseases and their results are reduced; third, the extent to which the burden of responsibility for water collection falls upon women and sometimes children. Measurable indicators are sought for each outturn.

Safe Water for Basic Needs is the key indicator of an intervention bringing safe water to a community. It is based on the measured amount of water taken on a typical day from the borehole by pumping water into bowls or other containers, for a manual pump. Alternatively, from faucets in the case of a powered pump. The volume is then divided by the number of people served by the borehole and also by the basic daily needs volume chosen for Ghana. The result is an *indicator* of the borehole's contribution to SDG6. For a mechanised borehole, knowledge of population size, the capacity of the storage tank, and the frequency of the need to refill it from empty will also enable the above calculation.

This indicator requires qualification regarding water collection behaviour in the rainy season, coincident with the short period when farming is possible. At this time, there is a temptation for women to save precious time for farming by ignoring the safe water of a borehole and instead collecting water from swollen rivers, ponds, and from abundant pools of rainwater on their way to and from their farms.

The minimum per capita requirement for Ghana, recommended by the Joint Monitoring Programme of the World Health Organisation and the Ghanaian Community Water and Sanitation Agency (CWSA) is 20 L per day per person (Ref. 5). This national average figure is for small urban areas, where water is piped to a stand-pipe and where people may tend to use more water because they have access to a relatively abundant supply. However, application of a minimum daily volume could lead to need not being addressed because of insufficient funds, and project which deliver less than the standard could be considered failures. Ghana Outlook does use a standard but only for project scoping design and for post-implementation comparative performance monitoring. The standard chosen in 15 L per day per person because all of interventions are in remote communities where safe water has never been freely and easily accessible. Note: the UK does not use basic needs requirements but, for planning purposes, about 150 L per capita is used for domestic supply, excluding car washing and lawn watering.

Health is threatened by ingestion of unsafe water. In Ghana, essential healthcare services are progressively being provided through government clinics but, as in the case for safe water provision, there is much still to do. Some of the most infamous health problems are now rare, including Guinea Worm, but diarrhoea and water-washed diseases prevail and cholera, hepatitis, amoebic dysentery, and typhoid do not provide acquired immunity. Diarrhoea is a debilitating disease and a risk to life, particularly in young children, when coupled with dehydration and malnutrition. It impacts on every aspect of communities, affecting farming activities, water collection, education, and well-being.

It would be expected that a simple comparison of the incidence of diarrhoea before and after the intervention would be relatively easy to obtain from absenteeism records of schools and records kept by health clinics or health visitors. However, this is not generally the case. The records kept by schools do not identify the reason for absence because the information given by parents can be evasive or unclear. Consequently, they include unforeseen requirements for a child to help collect water, caused probably by adults falling sick, and the need for children to work on farms at critical times during the short farming season.

Clinics, if available, would be expected to have records of illnesses related to unsafe water but, unless access to them is free of charge, they will not be used by the desperately poor people. It is rare to find an affordable clinic easily accessible to many of the project beneficiaries.

In most cases, therefore, it is important to ask questions of members of a community and listen to stories and opinions, at the project definition stage and following commissioning, in order to obtain anecdotal evidence.

Reducing the Burden; a water intervention project is not expected directly to address the culture of women having the duty to collect water for their families. Nevertheless, it may ease the burden of that obligation by reducing the time taken and effort made in collecting water every day, twice a day and sometimes more frequently. Before an intervention is committed, the local partner together with community representatives

should gather information and make estimates of population size, number of women involved in water collection, average distance walked to and from the water source, time taken to fill containers, and the size of typical containers used. The pattern of collection will probably be unique to each community and will have a bearing on some of the above data, notably the number of collectors and the distribution of dwellings around the community. Following installation of the borehole, the Intervention Management Committee would be well placed to make similar calculations. By such means the change in total time spent by women and the distance walked with full containers can be estimated, thereby producing an *indicator* of how the intervention contributes to reducing the burden of the obligation on women.

The procedure can be refined, if necessary, to take account of seasonal changes and to estimate changes in the burden of responsibility born by children.

5.2.4 Reasons for Failure of Boreholes

Effort to bring safe water to rural parts of the far north has been great but the need remains widespread. It is unfortunate that interventions, including boreholes, have not always produced lasting supplies of safe water. All too often, the initial euphoria brought by abundant supplies has changed to disappointment following a rapid decline in yield, sometimes to zero, with little or no revival. Such boreholes are then abandoned.

Boreholes can fail for a wide range of reasons but two are perhaps more common than others. First, drilling was carried out at the wrong time of year and to insufficient depth (Ref. 6). Second, extraction of water by pumping has been allowed to take place without supervision and without monitoring the yield.

Drilling during the short rainy season in the far north is likely to reach a charged aquifer at a relatively shallow depth, often 10–30 m. As the long dry season follows, the rate of recharge of aquifers will decline, beginning with the ones closer to the surface. If the borehole only reaches the first aquifer its yield will be most likely fall and will take progressively longer to recharge; sometimes it will not recharge until the onset of next year's rainy season.

It is important to appoint a specialist drilling contractor with knowledge of the local hydrology and experience of drilling in the area. This is exampled by the contractor who drilled a borehole for the Kukpali Community of about 1100 people in Upper West in July 2020. On the first attempt, a high-pressure aquifer was found at 10 m depth and the community were delighted and expected the contractor to dismantle the rig and leave. The contractor explained that as this was the height of the wet season, and given the daily volume of water required by the community, the yield would not last beyond a month or so and he should drill deeper. Continuing through rock, high pressure was again found at 30 m but it was not until drilling reached 120 m that the contractor was content that, in the hydrology of the area, the yield would be sustainable throughout the year.

Boreholes are normally used during two periods each day, shortly after dawn and shortly before dusk. Sometimes the yield of a borehole will fall as water continues to be extracted and, if it continues to fall, could result in damage to the filter and the pump; before this happens, pumping should stop so that the aquifer can recharge.

A very common cause of boreholes being abandoned is damage to the hand pump brought about by over enthusiastic and strenuous use of the pump in an attempt to fill bowls before the yield drops to zero. This is an understandable natural reaction of a woman in the midst of pumping who observes that the yield is low and is falling; she will also hear and feel the panic of those women in the queue behind her who have observed the same, but have not yet even begun to use the pump. The need for water is so pressing that groups of women will fight to join forces to pump harder in the mistaken belief this will bring more water to the surface.

Common types of damage are failure of the fixings of the pump to the concrete base and apron and physical damage to the lever and ful-

crum mechanism of the pump. Such damage can usually be repaired or parts replaced but the community does not always know how or from whom to seek help and will usually not acknowledge ownership or responsibility, believing they must wait for the owner to come and fix it. Together with the remote location of the pump and absence of funds to pay for repairs, this usually means the pump is out of action for considerable period and possibly could never return to proper operation.

A second result of over-pumping can be clogging of the pump filter itself, near the bottom of the borehole. Continuing to pump when the yield is very low can force more and more particles into a pump's filter. This problem is difficult to remedy except by high-pressure jetting which requires specialist machinery and, somewhat perversely, a large volume of water.

The above-described problems resulting from over-pumping as yield falls is less common with mechanised boreholes (those with a motorised pump, usually by electricity) because water is taken from faucets which are gravity fed from a storage tank and the collectors will not perceive a drop in flow. However, they must be closely managed during use. The tank must be kept reasonably full and the filling process must be carefully supervised. To reduce wastage, the pump must be promptly switched off when the tank is full and, if the yield falls during filling, severe damage to the pump and motor will occur if it is allowed to continue running. The pump and motor also need to be regularly maintained.

5.2.5 Management of Boreholes

Over-enthusiastic use of hand pumps is clearly a common occurrence and results in wasted investment and disappointment. Often the yield of a borehole will only fall during the height of the dry season; other boreholes exhibit falling yields throughout the year and some, during every period of extraction. However, in all cases when the yield fails there is risk that damage will follow and quickly.

There is a real need, therefore, to manage and control the use of the borehole at all times to ensure that as soon as the yield falls noticeably, pumping ceases and then is only allowed to restart when satisfactory yield has returned following the aquifer having recharged. Experience in Ghana suggests that restricting pumping to two periods each day, spaced apart to allow the most time when no extraction takes place and so allowing the aquifer to recharge. Given that these periods need to be during daylight, and allow for other activities to take place uninterrupted, the most common times chosen are following dawn and preceding dusk; often between 06.30 and 08.00 and between 16.00 and 18.00, although the periods are shortened if experience demonstrates that the yield is not maintained for so long.

The importance of close and consistent management will have been emphasised from the outset at the intervention identification stage and reflected in the MOU which establishes an Intervention Management Team with defined responsibilities. It is not only concerned with opening and closing the pump, it will also be concerned with other control issues in the interests of maintaining a supply of safe water for the community for years to come. The team is usually made up of women from the community.

Typical terms of reference will include the following:

1. Decide on the periods during which water can be extracted.
2. Ensure water is collected in an orderly fashion.
3. Enforce hygiene protocols, particularly prohibiting to personal cleansing at the pump.
4. Make sure that people from other communities do not take water unless with formal agreement.
5. Observing the yield throughout extraction and deciding if and when it has fallen to a level at which pumping must cease to avoid the risk of damage.
6. Lock the pump throughout the time between the agreed extraction times.
7. Agree, and review periodically, the maintenance fund charge to me made for water and the basis of charging: family per month, per 20 L container, etc. In the far north two forms

of charge have been noted: US$0.03 per 20 L and US$0.60 per family per month, US$0.90 if motorised pump.
8. Set up a maintenance account, with appropriate records.
9. Observe and keep records of the people taking water, how often and how much, and appoint one member as sales charge officer.
10. Collect data and provide information to enable project outturn indicators to be calculated.
11. Ensure that routine maintenance activities for the pump and apron are carried out: daily cleaning, periodic inspection, tightening, and greasing.
12. Commission and pay for occasional repairs which cannot be carried out by the community and, for a mechanised borehole, receive and pay the monthly charges for electricity.
13. Appoint sales receivers to collect charges and record them in the maintenance fund.
14. Use any surplus income to support agreed self-help, community-initiated projects such as classroom renovation and improved sanitation.

5.2.6 Borehole Interventions Following Community Filters

The most common appropriate intervention to address the need for safe water is a borehole. Unfortunately, these come at a price, about $5300 including the cost of travel and subsistence for partners at project definition, development, installation, and evaluation stages. For a small NGO of five members, even with energetic fundraisers and generous support, the demand far outstrips resources; to date our best year, 2020, has been ten boreholes.

One response has been to supply a filter to enable a community to produce safe water for drinking and cooking from the water brought in, until such time as funds are available to sink a borehole. The filter chosen by Ghana Outlook is the Community Filter obtained from Aquabox (Ref 7), a UK registered charity and a major player in rapid response disaster relief. The filter was developed by The Safe Water Trust, a not-for-profit UK charitable company. It can deliver some 300 L of safe water per hour and, provided the sub-micron filter element is cleaned by reverse flushing after each use of the filter, it can continue to deliver safe water for several years producing over a million litres (Fig. 5.9). Ghana Outlook has eight community filters in Ghana, their application being managed by its Ghanaian partners. The cost of the filter in 2020 is US$325.

Having agreed that a community or a school without safe water should be provided with a borehole, but knowing that it will take some time to raise sufficient funds to sink it, a community filter may be loaned to the community or school until funds become available. After the borehole has been introduced and commissioned, filter can be relocated to another community without access to safe water. If all eight filters are applied in this way some 5000 people, who would otherwise have to wait, would have access from an early date. For them, the danger from unsafe water could be eliminated, although daily collections from traditional water sources would need to continue until a borehole were to be installed.

Because of the potential long life of the filters, a filter could be retained by a community beyond the time when permanent supply of safe water via a borehole has been made available. The filter could be a supplement to the borehole intervention, enabling the community to continue to have safe water by taking the filter with them at critical farming activity times, when there is no time available to visit the borehole to collect water.

5.2.7 Maintaining Access to Safe Water During the Farming Season

Having obtained a borehole, it is perhaps surprising to learn that a community does not always make enthusiastic use of it throughout the year. Investigation will reveal that some women will not collect water from the borehole when there is an over-riding requirement for them to spend all the daylight time on their farms. Instead, they

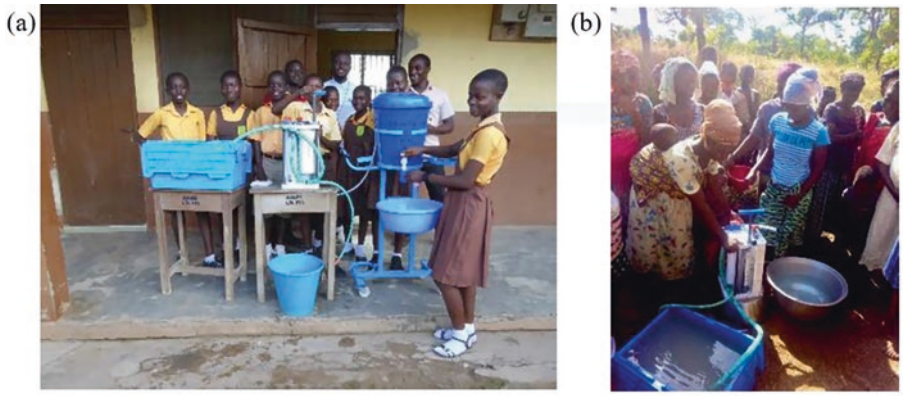

Fig. 5.9 (**a**) Aquabox Community water filters in Ghana. (**b**) People can carry the filter (7 kg) to water sources

Fig. 5.10 Farming communities

will collect from traditional sources on the way to their farms, thereby saving the time needed to walk to the borehole, queue, collect water and carry it back. This behaviour is most pronounced in the upper north, where the subsistence farming communities can grow only one crop per year and where a satisfactory harvest will result only if the short and critical periods available for tilling, sowing, tending, and reaping are taken full advantage of. All able members of a community must labour on the farms at these times and this reflects most noticeably in absenteeism from school and the propensity to save time by walking directly to their farms (Fig. 5.10). The change of habit is encouraged by farming only being possible during the short rainy season, when water is readily available everywhere in rainwater pools, swollen streams, and ponds. Although such water is unsafe, survival depends on the annual farming yield; people have scant other sources of food or income for essential health and secondary education costs; they have used traditional sources for generations before the borehole intervention was made, so they choose to take a chance.

Reliance on the harvest for survival is the dominant motivator. The choice taken to revert to using traditional unsafe water sources in the farming season is taken in full knowledge of the risks involved. It is important to recognise this probable outcome at the needs assessment stage and to acknowledge that the borehole will still be an intervention of immense and potentially life-saving benefit to the community for most of the year. It is also important, while not challenging ingrained and cultural behaviour, to identify measures to supplement the borehole so that access to safer water can be achieved in the farming season.

In this situation, an Aquabox Community Filter is a robust and, at 7 kg, easily portable means of enabling farmers to make safe water from the water encountered on the way to, and at, their farms. One filter would be able to produce some 2500 L of safe drinking water over a working day, sufficient for perhaps 500 people, and probably more than needed for the average community. The reluctance of people to share water outside the family could be overcome by families using the filter in rotation.

Rainwater harvesting can play a part. Many families already collect rainwater and use lined adobe or concrete tanks and/or recycled drums fed by gutters and pipes of galvanised steel sheeting or bamboo. Such tanks, given the weight of water and rain-soddened ground, should be substantially buried in the ground. Metal and plastic tanks are best placed on plinths with substantial foundations to avoid subsidence and to make collection easier using Gerry cans or similar from a tap placed near the base of the tank. In all cases, attention should be given to periodic cleaning following long periods when not in use.

Collection and storing water in this way provides relatively safe water for those remaining in the community at farming time and for farmers on returning home (Fig. 5.11).

Rainwater harvesting is particularly useful for schools and for latrine blocks where gutters and downpipes leading to large collection tanks can be introduced from the outset or, with minimal disturbance, anytime afterwards.

5.2.8 Borehole Interventions with Dry Season Livelihood Enhancements

The long dry season in the far north, coupled with a falling water table and evaporation, impacts of community life. Women have to spend more time collecting water and walk further as the dry season progresses. They have little time for childcare, home keeping or anything else. Men look after the family's goats and sheep but there is nothing else to do. Consequently, men leave in search of work and income in the larger townships to the south. Children go to school afterwards return home to occupy themselves without supervision until mothers return with the water.

Fig. 5.11 Safe water storage

Following a successful safe water intervention involving sinking a borehole close to the centre of a village, the women continue with their water collection responsibilities but spend less time doing so. Instead of walking three to four kilometres in the morning to find water and then doing the same later in the day, women will need to spend much less time in the morning and evening walking to the village borehole. At the height of the dry season, the borehole could be saving 6–7 h per day for every woman charged with collecting water.

The time saved is currently highly valued because it allows women to spend more time with children and on family responsibilities, but there is usually much time remaining; a new phenomenon and a consequence of having water close to hand. In a long season with no income, this can be frustrating and can be lost opportunity. The first challenge is to introduce activities which are sustainable during the dry season, which occupy a larger potential workforce and ideally generate health improvements and income. The second challenge is to replace the traditional dry season activity of collecting brushwood for selling on to make charcoal, an activity which encourages tree and bush felling with obvious adverse consequences.

Again, it is important to ask the community to explain their problems fully and then to discuss all the consequences of the intervention. The intervention may have potential benefits beyond bringing safe water; it may make dry season cultivation feasible. Three such supplementary interventions make use of available labour during the dry season and bring income to the community at traditional time of poverty.

Shea trees, although taking around 10 years from planting to harvest, can be grown and nurtured, requiring only minimal but regular irrigation throughout the year. The shea nut harvest is

a high value commodity which can be roasted and sold to specialist manufacturers in the south. Alternatively, the nuts can be processed within the community to produce shea oil, which itself can be made into shea butter. The oil and/or the butter can be used in soap-making and sold at local markets or taken to Burkina Faso where much higher prices are obtainable.

Market gardening projects become feasible with the proximity of all year-round water available for irrigation. Groups of women come together to set up nursery beds and growing areas for tomatoes, okra, pumpkin, spinach, and beans. The essentials which are not available locally are the seeds and fencing, the latter to keep out chickens, goats, sheep, rodents, and other wild animals. A half-hectare gardening project costs of the order of US$1250.

A further dry season income generating activity is bee keeping. Local styled hives are provided together with protective clothing, boots, smokers, and knives (Fig. 5.12). A group of five families, requiring ten sets of protective clothing, ten pairs of boots and having ten hives will cost US$450 and could produce two harvests per year of around 80 kg honey in total and, if sold, cover the initial cost outlay. The hives will be serviceable for 4–5 years, enabling the families to gain income in years beyond the start-up year. Beyond direct financial considerations, it is well known that Keeping the bees helps to improve crop yields through pollination.

Fig. 5.12 Bee keeping

5.3 Sand Dams

Sand dams are a sustainable, low cost means of collecting and storing large volumes of water throughout the year. In the north of Ghana there are many streams and small rivers which dry up during the long dry season. If a dry stream bed is close to a community, if it is composed of coarse sand, if there are banks of at least 3 m height on both sides, if the stream width is up to 15 m and if the underlying impermeable layer of rock, shale or clay is less than 3.5 m below the stream bed, construction of a sand dam should be considered. The above dimensions are specified because all aspects of construction would be carried out manually.

The main threat to the stability of a dam is the risk of water in flood being resisted by the dam itself, quickly causing the flood water to seek forward movement by forcing its way around and over the obstruction, causing erosion of the sides of the dam wall and at the toe of the wall, the latter caused by eddies formed by water cascading over the wall. The result is permanent re-routing of the flow around the dam, the structure becoming redundant and an island monument.

Proper design of safe above-surface dams requires extensive hydrological and geophysical information but this is rarely available for the area in which construction is proposed and the costs of obtaining it and the subsequent design would take project costs beyond realistic levels of funding. Sub-surface dams, although able to store less water, present much less resistance to flow and consequently, risk of failure caused by water re-routing is lower. Designs can be based on information gathered on site visits and limited investigation via trial pits. They are a more sustainable and affordable solutions and can more easily be built by the community.

A sub-surface sand dam structure should be mainly hidden below the stream bed and extend into the stream banks by hidden wing walls below the slope of the banks and the adjacent ground level (Fig. 5.13a).

The dam wall, set on or keyed into the underlying impermeable layer can be made of mass concrete with plums, or using masonry or made

from stone gabions attached each side of a tough impermeable membrane. For safe excavation in sand, where the sides will collapse at about 45 degrees as digging proceeds, 3.5 m depth of sand and 12 m stream bed width, set a reasonable maximum project size to adopt - such a project was constructed within 1 month entirely by community labour at Kpaloworgu in Upper West (Fig. 5.13b).

Construction would, of necessity, take place at the estimated peak of the dry season. The following rainy season would see flood water run its course as usual, encountering no above ground obstruction. Throughout the next dry season, the upstream sand remains saturated because the sub-surface dam wall obstructs the downstream flow. Assuming the riverbed slope is 3% and the sand, when saturated, contains 40% water, a dam with the above dimensions would retain about three million litres of water. The water would suffer little evaporation, be relatively free from human and animal pollution and would not be a breeding opportunity for mosquitoes.

Water subsequently extracted by scooping into the sand or by an upstream shallow well, would be replenished by water, from higher up the catchment, percolating through the sand. Thereby, the water table around the sand dam would be raised permanently. At Kpaloworgu, after 3 years, growing of beans and spinach commenced (Fig. 5.14); after 5 years, no maintenance has been required. Today, the dam would cost $US12,000.

The above sand dam is to date the only one in West Africa but there are many suitable locations in northern Ghana, and surely elsewhere, for similar projects. They could also be constructed at intervals along the same stream, the separation being dependent upon the slope of the bed.

5.4 Safe Sanitation

Safe toilets are safe to use in terms of cleanliness and immediate safe storage of waste; they do not pollute water supplies and have self-washing facilities close by.

5.4.1 Pit Latrines

In the semi-arid north, plumbed-in flushing toilets are only found in towns, mainly in hotels and government offices. Elsewhere, some pit latrines with pour-flush facilities are found, with which, after use, water is poured or thrown down the toilet bowl to flush. Notwithstanding, in rural areas open defecation or dig and bury still prevail, with obvious hygiene and safety issues. The practice involves risk of personal harm from dogs, scorpions, and snakes. Fortunately, simple dry pit latrines are becoming more common, usually for

Fig. 5.13 (**a**) Sand dam construction nearing completion (**b**) during construction

Fig. 5.14 Growing beans and spinach

single family use but schools and other institutional buildings have blocks of latrine cubicles.

The author's experience of providing safe toilets in Ghana is limited to dry pit latrine blocks for schools but much of it is applicable to family and small commercial activities. There are many variants of pit latrine (Refs 8 and 9) but they fall into two main categories: dry pits and pour-flush pits.

Common features of both dry pit and pour-pit latrines include the following:

- a privacy cubicle with:
- a lockable door facing the prevailing wind and in full view of the school:
- a hole in its floor leading to:
- a deep pit to provide 3.0 m long drop:
- a concrete slab forming the floor of the cubicle:
- a ventilation pipe to reduce odours, leading from the pit to some 0.6 m above the roof of the cubicle—wind crossing to top of the pipe causes up-drought in the pipe:
- a fine net over the top end of the ventilation pipe to prevent flies entering or leaving:
- a gutter at roof eaves to collect rainwater and direct it to:
- a storage tank with tap and soap, near the exit, to enable hand washing.

For pit latrine blocks at schools in Ghana, cubicles are allocated to girls specifically and to boys specifically and there is usually and one reserved for staff. Standards for the number of cubicles to be provided per number of students are unclear but, in Volta and Upper West Regions, 35 users per cubicle appears to be used, with additional urinals for boys and sometimes for girls.

5.4.2 Dry Pit Latrines

Dry pit latrines are clearly the preferred option, if feasible, in areas where water is scarce. They have significant advantages over pour-flush pit latrines. Dry pits have lower operation costs largely because they require emptying much less frequently. Provided water is only introduced via urine and daily cleaning, the sludge will accumulate at the bottom of the pit and will, if the base is porous, be digested over time, the rate of digestion depending on ground conditions. On average, an adult will produce approximately 45 L of solids in 1 year so, for a cubicle serving 35 students, some 1600 L would be produced. A typical pit will have a volume 6000 L (6.0 m^3). Even if digestion, and therefore shrinkage, is ignored the pit would only become 80% full after 3 years. In practice, a pit should never be filled completely, the contents would also need to accommodate self-cleansing bio-degradable materials such as corn cobbs and absorbent paper. However, it is reasonable adopt, for planning purposes, an emptying frequency of 2 years, thereby having a substantial margin to accommodate variations in usage.

Instead of emptying the pit following 2 years of usage, if it could be sealed and left for a further 2 years, the solids would continue to be digested and would shrink as the water content is adsorbed into the ground. The remaining material would be dry, odourless, safe to handle and of considerably less volume, perhaps less than 80% of its volume at pit closure. Closing pits for 2 years would seem to imply doubling the required total number of toilets so when a number of pits are taken out of use, there are others to open as replacements. However, there is a cheaper way, achieved by adopting the twin-pit and twin squat hole concept, for a multiple toilet cubicle building.

Each cubicle is built with two squat holes, only one of which, A, is used first and a heavy flat slab is placed over the other, B. The pits beneath the cubicles connect with two adjacent squat holes, AA or BB, one of each located in two adjacent cubicles, one each side of the dividing wall. All squat holes A are used for 2 years and then closed and capped as squat holes B are brought into use. The closed pits are left for 2 years and then emptied and brought back into use as squat holes B are closed and sealed. In this way, the latrine block will be available continuously and pit emptying, if and when required, can take place without interrupting availability of latrines.

To achieve maximum digestion there must be no cross seepage of material between adjacent pits so the walls of pits must be constructed with non-porous brick/block, fully mortared and cement rendered. The ventilation pipe should remain open during the digestion stage so that gases produced can escape; aerobic digestion occurs.

A further feature of the dry pit latrine can be its ability to trap flies and to remove odour more effectively than pour-pit latrines. The simple squat hole of dry pits allows air flow between the cubicle and the pit and as wind moves across the top of the vent pipe it draws air and smells up the pipe, thereby creating stronger circulation, pulling air into the cubicle over and under the door, through the squat hole and up the ventilation pipe. The airflow assists flies to enter the pit via the squat hole but once in, provided the cubicle is relatively dark, they will be drawn to the light coming from the top of the vent pipe. The fine mesh across the pipe will ensure the flies are trapped and never leave the pit. The cubicle must be kept dark by having no windows or openings except for a gap between the top of the door and its frame.

Dry pit latrines also offer the opportunity to slope the surface of floor towards the squat hole from all sides when laying the concrete. This will help to avoid water and urine pooling and reduce the chance of soiling clothes.

The capital cost of an eight-cubicle, dry pit latrine block with water harvesting and the twin-pit feature, is of the order of $7000 provided that excavation and carrying are undertaken by the benefitting community free of charge.

5.4.3 Pour-Flush Pit Latrines

Unlike the dry pit latrines described, only one pour-flush toilet within each cubicle is practicable so the above-described twin-pit feature is not appropriate. They also use different, yet effective, methods to reduce flies and odours. They can be fitted with either a squatting toilet pan or a bowl with seat but both feature some means at the bottom of the pan which retains some water, thereby reducing odours and not enabling flies to enter the pit.

However, by definition, they do require water for flushing and, although they use much less water than plumbed-in toilets, 4 L per user per day is recommended (Ref. 10). This, for a typical Junior High School of 250 students and staff, would require over 1000 L to pour-flush every day. This requirement is perhaps at odds with the severe shortage of water in the semi-arid north. A typical intervention to bring safe water to a community is to install a borehole; drawing off 1000 L every day to flush toilets is a significant responsibility and may not be practical in the height of drought when yields fall.

If the walls and/or floor of the pit were porous, much of the excreta and pour-flush water could be absorbed into the ground and could move quickly to reach water sources before dangerous contents including pathogens gave been neutralised. In addition, depending on ground conditions, the regular influx of large volumes of fluid could weaken the structure of the building, leading eventually to collapse (a common occurrence in Ghana), with inherent risks of both physical and health hazard. To avoid such situations, pour-flush pit latrines should only be built with pits having impermeable walls and floors. Retention of large volumes of material requires careful design and construction and results in significant construction cost implications.

The requirement also has high operating cost implications. Pit design should expect, for 35 users per cubicle, 140 L of water per day (700 L

per week) plus solids and urine. A typical pit would have circa 6000 L volume so would require emptying 8–10 weeks. Emptying would have to be carried out by pump and carried away to be disposed of safely and legally. For the above exampled school of 250 with eight toilet cubicles, the volume of waste for safe pumping and disposal would be more than 30,000 L. Safe access for pumping must be provided and the waste must be disposed of at a licenced location, usually designated land fill sites, in accord with government regulations.

Although the capital and operating costs of pour-flush pit latrines are relatively high, they are sometimes preferred to dry pit latrines, notably in locations where the water table is persistently high or where they cannot be constructed at suitable distance from a water source. Where waste would drain through the ground to a water source, water-tight pits must be constructed instead those used for dry pit latrines. Such sealed pits must be strong and well-founded to avoid cracking and subsidence.

5.4.4 Hand Washing

An essential feature to pit latrines, whether dry or pour-flush, is the opportunity to self-cleanse after use of the toilet, before leaving the precincts of the building. In all cases, a simple, low-cost rainwater harvesting system, with soap, should be added to the latrine project. This takes the form of a roof sloping towards the exit side of the building, with a gutter of plastic, bamboo or galvanised steel fixed to the eaves to direct rainwater to a downpipe leading to a water container, often a 5000 L polytank, with tap and soap. Users pass the tank on their way out and can wash. In Ghana, the hand washing addition was first introduced in Ashanti Region and is called the Kumasi Ventilated Improved Pit or KVIP (Fig. 5.15).

A built-in washing facility is particularly important if a borehole has been installed in the community, otherwise people will walk to the borehole to avail themselves of water for self-cleansing, thereby risking contamination of the borehole area.

Fig. 5.15 Kumasi Ventilated Improved Pit or KVIP with hand washing facility

In the dry north, rainwater can only be harvested over about 4 months in the year but even in dry conditions, the community should agree to make sure the tank is kept sufficiently full of water, replenishing the tank with water carried in every day or, if present, directly from a borehole.

5.5 Conclusions

Like many other developing countries, Ghana faces severe problems associated with the supply of safe drinking water and the provision of sanitation facilities. To a large degree, this situation is related to the country's tropical climate which is characterised by seasonal extremes—drought conditions for much of the year, and excessive rainfall for a shorter period. The resultant hardships are experienced most heavily in the remoter settlements, typically inaccessible by road and not supplied by electricity. Without direct access to water, villagers, usually women and children, have to obtain their water supply from natural sources that are not only unreliable under changing weather conditions but commonly become health hazards due to pollution of various kinds.

As this paper demonstrates, several different technical solutions are available. It is their implementation and continuing maintenance that is the challenge. Part of the problem, of course, is funding, a situation that is shared by all poor "devel-

oping" countries. In these circumstances of limited funds, it is particularly important to recognise the necessity of appropriate organisation to achieve the intended goals. This is demonstrated well by the experience of small NGOs such as Ghana Outlook. This UK based charity has gained its successes largely by working closely with local community leaders and partner organisations. In this way, the limited funds made available to charitable bodies can be most effectively used to improve the lives the people they are intended to help.DeclarationThe author is a trustee of Ghana Outlook, a charity registered in the United Kingdom, No. 1091636. 27 Pengeston Road, Penistone, Sheffield, United Kingdom S36 6GW. The narrative draws on the author's experience of water and sanitation in Ghana, much of it with the charity, although the views expressed are not necessarily those held by the charity.

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6 Russia's Readiness to Achieve SDG 6 in Drinking Water and Sanitation by 2030

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Abstract

In Russia, there are over 2.5 million large and small rivers, more than 2 million lakes, hundreds of thousands of swamps and other water resources. Russia is experiencing a water shortage in a number of regions. The main reason for this is the extremely uneven distribution of water resources over the water basins of the country. The Far Eastern and Siberian Federal Districts (FDs) are very well provided with water resources, the Ural and North-Western FDs are somewhat less well supplied; The most densely populated districts—Privolzhsky, Central, Crimean, and North Caucasian districts—have limited water resources. The water resource management with comprehensive and reliable data collection methods with statistical observations are discussed. Impact of the development of digital economy and telecommunications infrastructure on reducing inequalities, such as SDG 3 (Good Health and Well-Being) is highlighted. The chapter briefly discusses how Russia has progressed toward achieving each of the SDG6 targets 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6a and 6b. The current environmental situation in Russia requires many measures for regeneration, protection, and rational use of water resources. There is a need for safe and effective water engineering works to provide a reliable supply for the population, and for industrial and agricultural enterprises.

Keywords

Russia · Water resources management · SDG progress · Challenges

6.1 Introduction

In Russia, as in other countries, Sustainable Development Goal 6 (SDG 6) on water and sanitation, adopted by United Nations Member States at the 2015 UN Summit as part of the 2030 Agenda for Sustainable Development, provides the blueprint for ensuring availability and sustainable management of water and sanitation for all. SDG 6 aims to ensure universal access to safe and affordable drinking water, as well as complex water resources management at all levels, to protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes.

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It provides for the following tasks:

- Improve water quality by reducing pollution, eliminating waste disposal, and minimizing the release of hazardous chemicals and materials, halving the proportion of untreated wastewater and significantly increasing the recycling and safe reuse of wastewater worldwide;
- Significantly improve water use efficiency across all sectors and ensure sustainable withdrawals and supplies of fresh water to address water scarcity and significantly reduce the number of people suffering from water scarcity;
- Protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes.

Without sufficient quantity and quality of water resources, it is impossible to achieve other goals of sustainable development (sustainable agricultural development, health, conservation of ecosystems) and other SDGs.

6.2 Water Resources for Sustainable Development in Russia

6.2.1 Water Reserves in Russia

According to the Water Code of the Russian Federation, water bodies are subdivided into several types, depending on the physical-geographical, hydro-regime, and other characteristics (Water Code, 2006).

They can be defined as follows:

- Surface water bodies consist of surface waters and lands covered by them and associated with them (bottom and banks). These are surface watercourses (rivers, streams, canals), lakes, reservoirs, swamps, and ponds, as well as glaciers and snowfields (natural and permanent accumulations of ice and snow),
- Sea waters (seas, bays, straits, etc.),
- The territorial sea of Russia (coastal sea waters 12 nautical miles wide in accordance with the norms of international law),
- Groundwater bodies (groundwater basins, aquifers, groundwater deposits, natural groundwater outlets).

The combination of all the listed water bodies within the territory of Russia, included or subject to inclusion, forms the total national water reserves of Russia.

For the territory of the Russian Federation, data on water reserves and on approximate periods of their renewal are given in Table 6.1.

Russia, occupying 1/9 of the entire earth's land with a length of 60.9 thousand km of coastline, is washed by the waters of 12 seas belonging to the basins of the Arctic, Pacific, and Atlantic oceans, as well as the inland Caspian Sea. It is distinguished by an abundance of natural waters, a well-developed river network and a system of lakes (NIA-Priroda, 2019).

In Russia, there are over 2.5 million large and small rivers, more than 2 million lakes, hundreds of thousands of swamps, and other water resources. In general, 72.2 million hectares are occupied by water (excluding swamps), of which 27.4 million hectares (38.0%) are included in the

Table 6.1 Water reserves on the territory of Russia

Types of water reserves	Reserves, km^3
Big lakes	24,855
Swamps	1520
Soil and ground	6430
Ground water	2,874,124
Polar glaciers	13,470
Mountain glaciers	133.1
Underground ice in the permafrost zone	17,178
Overlapped river and ground waters	84.8
Water in the channels of the largest rivers	116.5
Biological water	130
Atmospheric moisture	180

Source: [RosNIIVKh, 2016]

land of the water reserves. The water reserves for the federal districts of the Russian Federation are presented in the Table 6.2.

6.2.2 Water Resources in Russia

The current environmental situation in Russia requires many measures for regeneration, protection, and rational use of water resources. There is a need for safe and effective water engineering works to provide a reliable supply for the population, and for industrial and agricultural enterprises.

The total volume of static water resources in Russia is estimated at 88.9 thousand km^3 of fresh water, a significant part of which is concentrated in groundwater, lakes, and glaciers. According to recent data, the average long-term renewable water resources are estimated at 4258.6 km^3/year, of which the bulk is formed on the territory of the country, and just over 200 is an inflow from adjacent territories (Water resources, 2008).

The most rapidly renewed stocks are in riverbeds. At the same time, the share of rivers (their static water resources) of Russia is more than 20% of the global share, freshwater lakes—about 30%, swamps and wetlands—over one quarter. Groundwater reserves account for less than 1% of the world's volume. Water reserves in permafrost and ground ice in Russia slightly exceed 5% of the world volume. Water in Russian glaciers occupies less than 0.1% of the global value of this group of water resources.

The average long-term value of the river runoff in Russia is at the level of 4.2–4.3 thousand km^3 per year (10% of the world river runoff, second in the world after Brazil). On a per capita basis, Russia accounts for about 30,000 m^3 of river runoff per year. The average long-term (renewable) runoff from the lakes exceeds 530 km^3/year. Approximately 3000 km^3/year of water concentrated in bogs provides an annual runoff (discharge) of about 1000 km^3. On the land of Russia, groundwater deposits have been explored, suitable for household, drinking, industrial, technical, and agricultural water supply, with total operational reserves of over 34 km^3/year. The predicted groundwater resources according to the State Monitoring of the Subsoil Condition are estimated at almost 320 km^3/year. At the same time, the total reserves of all groundwater, a large part of which is not associated with surface runoff, are much more significant. A large volume of fresh water, estimated at approximately 16,000 km^3, is concentrated in underground ice and permafrost. Another 15,000 km^3 of water is concentrated in glaciers. Thus, Russia is consistently included in the group of countries in the world with the most water resources, both

Table 6.2 Water reserves of the Russian Federation by federal district

Federal district	Land area under water, thousand hectares	Rivers	Lakes and artificial reservoirs	Swamps and wetlands	Average long-term river runoff, km^3/year	Groudwater
		River network, thousand km	Square, thousand ha	Square, thousand ha		Reserves, m^3/cyr.
Northwest	10,515.2	1000	84	25,682.2	607.4	4939.1
Central	1327.4	200	900	1238.4	126	27,851.1
Volga region	2458.8	400	2000	898.6	271.3	17,226.2
Crimean	–	6	44	5.1	0.91	–
Southern	2140.4	85	1100	513.2	288.9	8735.4
North Caucasian	383.6	47	120	55.2	60.1	7342.3
Ural	18,034.8	5	7000	40,193.8	597.3	5696.2
Siberian	17,213.6	2000	12,000	41,821.4	1321.1	13,707.9
Far eastern	20,172.6	4000	11,200	42,375.3	1847.8	5925.9

Source: [NIA-Priroda, Moscow—2019]

in terms of total reserves and per capita (Water resources, 2008).

At the same time, having such significant water resources and using annually on average no more than 2% of river flow, Russia is experiencing a water shortage in a number of regions. The main reason for this is the extremely uneven distribution of water resources over the water basins of the country. Water resources by Federal Districts (FDs) of the Russian Federation are presented in Table 6.3.

The Far Eastern and Siberian FDs are very well provided with water resources, the Ural and North-Western FDs are somewhat less well supplied; The most densely populated districts—Privolzhsky, Central, Crimean, and North Caucasian districts—have limited water resources.

About 15 constituent entities of the Russian Federation have water resources less than 10 km^3/year. At the same time, territories located in areas of insufficient moisture and having very limited water resources. They, like federal districts, have, as a rule, very large variability of them, both in the long-term context and within the year, which imposes very significant additional difficulties in solving water supply problems.

Table 6.3 Average long-term value of water resources by federal districts of the Russian Federation

Federal district	Population ($\times 10^3$) in 2016	Water resources, km^3/year	Water availability per resident, ($\times 10^3$) m^3/year
Russian	146,880	4260.3	29.0
Northwest	39,311	328.2	8.3
Northwest	13,952	867.7	62.2
Southern	16,442	560.6	34.1
North Caucasian	9823	61.4	6.3
Volga region	29,543	1490.9	50.4
Ural	12,356	1206.1	97.6
Siberian	19,288	1975.7	102.4
Far Eastern Federal District	6165	2458.7	398.8

Source: [NIA-Priroda, Moscow—2019]

6.2.3 Use of Water Resources

The total withdrawal of water from water bodies in the Russian Federation in recent years up to and including 2018, had a downward trend, although in some years this trend varied slightly. If we carry out the analysis in retrospect, it can be noted that the dynamics of water use did not always correspond to the vector and rates of general economic development. From 2010 to 2018, the indicator of the total water withdrawal in the Russian Federation decreased by almost 14%, while the GDP increased over the same period by approximately 12–13%. In 2018, compared to the previous year, there was also a slight decrease in water withdrawal with a certain increase in GDP. The leading indicators include the water use of both the country's economy and the constituent entities of the Russian Federation [NIA-Priroda, 2019].

The water management system in Russia, which is one of the largest in the world. It includes more than 30,000 reservoirs and ponds with a total volume of over 800 m^3 km and a useful volume of 342 m^3 km. The network of channels for inter-basin and intra-basin redistribution of runoff, water management systems for water transport purposes with a total length of more than 3000 km allows for the transfer of runoff in a volume of up to 17 m^3 km per year [NIA-Priroda, 2019].

There are two main aspects of water resources use: water use and water consumption. Organizations using water for technological processes, as well as in public utilities systems, are called water consumers. Industries that use water as a resource without changing its physical and chemical state are called water users. Both of them have a significant impact on the state of water resources (see Sect. 6.4.3 for more details).

6.2.4 Water Resources Management

In Russia, much attention is paid to the need for comprehensive and reliable data collection methods with statistical observations, and the performance of these functions are assigned to state bodies.

The main source regulating relations in the sphere of water use in Russia is the Water Code of the Russian Federation. Guided by Articles 30 and 31 of the Water Code of the Russian Federation, the entire system of accounting for water bodies and their use is based on three categories of indicators. They are:

- Water resources accounting;
- Water use without intake (withdrawal) and with the intake of water resources from water bodies;
- Water disposal [Water Code, 2006].

All data are stored in the State Water Register. The recording of the State Water Register with indicators of the first category is ensured by monitoring data obtained by the Federal Service for Hydrometeorology and Environmental Monitoring, the Federal Agency for Subsoil Use, authorized executive bodies of the constituent entities of the Russian Federation. The procedure for submitting to the Federal Agency for Water Resources data on state monitoring of water bodies received by participants in the conduct of state monitoring of water bodies was approved by the Resolution of the Government of the Russian Federation. The collection and processing of data of the second and third categories of indicators is carried out within the framework of statistical observation on water use carried out by Rosvodresursy. For these purposes, the annual form of federal statistical observation No. 2-TP (vodkhoz) "Information on water use" has been approved.

According to the provisions of the Water Code of the Russian Federation and regulations governing the provision of a water body for use, each water user is obliged to submit reports, to the Rosstat and other authorities.

Analysis of the state of statistical and departmental accounting systems shows that the existing approach does not provide an opportunity to analyze all aspects of the use of water bodies in a complex system. It is necessary to improve the accounting of water resources, to introduce into practice new forms of statistical reporting, which should reflect: (a) predicted water content by posts in the basin for calculating predicted resources at the beginning of a hydrological year, (b) levels for lakes and reservoirs, and (c) cost assessment of water resources at the beginning and end of the year [RosNIIVKh, 2016].

The Water Code of the Russian Federation provides for the collection and analysis of quantitative and qualitative data at places of discharge/intake of water points. These data are available to the territorial bodies of the Federal Agency for Water Resources (Rosrybolovstvo) and others as part of the coordination of standards for permissible impact on water bodies for operating, reconstructed or projected enterprises. In addition, the data on the proposed projects become available as part of the examination of the design documentation. Data required for the formation of the state of the water register are submitted to the Federal Agency for Water Resources on paper and electronic media in a form that cannot be processed by machine. This is regulated by the relevant orders of the Ministry of Natural Resources of Russia, with the exception of data flows from the territorial bodies of the Federal Agency for Water Resources itself.

The Federal Agency for Subsoil Use has achieved the greatest level of automation. Also, much work has been done by Rosreestr, Roshydromet, and Rosprirodnadzor. They have developed information systems that provide automated collection of primary information, its storage and systematization.

6.2.5 Schemes of Integrated Use and Protection of Water Bodies

Schemes for the integrated use and protection of water bodies (SKIOVO) include systematized materials on the state of water bodies and their use and are the basis for the implementation of water management measures and measures for the protection of water bodies located within the boundaries of river basins.

They are designed to:

1. Determine the permissible anthropogenic load on water bodies;
2. determine the need for water resources in the future;
3. ensure the protection of water bodies;
4. determine the main directions of activities to prevent the negative impact of waters.

Schemes for the integrated use and protection of water bodies establish:

- Target indicators of water quality in water bodies for the period of,
- Validity of these schemes;
- A list of water management measures and measures for the,
- Protection of water bodies;
- Water management balances designed to assess the amount and degree of development of water resources available for use within the boundaries of river basins and representing calculations of the needs of water users in water resources in comparison with the water resources available for use within the boundaries of river basins, sub-basins, water management areas under different conditions of water availability (taking into account the uneven distribution of surface and groundwater flows in different periods, territorial redistribution of surface water flows, replenishment of water resources of groundwater bodies);
- Limits for the intake (withdrawal) of water resources from a water body and limits for wastewater discharge, corresponding to quality standards, within the boundaries of river basins, sub-basins, water management areas under various conditions of water availability;
- Quotas for the intake (withdrawal) of water resources from a water body and discharge of wastewater, corresponding to quality standards, within the boundaries of river basins, sub-basins, water management areas under different conditions of water availability in relation to each constituent entity of the Russian Federation;
- The main target indicators for reducing the negative consequences of floods and other types of negative impact of water, a list of measures aimed at achieving these indicators;
- The estimated amount of necessary financial resources for the implementation of schemes for the integrated use and protection of water bodies.

The body authorized by the Government of the Russian Federation for the development of SKIOVO is Rosvodresursy. Currently, 69 projects have been completed [RosNIIVKh, 2016].

6.3 Water Strategy of Russia and the Federal Program "Clean Water" for the Implementation of MDG 7

During the implementation period of MDG 7, the most important documents in the field of water resources in Russia should include the "Water Strategy of the Russian Federation" for the period until 2020. This is a strategic planning document that defines the main directions of activities for the development of the water sector in Russia. The strategy was developed in order to provide water resources for the implementation of the Concept of long-term socio-economic development of the Russian Federation for the period up to 2020.

The strategy defines the main directions of activities for the development of the water management complex of Russia. The purpose of this is to ensure sustainable water use, protection of water bodies, protection from the negative impact of water, as well as activities to form and implement Russia's competitive advantages in the water resource sector; establishes the basic principles of state policy in the field of use and protection of water bodies; provides for the adoption and implementation of management decisions on the preservation of aquatic ecosystems that provide the greatest social and economic effect, the creation of conditions for effective interaction between participants in water relations.

In Russia, the Federal Target Program (FTP) "Clean Water" for 2011–2017 has also been approved. Work is underway to establish, equip, and ensure the regime of sanitary protection zones for water bodies that are sources of drinking and domestic water supply. The Federal Target Program "Clean Water" for 2011–2017 is a state program aimed at providing the population of Russia with clean drinking water. The program is being implemented within the framework of the Water Strategy of the Russian Federation until 2020. Work is underway to cause people's awareness of the use and protection of water bodies, rational water use.

Lack of clean water and sewage systems is the main reason for a variety of infections that lower the quality and life expectancy of the population. Problems in the field of drinking water supply are caused by insufficient measures for the protection of water sources, poor conditions of water supply, sewerage, and wastewater treatment systems, inefficient financial support for public utilities, imperfection of the regulatory legal framework, and inefficient economic mechanisms in the field of water use.

6.4 Implementation of SDG 6 in Russia (2015–2030)

At the end of MDGs in 2015, Member States of the United Nations (UN) adopted the 2030 Agenda for Sustainable Development, which is composed of 17 Sustainable Development Goals (SDGs) and associated 169 targets to eradicate poverty, protect the Earth's resources, and well-being for all. Goal 6 (SDG 6) aims to ensure universal access to safe and affordable drinking water, as well as complex water resources management at all levels, to protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes. The SDG 6 has eight targets: 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6a and 6b. The following sections discuss how Russia has progressed toward achieving some of these targets in relation to SDG 6 in relation to clean water and sanitation.

6.4.1 Providing the Population with Clean Water and Sanitation Services (SDG Targets 6.1 and 6.2)

Over the past two decades, Russia has made significant progress in providing the population with clean water and sanitation and hygiene services, which is associated with the implementation of SDG targets 6.1 and 6.2.

In 2018, 91.5% of the Russian population was provided with safe drinking water (target 6.1), compared to 90.4% in 2015. The same coverage data for urban areas was 96.2% in 2018 (95.0% in 2015) and 77.7% in 2018 (77.2% in 2015) for rural areas. By 2024 it is targeted to increase the safe drinking water coverage from centralized water supply systems to 90.8% and 99% for rural and urban populations, respectively.

The improved coverage to both rural and urban areas is a result of increased services through the provision of piped water, sewerage, bath/shower, and hot water facilities, as shown in Table 6.4.

Over the past 20 years, significant progress has been achieved in the provision of water services, which was facilitated by an increase in the improvement of housing, which is also reflected in both the MDG targets for Goal 7

Table 6.4 Amenities of housing stock end of year (%)

	Piped water	Sewage (canalization)	Bath (shower)	Hot water supply
Total housing stock				
2000	73	69	64	59
2010	78	74	67	65
2019	84	79	72	72
Urban housing stock				
2000	86	84	79	75
2010	89	87	81	80
2019	92	89	83	83
Rural housing stock				
2000	39	30	24	17
2010	48	39	29	25
2019	63	52	40	40

Source: Rosstat, 2020

and SDG 6. The increase in the provision of housing with water supply and sanitation for 2000–2019 amounted to about 20% p.p. In the whole country, 72–84% of the housing stock is provided with hot and cold water supply, and sewerage. The provision of these services in urban housing stock is significantly higher than in rural housing. Nevertheless, the improvement of rural settlements over the past two decades has grown faster than in cities. After 2000, especially significant progress was achieved in the provision of water supply to rural housing stock (an increase of 24% of the area), sewerage (22%), and hot water supply (23%) (Table 6.4).

At present, 84% of households in Russia are provided with water supply, 79%—with wastewater disposal (sewerage), 72%—with baths (showers), and 72%—with hot water supply (Table 6.4).

Nevertheless, the problems of providing the population with clean water persist. In 2018, 11.5 million people (9.0%) were provided with water from non-centralized water supply facilities, 0.8 million people (0.6%)—by supplying drinking water. The population without drinking water supply amounted to 1.5 million people (1.2% of the total population). Average water consumption per person in 2018 was 0.14 m^3 per day. The indicator remained at the level of 2015, but decreased by 22.2% compared to 2010. The share of the population using water supply services organized in compliance with safety requirements was 93.6% in 2018.

In order to improve the quality and availability of water supply, the federal "Clean Water" project is being implemented within the framework of the national "Ecology" project (2018–2024). The Ministry of Construction of Russia signed 82 agreements on the provision of subsidies from the federal budget to the constituent entities of the Russian Federation for the implementation of measures for the construction and reconstruction (modernization) of water supply facilities for a total amount of 4.2 billion rubles [Analytical Center, 2020].

Equitable Sanitation and Hygiene for All (Target 6.2)

The basic sanitation and hygiene facilities accessible to the population are centralized wastewater disposal (sewerage) system, and toilet facilities (in a house or stand-alone building).

In 2018, about 86.9% of households in Russia had a toilet in an apartment or a house—an increase as against 2016 (84.1%); 12.6% had toilets in common use (for instance, in a shared apartment) or a toilet in a stand-alone building. In 2018, the proportion of population using safe sanitation services was 85.8% (Analytical Center, 2020).

6.4.2 Improving Water Quality and Reducing Water Pollution (Target 6.3)

The scale of water use, the negative impact on water bodies, on the one hand, and the volumes of various types of costs for the protection and rational use of water resources, on the other, in many cases differ significantly for different types of economic activities.

In recent years, both the intake of fresh water and the rates of its use have been decreasing. This is explained by water savings through the introduction of appropriate technologies. The indicators of water use are improving, which is associated with the excess of the growth rates of final products (including GDP) over the consumption of water resources and the discharge of polluted waters, i.e. the decoupling effect taking place (*different asset classes that typically rise and fall together start to move in opposite directions, such as one increasing and the other decreasing*). This is demonstrated by the prevailing trends in water consumption for 1990–2018, when a significant reduction in water consumption occurred against the background of GDP growth.

Since 1990, the discharge of polluted waters in the country has more than halved (Fig. 6.1). The main sources of pollution of

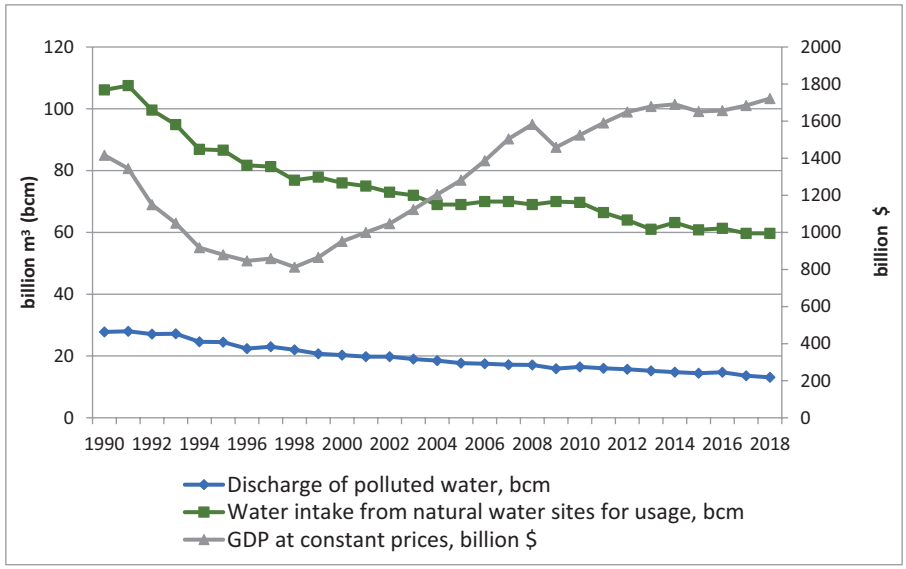

Fig. 6.1 Dynamics of water intake, discharge of polluted water and GDP (1990–2018)

water bodies are enterprises of various industries, energy, housing, and communal services, wastewater from agricultural enterprises, etc. In 2015–2018, discharged pollutant volumes reduced both in general from 14.4 billion m^3 to 13.1 billion m^3 (by 9%) and by primary sectors, other than transport, with the maximum reduction (11.2%) in the manufacturing sector.v

The predominant types of pollution at water supply sources include mineralization, turbidity, color, etc. In general, in Russia, this type of pollution is present in 21.2% of water samples at sources. In order to modernize the enterprises of the water supply and sewerage system, 516 investment programs in the field of water supply were approved. The total amount of funds provided for by investment programs, according to information from the regions, amounted to 134.4 billion rubles (Analytical Center, 2020).

In addition to the federal "Clean Water" project of the national project "Ecology," in April 2017, the Strategy of Environmental Safety of the Russian Federation for the period up to 2025 was approved. The introduction of technologies aimed at reducing the volume or mass of discharges of pollutants into water bodies was identified as one of the priority directions of the Strategy.

As part of the reform of environmental legislation carried out by the Government of the Russian Federation, a transition to technological regulation based on BAT indicators (best available technologies) is envisaged. This provides for the introduction of such technologies at water supply and sewerage facilities, encouraging water users to introduce BAT, a circulating water supply system, and increased investment in water treatment.

The Strategy for the Development of Inland Water Transport of the Russian Federation for the period up to 2030 sets the task of ensuring environmental safety during the operation of ships, to prevent pollution from ships by household, waste and oily waters, oil and other substances harmful to human health, and aquatic biological resources.

Table 6.5 Consumption and use of water resources in Russia (2005–2018)

Index	2005 г.	2010 г.	2015 г.	2018 г.
Water intake from natural water sources for use, billion m^3	69	69.7	60.8	59.7
Water losses during transportation, billion m^3	8.0	7.7	6.8	7.0
Recycling and sequential use of water, billion m^3	135	140.7	138.9	144.2
Water resources exploitation index (IEWR), %	1.75	1.71	1.46	1.46
Average daily supply of water to the population and budget-funded organizations per one city dweller, liters	200	194	145.2	138.6

6.4.3 Improving the Efficiency of Water Use in the Sectors and Solving the Problem of Water Scarcity (Target 6.4)

Improving the efficiency and rational use of water resources is one of the most pressing aspects of sustainable development both at the national and international levels.

At present, 60 km^3 of water is taken from natural water sources in Russia for human use (Table 6.5). The Special Index of Water Resources Exploitation (IEWR), which correlates water intake (its extraction and transportation to places of use) to its total reserves, is only about 1.5% of water reserves. However, for individual basins, the ratio of intake to reserves is significantly differentiated. For example, in the Don basin, about 30% of the annual runoff is taken annually, in the Terek basin—over 40%. One-third of the total water intake in Russia comes from the Volga basin.

Of the 53 km^3 that have reached the stage of consumption, 29 km^3 (55%) are used for industrial water supply, 8 km^3 (14%) for drinking and domestic water supply, 7 km^3 for irrigation and agricultural water supply (13%) (Fig. 6.2).

The main water-consuming industry is the production and distribution of electricity, gas, and water (59% of all industrial water consumption), 26% falls on manufacturing. The absolute water consumption in all sectors is decreasing.

At present, the volume of recycled (reusable) water as a percentage of the total volume of water consumption for industrial needs is 70%. In absolute terms, this is more than the annual flow of the Volga. If such systems did not exist, the intake of fresh water for the industry would have tripled. The indicator of recycled and consistent water use has increased since 2005 (Ministry of Natural Resources of Russia, 2019).

Various indicators are used to assess the efficiency of water use.

The most generalized indicators of the efficiency of water resources use, which compare the volume of consumed water with the results of economic activity, are the water capacity and the intensity of pollution of water resources (specific pollution). These indicators are particular indicators of the intensity of nature and the intensity of pollution. On the scale of the economy as a whole, water capacity can be measured as follows:

$$W = R / V \tag{6.1}$$

where

W is the water capacity per unit of GDP;
R is the annual consumption of fresh water;
V is the final product (GDP).

Water capacity at the macro-level shows how much water resources need to be spent to obtain a unit of GDP. The dynamics of this indicator can serve as an indicator of the efficiency of water resources use. Similar indicators can be calculated both for industry complexes and for individual industries. The intensity of pollution of water resources accordingly reflects the volume of wastewater per unit of production (GDP). These two water indicators are widely used at the micro-level, within individual enterprises, firms, and corporations.

Since 1990, both the water capacity and the intensity of pollution in Russia as a whole and in

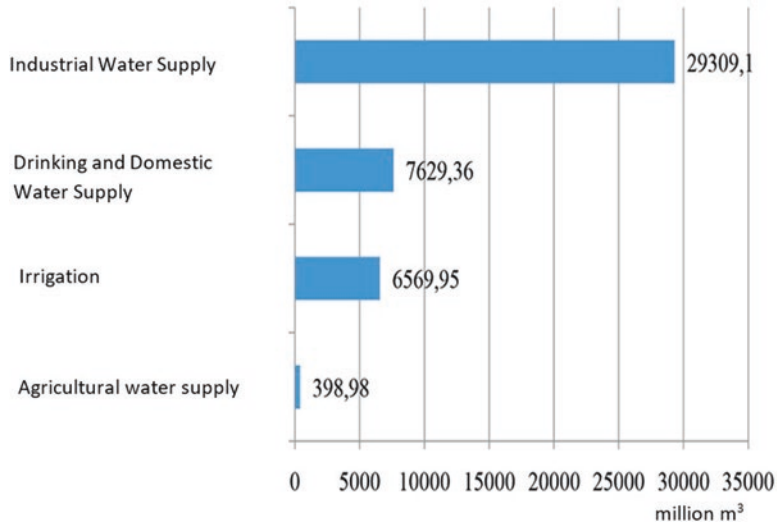

Fig. 6.2 Use of water for various needs (2008). (Source: Ministry of Natural Resources of Russia, 2019)

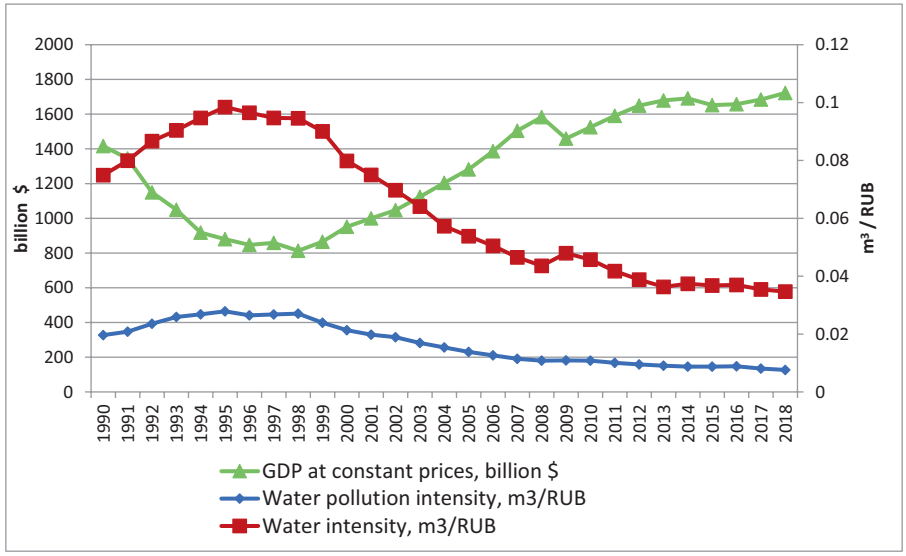

Fig. 6.3 Water intensity, pollution water intensity and GDP dynamics (1990–2018). (Source: Calculated by the authors based on Rosstat data)

individual regions have decreased (Fig. 6.3). Therefore, according to the authors' calculations, the water capacity and intensity of water pollution in general for 1990–2018 decreased by almost half, and in comparison, with 1995, fell even more significantly. These indicators as already noted, highlight the effect of decoupling in the field of water resources.

The average per capita water usage in Russia has decreased from 200 L/capita/day in 2005 to 138.6 L/capita/day in 2018, a 30.7% reduction over that period (Table 6.5). These water saving efforts are complemented by the mandatory installation of metering devices for cold and hot water supply in houses and apartments. Therefore, in 2014–2018, the share of households with cold water meters increased from 66.4% to 80.7% and hot water increased from 43.3% to 53.4% (Analytical Center, 2020).

In recent years, water problems have become greatly aggravated by anthropogenic changes in river runoff and inefficient use of water. In the most inhabited regions of the country, there are no large rivers that have not been disturbed by economic activity, both in the catchments and in the channels of the rivers themselves. Impact on runoff and water quality was exerted by: agricultural practices associated with forest reclamation activities; urbanization, as a result of which hundreds of square kilometers of land surface in each city were covered with asphalt; irrigation and drainage reclamation, which now covers an area of many millions of hectares; regulation of runoff by a large number of reservoirs; increased water withdrawals for irrigation, industrial and municipal water supply; discharge of contaminated water into water sources. In recent decades, among anthropogenic causes, a major impact on river flow has been exerted by the intake of water for its transmission by canals to areas with an acute water shortage. More than 100 km^3 of water are redistributed by canals. As a result of water intake from water sources for various needs of the national economy, the annual flow of the Don, Urals, Terek decreased by 17–25%. In dry years, the runoff decreases by 40–60%. A few decades ago, the decrease in runoff in the basins of these rivers did not exceed 2–5%.

An analysis of the results of numerous studies produced in the last 10–15 years by both Russian and foreign scientists using various climatic scenarios and hydrological models convincingly shows that most part of Russia in the first half of the twenty-first century, an increase in water resources and a decrease in their intra-annual unevenness.

According to these estimates, in most regions of the Russian Federation, one should expect an increase in the annual river runoff up to 10–15%. At the same time, in a number of densely populated regions—in the territories of the subjects of the Chernozem regions, the Central FD, the Southern FD, the southwestern part of the Siberian FD, which in modern conditions have rather limited water resources, one should expect a decrease in the annual river flow from 5 to 15%. In general, Russia can expect an increase in water resources by 8–10% (Ministry of Natural Resources of Russia, 2019).

Climate warming has a particularly large effect on the seasonal flow of rivers. These processes are already taking place practically everywhere in Russia, and they are expected to intensify in the future. The winter runoff of rivers will change most significantly: in the Central, Volga, and southwestern parts of the North-Western FD, the increase in winter runoff will be 60–90%, summer 20–50%; in other FDs, the increase in winter and summer runoff will be in the range from 5 to 40%. In a number of regions of Russia, a slight (up to 10%) increase in the runoff of the spring flood will occur, while in the regions of the Chernozem Center and in the southern part of the Siberian FD, the runoff of rivers in the spring will decrease by 10–20% [Ministry of Natural Resources of Russia, 2019].

It should be noted that despite the projected noticeable increase in water resources in the non-chernozem regions of the Central Federal District, in others, primarily in the Moscow region (together with Moscow), as a result of economic development, an increase in the population and an increase in the well-being of the population, an increase in the load can be expected, on water resources and a decrease in water availability, which are currently at a critical level.

Groundwater resources in our country are widely used for various economic purposes. This is facilitated by the greater uniformity of their territorial distribution and purity. Groundwater resources are divided into natural and operational. The volume of natural resources on the territory of Russia is estimated at 1100 km^3, the operational resources of fresh groundwater are about 340 km^3/year, and half of them are associated with surface runoff. Up to 5% of these reserves are used for water supply. Groundwater, hydraulically not connected with surface water (about 170 km^3), represents additional water resources [Ministry of Natural Resources of Russia, 2019].

In a number of industrially developed regions of the country such as Moscow and St. Petersburg, the intensive exploitation of groundwater causes a constant decrease in their level (up to 1 m per year). Depression funnels in the zones of concentrated groundwater abstraction have already developed over an area of hundreds of square kilometers. In these areas, the quality of groundwater is deteriorating, there is a leakage of sea water to water intakes, for example, in the Crimea, subsidence of the earth's surface, and karst processes are activated.

Thus, there is a need for measures to artificially replenish groundwater and manage their quality and use in many regions of our country.

The largest share of water abstraction from natural sources goes to economic activities such as production and distribution of electricity, gas and water (over 54%), and agriculture (over 23%). The structure of water intake from natural sources by type of economic activity is shown in Fig. 6.4. It should be noted that there is a large percentage of water losses during transportation, which is about 10% on average in the economy.

Another important fact that illustrates the irrational use of water in the country is the ratio of the discharge of contaminated wastewater to the discharge of normatively treated wastewater, which is more than seven times [Ministry of Natural Resources of Russia, 2019; RosNIIVKh, 2016].

The above indicators highlight serious infrastructure problems and a constant lack of investment in the country's water use. The process of introducing the best available technologies (BAT) in the sectors of the country's economy should make a noticeable contribution to rationalizing the use of water resources [RosNIIVKh, 2016; TsGEI, 2019].

Fifty-one information and technical reference books (ITS) BAT have been produced [TsGEI, 2019]. It is assumed that the "life cycle" of BAT reference books will be 5–7 years, after which they will be updated every 2 years or so taking into account the achievements of scientific and technological progress. The improvement of technologies will stimulate the adjustment of the existing ITS and the development of new ones. When adjusting the ITS, the general criteria for classifying the best available "green" technologies in all industries should be considered. This requires:

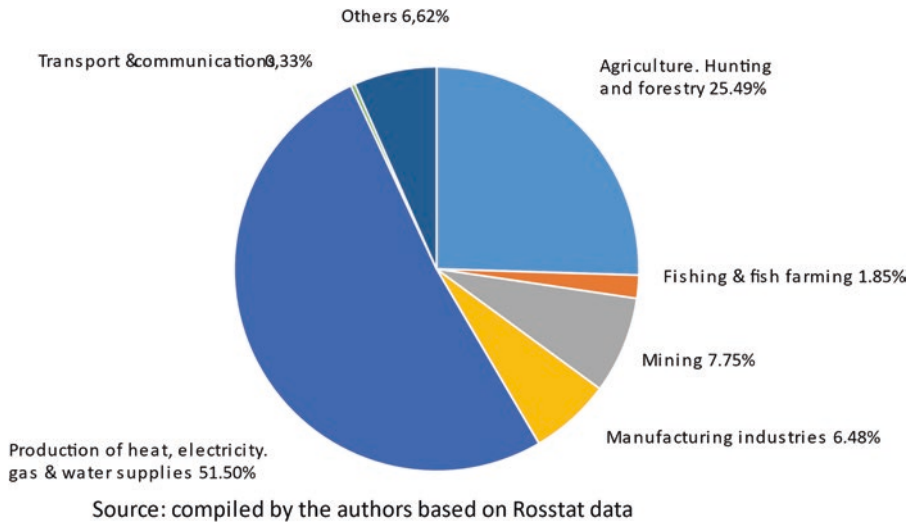

Fig. 6.4 Water withdrawal by type of economic activity (2020). (Source: Compiled by the authors based on Rosstat data)

- Implementation of the environmental policy of the enterprise, including the development of principles and sequence of actions for its implementation;
- Creation and maintenance of an environmental management system.

Transport

The water potential of Russia for these purposes is enormous. The total length of Russian rivers is 2.3 million km, and the sea coast is 60.9 thousand km. However, the length of inland waterways is significantly less in relation to the length of rivers—only about 100,000 km. In terms of cargo turnover, river transport ranks fourth in Russia (after road, rail and pipeline), and sea transport is fifth among all freight carriers. In terms of passenger turnover, water transport takes the last place, and is in decline. The main environmental problems in this case are obsolescence and deterioration of fleet equipment and accidents leading to the ingress of pollutants into water bodies [TsGEI, 2019].

Fishing

Several negative factors relating to the fishing involve rational use of water and pollution in this area. Firstly, there is the pollution of water bodies. Secondly, water intake for household needs from natural sources. Thirdly, the construction and operation of hydroelectric power plants, the dams of which impede the free passage of fish, and most importantly, cut off spawning grounds. Fourthly, the frequent lack of fish protection means at water intakes. Finally, violation of the regime and non-observance of catch quotas [TsGEI, 2019].

Hydropower

Russia has more than 40 large hydropower plants. Hydropower is considered the cleanest, most environmentally friendly source of energy. This is true primarily for small- and medium-sized hydroelectric power plants. When assessing large hydroelectric power plants, it is necessary to take into account the ecological and economic value of lands alienated during hydro-construction. Some of these areas include most agriculturally productive land. To date, 5–6 million hectares of farmland have been flooded by under the zones of hydroelectric schemes. This problem is most significant for flat areas, where flooded areas are especially large, in particular in the Volga River basin. In addition, the dams of hydroelectric power stations interfere the normal water flows of rivers, in particular, the Volga with its cascade of hydraulic structures.

Water Supply and Sewerage

The main strategy for increasing the efficiency of water use is the reduction in water consumption by the main water-consuming industries. This applies to fresh water, primarily by the introduction of water saving technologies (BAT) and a decrease in domestic water use. The second approach is the elimination of water losses at all stages of its use, from source to consumers. Some 7 km^3 are lost annually. Large losses are also noted directly at water consumers, in particular in irrigation. Due to the use of outdated technologies, the efficiency of many irrigation systems in the recent past was only 0.5, which means almost 50% losses.

The problem of water quality is also becoming more acute. Due to widespread pollution of water bodies, the lack of modern treatment technologies and the lack of funds for upgrading treatment plants, the quality of water in terms of its physical and chemical composition is low in many water basins and cities in Russia [TsGEI, 2019].

An important task for the implementation of the SDGs is to increase the level of water supply to the population and improve the operation of sewerage and wastewater treatment systems. This is a huge task for the entire housing and communal services sector. The industry supplies water to 124 million people, and provides a wastewater disposal service to 99 million. At the same time, the length of the network is 776,000 km and the annual turnover of the industry is 441 billion rubles. The total number of employees in the industry is 405,000 people [RAVV, 2020].

There are problems in the industry in the design and construction of water supply and sewerage facilities. There is also a need to create a new state program for the construction and reconstruction of communal treatment facilities, since this problem is not systematically solved in any of the existing federal projects.

Integrated Water Resources Management (Target 6.5)

The state management of water resources in Russia is characterized by an integrated approach. The Water Code of the Russian Federation defines the basic principles of water legislation, under the guidelines of "the priority of protecting water bodies over their use" and "the priority of using water bodies for drinking and domestic water supply over other purposes of their use" [Water Code, 2006].

The 21 districts are the main management units in the use and protection of water bodies. These consist of river basins and associated groundwater bodies and the seas. For the management of water bodies in all basin districts, basin councils have been created from representatives of state authorities, local governments, water users, public associations, communities of indigenous peoples of the North, Siberia, and the Far East.

The process of creating a digital model for water resources management systems in Russia is underway. Thus, the discussion of the federal project of integrated water resources management "Digital Ob-Irtysh basin" was organized. The project involves the creation of the world's first digital interconnected double-river basin system with simulation and mathematical modeling capability. In Moscow, the "Smart City—2030" project is being implemented, within the framework of which it is planned to introduce and develop digital technologies for managing water supply and sanitation systems.

The basic principles of state policy in the field of the use and protection of water bodies are enshrined in the Water Strategy of the Russian Federation for the period up to 2020. The main objectives of the Strategy are guaranteed provision of water resources for the population and sectors of the economy; protection and restoration of water bodies; ensuring protection from the negative effects of water.

Currently, the provision of water and sanitation services is within the framework of the execution of the Decree of the President of the Russian Federation through the implementation of the national "Ecology" project (Decree of the President, 2018).

At the end of 2017, new initiatives and projects were launched in Russia that can have a significant impact on the development of the water supply and sanitation sector, as well as water use technologies. These include the VEB Project Financing Factory. The scope of the Factory's activities for support will include, among other things, projects envisaged by the national project "Ecology" (federal project "Clean Water," federal project "Transition to the best available technologies").

As of March 2020, 45 concession agreements in the field of water supply and sanitation were concluded in Russia with a total volume of investment commitments of 178.5 billion rubles. Fifty-two water supply and sanitation concession projects are being implemented in 25 constituent entities of the Russian Federation (Analytical Center, 2020).

The Federal Target Program "Development of the water sector of the Russian Federation in 2012–2020" (FTP "Water of Russia"), a state program aimed at achieving the goals of the Concept of long-term socio-economic development of Russia. It played a significant role in water resources management and ensuring the implementation of the MDGs and SDGs and the Water Strategy of Russia until 2020. FTP "Water of Russia" (VHK program, 2012).

FTP "Water of Russia" provides for a comprehensive solution of issues related to the use of water bodies, including the rationalization of the use of water resources while respecting the interests of all water users. The management aspects include the protection of water bodies, the implementation of measures and the introduction of mechanisms to improve the quality of wastewater,

as well as preventing the negative impact of water and ensuring the safety of hydraulic structures.

Over the 8 years of the program implementation, 997 hydraulic structures were brought into a safe state, 735 km of engineering protection and bank protection structures were erected and reconstructed, 855 gauging stations were modernized, 21 hydroelectric complexes were reconstructed on reservoirs, main canals, and water supply routes. On the territory of 8825 ha, restoration and ecological rehabilitation of reservoirs was carried out, and 1.84 million people received increased availability and reliability of water supply in areas of water shortage.

One of the most important areas of the program's work is the protection of the population from flood disasters. For example, in the Karachay-Cherkess Republic, the prevented damage from floods exceeded 3.05 billion rubles. We see that the risks to the life of people and economic objects are decreasing. More than a million people are protected from floods and floods. These are residents of Ufa, Kazan, Biysk, Volgograd, Kislovodsk, Magas, and other cities of Russia. The solutions and practices developed within the framework of the program formed the basis for two federal projects of the national project "Ecology"—"Rehabilitation of the Volga" and "Preservation of unique water bodies.

More than 5.7 billion rubles of subsidies were provided from the federal budget to 39 organizations for the implementation of 72 projects for the construction, reconstruction and modernization of recycling water supply systems and treatment facilities with a total value of 123.7 billion rubles.

Among the organizations that received subsidies, 24 water utilities (including Moscow, St. Petersburg, Yekaterinburg, Vladivostok, Rostov-on-Don), 9 industrial enterprises and 1 transport organization, 2 agricultural organizations (meat processing plants: breeding plant "Elizovsky"), 3 energy organizations (TGK-11, companies "T-plus" and "Inter RAO-Electric Power Plants".

During the implementation of projects, the following performance indicators were achieved:

- Increase in the capacity of treatment facilities by 203 million m^3/year;
- Reduction of the volume of polluted wastewater discharge into surface water bodies by 940 million m^3/year;
- Reduction of discharge of pollutants by 189,000 tons/year;
- Saving of water resources (reduction of water withdrawal)—675 million m^3/year.

The Federal Target Program "Water of Russia" has become one of the instruments of the Water Strategy of Russia.

In addition to scientific research in the Volga basin, the program also included research in the basins of the Western Dvina, Angara, Selenga and Don. Already today, solutions developed as a result of surveys have been implemented to improve the ecological state in the basins of rivers and lakes: Tambukan, Volga, Don, Khanka, and Seliger. In total, since 2012, 75 research projects have been carried out with a total cost of 1.3 billion rubles only through the Ministry of Natural Resources of Russia [Water Congress, 2020].

6.4.4 Protection and Restoration of Water-Related Ecosystems (Target 6.6)

In Russia, the protection and rational use of water resources is associated with many ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes. In some federal districts, the wetlands can reach 15–22% (Ministry of Natural Resources, 2019).

The National Project "Ecology" (2018–2024) contributes to the protection and restoration of water-related ecosystems. The goal of the "Ecology" project is to radically improve the ecological situation and positively influence the health improvement of Russians. Authorities, executors, curators of federal projects, public organizations, and citizens take part in this multilateral work.

The National Project includes 11 federal projects. The work is carried out in five areas: waste,

water, air, biodiversity, and technology. The term for the implementation of the national project is until December 31, 2024.

Budgets for the federal projects are: "Improvement of the Volga"—180.5 billion rubles, "Preservation of Lake Baikal"—27.8 billion rubles, "Preservation of unique water bodies"—6.3 billion rubles [National project "Ecology", 2018].

Key actions to protect and restore water-related ecosystems are reflected in SDG 14 and SDG 15.

6.4.5 International Cooperation on Water Use and Protection of Water Resources (Target 6.a)

International cooperation of Russia is carried out within the framework of a number of fundamental conventions and agreements, namely: the International Convention on the Establishment of the International Fund for Compensation for Oil Pollution Damage (Supplement to the International Convention on Civil Liability for Oil Pollution Damage), Brussels, 1971; Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Materials, Moscow—Washington—London—Mexico City, 1972; Convention on the Protection and Use of Transboundary Watercourses and International Lakes, Helsinki, 1992 (Water Convention); Framework Convention for the Protection of the Marine Environment of the Caspian Sea, Tehran, 2003 [Analytical Center, 2020].

The Russian Federation has concluded a number of key intergovernmental agreements in the field of protection and use of water bodies with countries such as Azerbaijan, Belarus, Kazakhstan, China, Mongolia, Ukraine, Finland, and Estonia.

The agreement on the basic principles of interaction in the field of rational use and protection of transboundary water bodies of the CIS member states was signed in Moscow in 1998 and entered into force on June 6, 2002. It is also intended to solve some important problems, including: calculating the damage caused to water bodies on a unified methodological basis; refusal to carry out water management activities that may have a negative impact on the environment, including water bodies.

6.4.6 Participation of Local Authorities and Citizens in Improving Water Management and Sanitation (Target 6.b)

One of the priorities of the state policy of the Russian Federation has become a systematic, purposeful environmental education and training, and the formation of a public environmental outlook.

The Russian Federation engages the public by supporting the establishment and operation of associations of non-governmental organizations. More intensive funding for science, as well as grant support, contribute to the effective dissemination of information.

6.5 Conclusions

Russia's current position on the path to achieving the Sustainable Development Goals (SDGs) is reflected in a number of reports, including the voluntary national review (Voluntary national review, 2020).

For each SDGs, Russia has shown positive results in recent years.

In 2018, 91.5% of the Russian population was provided with safe drinking water (target 6.1), compared to 90.4% in 2015 and 86.6% in 2010. In 2018, 96.2% of the urban population was provided with drinking water that meets safety requirements, and this figure was 95% in 2015. In the same year 77.7% of the rural population received safe water compared to 77.2% in 2015. The achievement of SDG 6 is one of the goals of the National Project "Environment" aimed at increasing the share of population suppled with quality drinking water from centralized water

supply systems to 90.8% and 99% to urban populations by 2024.

In 2018, about 86.9% of households in Russia had a toilet in an apartment or a house, compared to 84.1% in 2016. In 2018, 12.6% had shared toilets (in shared apartments) or a toilet in a standalone building, and the proportion of population using safe sanitation services was 85.8%.

All SDGs are interconnected, therefore, measures taken to achieve one of the SDGs inevitably have an impact on the achievement of other SDGs. The development of the digital economy and telecommunications infrastructure, for example, has an impact on reducing inequalities, such as, for example, SDG 3 (Ensure healthy lifestyles and promote well-being for all at all ages) is interconnected with SDG 6 (safe water and sanitation for all) and SDG 4 (Achieve inclusive and equitable quality education and promoting lifelong learning opportunities for all).

There are noticeable achievements in SDG 1 (End poverty in all its forms everywhere), SDG 4 (Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all), SDG 8 (Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all). At the same time, the tasks remain, the solution of which requires the intensification of joint efforts of the state, business and society.

An important goal for solving the problems of providing sectors of the economy and the population with water, complying with sanitation requirements, maintaining ecosystems is SDG 6 (Ensuring the availability and rational use of water resources and sanitation for all).

The Russian Federation is committed to the tasks set by the international community in the 2030 Agenda. At the national level, consistent efforts are being made to achieve the Sustainable Development Goals. Work in this direction has become a direct continuation of activities within the framework of achieving the Millennium Development Goals, and the concept of sustainable development was formulated and integrated into the concept of national development of Russia back in 1996.

As part of SDG 6, Russia continues to work on several major tasks. The first is to ensure access to safe and affordable drinking water, and raising the standards of housing and communal services. Equally important is ensuring universal and equitable access to adequate sanitation and hygiene for all. Essential to this program is the improvement of water quality and the reduction of water pollution.

To solve the pressing problems of the water supply sector in Russia, the implementation of tasks for the modernization and construction of water facilities is envisaged. The current water management regime is undergoing a transition to a more flexible and adaptive management system and strategy.

A number of tasks in some areas, including SDG 6, have yet to be solved by joint efforts of the state, business and society. It is quite difficult to predict the achievement of SDG 6 by Russia in the absence of target water indicators by 2030. This also applies to all other SDGs, for the vast majority of which the state has not set quantitative targets in 2030.

Other difficulties in the implementation of SDG 6 include underfunding of some water management areas and facilities, associated with a slowdown in economic growth, economic crisis, international sanctions, and the coronavirus epidemic.

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Progress of SDG6 Goals in China Since 2015

7

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Abstract

China has fully implemented and progressed far towards the completion of the relevant goals of the Millennium Development Goals (MDGs) and has actively participated in the implementation of the Sustainable Development Goals (SDGs) in 2016 (SDG6). This chapter summarizes SDG6 under three headings: drinking water safety, environmental sanitation, and water resources management. Mainly employing the latest and most authoritative data, it summarizes China's plans and achievements for the successful completion of SDG6 since the implementation of SDGs. The differences between urban and rural areas are considered. Policies and regulations formulated in different years and the results achieved step by step are discussed in detail. In this way we hope to provide some method reference and experience for the smooth implementation of global SDG6.

Keywords

MDGs · SDGs · Drinking water safety · Environmental sanitation · Water resources management · COVID-19 · Projecting progress

7.1 Introduction

Today, with the population growth and increasing environmental pollution, the management of water resources faces increasingly complex problems. These are related to the climate crisis, refugee crisis, food crisis, and even lead to international conflicts. Therefore, it is important for people's well-being to improve the safety and control of water resources and environmental sanitation.

In China the total freshwater resource is 2.90×10^{12} m^3 in China (2904.1 billion), ranking sixth in the world below Brazil, Russia, Canada, the USA, and Indonesia. However, due to its large population of over 1.4 billion, the per capita water resources are only 2.3×10^3 m^3. This is just one-fourth of the world average level, ranking 110th in the world. Thus in this regard, China is one of the poorest countries in the world. Although water shortage is serious in China, her

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water consumption is relatively large. It is the country with the largest water consumption in the world. In 2019 alone, the freshwater consumption in China reached 6.02×10^{11} m^3 (602.1 billion m^3) [1].

The figures and tables used in this chapter all include the latest and authoritative data. Most of them come from the government bulletins or annual reports, and some from authoritative websites, such as the website of the Central People's Government of the People's Republic of China. Because of the great differences between conditions in China's urban and rural areas, we will discuss their problems separately, in the following sections.

7.2 Drinking Water Safety

The following sections will introduce China's progress in the field of SDG6 to the end of 2020 from both rural and urban perspectives.

7.2.1 Rural Population

According to the "Statistical Yearbook of China's Urban and Rural Construction" released by the Ministry of Housing and Urban-Rural Development of China (MOHURD), China made significant progress in providing centralized water supply to rural village populations. These improvements to water supply services through new infrastructure (pipe lengths), average per capita consumption, and increased coverage for the period 2015–2019 are shown in Table 7.1.

It can be seen that when the goal of MDGs was achieved in 2015, the water coverage in rural villages in China had reached 63.42%. Unfortunately, this is far lower than that of cities, counties, towns, and townships. Also, the drinking water safety was a major concern at that time. In recent years, the Chinese government has given great attention to the provision of safe drinking water in rural areas. It has taken a series of policies and measures, which have greatly improved the drinking water conditions of rural residents. Compared with the situation in 2015, the coverage of water use in administrative villages has been greatly improved, with an increase of 17.56% and an average annual growth of 3.51% by the end of 2019. The result is impressive, but there is still great potential for further improvements [3].

By 2020, the water supply to 270 million rural people had been consolidated and improved. The drinking water safety problem of 17.1 million poor people had been solved and more than 83% of Chinese rural people had access to tap water. The drinking water safety index has been significantly improved. Figure 7.1 shows the water storage well used to collect rainwater for drinking and the existing water supply equipment in a village in mountainous area in the middle of Shandong Province. Compared with agricultural areas under cultivation, it is relatively difficult to improve drinking water safety in pastoral areas. In 2005, Tibet began to implement the rural drinking water safety project. Since the implementation of SDG6, from 2016 to the end of 2019, a total of 4.324 billion CNY (about 668.6 million USD) of special investment has been implemented. Nowadays, water use in Tibet's agricultural and pastoral areas has changed from centralized public water supply points to tap water supply to households, from surface water supply to groundwater supply, and from irregular water supply to all-weather water supply, achieving a qualitative leap. In recent years, the endemic fluorosis caused by drinking water in Tibet has been controlled. The Kashin Beck disease (KBD) is a chronic osteoarthritic disease, endemic in parts of China. Its etiology is unknown, but high concentration of organic matter (mainly fulvic acid) in drinking water has been among suspected environmental causes. The prevalence rate of children in KBD areas has dropped from 37.86% in 2000 to 0, and no new cases were reported during 2019–2020. The KBD has been eliminated in all 54 areas that had previously suffered from it [4].

There are obvious differences in the water coverage and water consumption rates of administrative villages in different regions. For example, the water coverage of administrative villages in the eastern region is higher than that in

Table 7.1 Progress in safe water provision to rural population in 2015–2019

Item	Year				
	2015	2016	2017	2018	2019
The number of administrative villages with access to piped water	355,481	361,572	383,526	366,685	370,971
Annual domestic water consumption (10,000 m^3)	1,348,494	1,391,781.87	1,632,547.38	1,348,194	1,850,082.88
Water coverage rate (%)	63.42	65.23	75.51	77.69	80.98
Av. per capita daily water consumption (L)	73.51	73.94	87.73	86.56	91.19
Length of water supply pipelines (km)	1,293,203	1,339,862.71	1,496,198.22	1,496,198.22	1,836,373.20

Sources: [2, 3]

Fig. 7.1 (**a**) A cistern used for drinking water in the countryside. (**b**) The tap used for tap water entering the household. Location: One Village, Zibo City, Shandong Province, China

the central region and the western region. In 2015, Shanghai (94.63%), Jiangsu (94.57%), and Shandong (93.08%) were the provinces with the highest water coverage, while in the central and western regions, Sichuan (37.97%), Jiangxi (38.45%), and Hunan (40.64%) had much lower coverage. Similar to this trend, the per capita daily domestic water consumption of administrative villages decreased from the eastern region to the central region and the western region. In 2015, the highest value was Shanghai (93.04 L), Guangdong Province (90.52 L), and Zhejiang Province (89.41 L), all of which were in the eastern coastal areas, while the last three were in Inner Mongolia Autonomous Region (47.33 L), Gansu Province (49.51 L), and Shanxi Province (57.30 L). Overall, in the eastern region, the central region, or the western region, the water uses in administrative villages in 2019 were significantly higher than that in 2015 [3].

In addition to the above, there are also a small number of decentralized water supply projects to connect the tap water pipes to the households through small wells and water cellars. Some parts of China, notably, mountainous areas, pastoral regions, and remote districts do not have appropriate conditions for water supply to individual households. Getting through the "Last Kilometer" of rural water supply is an important task to consolidate and improve rural drinking water safety in the future. First, the scale of centralized water supply projects in rural areas should be expanded by means of pipe networks and extensions, so as to gradually provide the supply of tap water to households. Second, it is necessary to strengthen the promotion of drinking water safety through water quality improvements. We also need to promote the benefits of water supply to the people and change their usual water use habits [5].

7.2.2 Urban Population

Since the implementation of SDG6, the urban water supply coverage in China has been stable at about 98.5% as shown in Table 7.2. The daily water consumption per capita of urban residents has increased from 174.5 L in 2015 to 180.0 L in 2019. In order to adapt to the increasing water consumption, the total domestic water supply in China has increased from 28.727 billion tons in 2015 to 33.90 billion tons in 2019. There are also regional differences in water supply. In 2018, the urban water supply in East China was 21.39 billion m^3, accounting for 35% of the total urban water supply in China, ranking first, followed by

Table 7.2 Progress in National urban water supply in 2015–2019

Item	Year				
	2015	2016	2017	2018	2019
Total quantity of water supply for residential use (10,000 m^3)	2,872,695	3,031,376	3,153,968	3,288,616	3,389,936
Water coverage rate (%)	98.07	98.42	98.30	98.36	98.78
Per capita daily water consumption (L)	174.5	176.9	178.9	179.7	180.0

Data source: Statistical yearbook of urban and rural construction 2015–2019

18.98 billion m^3 in Central and South China, accounting for 31% of the total urban water supply in China [6].

Compared with the rural areas that focus on improving the water supply coverage, the urban drinking water schemes should focus on ensuring the safety of water quality. As early as 2007, the National Development and Reform Commission, the MOHURD, the MWR, the Ministry of Health (MOH), and the Ministry of Environmental Protection (MEP) jointly issued the "National Urban Drinking Water Security Plan (2006–2020)." In 2010, the five departments jointly issued the "National Urban Drinking Water Source Environmental Protection Plan (2008–2020)," which is China's first drinking water source environmental protection plan. It will effectively guide all localities to carry out environmental protection, pollution prevention, and control of drinking water sources. In 2015, the State Council issued the "Water Pollution Prevention and Control Action Plan," which proposed to supervise the whole process of drinking water safety from water source to tap. Local people's governments at all levels and water supply units shall regularly monitor, test, and evaluate the drinking water safety status of drinking water sources, water quality of water supply plants, and users' taps in their respective administrative areas. Since 2018, the drinking water safety information of all cities at or above the county level should be available to the public.

In order to ensure the smooth use of water in apartments and high-rise buildings, the urban public water supply is traditionally stored and pressurized, and then supplied to users through pipelines that becomes secondary water supply. Because of the traditional way of water supply, it is easy to cause secondary contamination, especially in summer. Since 2017, China's provinces and cities from south to north have introduced measures to resolve the "Last Kilometer" problems of secondary contamination in a number of old residential areas through equipment transformation, strengthening supervision, and other means and achieved very good results.

7.3 Environmental Sanitation

With the economic and social development and the improvement of people's quality of life, the government and the masses attach great importance to environmental health and the transmission of diseases. The improvement of environment is inseparable from the improvement of public infrastructure. Good health facilities are the support system to ensure the survival and sustainable development of the city, which is directly related to the development of national economy and the overall progress of society. Strengthening basic health facilities and improving environmental sanitation is a major event to improve the living environment, improve the quality of life, and protect the health of the masses. One of the important goals of SDG6 is infrastructure. Since the new century, China has not only achieved rapid economic development, but also increased environmental health improvement efforts, launched a series of reform measures, and achieved remarkable results in the field of environmental health. At first, this section describes the progress in rural and urban waste treatment and toilet improvement in China since 2015.

7.3.1 Rural Waste Discharge and Treatment

With the continuous advancement of China's urbanization process, the rural population continues to decrease. However, the output of rural garbage increased from 4.626 billion tons in 2012 to 5.009 billion tons in 2017. With the acceleration of rural economic development, the continuous improvement of farmers' living standards, and the increasing consumption capacity, the status quo of rural waste treatment has attracted more and more attention from all walks of life [7].

On November 13, 2015, the MOHURD and other ten departments jointly issued the "Guiding Opinions on Comprehensively Promoting Rural Garbage Treatment," which is the first document specifically for rural waste at the level of the central government of China, officially starting the battle of implementing SDG6 for health facili-

ties. The Office of the Central Rural Work Leading Group proposed the "National Rural Revitalization Strategic Plan (2018–2022)" in 2018. In 2019, the MOHURD issued the "Guiding Opinions on Establishing and Improving the Rural Domestic Waste Collection, Transfer and Disposal System." In March 2020, the Ministry of Agriculture and Rural Areas (MARA), the National Development and Reform Commission, and other departments jointly issued the "Notice on the Rectification of Problems Found in General Inspection and the Improvement of Rural Human Settlement Environment." These files fully reflected the strength and determination of the country in the improvement of rural environment. Driven by the state, China's rural waste treatment capacity increased from 2.086 billion tons in 2012 to 3.148 billion tons in 2017, and the rural waste treatment rate increased from 45.09% in 2012 to 62.85% in 2017. At the end of October 2019, more than 80% of the rural domestic waste in administrative villages in China has been effectively treated, which is about 7% higher than that in 2017 [8]. During the 5 years from the end of MDGs in 2015, throughout the SDG6 period of implementation in 2019, the situation of rural garbage disposal in China is shown in Table 7.3.

Now every village has dozens or even hundreds of garbage bins for the villagers to dump their garbage. Once garbage is transferred to the treatment station, they will be sorted and recyclable waste is processed and reused, while the rest will be treated scientifically without pollution (Fig. 7.2 shows the appearance of rural garbage collection bins).

7.3.2 Urban Waste Discharge and Treatment

China is not only a country with a large population, but also a country with a large amount of garbage generation. With the economic development and the continuous improvement of people's living and consumption level, both the amount of garbage generated and the amount of garbage handled are increasing year by year. As shown in Table 7.4 [5], in 2015, the amount of collected and transported domestic waste by large and medium-sized cities in China was 191 million tons. By 2016, the number will reach 203 million tons, and by 2019, China's urban domestic waste removal and transportation volume reached 242 million tons. The rapid growth of the total amount of municipal solid waste has brought great pressure to the urban environment, so it is urgent to clear and transport domestic waste. Since the implementation of MDGs, with the rapid growth of urban waste production, the capacity of waste cleaning and transportation has been growing. By the end of 2015, the harmless treatment capacity was 576,900 tons per day, and the annual harmless treatment capacity was 180 million tons. By 2019, the harmless treatment capacity expected to reach 869,900 tons per day, and the annual harmless treatment capacity to 240 million tons.

With the gradual shortage of land resources for landfilling, waste incineration is the only way for big cities to realize self-production and self-marketing of waste. And waste classification can effectively improve the efficiency of waste incineration. In early 2018, the MOHURD issued a notice requiring 46 key cities to issue implementation plans or action plans for domestic waste classification management by the end of March 2018. From 2019, domestic waste classification will be started in cities at prefecture level and above. By the end of 2020, the domestic waste classified delivery and collection of 46 key cities in China have basically achieved full coverage, the classified transportation system has been basically completed, and the classified treatment capacity has been significantly enhanced. The daily treatment capacity of domestic waste in these cities has reached 483,000 tons, which can realize 100% harmless treatment. The average recycling rate of waste reaches 30.4%. The accuracy rate of domestic waste in Xiamen, Ningbo, Guangzhou, Hangzhou, Suzhou, and Shenzhen is more than 70% and that in Shanghai is more than 95% [5, 9].

Table 7.3 Administrative villages domestic garbage treated during 2015–2019

Item	Year				
	2015	2016	2017	2018	2019
Administrative villages with domestic garbage treated rate(%)	62.2	65	73	–	80
Construction input (million CNY)	8837.74	11,033.22	13,563.13	28,937.03	17,311.37

Data source: Statistical yearbook of urban and rural construction 2015–2019

Fig. 7.2 The garbage collection bins are put in the rural ponds (**a**) and residential areas (**b**). Location: One Village, Zibo City, Shandong Province, China

Table 7.4 National urban environmental sanitation in 2015–2019

Item	Year				
	2015	2016	2017	2018	2019
Quantity of collected and transported (10,000 ton)	19,142	20,362	21,521	22,802	24,206
Harmless treatment capacity (ton/day)	57.69	62.13	67.99	76.62	86.99
Annual harmless treatment capacity (10,000 ton)	18,013	19,674	21,034	22,565	24,013

Data source: Statistical yearbook of urban and rural construction 2015–2019

7.3.3 Toilet Revolution

Rural Toilets

In 2015, China intensified the transformation of rural toilets, and by the end of October 2017, 68,000 new toilets had been reconstructed in China [10].

At the end of 2018, the Central Agricultural Office, the MOHURD, and other departments jointly issued the "Guiding Opinions on Promoting the Special Action of Toilet Revolution in Rural Areas" and the "Action Plan of Village Cleaning for Rural Residential Environment Improvement" to speed up the transformation of rural toilets. In 2018, more than ten million rural toilets were changed nationwide (more than 60%) into sanitary toilets. In China the term sanitary toilet refers to different types of toilets. The basic requirements for sanitary toilets are that they are enclosed but ventilated, have sealed and covered septic tanks, and that there are no fly maggots or persistent odors. Then there are harmless sanitary toilets and sanitary public toilets. The type of sanitary toilets that can effectively kill pathogenic microorganism and prevent infection is categorized as harmless sanitary toilets. Harmless sanitary toilets include flush toilets/pour-flush latrines to piped sewer system, three-compartment septic tank latrines, double-urn funnel-shaped latrines, three-in-one biogas septic tank latrines, urine-diversion latrines, and twin-vault alternating pit latrines. Finally, public sanitary toilets referred to the ones that are available in public areas for those who do not have toilets available at home.

Finally, in 2017, the China National Tourism Administration, a government agency, announced a plan to enhance the country's tourism industry, by building "tourist toilets" in scenic areas and along tourist routes.

Figure 7.3 shows the appearance of the sanitary toilets built with state subsidies.

In 2019, in order to mobilize the enthusiasm of rural residents to carry out toilet renovation, the Central Government invested 7 billion CNY (about 1.085 billion USD) to promote "toilet revolution" in rural areas for improving toilets. By the end of 2020, many provinces and

Fig. 7.3 Sanitary toilets built with state subsidies. Location: One Village, Zibo City, Shandong Province, China

cities in China made great progress in the transformation of rural toilets. For example, Hainan Province has built 1.2442 million rural sanitary toilets, with a coverage of 98.5%; Henan Province has increased financial support for the improvement of toilets in poor areas; and the provincial financial subsidy for the improvement of toilets in poor counties reached 260 million CNY (about 40.248 million USD) in 2019. The sanitary latrines reached 85% coverage, and the safe sanitary latrines should be improved for the poor households who have the will [11, 12].

Public Toilets

The progress of toilet revolution in the city is mainly reflected in the new construction and transformation of public toilets that are mainly attached to public places such as stations, shops, cinemas, exhibition halls, office buildings, parks, and so on. Nowadays, public toilets have become a symbol of social culture, a window of modern urban civilization image, reflecting the development level of urban material civilization and spiritual civilization. Up to 2015, there are 126,000 public toilets in China, and nearly 2000 new ones were built in 2015. In September 2016, the MOHURD also issued the notice of "Design Standards for Urban Public Toilets," which has been implemented since December 1, 2016, putting forward new requirements for the construction of urban public toilets. In the same year, the number of public toilets in China reached 129,800, and the number of public toilets per 10,000 people was 2.75. In 2017, the investment market scale of public toilets in China was 15.03 billion CNY (about 2.3266 USD), an increase of 34.56% over the previous year. The total number of public toilets reached 136,100, and the number of public toilets per 10,000 people was 2.77. By the end of 2019, there are 193,400 public toilets in China, with 2.93 per 10,000 people [5].

In recent years, in addition to increasing the number of toilets, the Chinese government has also upgraded the previous toilets, completely changing the previous problems such as the bad smell of toilets, the large amount of sewage, and the difficulty in finding one toilet. The reformed public toilets have a variety of advantages and features. Besides simple and elegant appearance, as well as clean and bright inside, they are also equipped with facilities and equipment such as aromatherapy, hand sanitizer, and paper drawing. Technically in some newly built public toilets, anoxic oxic (AO) and contact oxidation process is adopted for septic tanks, solar panels are used for power supply in toilets, collection covers are set for odor collection in squatting pits, and LED display is set outside toilets. The display shows the idle condition of the toilet (Fig. 7.4 shows a public toilet in a city of northern China).

Tourist Toilets

In 2017, the National Tourism Administration issued the "New Three-Year Action Plan for Construction and Management of National Tourist Toilets (2018–2020)." From 2018 to June 2019, 30,000 tourist toilets have been newly built, reconstructed, and expanded. In 2019, 23,700 tourist toilets were built, rebuilt, or expanded. In the same year, in order to improve

Fig. 7.4 The appearance (**a**), sign (**b**), interior (**c**), and intelligent guiding screen (**d**) of the public toilet built by the municipal government. Location: Nankai District, Tianjin, China

the convenience of domestic and foreign tourists, the Ministry of Culture and Tourism (MCT) organized the online work of tourism toilet electronic map. By January 2020, 107,000 tourist toilets have been marked on Baidu map, with an overall marking rate of 89.2% [13].

7.4 Improve Water Use Efficiency

In China, the water resources situation is that there are more people and less water. At the same time, the problems of water shortage, serious water pollution, and water ecological deterioration are also very acute. Water, as one of the essential elements to guarantee life continuity, production development, and ecological balance, is very important for the survival and development of the Chinese people. At the same time, the uneven distribution of water resources in time and space aggravates the shortage of freshwater resources. Therefore, it is very important to manage water resources reasonably and improve the utilization rate of water resources to ensure the health of drinking water and production and life. The general situation of China's water resources can be summarized as follows: First, the total amount of water resources is rich, but the spatial distribution is uneven; second, the coexistence of water shortage of resources, engineering, and water quality; third, there is more water (flood disaster loss), less water (2/3 of the cities are in the state of water shortage), turbid water (increasing sediment content), and dirty water (water pollution). In 2017, the State Council put forward clear requirements for the implementation of national water-saving action, the overall management of landscape, forest, field, lake, and grass system, and the strengthening of water conservancy infrastructure network construction.

The following is a brief description of China's work in water resources management since the implementation of SDGs from the aspects of building a water-saving society, water resources protection and treatment, sewage treatment, new technology recycling water, etc.

7.4.1 Building a Water-Saving Society

At the end of MDG period, China's water-saving irrigation reached 62%, and the annual water saving was 110 million cubic meters [14]. In October 2016, China issued the "National Water Saving Action Plan." In the same period, the MWR and the National Development and Reform Commission issued the "13th Five-Year Plan

Table 7.5 Sewage volumes and treatment capacities (2016–2019)

Year	Discharge volume (billion tons)	Treatment capacity (billion tons)	Treatment (%)
Urban			
2017	49.239	46.549	94.54
2018	52.112	49.761	95.49
2019	55.465	52.585	96.81
Rural			
2016	9.272	8.102	87.38
2017	9.507	8.777	90.21
2018	9.940	9.064	91.16

Water Resources Consumption Total and Intensity Double Control Action Plan," which proposed that by 2020, the total annual water consumption of the country should be controlled within 670 billion m^3, and the water consumption of 10,000 CNY (about 1548 USD) of GDP and 10,000 CNY of industrial added value should be reduced by 23% and 25% compared with 2015, the water use coefficient of farmland irrigation increased to more than 0.55. In November 2019, 266 counties (districts) have completed the construction task, effectively improving water use efficiency and benefits, and promoting the coordinated development of economy, resources, and environment.

7.4.2 Protection and Management of Water Resources

According to the data provided by the "Bulletin on the State of China's Environment in 2015," the proportion of different water quality sections in China's surface water is 2.8% for class I water quality sections (points), 31.4% for class II water quality sections, 30.3% for class III water quality sections, 21.1% for class IV water quality sections, 5.6% for class V water quality sections, and 8.8% for inferior class V water quality sections [15]. As far as the whole surface water is concerned, the proportion of seriously polluted inferior class V water bodies is obviously on the high side. Conversely, the ditches and dams of some river sections in cities and towns are polluted by organic matter, and there are many black and odorous water bodies. In order to deal with this situation, the State Council issued the "Water Pollution Control Action Plan" (hereinafter referred to as "Water Ten Articles") in April 2015, which became the programmatic document of water resources management in the following years, and the black and odorous water body was included in the total amount of control target for the first time. In July 2015, the Ministry of Finance (MOF) and the MEP of China issued the "Measures for the Management of Special Funds for Water Pollution Prevention and Control," in which the remediation of urban black and odorous water bodies was included in the key support scope of special funds. In February 2016, the MOHURD and the MEP issued the "Notice on Publicizing the Investigation of Urban Black and Odorous Water in China." Among the 295 cities at prefecture level and above, a total of 1811 black and odorous water bodies were found in 216 cities, including 1545 rivers, accounting for 85.4%; 264 lakes and ponds, accounting for 14.6%. In December 2016, the former MEP, together with ten ministries and commissions, issued the "Regulations on Assessment of Implementation of Water Pollution Prevention and Control Action Plan (for Trial Implementation)," which established the assessment idea of taking the improvement of water environment quality as the core and taking into account the key work. Up to November 30, 2020, according to the National Urban Black and Odorous Water Remediation Regulatory Platform, the total number of black and odorous water remediation projects is 2869, of which 2313 have been completed and 556 are under treatment. According to the "Bulletin on the State

of China's Environment in 2018" published in 2019, among the 1935 water quality sections (points) monitored nationwide, the proportion of class I–III water quality is 71.0%, which is 3.1% higher than that in 2017; the proportion of class V water quality is 6.7%, which is 1.6% lower than that in 2017 [16].

7.4.3 Sewage Treatment

Due to the increasingly serious problems of water pollution and water shortage in China, a series of policies have been issued in recent years to support the development of sewage treatment industry and strengthen the construction of sewage treatment facilities. Since 2012, the "Environmental Protection Law" and the "Water Pollution Prevention and Control Law" have been revised. The "Regulations on Urban Drainage and Sewage Treatment" and "Water Pollution Control Action Plan" have been promulgated and formulated, the "13th Five-Year Plan for the Construction of Urban Sewage Treatment and Recycling Facilities in China" has been prepared in 2016, and the "Three-Year Action Plan for Improving the Quality and Efficiency of Urban Sewage Treatment (2019–202)" has been issued in 2019. In 2020, policy documents have also been issued such as "Policy Guidance on Improving Sewage Treatment Charging Mechanism in Yangtze River Economic Belt," "Implementation Plan for the Weak and Strong Items of the Short Board of Urban Domestic Sewage Treatment Facilities," which promoted the capacity construction of sewage treatment facilities to achieve remarkable results and played an important role in winning the battle of pollution control and improving the quality of urban water environment in China.

The data on sewage discharge volumes and treatment capacities for urban and rural sector from 2017 to 2019 is shown in Table 7.5.

In recent years, with the revitalization and construction of beautiful villages, the environment of villages and towns in China has been greatly improved, and the rural sewage treatment has also made great progress. According to the statistics from the MOHURD, by the end of June 2019, there were more than 5000 municipal sewage treatment plants in China (excluding township sewage treatment plants and industries) with a treatment capacity of 2.1×10^8 m^3/day [17].

In 2019, the MOHURD issued the "Technical Standard for Rural Domestic Sewage Treatment Engineering," which suggests that the county-level administrative region should be taken as a unit to implement unified planning, construction, operation, and management. In addition, based on the experience of centralized and decentralized treatment of rural sewage treatment at home and abroad, the treatment methods of urban sewage pipe network such as domestic sewage treatment, rural sewage centralized treatment, and urban sewage treatment are proposed. By the end of 2020, all provinces in China have made great efforts in rural sewage treatment and achieved certain results. Compared with the mature sewage treatment technology in cities, the rural sewage treatment scheme still has room for further development.

In addition to the aforementioned measures to improve the utilization rate of water resources, China also vigorously develops high-tech industries. So as to improve the utilization efficiency of water resources, these high-tech industries are mainly focused on new technology industries, such as seawater desalination, membrane water treatment, remote sensing, and big data. At the same time, China will continue to strengthen international cooperation. For example, promote cooperation in water resources in the Lancang-Mekong region; further strengthen the sharing of water resources data, information, knowledge, experience, and technology among countries; train the young people in the water conservancy and other areas, facing the "One Belt, One Road" along the country and region.

7.5 Water Safety During COVID-19 Outbreak

Faced with the sudden outbreak of New Coronavirus, the Chinese government started every little bit to build up a safety line. In the

early stage of safe drinking water, Ministry of Ecology and Environment of China issued a plan for emergency monitoring of New Coronavirus infection in the early 2020 in response to the crisis of COVID-19. It studied and deployed emergency monitoring work against the infection of pneumonia in COVID-19 and resolutely prevented the secondary disasters from causing the adverse effects on the ecological environment and human health [18].

The emergency response plan for dealing with COVID-19 infection is mainly from the three sides of the ecological environment as the focus of emergency monitoring. First, do a good job in monitoring the environmental quality of air and surface water; Second, strengthen the early warning and monitoring of drinking water source and quality; Third, improve the emergency monitoring plan and plan emergency preparedness in advance; At the same time, strengthen the reserve of emergency monitoring materials and strive to improve the response capacity.

In response to the epidemic, waterworks across China have also accumulated rich experience. For example, Wuhan Water Group Co., Ltd., which is at the center of the epidemic, urgently started the wartime water supply emergency guarantee mechanism in the face of the new situation of COVID-19 [19]:

1. Within the water plant, emergency response teams were established by category to implement closed management for the production of the water plant in terms of virus prevention and control. Meanwhile much attention was paid to environmental disinfection and personal protection.
2. Cooperate with multiple departments to ensure the safety of water sources and strengthen supervision to ensure that materials are supplied in place and factory water quality is excellent.
3. The recycling of sludge water from flocculation sedimentation tank and backwash water from filter tank was suspended in the plant to reduce the risk of microbial enrichment.
4. Strengthen the monitoring of water quality and disinfection by-products of pipe network outside the plant. Strengthen the safety inspection of water supply facilities, such as water plant, regional pressure transfer station, and transmission and distribution pipe network. Increase the safety supervision of secondary water supply tanks, especially old water tanks.
5. Sewage group has undertaken the water supply guarantee of 144 medical treatment points, including Huoshen mountain and Leishen mountain hospitals, as well as the domestic water guarantee of 146 isolation hotels and 99 medical rescue personnel. For these medical institutions, the water supply scheme of "one hospital, one policy" and the contact mechanism of "one point, one person" were established to communicate and connect in real time and submit information every day.
6. With the help of artificial intelligence and other new technologies, welink intelligent working platform has been quickly established, implemented, and networked to realize meeting discussion and water supply command, do a good job in employee protection, avoid cross infection to the greatest extent, and open up the epidemic barrier with "invisible service."
7. Make use of the media and other channels to timely release the water supply related information to the public, so that the public can be satisfied with the water supply during the epidemic prevention and control period.

7.6 Concluding Remarks and Projecting Progress of SDG6

Since the formation of Agenda 2030, China has attached great importance to the agenda and is committed to successfully implementing the SDGs in reaching the 2030 development agenda.

China has adopted the strictest water resources management systems, extensively mobilized the people to build a water-saving society, built water conservancy projects to ensure the safety of drinking water for all, promoted the toilet revolution and garbage sorting, and accelerate the realization of SDG6.

The drinking water safety index has been significantly improved from 2015 to 2019. By 2020, more than 83% of Chinese rural people had access to tap water, compared to 63% in 2015. There are obvious differences in the water coverage and water consumption rates of administrative villages in different regions. In rural sector, the average per capita water usage increased from 73.5 L in 2015 to 91.1 L in 2019. The urban water supply coverage in China has been stable at about 98.5%, with per capita usage increased from 174.5 L in 2015 to 180.0 L in 2019. In China, the KBD, a suspected water borne disease has been eliminated in all 54 areas that had previously suffered from it, and no new cases were reported during 2019–2020.

At the end of October 2019, more than 80% of the rural domestic waste in administrative villages in China has been effectively treated, which is about 7% higher than that in 2017. By the end of June 2019, there were more than 5000 municipal sewage treatment plants in China with a treatment capacity of 2.1×10^8 m^3/day. China's urban sewage treatment rates increased from 94.54% to 96.81% from 2017 to 2019, while in the rural sector the treatment rates increased from 87.38% to 91.16% from 2016 to 2018.

In terms of long-term planning for safe drinking water, China will realize the modernization of rural water supply by 2035 [20, 21]. In April 2021, under the guidance and support of the China's Ministry of Housing and Urban-Rural development, the outline of 2035 industrial development plan for urban water affairs was released, highlighting that in the future, the tap water quality will fully meet the requirements of the hygienic standard for drinking water (GB5749–2006) [22]. The Yangtze River Delta region will fully build a modern water security network free from floods to ensure safe drinking water efficient water use.

From 2021 to 2025, the focus is to improve the river basin coordination mechanism for water pollution prevention and control, enhance the river/lake management and protection mechanism, as well as strengthen the river head system and lake head system. China will strengthen the comprehensive management of key river basins, key lakes, urban water bodies, and coastal waters, promote the protection and construction of beautiful rivers and lakes, reduce the total chemical oxygen demand and ammonia nitrogen emissions by 8%, respectively. China will basically eliminate class V state-controlled sections and urban black-smelly water bodies. In addition, China will increase the proportion of groundwater meeting or better than the class III water body standard from 83.4% in 2020 to 85% in 2025.

1. Urban drinking water safety: Carry out the standardized construction of urban drinking water sources and promote the relocation and transformation of heavily polluting enterprises in key river basins. China implemented the national water-saving action, established a rigid constraint system on water resources, strengthened agricultural water-saving efficiency, industrial water-saving emission reduction, and urban water-saving loss reduction, encouraged the use of renewable water, and reduced water consumption per unit of GDP by about 16%.
2. Rural drinking water safety: In view of the instability of water sources and the low guarantee level of water quantity in some rural areas, relevant departments will further strengthen the construction of rural water supply guarantee, strive to increase the national rural tap water coverage by 5–88% by 2025, and optimize the layout of rural water supply projects, and continuously improve the operation and management system and mechanism. The project operation management and protection level will be continuously improved, to improve water quality. By 2035, China will basically realize the modernization of rural water supply [21].
3. Infrastructure: Build an environmental infrastructure system integrating sewage, garbage, solid waste, hazardous waste, and medical waste treatment and disposal facilities with improved monitoring and supervision capacity and form an environmental infrastructure network extending from cities to towns and then to villages. China will promote the full coverage of urban sewage pipe networks,

carry out differentiated and accurate standard upgrading of sewage treatment, and promote the centralized incineration and harmless treatment of sludge. The harmless disposal rate of urban sludge will reach 90%, and the resource utilization rate of sewage in cities with water shortage will exceed 25% at prefecture level and above. During the period from 2021 to 2025, relevant departments will focus on improving the rural living environment and steadily solve the prominent environmental problems, such as "enclosing villages with garbage" and rural black and smelly water bodies. China will promote the on-site classification and resource utilization of rural domestic waste and favors the treatment of rural domestic sewage in echelons focusing on township government stations and central villages.

In the next 5 years, China will continue to support the promotion of the rural toilet revolution according to local conditions, carry out in-depth village cleaning and greening actions, and ensure that the village public space, courtyard houses, and surrounding villages are clean and tidy. By 2025, China can orderly promote the transformation of rural toilets in economically underdeveloped areas, high-altitude cold and water shortage areas, support 600 counties to promote the improvement of human settlements, and build rural garbage and domestic sewage treatment facilities.

Considering China is a water shortage, developing country with a large number of people, the implementation of SDG6 will face many difficulties and challenges in drinking water, toilet, and other aspects, especially in remote and alpine areas. China attaches great importance to international cooperation and actively cooperates with United Nations agencies and international water related organizations in the implementation of SDG6 for the benefit of all human beings and the planet earth.

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8 Readiness of South Asian Countries to Achieve SDG 6 Targets by 2030 in the Sanitation Sector

George Danso and Miriam Otoo

Abstract

In 2015, the United Nations Member States adopted the Sustainable Development Goals (SGDs) with the intent of bringing the world to a state of life-changing zeros—zero poverty, hunger, AIDS, and discrimination against women and girls. Historically, it has never been easy to achieve global targets and available estimates show that before COVID-19 pandemic, progress remained uneven and most countries were not on track to meet the goals by 2030. Some gains were visible including the decline of many communicable diseases, decline of the share of children and youth out of school, and improvement in access to safely managed drinking water. In spite of these gains, many Asian countries are behind other developing countries, in terms of key indicators for SDG 6 targets. The purpose of this paper is to review and examine the current progress of SGD 6 targets among selected countries in South Asia. The paper will specifically examine how these countries are working to achieve sanitation-related SGD targets 6 by 2030. We use a case study approach as our analytical framework, which is suitable for studying a contemporary situation to which local "real-life" context is intrinsically linked and where the research team has little or no control. We conduct a cross-country analysis to illustrate strategies that other countries can potentially adopt to move toward achieving their SGD targets and propose effective recommendations for the sanitation sector in these countries.

Keywords

Sustainable development goals · South Asia · Sanitation · Wastewater · Indicators

8.1 Background and Justification

Globally, water and sanitation services are major challenges for policymakers. The international community including the United Nations has been developing various strategies to improve the current situation. As part of this process, the United Nations (UN) member states formally adopted the Sustainable Development Goals

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(SDGs) agenda on September 25, 2015 (United Nations, 2020a; UN Water, 2021). The 17 SDGs, and the associated 169 targets with 232 indicators, aim to end poverty, hunger, and inequality; act on climate change and the environment; improve access to health and education; care for people and the planet; and build strong institutions and partnerships. It is worth highlighting that these goals are not developed in isolation but were developed to improve the previous Millennium Development Goal (MDG),[1] which ended in 2015. Notwithstanding, some members made significant progress on MDG goals. This paper, however, focused on the recent SGDs agenda.

It is paramount to assess the status of these goals over the last few years of implementation. A recent report by the United Nations shows that progress remains uneven and most of the countries were not on track to meet the goals by 2030 (United Nations, 2020a). What is important is that this progress will be impacted by the current COVID-19 pandemic as well. Any policy development and assessment need to factor the impact of the pandemic. In spite of these, there have been some gains before the pandemic, for instance, the share of children and youth out of school has fallen; the incidence of many communicable diseases has declined; access to safely managed drinking water has improved; and women's representation in leadership roles has been increasing. At the same time, the number of people suffering from food insecurity was on the rise, the natural environment continued to deteriorate at an alarming rate, and dramatic levels of inequality persisted in all regions. While many studies have looked at the progress of these 17 SGDs, we decided to focus on the SGDs 6—sanitation and water.

Achieving SDG 6 is a national responsibility. More than anything, politicians and policymakers at the national level need to set bolder priorities. Researchers, investors, and other stakeholders must make sure that decision-makers are clear about the economic case: when we invest in water and sanitation, there is a catalytic effect on other areas such as health, education, and agriculture and job creation. On this indicator, the global community has made progress on key indicators. For the Asian countries, despite good progress in some components of the goal, such as the reduction of open defecation, overall progress is slow. The biggest hurdle for the region is water stress, where the situation has significantly worsened since 2000 and is likely to continue to regress unless collective action is taken. To achieve the 2030 targets, the region needs to build greater capacity for participatory water and sanitation management and water-use efficiency (United Nations, 2020b).

In 2019, the UN Water launched the SDG 6 Global Acceleration Framework, with the full backing of the United Nations family, to mobilize action across governments, civil society, the private sector, and the UN to better align efforts, optimize financing, and enhance capacity and governance. Making sure that there is water and sanitation for all people, for all purposes, by 2030 will help future-proof global society against the many and varied threats coming down the line. Our immediate, shared task is to establish safe water and sanitation services in homes, schools, workplaces, and health care facilities. Ultimately, it is essential to integrate new approaches, with improved governance and coordination across sectors and geographical borders.

In this paper, we review the progress made by selected Asian countries on SDG 6. The aim of the study is to assess the current state of these countries and evaluate the barriers that limit their progress in achieving targets by 2030. The rest of the paper is organized as follows: We present the methods used for the research and then outline the key results for all the countries. Then, we present the current and future states of the countries.

[1]The legacy and achievements of the MDGs provide us with valuable lessons and experience to begin work on the new goals. However, for millions of people around the world the job remains unfinished. We need to go the last mile on ending hunger, achieving full gender equality, improving health services, and getting every child into school beyond primary. The SDGs are also an urgent call to shift the world on a more sustainable path (https://www.mv.undp.org/content/maldives/en/home/sustainable-development-goals/background.htmlUNDP).

Finally, we look at the policies and recommendations even beyond the SDG 6 for the Asian countries.

8.2 Methodology

We used a case study approach with embedded units of analysis (Yin, 2003). The case study framework is suitable for studying a contemporary situation to which local "real-life" context is intrinsically linked and where the research team has little or no control (Geneviève et al., 2015). We focused on the SGD 6, which includes eight global targets that are universally applicable and aspirational. The review is limited to targets 6.1, 6.2, and 6.3 due to data availability and time limitations (Table 8.1). We applied the indicators to selected countries in Asia. The selected countries are Afghanistan, Pakistan, India, Nepal, Bhutan, Bangladesh, and Maldives. In each country, we focused on the key indicators and compared year-over-year values, where appropriate. In most cases, we used the year 2000 as the baseline year and compared to 2017. Where the recent data is available, we used that instead of existing old data. This is an opportunity to highlight that there are limited data for these countries. Conversely, information on population, macroeconomic factors, and contribution of various sectors to the economy was relatively easy to find from various international databases.

Table 8.1 SGD 6 targets and selected indicators

Targets	Indicators
Target 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
	1. Population using safe drinking water (%)
	2. Household with access to piped water supply (%)
	3. Basic water supply coverage (%)
Target 6.2 By 2023, achieve access to adequate and equitable sanitation and hygiene for all	6.2.1 Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water
	1. Households using improved sanitation facilities, which are not shared (%)
	2. Proportion of population using latrines (%)
	3. Sanitation coverage (%)
Target 6.3 By 2030, improved water quality	6.3.1 proportion of safety treated wastewater
	Proportion of untreated industrial wastewater (%)

8.2.1 Study Area[2]

All the countries selected for the study are located in Asia and are in the SDG classification as central and southern Asia region. *Afghanistan* has a total population of 38 million and 58 people per km^2. Majority of the population lives in the rural areas and the country occupies a total area of 652,860 km^2 with most of its land being used for agriculture and other uses. The country has 78 billion USD per year and GDP per capita of 2065 USD per year. Agriculture and services constitute the major sectors of the economy. *Pakistan* has a total area of 770,880 km^2, which is slightly higher than Afghanistan, but surprisingly close to the size of Bhutan. In terms of land use by sector, agriculture uses 48%, 2% for forestry, and a substantial use goes to the service sectors. Pakistan has a population of 216 million and 281 people per km^2. About 37% of the population lives in urban areas and 63% lives in rural areas. The country has a GDP of 1 trillion USD per year and 4690 GDP per capita per year. In terms of valued added by sectors, 54% comes from services, 22% from agriculture, and 18% from industry. *India* has a population of 1.4 trillion and 460 people per km^2. About 66% of the people live in rural areas and primarily work in the agricultural sector. India, one of the populous nations in the world

[2]Information presented in this section are UN Water database (https://www.sdg6data.org/country-or-area).

has a GDP of 9 trillion USD per year and GDP per capita of 6700 USD per year. Major contributors of the GDP are from service sector (49%), industry (25%), and 16% from agriculture. India and Pakistan both operate service-based economies. *Sri Lanka* has a total population of 22 million and 348 people per km^2. Majority of the population lives in the rural areas (81%) and the country occupies a total area of 62,710 km^2 with most of its land being used for agriculture (44%), forestry (33%), and other uses. The country has a GDP of 285 billion USD per year and GDP per capita of 13,078 USD per year. Agriculture (7%) and services (58%) constitute the major sectors of the economy. About 27% of the GDP comes from the industrial sector. *Nepal* has a total population of 28 million and 200 people per km^2 and smaller in size and the number of people when compared with Pakistan and India. Similarly, to other countries, majority of the population lives in the rural areas and the country occupies a total area of 143,350 km^2 with most of its land being used for agriculture, forestry, and other uses. The country has 97 billion USD per year and GDP per capita of 3417 USD per year. Agriculture (24%) and services (51%) constitute the major sectors of the economy. *Bhutan* has a total population of 763,092 and 20 people per km^2. About 42% of the population lives in urban areas, while 58% lives in rural area. The country sits on a total land area of 38,144 km^2 and has 72% of land for forestry and the rest for agriculture. The country has 9 billion USD per year and GDP per capita of 11,832 USD per year. Agriculture (16%) and services (43%) constitute the major sectors of the economy. About 36% of the GDP comes from the industrial sector.

Bangladesh has a total population of 163 million and 1253 people per km^2. Majority of the population lives in the rural areas and the country occupies a total area of 130,170 km^2 with most of its land being used for agriculture, forestry, and other uses. The country has 775 billion USD per year and GDP per capita of 4754 USD per year. Agriculture (13%) and services (53%) constitute the major sectors of the economy. About 30% of the GDP comes from the industrial sector. *Maldives* has a population of 530,953 and 1770 people per km^2. About 60% of the population lives in urban areas, while 40% lives in rural area. The country sits on a total land area of 300 km^2 and has 72% of land for other sectors, 3% for forestry, and the rest for agriculture (26%). The country has 10 billion USD per year and GDP per capita of 19,531 USD per year. Agriculture (5%) and services (70%) constitute the major sectors of the economy. About 12% of the GDP comes from the industrial sector.

Bhutan and Maldives are the two countries with a different distribution of people, where most people live in the urban areas than in the rural areas. In addition, their economies depend on services than agriculture or forestry.

8.3 Situational Analysis

In this section, we present the current projects and policies various countries in the study area have implemented toward achieving the goals of the SGDs. The emphasis is on sanitation and wastewater use for diverse purposes.

8.3.1 Afghanistan

Historically, Afghanistan struggles in improving sanitation, particularly when it comes to rural sanitation because of harsh local environmental conditions. Also, decades of conflict and weak governance have curbed investment in public infrastructure and made enforcing relevant sanitation and hygiene regulations difficult. Afghanistan's harsh conditions and rough terrain impede the expansion and maintenance of public infrastructure, including water supply and sanitation systems. Cities across the country are growing at rates double the current average in Asia. While many countries struggle with population growth rates due to natural birth, Afghanistan's urbanization and shifting demographics are driven by the increasing number of people displaced by fighting in the countryside, refugees who are returning from Pakistan and Iran, and rural residents who are looking for economic opportunities. According to the Global Water

report in 2021,[3] only 63% of Afghans have access to basic drinking water, and only 39% have access to basic sanitation. Afghanistan also has no functioning sewage and wastewater treatment systems, and existing septic management systems are informal.

Poor sanitation exposes people, mainly children and elders, to life-threatening diseases. This issue also affects women and girls, putting them at risk for both physical and psychological damage. It affects menstrual, pregnancy, and postnatal periods and creates an unsafe environment when in these periods. In rectifying the situation, the U.S. Agency for International Development (USAID) worked with the United Nations Children's Fund (UNICEF) to support the Afghan government and civil society to increase access to safe drinking water and community sanitation facilities and improve hygiene practices in households, schools, and health centers for at least 525,000 Afghans in 17 priority rural provinces (USAID, 2021).

As part of the nationalization process of the SDGs, the Afghanistan government developed national targets and indicators and adopted key goals including SGD 6. The government is also committed to aligning all its strategies, agendas, developmental plans, priorities, and policies in line with the development goals to achieve the adopted goals and targets until 2030. Current assessment indicates that a little more than 80% of families have toilets or latrines, only about 43% are improved and safe—meaning they hygienically separate human waste from human contact. It is important to note that open defecation continues to be a dangerous challenge in Afghanistan because human waste near waterways and living environments spreads diseases quickly and puts children and their families at risk (UNICEF, 2021).

Open defecation is an issue that many countries face on a daily basis; however, it has been an astonishingly prevalent issue in Afghanistan. It places many of the individuals and families leaving near waterways in much danger as human waste spreads disease quickly. To combat this issue, UNICEF alongside the Ministries of Rural Rehabilitation and Development, Public Health and Education have collaborated to end open defecation by 2025. They are pushing for the Community-Led Total Sanitation approach, which advocates for people to build and use their own latrines.

8.3.2 Pakistan

Pakistan is one of the countries that achieved the MDG goals in 2015, reducing by half the proportion of people without sustainable access to basic sanitation: this included increasing rural access to sanitation to 67% from 23% in 1991 (World Bank, 2018b). Notwithstanding the disparities between rural and urban areas, many studies suggested the government needs to do more to improve sanitation in all areas. Interestingly, fecal sludge management is gaining attention, as treatment of waste from pit latrines is expensive, neglected, and poorly developed (Junaid, 2016). It has been documented that very little investment has been made in the management of fecal sludge or wastewater in the country. About 42% of households in rural Punjab do not access or connected to drains (World Bank, 2018). In situations where drains exist, they are commonly open drains with no treatment of effluents, leading to water and soil contamination. Only 10% of households in rural Punjab and 1% of households in rural areas have access to covered or underground drains connected to their toilets (World Bank, 2018). In urbans and rural areas, about 4.1% and 59%, respectively, have access to toilets connected to sewer systems: in urban households mainly rely on flush toilets connected to septic tanks (World Bank, 2018). The opportunity to have toilets connected to drainage system is a good indicator for safety for the communities and the environment. The Government's Pakistan Vision 2025 commits to increasing the proportion of the population with access to improved sanitation to 90%, halving the incidence of diarrhea, and halving the food insecure population (World Bank, 2017).

[3] https://www.globalwaters.org/wherewework/asia/afghanistan

Following the 2010/2011 floods, the Government of Pakistan developed the Pakistan Approach to Total Sanitation (PATS) as a country specific strategy to scale up sanitation programs, particularly in rural areas to end open defecation (UNICEF, 2015). PATS endorses several models including community-led total sanitation, school-led total sanitation, component sharing, sanitation marketing, and disaster response (Edouard-Tiberghien, 2016). It is backed by strong political will and increasing budget allocations (Edouard-Tiberghien, 2016). In 2014, the Government of Punjab began implementing PATS in 6% of villages across all districts (World Bank, 2017). The provincial government has allocated Pakistani Rupees (PKR) 400 million (USD 2.97 million) for sanitation (UNICEF, 2015).

8.3.3 India

Improving sanitation is a major challenge to the Indian government. In 2014, less than half of Indian households had access to sanitation facilities and only 30% of the wastewater and sewage originating in urban areas were treated. Since 2014, India has been implementing a well-targeted and time bound strategy to transform the state of sanitation in the country. While significant progress has been achieved in recent years, this is a continuous endeavor. According to the World Bank, more than 520 million in India were defecating in the open—the highest number in the world. This figure is expected to have reduced significantly given that improving sanitation is a key priority of the government, which has introduced several flagship programs including Swachh Bharat Abhiyan to clean India, the National Rural Drinking Water Programme, and Namami Gange, which aims at the conservation of the River Ganga. The flagship initiative of the *Swachh Bharat* Mission has successfully achieved the target of making India open-defecation-free. The project constructed over 109 million household and community toilets in 2014 in 6000 villages in 706 districts across the country. Percentage of rural households with individual household toilets increased from 38.7 in 2014 to 2015 to 100 in 2019. Similarly, percentage of urban households with individual household toilets rose from 88.8 to 97.22 during the same period. The use of toilets has also dramatically increased over the last 5 years with 97% of rural households using them, as per independent third-party evaluation surveys.

Another program called The Clean India Campaign succeeded in effecting a behavioral transformation by creating a nudge, which resulted in widespread awareness to shift toward better sanitation and hygiene facilities. The program also focused on conversion of unsanitary toilets to pour-flush toilets, municipal solid waste management, raising awareness, and nudging positive behavioral change. The improvement in sanitation has had a positive influence on the life and health of women and girls. Increase in proportion of households with toilets has been found to have a positive impact on the safety of women. There are remarkable positive linkages of sanitation with health and nutrition outcomes and educational attainment of women. As part of sanitation programs, separate toilets for girls have been built in 97.43% schools across the country, which has contributed, among other factors, to improved enrolment and retention of girls in primary education.

8.3.4 Nepal

Nepal has made significant progress on SGD projects. In particular, the basic sanitation coverage in the country reached 99%. Also, the proportion of people using latrines increased from 68% in 2015 to 85% in 2019. Within the same period, untreated industrial waste in water remains the same and the country could not reach the projected target of 73% in 2019. This suggests that the SGD 6 target of achieving universal and equitable access to safe and affordable drinking water for all needs to be accelerated. Regarding basic water supply coverage, Nepal reached 91% of the population in 2019, while only half of households have access to piped water supply. Households having access to tap water supply are those that have perennial water sources located within 30 min. However, providing safe drinking

water is challenging as only 25% of the population has access to safe drinking water.

Over the years, the government created several initiatives for the WASH sector. The 20 years' Water and Sanitation Strategies, which was formulated in 1997, the National Rural Water Supply and Sanitation Policy and Strategy 2004, the National Policy for Urban Water Supply and Sanitation in 2009, and the Sanitation and Hygiene Master Plan were some of the programs implemented by the government. Presently, a Sectoral Development Plan (2017–2030), designed by the Ministry of Water Supply, is under implementation in line with the SDG of ensuring access to safe, adequate, and affordable drinking water and sanitation services to all by 2030.

Building on the priority given to this sector, more needs to be done to make progress. In these goals, the challenge to the government is ensuring equal access of WASH facilities to high- and low-income households, as well as addressing the disparity between different provinces and regions. Geographical difficulties may pose a serious challenge to the government's plans of ensuring universal access to water and sanitation to all households. Since some still use solid fuels as their primary source of energy for cooking, the targets for 2019 and 2030 are 65% and 30%, respectively. People using Liquid Petroleum Gas (LPG) for cooking and heating has increased from 18% in 2015 to 27% in 2018–2019, which is more than the target of reaching 24% in 2019. While the actual supply of energy was not sufficient a few years back, there has been substantive improvement in this sector. The per capita electricity consumption has also increased from 80 kilowatt-hour (kWh) in 2015 to 260 kWh, which is again more than the target of 230 kWh in 2019. These targets are quite ambitious considering the status of progress; efforts will need to be accelerated in the days ahead.

8.3.5 Bhutan

The government had a specific goal to ensure that by 2030 every individual and households have access to clean water in their homes and adequate sanitation (safe toilet facilities). It is to ensure improving water quality through environmental protection measures and sustainable waste management. Bhutan is endowed with water resources with an average flow of 2238 m^3/s and with 94,500 m^3 per person per year, the highest in the region. The country's water resources are best described in terms of glaciers, glacial and high altitude wetlands, rivers, river basin, groundwater, and reservoirs. In recognition of the importance of managing water resources for a secure future, Bhutan adopted Bhutan Water Policy 200884, the Bhutan Water Act, and the National Integrated Water Resource Management Plan (IWRMP). In addition to these, Water Regulation 2014 was approved and Water Safety Plan for 22 municipalities has been developed. About 10,707 households also benefit from the WASH system piloted through Community Health Pilot Project. About 99.5% of the households have access to improved water sources, with 45.5% piped water in the dwellings, 50.4% piped water in the compound, and 63% of the households that have 24 h access to drinking water (Royal Government of Bhutan, 2018). Notwithstanding that, timely and continuous water supply remains a top priority for both rural and urban households, suggesting that physical access to infrastructure does not necessarily mean having regular access to water.

In 2018, the government launched a new imitative called the 12th National Five-Year Plan. The primary aim is to reduce poverty levels. Also in the plan is a key aim to improve water and sanitation by creating a flagship program that will prioritize this sector. This is relevant as pointed out by the Annual Health bulletin (2017) that 4.1% of people in the country practice open defecation due to no access to hygienic toilets and proper water sanitation.

Bhutan is working with many other organizations to improve sanitation in the country. For instance, Bhutan joined the organization sanitation and water for all in 2017 and working with SNV Netherlands Development Organization (SNV) to develop water, sanitation, and hygiene protocols for the country and immediately increased sanitation to almost 99% in certain districts. Bhutan is making progress on the SDG 6

with its partners, and this is highly supported by the king of Bhutan (https://borgenproject.org/sdg-6/).

8.3.6 Bangladesh

In 2015, Bangladesh failed to meet the Millennium Development Goal (MDG) target of halving the proportion of population without access to improved sanitation. Much of the population mostly concentrated in hard-to-reach geographical areas or among socio-economically vulnerable populations are still using poor sanitation. According to 2015 WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP) Report, only 1% of the population were practicing open defecation, 10% using unimproved latrines, 28% enjoyed shared latrines, and 61% used improved latrines (UNICEF-WHO, 2015). However, the sudden influx of almost one million Rohingya refugees in Teknaf area has put enormous pressure on drinking water and sanitation facilities. It is an extremely difficult situation to arrange safe drinking water and proper sanitation in Teknaf, although the best efforts are being made by all concerned national and international agencies. Despite these challenges, the Joint Monitoring Progress report of 2017 jointly issued by the World Health Organization (WHO) and UNICEF on open defecation in Bangladesh is to be at 0%, a tremendous achievement for a country where the same rate stood at 34% in 1990.

Concerning SGDs, the country has made much improvement on sanitation targets. For instance, in 2019, the proportion of people using safely managed drinking water services was at 47% at the national level, while 45% was observed for the urban areas and slightly higher levels recorded for the rural areas (48%). Also, within the same year, about 99% of households members used improved sources of drinking water (GED, 2020). This is an improvement from 2017 when the country was at 87%. In 2019, 85% of household members used improved sanitation facilities, which is 91% in urban areas and 83% in rural areas (GED, 2020). In the same year, 75% of households reported practicing a handwashing facility with soap and water, which is 87% in urban areas and 71.4% in rural areas (GED, 2020).

The Government of Bangladesh understands that achieving SDG 6 is critical for achieving the rest of the SDGs. Bangladesh has by now made tremendous success to ensure people's access to safe drinking water and sanitation and plans to ensure safe water for all people. The government has adopted an action plan and a national policy on water, water supply, and sewerage, environment protection rules, and water act to facilitate implementation of the SDG 6. Several activities are currently ongoing to further address the SDG 6 issues. For instance, standards for WASH in health care facilities are being established. Bangladesh is also working to establish national targets for sanitation that are both contextually appropriate and aligned with SDG 6.

For Bangladesh, SDG 6 brings in issues of equity, quality, and sustainability, which will require more nuanced, integrated, and multisectoral ways of working in the sector. Further, the "leave no one behind" theme of the SDGs requires going beyond broad-brush interventions that raise beneficiary count, to focusing on hard-to-reach areas and populations, which will require innovative, context-specific technology, and programmatic solutions. Hygiene is perhaps the most lagging area of WASH in Bangladesh, and there is evidence of widespread poor practices. Determining effective ways to improve behavior will be a key challenge of SDG 6.

8.3.7 Maldives

Population increase, urbanization and environmental changes, including climate change present a number of challenges to the water security of the country. Due to geographic dispersion of the population, management of water resources and provision of sanitation services in Maldives remains a significant challenge. The high rate of urbanization in islands such as Male' increases the pressures on supply, as well as the risk of water borne diseases.

Approximately 87% of all population (including non-administrative islands) used rainwater for drinking purposes in 2014. Hence, there is a need to increase the rainwater harvesting within the country. Currently, Maldives is moving toward an Integrated Water Resource Management (IWRM) approach to address water insecurity in a changing climate. The country faces difficulty in access to clean water during the dry season especially in the remote islands given the high transportation costs incurred in supplying emergency water. The government has made major efforts to address this issue by increasing water storage facilities in affected islands with the expectation that it will be completed by the end of 2018. The government is steadfast and committed in developing the water and sanitation sector and in the recent years, major developments have been experienced in the sector. Over the past 3 years, the population with access to adequate sewerage networks has increased from 31% (in 2013) to 48% (by the end of 2016). Achievements in the water sector demonstrate that the population with access to water supply networks has increased from 25% (in 2013), to 39% (by the end of 2016). The government targets to continue this momentum and provide access to safe water supply and adequate sewerage services to 75% of the population by the end of 2018.

8.3.8 Sri Lanka

Sri Lanka as a country progressed under the Millennium Development Goals in areas such as education, health, and poverty. In spite of the historical conflict that hinders its progress, the country made commitment to join global community for solving sustainable development goals. The government of Sri Lanka endorsed the SGDs and has made several initiatives to support the success of the agenda. As part of this agenda, Sri Lanka made notable achievement in its paths toward becoming a resilient society, including the high coverage of water supply from safe resources and sanitation facilities, near universal electrification and increasing share of population living in permanent houses (Government of Sri Lanka, 2018).

Sri Lanka has made good progress in terms of access to safe drinking water over the years. On the issue of sanitation facilities, 87% of the population possess onsite sanitation facilities, which can be considered as a significant achievement. However, the same can be said about the wastewater disposal where only 2% households currently have piped sewerage connections. The rest of the households disposes wastewater using onsite pits within the premises which could lead to various environmental and health issues, especially contamination of groundwater. The situation is particularly problematic in densely populated urban and sub-urban areas. Major sewerage facilities are available in the urban areas such as Colombo and not in the rural areas. However, the government aims to have centralized sewerage facilities for all large and strategic cities by the year 2020.

Sri Lanka has formulated several plans, policies, and programs to cover specific subsectors in the water and sanitation sector, such as the National Drinking Water Policy 2008, the National Policy of Sanitation, the Rural Water Supply and Sanitation Policy, and the Rainwater Harvesting Policy. Stakeholders have highlighted the need for an integrated policy framework for water management in Sri Lanka in the local consultations. In addition, similar to many other sectors, the lack of institutional coordination is also a challenge for the water sector. There are major national agencies and sub-national agencies involved in the supply of drinking water and drainage facilities. Proper coordination among them is essential for achieving the national targets.

8.4 Assessment and Discussions

Previous sections focus on the current progress made by the selected countries. In this section, however, we evaluate sanitation specific goals and analyze what worked well for the countries and what can be done at national, urban, and rural levels. In this assessment, we considered the

SGD 6 and focused on sanitation and wastewater indicators. Based on the data collected and evaluated, it was clear that the countries are making progress in several areas and are either developing or implementing policies to reduce the impact of unimproved sanitation crises for the people and the environment. While this is a daunting task, current data suggests that the countries are trying to achieve the said goals on target 6.

A key indicator, we focused on for this assessment is wastewater treatment. On sanitation, it is crucial to know the proportion of wastewater treated for a given country. Untreated wastewater could pose several health and environmental challenges to the people, community, and the policymakers. Available estimates show that Bhutan attained 41% of wastewater treated, Nepal had 37%, and India obtained 27%. Bangladesh had 16%, but data is not available for many other countries including Maldives, Pakistan, and Afghanistan (UN Water, 2021).

Apart from wastewater treatment, we also looked at sanitation coverage and found diverse progress for the selected countries. We examined the proportion of household using improved sanitation facilities, the data show that from 2000 to 2017, most of the countries have made significant changes in three different areas—latrines, septic tanks, and sewer connections. The analysis only focused on shared sanitation facilities as this is a common practice in many developing countries including the selected countries (UN Water, 2021). A detailed analysis reveals that only Bhutan and Maldives recorded negative changes in the proportion of population using improved latrines. While Maldives continued with the negative changes for latrines improvement in rural areas, Bhutan recorded a positive change of 6% in 2017. Over the years, India recorded a higher increase in the latrine access than all other countries at the national level while Nepal, Bangladesh, and Afghanistan maintained a positive outlook in all locations—national, urban, and rural (Table 8.2). All the countries observed a significant increase in the proportion of the population with access to septic tanks. India again had the highest access, while Maldives attained only 16% from 2000 to 2017.

Handwashing is another important indicator and we looked at basic access to this indicator for the countries. In 2020, Afghanistan had the lowest access to handwashing facility for the population and this is followed by Bangladesh (Fig. 8.1). Maldives and Bhutan recorded the highest access with this indicator, while there is no data on Sri Lanka.

8.5 Countries on the SDG 6 Ladder

At the national level, the assessment shows that the countries have made progress toward achieving the target of SGD 6. Still there are numerous challenges and the most notable one being data availability. In this section however, we looked at progress made at the national level in relation to other countries and the global index of the SGD 6. A global report on health status of 188 countries based on the health-related Sustainability Development Goals (SGD) indicators found Bangladesh to be one of the poorest performing countries in South Asia, lagged by only Nepal and Afghanistan. This report clearly shows that no country can make sustainable progress on the global health goals without addressing the critical components of water, sanitation, and hygiene (WASH). Another report on the stage of India ranked it at 115 out of 162 countries, which is a score of 61%. In terms of SDGs performance, India is lagging behind East Asia and South Asia average regional score of 65.7%. India's massive population and its sheer diversity makes the implementation of policies a difficult task and progress on SDG 6 has been moderate. The same SDG Index Report observes that if India does not pick up its pace, the country will fail to reach the SDG 6 targets for 2030. At present, India scores 56.6% in terms of its SDG 6 achievement. Pakistan secured a score of 55.6 under SDGs' global index against a far better regional average of 63.3 and is even lower than regional peers Bangladesh's 56.2 and India's 58.1. The good news, however, is that its preparedness to deliver on 2030 targets is among some of the top in the world, raising hopes that it would not be repeat-

Table 8.2 Sanitation coverage among the selected countries

	Targets	2000			2017			Change (percent from 2000 to 2017)		
Countries	Proportion of population using improved sanitation facilities (including shared)	National	Urban	Rural	National	Urban	Rural	National	Urban	Rural
Afghanistan	Latrines and other	22	18	23	41	41	41	86	128	78
	Septic tanks	5	17	1	10	34	2	100	100	100
	Sewer connections	2	8	<1	3	8	<1	50	0	–
Pakistan	Latrines and other	<1	<1	<1	12	4	16	–	–	–
	Septic tanks	15	22	12	33	18	42	120	−18	250
	Sewer connections	20	52	4	25	60	5	25	15	25
India	Latrines and other	3	10	<1	28	14	36	833	40	–
	Septic tanks	12	33	4	33	50	24	175	52	500
	Sewer connections	7	23	<1	11	30	<1	57	30	–
Sri Lanka	Latrines and other	80	75	81	93	80	96	16	7	19
	Septic tanks	6	12	5	2	4	1	−67	−67	−80
	Sewer connections	2	9	<1	4	13	2	100	44	–
Nepal	Latrines and other	9	9	9	22	15	23	144	67	156
	Septic tanks	12	39	8	49	57	47	308	46	488
	Sewer connections	4	26	<1	5	19	2	25	−27	–
Bhutan	Latrines and other	41	62	34	21	<1	36	−49	–	6
	Septic tanks	11	15	9	51	75	35	364	400	289
	Sewer connections	4	12	1	6	12	1	50	0	0
Bangladesh	Latrines and other	25	21	26	52	46	55	108	119	112
	Septic tanks	11	31	4	13	22	9	18	−29	125
	Sewer connections	3	10	<1	5	14	<1	67	40	–
Maldives	Latrines and other	8	<1	11	4	<1	6	−50	–	−45
	Septic tanks	39	9	51	36	<1	59	−8	–	16
	Sewer connections	28	86	6	60	>99	34	114	–	467

Source: United Nations Children's Fund and World Health Organization, 2019

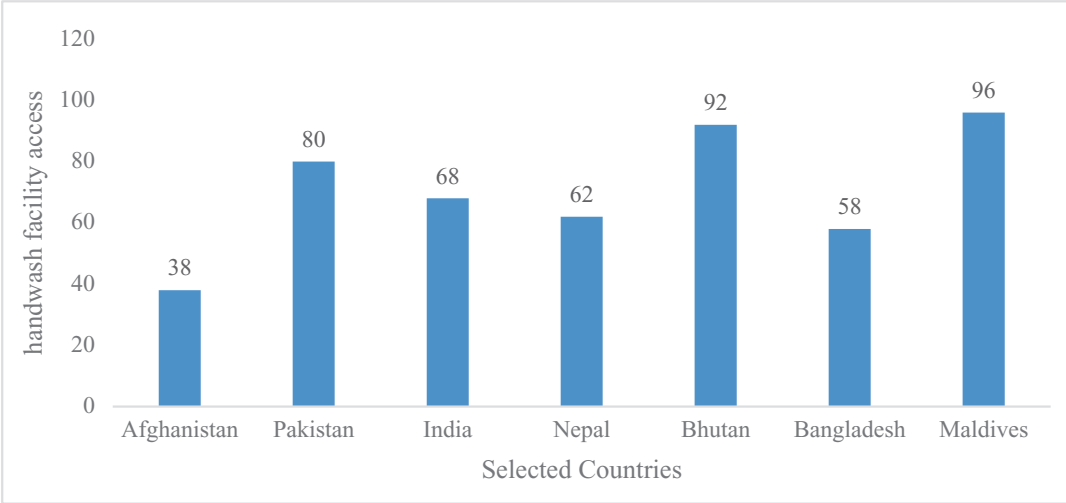

Fig. 8.1 Proportion of the population in the country have access to a basic handwashing facility, 2020

ing its dismal performance of the Millennium Development Goals (MDGs) when it missed almost all targets.

Sachs et al. (2021) recently ranked all these countries on the SDG index score and most of these countries ranked very high due to programs and policies implemented to achieve their targets. India, Pakistan, Afghanistan, and Bangladesh all ranked above 100 out of 165, while Bhutan ranked the lowest with score of 75. With respect to SDG 6 in relation to other goals, Maldives achieved 75% for this target and obtained 100% for goal number 1, 4, and 7. Thus, it is not surprising to see that it had achieved most of the SDG and it is on course to achieve a better score over all goals. On the SGD 6, India, Pakistan achieved 75% in relation to other goals, while Afghanistan obtained 25%, but had 100% goal 12 and 13. Bhutan and Nepal also obtained 75% in relation to other targets.

It is also important to look at the impact of each country's actions can have on other countries abilities to achieve the SDGs. In this context, it is better to use the spillover index, which assesses such spillovers along three dimensions: environmental and social impacts embodied into trade, economy, finance, and security. A higher score means that country causes more positive and fewer negative spillover effects. Based on this assessment, most the countries obtained a higher score except Maldives. This means that this country has less negative impacts on other countries in the trajectory of achieving the SDG 6 targets in 2030.

8.6 Status and the Way Forward

As highlighted in the previous section, these countries made progress toward achieving the SGD goals and particularly on SGD 6. We assessed the stage where each country is at with respect to SGD 6 on the sanitation indicators. In this context, we considered the indicator that deals with the proportion of the population using at least basic sanitation services. Afghanistan and Bangladesh obtained a low score, which means they are either at stagnating stage or increasing but at a decreasing rate. Maldives and Nepal obtained a score that indicate they are either on track or maintaining SGD achievement (Table 8.3). Only two countries obtained a green status on challenges, which means that most of the countries are still struggling to achieve the target on SGD 6 (Table 8.3).

As mentioned, most of the countries are developing policies and programs to monitor progress on the SGDs. For instance, Afghanistan, which

Table 8.3 Assessment of SGD 6 (sanitation and wastewater) for the countries

Country	Indicator population using at least basic sanitation services (2017) percent (2020)	Status	Indicators	Challenges
Afghanistan	43.42	→	Score stagnating or increase at less than 50% of required rate	●
Pakistan	59.87	↗	Score moderately improving, insfficient to attain goal	●
India	59.54	↗	Score moderately improving, insufficient to attain goal	●
Sri Lanka	95.78	↑	On track or maintaining SDG achievement	●
Nepal	62.1	↑	On track or maintaining SDG achievement	●
Bhutan	69.25	↗	Score moderately improving, insfficient to attain goal	●
Bangladesh	48.23	→	Score stagnating or increase at less than 50% of required rate	●
Maldives	99.37	↑	On track or maintaining SDG achievement	●

Source: Sachs et al., 2021

● SGD achieved, ● major challenge remain, ↑ on track, ↗ moderately increasing, → stagnating

obtained a low score of 43.42, has adopted the (SDSN) survey program, which is a forward-looking assessment of government efforts to achieve the SDGs. The country collects survey information on national coordination and implementation mechanisms at the central and federal level of government. The country is making progress because it has a national SGD monitoring of 178 indicators and has included SDGs in national COVID-19 recovery plan. Although the country submitted detailed plans and strategies on achieving SDGs, still, the national budget does not cover financial obligations of achieving the plans both at the national and sectoral levels. Unlike Afghanistan, Pakistan has adopted policies, developed plans to achieve the SDG, and included implementation cost in the national budget. It is not surprising to see that they obtained a slightly high score than Afghanistan and overall, its status is moderately improving. Similarly, Bangladesh, which is facing a stagnation in achieving the goals, has included implementation cost in the national budget. This is evident in recent numbers, where about 85% of the population use a safely managed sanitation service, which is 91% in urban and 83% in rural areas. Also, nearly three-fourth of the population see hand-washing facility with soap and water, which is 87% in urban areas and 71% in rural area. Still the country struggles with awareness on health and hygiene programs and need programs to strengthen this area. Bhutan is also on course of achieving the SGD 6 targets, where current number show that 99.5% of the people have access to improved water sources and about 63% of households have 24 h access to drinking water. The country has developed national plan on sanitation and hygiene with a strong focus on improving access and quality. However, the country still struggles with pressures from climate change and population growth, especially in urban areas and inadequate water and sanitation infrastructure and services are major bottlenecks. India is not different from Bangladesh and Bhutan (Table 8.3), the country is on course of achieving major goals for the SGD, especially 6. The country significant policy changes have seen improvement in the sanitation sector. For instance, rural household access to toilet facilities increased from 51% in 2015–2016 to 100% in 2019–2020 (Government of India, 2021).

Only three countries achieved a green status, indicating that they are on truck or maintaining the SDG goal. As evident in Table 8.3, Sri Lanka, Nepal, and Maldives attained this level of success in achieving the target for SGD 6. Maldives's success can be attributable to the firm commitment of the government to developing the water and sanitation sector for the country. As evident, by the end of 2019, the population with access to piped water and sewerage reached 68% and 80%, respectively (National Water and Sewerage Strategic Plan, 2020). The government made a commitment to continue to provide access to safe water and adequate sewerage services in all inhabited islands by the end of 2023. Another factor is the formulation of the National Water and Sewerage Strategic Plan under the Water and Sewerage Act, to guide the sector and ensure that water and sanitation will be improved by 2025. Finally, the government made a financial commitment to support the implementation of this strategy and to cooperate with the international community for additional financial resources to ensure sustainable implementation of the strategy.

Sri Lanka made significant progress on the water and sanitation indicator of the SDG 6. As indicated in Table 8.3, the country obtained green status for the sanitation target. Available values show that the country increased access to improved drinking water and sanitation to 95% and 96% of the population, respectively. Additionally, the country completed about 18,000 individual's toilets and 8000 more under construction as of April 2021. The country also provided 30 schools with improved sanitation facilities and conducted 627 hygiene awareness programs for 106,863 beneficiaries.[4] The success of the country is primarily due to collaborative approach adopted with local institutions and the international partners such the World Bank to ensure sustainability of these projects and pro-

[4] https://www.worldbank.org/en/results/2020/06/23/sri-lanka-building-a-healthy-nation

grams in the sanitation sector. Another point to note that the overall development of the country will be limited by the pandemic and this will affect the progress to achieve good clean sanitation facilities and for people to practice good hygiene behaviors at all times.

8.7 Policy Conclusion

Although most of the countries selected for the study are making progress and developing policies to achieve the targets for the SGD 6 and other goals, there are significant barriers for these countries. Aside financial challenges, data availability is a major barrier for the countries. It is certainly almost impossible to obtain accurate date on key indicators. The difficulties in data collection are due to lack of technical capacity, inadequate resources, and insecure environment. Countries must coordinate with different stakeholders and international institutions on how to develop protocols to collect accurate date for the SGD targets. This will support the idea of monitoring and reporting on many other fronts including data availability. In addition, the need to set aside baseline for the national targets and indicators, which require professional technical assistance with increased funding, will be useful for the countries. Apart from coordination and monitoring, there is the need to create awareness on the indicators at different levels of government that is national, urban, and rural areas. This will help the government to gain support from different stakeholders. This is an effective strategy, as it will ensure local people to adopt any policy intervention to improve the sanitation in the countries. It is also relevant to explore different communications tool and educational materials targeting local ways of giving information to the communities on the benefits of risks unimproved sanitation. The lessons learned report from other countries such as Maldives and Nepal could be relevant for other countries in Asia.

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9 Readiness of Sri Lanka to Achieve SDG 6 Targets in Water and Sanitation by 2030

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Abstract

Provision of safe drinking water is one of the Sri Lankan government's priorities and targets are set periodically with regard to the achievements of safe drinking water access and adequate sanitation. The MDG7 target was met by Sri Lanka and the country found itself in a better position at the end of 2015, in the preparation towards SDG 6 targets. Sri Lanka is committed to work towards the Agenda 2030. The enactment of Sustainable Development Act, establishment of Sustainable Development Council, and the appointment of a Select Committee of Sri Lankan Parliament Board SDG 2030, in 2016 were some milestones towards this commitment. In 2020, the nodal agency for policy implementation, monitoring, and reporting in the drinking water and sanitation sector in Sri Lanka was the Ministry of Water Supply together with National Water Supply and Drainage Board (NWSDB or Water Board) and Department of National Community Water Supply. Revision of policies to reflect the sector policies by these bodies is continuously undertaken to achieve Agenda 2030 goals. The government's accelerated programs to improve water supply coverage through short term, medium term, and long term projects by increasing capacity of existing treatment plants, laying new distribution pipes, developing new water supply and sewerage projects, and encouraging efficiency improvements are discussed. Sri Lanka has presented its first Voluntary National Review on SDGs to the UN High-Level Political Forum (HLPF) in 2018. The country's current SDG progress in the water and sanitation is presented with many challenges facing the country, such as the impact of climate change on water quality and quantity, water quality issues due to inadequate treatment, community engagement, and many others exacerbated by the COVID-19 pandemic.

Keywords

Sri Lanka · MDGs to SDGs · Policy · Coverage progress · Challenges · Covid-19 Impacts

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9.1 Introduction

9.1.1 Sri Lanka

Sri Lanka is an island in the Indian Ocean and experiences a tropical climate with distinct dry and wet seasons and two monsoons. There are two distinct rainfall zones: the wet zone and the dry zone. Wet zone comprises the central mountains and the southwest which receives an average of 2500 millimeters (mm) per annum (ranging as high as 5500 mm in some areas). Dry zone comprises most of the southeast, east, and northern parts of the country, which receives significantly less annual rainfall ranging from 1200 to 1900 mm annually. Average annual temperatures range from 28 °C to 32 °C. The population is 21.8 million and annual population growth rate of 0.73% (Fan 2015). Although population density is 348 people per km^2, 19% lives in urban areas and 81% lives in rural area (UN Water 2021).

9.1.2 Importance of Safe Water and Sanitation for Sri Lanka

Supplying safe and readily available, affordable water for drinking and other domestic purposes combined with safe sanitation services are important for the public health and well-being of a community. These services are directly or indirectly impact a community's and a country's overall economic development and growth. Therefore, provision of safe drinking water is one of the government's priorities in Sri Lanka and targets are set periodically with regard to population having access to safe drinking water and adequate sanitation (Fan 2015). These targets are mainly based on the availability of piped borne water supply and Sri Lanka is the best in terms of access to improved water and sanitation in South Asia. The MDG7 target was met by Sri Lanka in a better position at the end of 2015 by confirming the possibility to achieve SDG 6 targets related to drinking water supply and sanitation (target 6.1 and 6.2) in the 2030 agenda for sustainable development by UN.

Access to safe drinking water, sanitation, and hygiene is fundamental to health and well-being of the population and varies both among and within nations (Third World Academy of Sciences 2002). Similarly, use of freshwater resources varies from one country to another. In low income countries, almost 82 percent of freshwater is used for agriculture, 10 percent for industry, and only 8 percent for households. In high-income countries, industry uses 59 percent, agriculture 30 percent, and households just 11 percent (Pearce 2012). Besides, it is estimated that globally 3 in 10 people lack access to safely managed drinking water services and that number is projected to go even higher as a result of climate change while 6 in 10 people lack access to safely managed sanitation facilities in the world (United Nations 2021). Therefore, 17 Sustainable Development Goals (SDGs) were established with the agreement of 193 countries to overcome the poverty, while SDG6 encompasses "clean water and sanitation for all" (Herrera 2019) as an upgraded amendment to UN Millennium Development Goal 7 (MDG7) which aimed to reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation by the year 2015. Safely managed water and sanitation is very important since global health burden associated with water and sanitation is staggering and increasing children death rate (Moe and Rheingans 2006). Although some parts of the world are progressing to achieve the 2030 agenda for sustainable development by UN, disparities are still remaining. But Sri Lanka's continued efforts to improve its social development indicators have placed the country ahead of most other South Asian countries (Ministry of Water Supply and Drainage 2001).

This review aims to (1) provide a comprehensive and detailed understanding of Sri Lanka's current status and progress with respect to the SDGs, and successes and challenges in achieving them; (2) identifies gaps and challenges and outlines the steps that need to be taken to enhance the implementation of the 2030 Agenda.

9.2 Transition from MDGs to SDGs in Sri Lanka

The SDGs build on the successes of the Millennium Development Goals (MDGs). The SDGs expanded its scope to 17 goals from the 8 goals in the MDGs to all countries whether rich, middle, or poor (Philippine Statistics Authority 2021).

Among the 8 MDGs, the seventh MDG "ensure environmental sustainability" is concerned with reversing the loss of environmental resources such as forest cover, reducing biodiversity loss, and monitoring CO_2 emissions due to their impact on global warming. It also looks at whether people have access to safe drinking water and basic sanitation. The proportion of the population with access to safe drinking water and basic sanitation has been increased during past three decades. The safe water cover was 68% in 1992 and it has been increased to 90% in 2013. Similarly basic sanitation cover was 69% in 1990 and it has been increased to 90% in 2013 (United Nations Sri Lanka 2015).

In 2013, Queensland University of Technology (QUT) offered a training program for a group of twelve, senior executives, engineers, and water scientists of the National Water Supply and Drainage Board of Sri Lanka (hereafter referred to as NWSDB or Water Board) with the support of Australian Government (AusAID). This was organized by one of the authors as part of the "Australian Leadership Awards Fellowship program-Round 12 (ALAF 12) scheme. The approach and program for the project was informed by: responses to a needs analysis questionnaire; field visits to lagging regions; and discussions with the chairman and senior staff of the NWSDB prior to and end of field visits. The field visits to 21 water supply/treatment facilities across the country in Sabaragamuwa, Uva, Eastern, North-Central, and Northern provinces were carried out. These visits included, from small water supply schemes supplying 200 families (about 800–1000 population) operated by community-based organizations (CBOs) to state-of-the-art treatment plants. It was noticed that apart from the most recently constructed schemes, many water supply systems were only concerned with the quantity, but not the quality at that time. No proper monitoring systems were available at some plants; therefore, "safe water" was questionable at the time. During the Millennium Development Goal (MDG) period, MDG Target 7c was to halve the "proportion of the population without sustainable access to safe drinking water" between 1990 and 2015. Although "safe drinking water" was the target, the target relied on a classification of water sources as "improved" or "unimproved" as an indicator for water safety. According to the Joint Monitoring Programme for Water Supply and Sanitation (JMP) classification, piped water connection to dwelling, plot, or land was also considered as "improved drinking water source" (WHO/UNICEF 2010).

Treating these piped and other-improved water supplies that may be fecally contaminated at source as an indicator for "safe water" is likely to overestimate the data on population using safe water. This is because some so-called "improved sources" that are microbiologically or chemically contaminated may be piped to a dwelling, plot, or land as "safe water" (Onda et al. 2012; Godfrey et al. 2011). Having been identified during 2013 site visits, one such example comes from the village of Kolatenna in the suburb of Bandarawela town (Uva Province), and the community of nearly 300 people is still waiting for safe water in 2022. Luckily, this village is now included in the 2020–2025 Corporate Plan, to be supplied with safe water by 2025.

The ALAF Fellows engaged in capacity development and water policy reviews and implementation of activities shown in Fig. 9.1 (AusAID-QUT-NWSDB 2014).

ALAF fellows developed a Return to Work Action Plan (RTWAP) and collaborated to provide a strategic framework to guide a new amended drinking water and sanitation policy initiatives necessary to ensure the safe drinking water and sanitation practices while addressing climate change adaptation (CCA) and integrated catchment management (ICM).

The National Drinking Water Policy (2010) was approved in 2010 (NWSDB 2010) and the National Sanitation Policy in 2017 (CGIAR

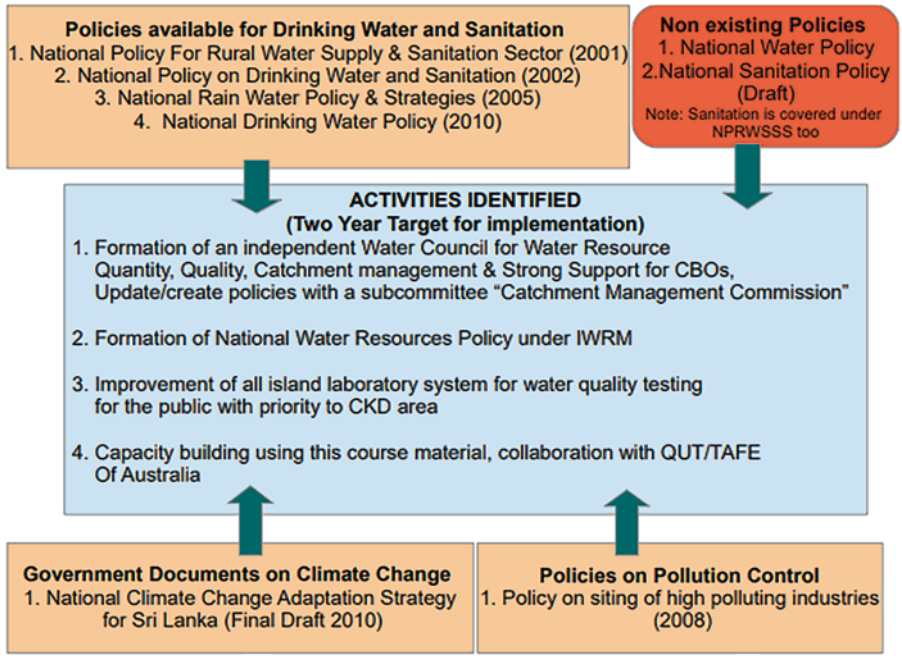

Fig. 9.1 ALAF 12 water policy recommendations and 2-year time frame for implementation (Source: AusAID-QUT-NWSDB 2014)

2021), by the Cabinet of Ministers. The Ministry of City Planning and Water Supply jointly with the NWSDB is in the process of reviewing these policies to reflect commitment to achieve SDG 6 target 6.1 and 6.2.

At the request of the Chairman of Water Board, some final amendments were made to the RTWAP including the incorporation of a 2-year Action Agenda for the recommendations. A final amended RTWAP report (AusAID-QUT-NWSDB 2014) with the Chairman's feedback was handed over to the President of Sri Lanka and the Secretary to the Ministry of Water Supply at the time.

As a result of the recommendations made by the AusAID-ALAF Fellows and their continued engagement with the high-level senior executives of the NWSDB and Government agencies, significant progress was achieved. Policy changes and water security, climate change, better water treatment, and operator training were all matters which received greater attention. Most importantly, within the organization, there was a significant change in the culture of thinking, in the context of safe water and sustainable development. In order to address the water quality issues (safe water) mentioned earlier, ALAF participants were motivated to learn and bring in water safety planning (WSP) to Sri Lanka in 2014. At that time (2013) Sri Lanka was not in the WSP South Asian Regional Program led by SEARO of WHO. Some of the achievements that emerged out of the RTWAP recommendations are:

- *Catchment management*: The commitment towards Activity 1 was supported by other background events such as "Water Safety Plan (WSP)" master training by WHO in 2014. By December 2019, the NWSDB has completed the development of WSPs for 74 water supply schemes (i.e. 22%) out of 342 schemes operated by the NWSDB (Jayaratne/WHO 2020).
- *National Water Resources Policy under IWRM*: Although this is still (in 2021) not well institutionalized in Sri Lanka, the principles of WSP guide the preparation of water supply systems

for risk management in partnership with regional stakeholder teams towards this goal.

- *Improvement of all island laboratory system for water quality testing for the public with priority to CKDu areas*: NWSDB has gone beyond this target by extending the services into the research and field applications. This includes an international collaboration to build a state-of-the-art water laboratory and R&D Center through an MOU between Sri Lanka and China in March 2015. This MOU was to investigate the chronic kidney disease of "unknown" etiology (CKDu) in Sri Lanka and provide clean drinking water for CKDu prevalent areas in the country. This collaboration was further extended in October 2020, with another MOU on water research and technology cooperation, aimed at providing clean drinking water to several other areas of Sri Lanka.

9.3 Government Strategies to Achieve SDG Targets

As a nation, Sri Lanka has always demonstrated its commitment to the global effort in protecting the environment, promoting social justice, and fostering economic prosperity (Sri Lanka Stakeholder SDG platform 2018). Having successfully achieved the Millennium Development Goals in 2015, Sri Lanka reaffirmed its commitment by aligning national policies and strategies, which has greatly facilitated the achievement of its Sustainable Development Goals (SDGs). Since the endorsement of the 2030 Agenda for Sustainable Development, the Government of Sri Lanka has undertaken several initiatives to facilitate its implementation in the country. These include: the establishment of a dedicated ministry for sustainable development as the focal point for coordinating, facilitating, and reporting on the implementation of the SDGs; the establishment of a Parliamentary Select Committee for Sustainable Development to provide political leadership for the implementation of the SDGs. Furthermore, Sri Lanka has already enforced the Sri Lanka Sustainable Development Act, No.19 of 2017, which provides for the development and implementation of a national policy and strategy on sustainable development and for the establishment of a sustainable development council.

Also, Sri Lanka expressed an interest in presenting its first Voluntary National Review (VNR) at the High-level Political Forum, which was held in 2017. The VNR preparation process adopted a multi-stakeholder approach, driven by an appointed task-force consisting of officials from key government institutions, private sector, community organizations, experts, academia and presented at the July 2018 High-level Political Forum.

Providing safe drinking water to the people of the country is a main goal of the government. SDG 6 targets the clean water and sanitation. Also targets the improved water quality by reducing pollution, increased water use efficiency, integrated water resource management, protection and restoration of water related eco systems, and strengthening the participation of local communities in improving water and sanitation management (NWSDB 2020a). Among all the subsections coming under SDG 6, "Clean water and Sanitation" is very important for Sri Lanka which is coming under SDG 6.1 and 6.2. By considering that, a separate ministry has been established under each government and a cabinet approved expert committee consists of internationally recognized expert in land and water study was established to develop a common Watershed Management Approach. Accordingly, Ministry of City Planning, Water Supply and Higher Education has been established by Extra Ordinary Gazette Notice No. 2103/33 and dated 28th December 2018 and under the same Ministry the responsibility of providing safe drinking water and sanitation facilities for the population was accomplished in the year 2019. Subsequently the Ministry of Urban Development, Water Supply and Housing Facilities was established by the Extra Ordinary Gazette Notice No. 2153/12 and dated 10th December 2019. Then on the 13 August 2020, by Extra Ordinary Gazette Notice No. 2188/42, the Ministry was renamed to "Ministry of Water Supply." The new "Ministry of Water Supply" together with "National Water

Supply and Drainage Board (NWSDB) and Department of National Community Water Supply" is currently responsible for policy implementation, monitoring, and reporting in the drinking water and sanitation sector in Sri Lanka.

The Ministry has taken a number of steps to mainstream SDG 6 in the water sector including leadership for knowledge management JMP reporting. The Ministry established the baseline for SDG 6 targets 6.1 and 6.2 on access to safely manage water and sanitation in terms of the WASH ladder. Revision of policies to reflect the sector policies to achieve 2030 goals is continuously undertaken. The National Drinking Water Policy and the National Sanitation Policy are the two main policies which are providing directions to all stakeholders involved in the water and sanitation development.

Although the scope of the Ministry amended periodically the responsibility of providing safe drinking water and sanitation facilities is vested to this Ministry continuously. Assure equitable access of safe drinking water to the entire population, ensure adequate and equitable sanitation for all, and improve the infrastructure facilities in lagging regions of the country are the main objectives of the particular institution. Department of National Community Water Supply is also functioning under the ministry while major institutions like National Water Supply and Drainage Board, Regional Center for Sanitation (SACOSAN) also serve under the same ministry.

9.3.1 Water Supply Coverage and Corporate Goals

In line with Sri Lanka Governments policy framework, NWSDB prepared its corporate plan targeting to reach 100% safe water and pipe-borne water coverage by 2025. Realizing this ambitious target on time will enable to reach the SDG targets well in advance. The Corporate plan 2020–2025 is formally launched by the Prime Minister in November 2020. The Government of Sri Lanka by its budget speech for 2021 declared allocating LKR 1 Trillion for implementing the Corporate Plan under the "Water for All" program.

The development of Corporate Plan was an exercise which involved various disciplines in the organization at all levels, starting from the Officer In charge of the Water Supply Schemes and moving upwards to Regional Operational Mangers, Senior Management, The General Manager, and the Chairman. The budgetary requirements once established by technical staff have been analyzed to determine the rate of return, debt servicing, improving business efficiency, generating additional revenue to meet operational expenditure.

The robust plan developed targets increase in the pipe borne water supply coverage of NWSDB of 40% in 2018 to 79% in 2025. This requires constructing water treatment infrastructure to double the production capacity, doubling the distribution pipe network by laying 40,000 km pipes. The consumer base will be doubled to reach 5.1 million consumers.

The program is planned considering short term, medium term, and long term projects covering five types of projects: (1) Capacity and quality enhancement of existing treatment plants, (2) Infilling by laying new distribution pipes to utilize excess capacities available in treatment plants, (3) New water supply projects, (4) New sewerage projects, (5) Accelerated NRW reduction program and efficiency improvement projects.

Several challenges are faced by the NWSDB in implementing this ambitious program of doubling its infrastructure and customer base developed during the last 40 years, within a very short period of 4–5 years. The corporate plan has identified 95 projects under Category 1, 76 projects under Category 2, and 93 projects under Category 3 in "water for all" program to implement within next 4 years to facilitate water and sanitation necessities of Sri Lanka. Presently all of these projects are supposed to be funded by GOSL. Also, there are 44 numbers of ongoing projects either foreign funded or local bank funded, while 27 numbers including Water Supply projects, Water and Wastewater Management Improvement Investment Programmes, Waste Water Management Projects, Expansion of Pipe-Borne Sewer Coverage projects are foreign funded (Ministry of City

Planning, Water Supply and Higher Education 2019; NWSDB 2020a). Sri Lankan government has to repay more than 20 LKR Billon per annum for both local banks and foreign agencies for the loans obtained for ongoing projects and the debt repayment is increasing day by day due to the following reasons when revenue is only sufficient to meet its operational expenses. (1) The loans obtained on a commercial basis comprise shorter grace periods as well as high interest rates. (2) Furthermore the foreign loans are to be repaid in foreign currency. The exchange rate and depreciation of the Rupee is hence an additional burden on debt repayment and interest payment. (3) Most 91% of domestic consumers consume less than 30 units per month, whereas 67% of production is supplied to domestic consumers at a subsidized rate which is less than the cost of production. Thus, higher the number of domestic connections given, higher would be the likelihood of revenue losses. (4) Rising costs of energy and chemicals and other related cost (NWSDB 2020a).

In the context of rising costs, increasing the water tariff has become a necessity in order to remain sustainable. According to the National Water Supply and Drainage Board Law, No. 02 of 1974, different tariff structures apply for domestic and industrial sewer services based on total amounts of water consumption from all water supply sources for each billing month. The sewer service rate for residential use varies according to the water consumption and an additional service charge of 200 LKR also applies. For commercial purposes a flat rate of 40 LKR per cubic meter and for the industrial purpose, a flat rate of 65 LKR per cubic meter applies.

At the same time, the NWSDB has initiated several alternate measures to manage its cash flows without passing an undue burden to consumers and thus contribute to Sri Lanka's economic growth over the next 5 years. These include initiatives to reduce cost of production by increasing business efficiency, enhancing revenue by increasing the number of connections, and implementation of a number of reforms for Business Efficiency Improvements (NWSDB 2020a).

Also, government is keen on the key aspects of mainstreaming SDG in the WASH sector and monitoring the progress of the program, while the Ministry of Water Supply has invited other water and environment agencies to focus on targets 6.3, 6.4, 6.5, and 6.6.

9.4 SDG 6.1 Safe Drinking Water

The United Nations considers universal access to clean water a basic human right and an essential step towards improving living standards worldwide. Water-poor communities are typically economically poor as well, their residents trapped in an ongoing cycle of poverty (NWSDB 2020a). Therefore supplying of safe water is a crucial factor. Polluted or non-treated water severely affected the public health. Therefore, waterborne diseases have become a common issue due to poor water quality. CKDu is defined as kidney disease without diagnosis of diabetes and hypertension and it has become one of the most serious issues associated with water quality in Sri Lanka as number of patients is increasing day by day. The CKDu is common among the people living in 11 districts and LKR 500 million has been spent for the supply of water through RO plants and for providing a pipeline extension for provision of safe drinking water under short term remedial actions for the people living in those areas (NWSDB 2020a).

On a national basis, safe water coverage defined here as the proportion of the population having access to water supplies from piped water systems, self-sufficient methods of protected dug wells, rainwater harvesting systems, and nearby public point sources including hand pumps and dug wells is currently 92.2%. Among them, more than 52% of the population have access to piped water, 3.2% have access to hand pump tube wells, 36.4% of the rural population has access to safe drinking water through protected dug wells, and about 0.5% of the population uses rainwater harvesting systems. The Community Managed Water Supply Schemes and Local Authorities provide water to a further 13.7% of the population. In the

estate sector, 70% of the population has access to a basic water supply, with a growing percentage gaining access to safely managed, treated water supply (Ministry of Water Supply and Drainage 2001). The other side of the coin, however, is that 7.8% of the population is unable to access a safe water source within 200 m of their residence (NWSDB 2020b).

Even though Sri Lanka is a water rich country having an average rainfall 2000 mm per annum, the geographical distribution of rainfall and seasonal variation has made the water availability at different locations in the country to vary in a range from 750 mm to 5000 mm. The available water in the surface water sources has to be shared among various competing water users. The groundwater availability in the country is very limited. Even the limited quantities of available groundwater have quality issues such as hardness ($CaCO_3$, $MgCO_3$) and excessive quantities of metals iron, manganese, etc. With this background, major problem faced by the NWSDB in implementing the projects identified in the Corporate Plan is securing appropriate water sources.

Although safe drinking water coverage has been reached to a higher level as 92.2% in Sri Lanka at present, the quality of water has not yet been confirmed in some areas. Although potable water is provided to urban communities, it is equally important to maintain well-designed rural water supply systems and focus on the drinking water quality. Although there is water supply coverage from Community-Based Organizations, quality of the supplying water has also not yet been confirmed and presently introduction of water purification methods is being implemented (Ministry of City Planning, Water Supply and Higher Education 2019).

As groundwater is the main source of water for most of the Community Based Water Supply Systems (CBOs) and Water Supply Schemes managed by local authorities, institutionalized continual backup support is needed to ensure sustainability. But it has become a challenge to confirm the quality of groundwater. Presently a survey is being implemented by the National Water Supply and Drainage Board to confirm the quality of groundwater.

Also, there are many challenges towards the supplying of safe drinking water in Sri Lanka, climate change and water scarcity, quality of public point sources and chronic kidney disease, community engagement, inadequate treatment, limitations in distribution network, limitations in production capacity, water resources stress, partial treatment and water quality deterioration, salinity intrusion, boreholes and tube wells depletion are some of them. The climate change experienced during the last few years with long drought periods followed by flash flooding events has contributed to huge stress in managing water availability to the consumers.

Besides, assessment to identify the water supply schemes and water treatment plants that can be expanded with the minimum amount of investment, which will bring immediate benefits through improved process designs and with minimum technical intervention is being undertaken.

Also, government has introduced a strategic plan to achieve SDG targets as provision of safe drinking water for all the people of the country as a main policy of the government. NWSDB has taken up new strategies after delving into research and details. These strategies will lead up to accomplishing the targets as planned if executed correctly. Those are expansion of pipe-borne water coverage by considering residential and non-residential demand which is being increased, minimization of geographical disparity for accessing safe drinking water, planning of new water supply schemes considering area based factors and cost-effectiveness, provision of safe drinking water for the areas affected by unknown kidney disease, increase the water quality and the quantity in water sources/intakes/schemes managed by the Community Based Organizations, promotion of piped water supply systems by introducing standards for water equipment/other accessories, conducting advanced and modern researches/studies in order to identify the root cause for the unknown kidney disease and to identify more feasible purification system to purify underground water, cater the ever increasing demand of the

industrial sector to have 24 h piped water service, improvement of the capacities of the institutions engaged in providing piped water services, guiding the National Water Supply and Drainage Board to function as a people friendly and profit-making institution (Ministry of City Planning and Water Supply 2018).

The variation of safe water supply and the pipe-borne water supply in Sri Lanka from 2005 to 2020 is shown in Fig. 9.2.

Drinking water supply shows gradual increment and it has reached above 92% in 2020. Pipe-borne water supply has increased from 30% to 52% within 15 years (2005–2020) through 331 large and small water supply schemes across all 9 provinces in the island, servicing a total of 2.4 million domestic connections (NWSDB 2020a). Among that western province holds the highest coverage, 63.6% from the population (Fig. 9.3).

A 9.60% is reported as the lowest provincial coverage in Sri Lanka in Northern province. CKDu issue mainly affected the people in North-Central province and Sri Lankan government has been able to supply 32.60% safe drinking water supply of the population. Total water supply coverage in Sri Lanka is 40% in 2020 (Table 9.1).

National Water Supply and Drainage Board is committed to supply safe water for all and they expected to increase the coverage up to 58.6% in 2025 using short term and medium term strategies by spending 302.7 LKR Billion within the coming 4 years. All together government is aimed to provide pipe-borne water facilities to 4.7 million families in the next 4 years by implementing medium and large-scale water supply development projects. These projects are being implemented with local and foreign funds through local contractors and will require the laying of 40,000 km of new water supply pipes. Their overall target is to achieve 100% safe water supply in 2025, while NWSDB pipe-borne supply is 79%. The remaining 21% will be covered by community water supply schemes and point sources. The improvement of coverage by 2025 is shown in Fig. 9.4.

Also, they expect to generate 188.1 LKR Billion of revenue from existing and new connections using short term and medium term strategies. In addition, Sri Lankan government is planned to invest 687.2 LKR Billion for the new projects to obtain 112.5 LKR Billion of revenue by 2025. Almost 989.9 LKR Billion will be invested by Sri Lankan government on water supply by 2025 to satisfy SDG 6.1 target. Also, they will be able to 226.4 LKR Billion of overall revenue at the end of target period.

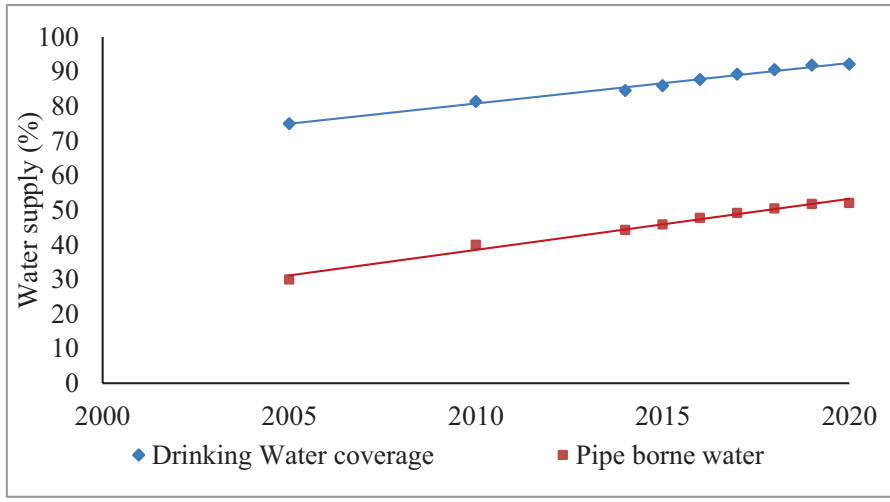

Fig. 9.2 Drinking water and pipe-borne water coverage in Sri Lanka

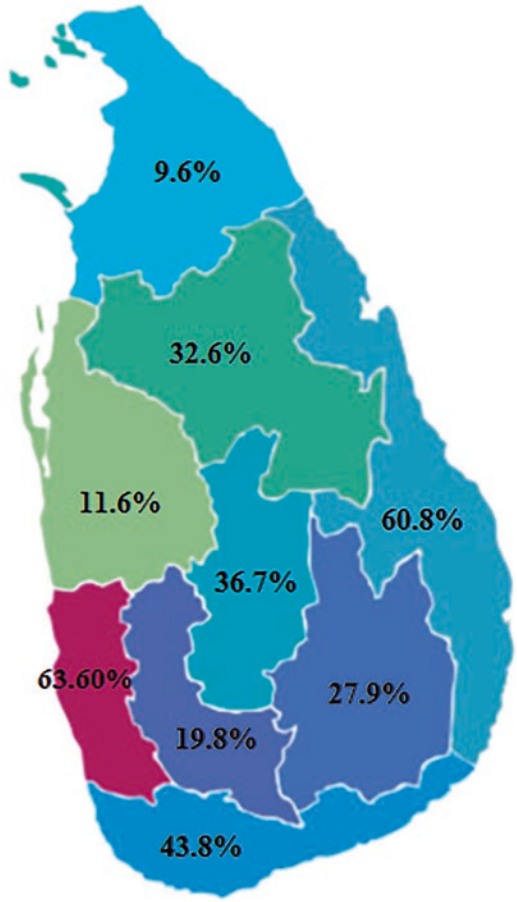

Fig. 9.3 Graphical representation of existing water supply coverage in each province (Modified from NWSDB 2020a)

Table 9.1 Existing provincial wise water supply coverage in year 2020

Province	Coverage
Western	63.60%
North Western	11.60%
North-Central	32.60%
Northern	9.60%
Central	36.70%
Southern	43.80%
Sabaragamuwa	19.80%
Uva	27.90%
Eastern	60.80%
Total	40.10%

9.5 SDG 6.2 Safely Managed Sanitation Services

Sanitation refers to collection and treatment of human excreta (often includes gray water) to protect human health and the environment. It is also aimed to safely reduce human exposure to pathogens by proper sanitation. Therefore it is one of the most important aspects of community well-being because it protects human health, extends life spans and is documented to provide benefits to the economy (Naughton and Mihelcic 2017).

Basic sanitation facilities are defined as being used by only one household and may empty onsite or are connected to a sewer system that may or may not be followed by treatment. The main challenge in the sanitation sector is to manage the septage generated at household level due to overflowing of poorly designed septic tanks.

Sri Lanka has adopted a policy of developing sewerage facilities for densely populated areas and septage management facilities for peri-urban areas in order to achieve safely managed sanitation. Besides, Sanitation Safety Planning (SSP) is a risk based management tool which is highly used for implementing WHO guidelines on sanitation and health and for safe use of wastewater, excreta, and gray water. SSP provides a structure to bring together actors from different sectors to identify health risks in the sanitation system and agree on improvements and regular monitoring (WHO 2016). It assists to systematically identify and manage health risk along the sanitation chain, guide investment based on actual risks, promote health benefits and minimize adverse health impacts, provide assurance to authorities and the public on the safety of sanitation-related products and services.

Reportedly in 2020, about 92% of the population of Sri Lanka has access to improved sanitation out of which 90% are served with onsite facilities comprising of septic tanks associated with soil absorption systems such as soakage pits and closed pit latrines, while 2.1% is connected

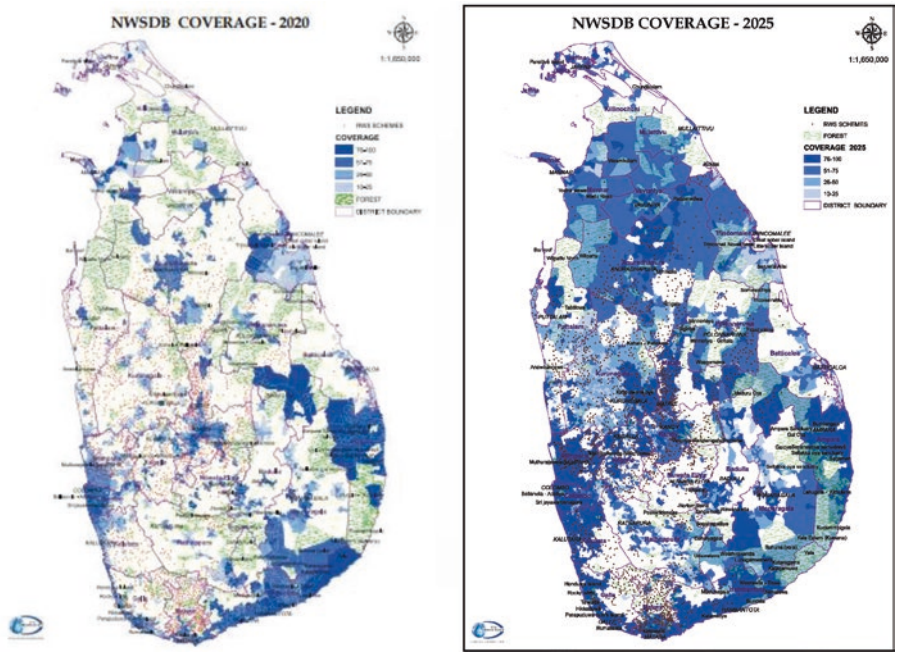

Fig. 9.4 Improvement of district wise NWSDB coverage from 2020 to 2025 extracted from (NWSDB 2020a)

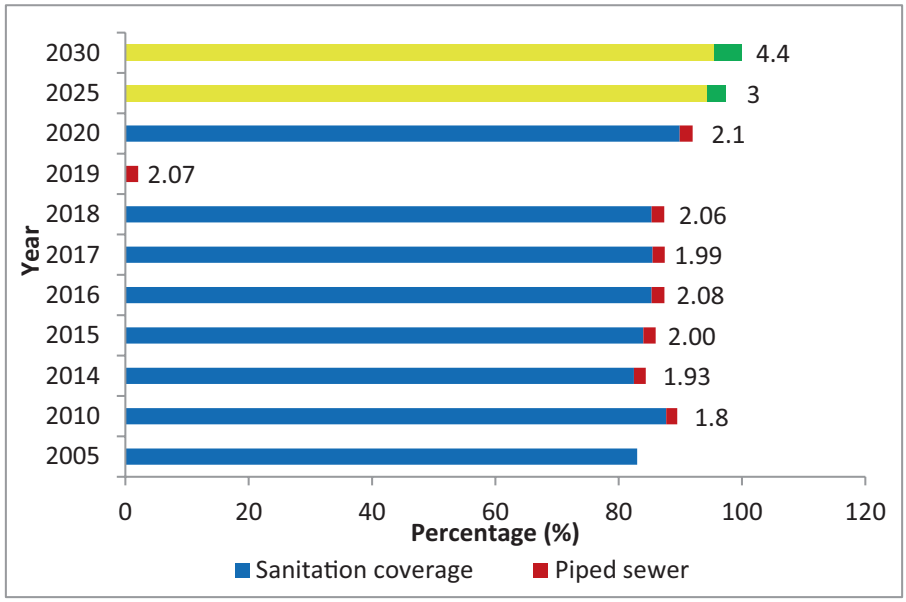

Fig. 9.5 Sanitation coverage and contribution of pipe sewer system

to piped sewer system in high population density areas in Colombo, Kandy, Kurunegala, and Kataragama.

Also, Sri Lanka is following a strategic plan to achieve SDG targets on sanitation. It is aimed to increase the piped sewer contribution up to 4.4% in 2030 when overall basic sanitation is 100% (Fig. 9.5). It includes increase the usage of sanitation facilities in rural and estate sector, conducting awareness programs on sanitation and hygiene,

improve the drainage facilities in main towns, restructuring the functions of the National Water Supply and Drainage Board so as to facilitate for a more efficient wastewater disposal services in the country.

To ensure safe sanitation facilities for 97.3% of the population by 2025; NWDSB, as a short term strategy, proposes the construction of septage treatment facilities in high demand areas where local authorities are reluctant to do so (NWSDB 2020a). It includes direct sewer connections, simplified and conventional sewer extensions, and simplified extensions to the existing Dehiwala/Mount Lavinia, Kurunegala, Kataragama, Hikkaduwa and Kolonnawa sewerage schemes located in Western, Southern, and North-Western provinces. Though only 2.1% is connected to piped sewer system now, 2.4% of the population has been blessed with access to organized piped sewerage facilities in selected cities. High density areas in Colombo, Ratmalana/Moratuwa, Ja-Ela/Ekala, Kataragama, Kolonnawa, Jayawadanagama, Kurunegala, Kandy, Hikkaduwa, and housing schemes at Raddolugama, Hanthana, etc. are already covered.

Therefore, Decentralized Waste Water Treatment System (DEWATS) will be introduced in Ella, Uva province due to low population density and high risk of pollution and contamination and the importance to tourism industry (NWSDB 2020a). Sri Lankan government has estimated to invest a total of 360 LKR Billion for sewerage improvement by 2025 including 309.3 LKR Billion of them for new projects.

9.6 Impact of COVID-19

The global epidemic COVID-19 has made a huge setback to the implementation of the Corporate Plan. The first COVID patient in Sri Lanka was confirmed on 27th January 2020 after a 44 year Chinese woman from Hubei, China was admitted to the Infectious Disease Hospital in Angoda, Sri Lanka. On 20th March 2020 the country went to its first lockdown which continued for a period of 3 months with gradual lifting of parts of the island or imposing night time curfew until 27th June 2020. Thereafter the cases reported and deaths reported were at a minimal rate until beginning of October 2020, the second wave hit the country. The case rates displayed a sharp incline in April 2021 and continue up to date (June 2021).

Illustrating the systematic nature of the impact of COVID-19 pandemic, it soon transformed from a health crisis to a social and economic crisis causing a number of adverse economic and social effects in the country. All the sectors which contribute to the countries development, purchasing, manufacturing, agriculture, fisheries, tourism, industries, services and construction industry, etc. have been severely affected. The impact of COVID-19 on the engineering and construction industry is unprecedented. Construction projects had to be delayed or cancelled. Global, as well as local supply chains are under pressure, while the health and safety of the employees is a concern. Most importantly, many construction and development companies operate without substantial capital reserves.

The original work plan of the NWSDB for implementation of "Water for All" program was considerably interrupted due to the current global and local scenario. The management had to find new strategies and mechanisms to move the program forward by using data analytics which lead to better informed decision-making, maintain a fine balance between efficiency and redundancy when managing the supply chain, and cognizant revisiting and reorienting the work plans with inbuilt project control, risk management, and governance strategies. Among the WHO recommendations for preventing the disease and its spreading through the community, one of the most important precautions is cleaning your hands frequently, keeping overall cleanliness in person as well as the environment. This demands availability of ample clean water in the midst of the restrains in day-to-day operation and maintenance activities such as high risk for operational

staff, restrictions for mobility, difficulties in deploying necessary manpower, machinery and material for sudden breakdowns, etc.

The analytics of impact of COVID-19 on consumer behavior, water production, and attending to water leaks and repairs is discussed below.

9.6.1 Water Consumption Before and During COVID-19

A comparison is made between the pre and during pandemic period to assess the water usage of the domestic consumers. Two consecutive periods of 1 year from April 2019 to March 2020 before the country went to its first lockdown and April 2020 to March 2021 during pandemic are analyzed. The average domestic water consumption throughout the country shows an increase of 11.4% compared to the pre-pandemic period. Figure 9.6 shows the geographic variation of increased water usage (as a percentage) in Domestic Consumption before (April 2019–March 2020) and during (April 2020–March 2021) the pandemic.

Similarly, Fig. 9.7 shows the percentage variation of non-domestic consumption pre (April 2019–March 2020) and during (April 2020–March 2021) the pandemic.

It is observed that the non-domestic consumption in the Western province has reduced in the range 25–35% (Locations 1–8 in the chart), whereas the same in the other provinces shows an increase in the range (3–14%). The reason for this variation between the geographical locations can be due to two main reasons; The Western Province is having the highest commercial and industrial activities in the country. Due to the prolonged lockdown periods and decrease of economic activities the usage of water for non-domestic activities has reduced. Whereas in the outstations the lockdown periods were intermittent compared to Western Province and most of the non-domestic consumers are shops, boutiques, small hotels, and small scale commercial activities where the shop owners residence also at the same locations. This leads to less commercial use of water but increase in domestic consumptions.

9.6.2 Water Production Before and During COVID-19

Water production of the treatment plants accounts for the water consumption and water losses in the headworks and transmission and distribution systems. Figure 9.8 gives the percentage increase in water production pre (April 2019–March 2020)

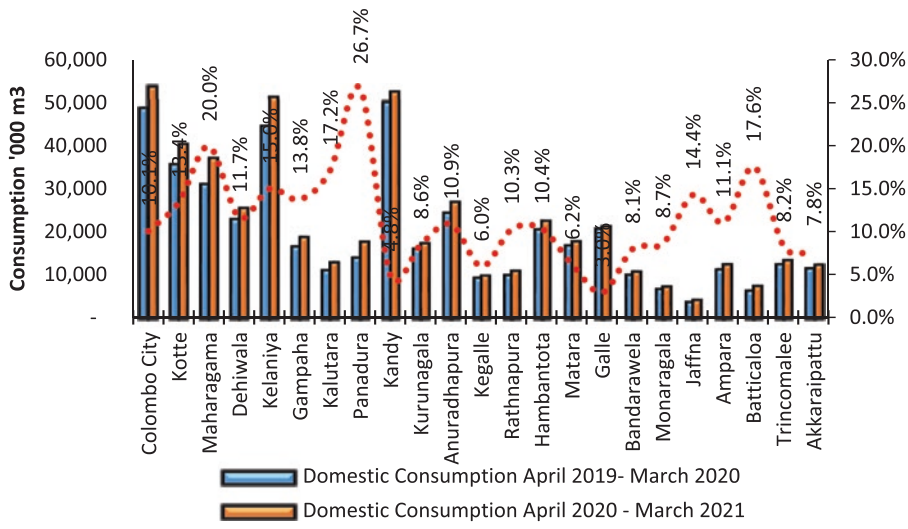

Fig. 9.6 Comparison of domestic consumption before and during the pandemic (Source: NWSDB 2019, 2020c, 2021)

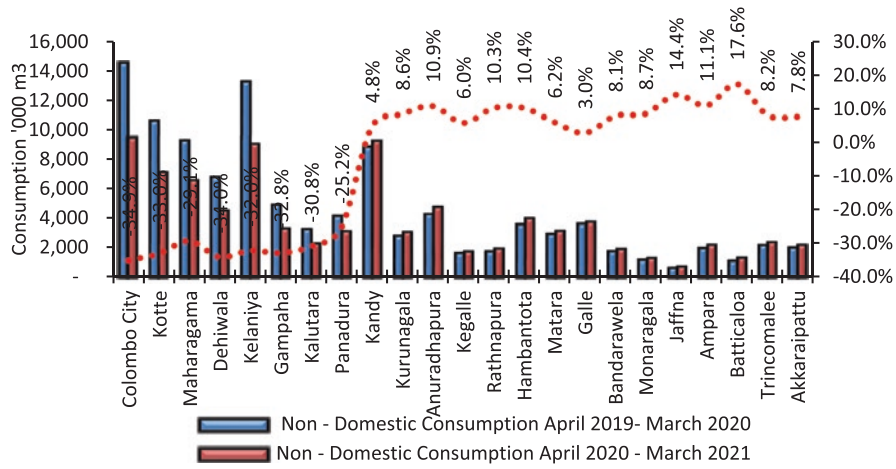

Fig. 9.7 Comparison of non-domestic consumption before and during the pandemic (Source: NWSDB 2019, 2020c, 2021)

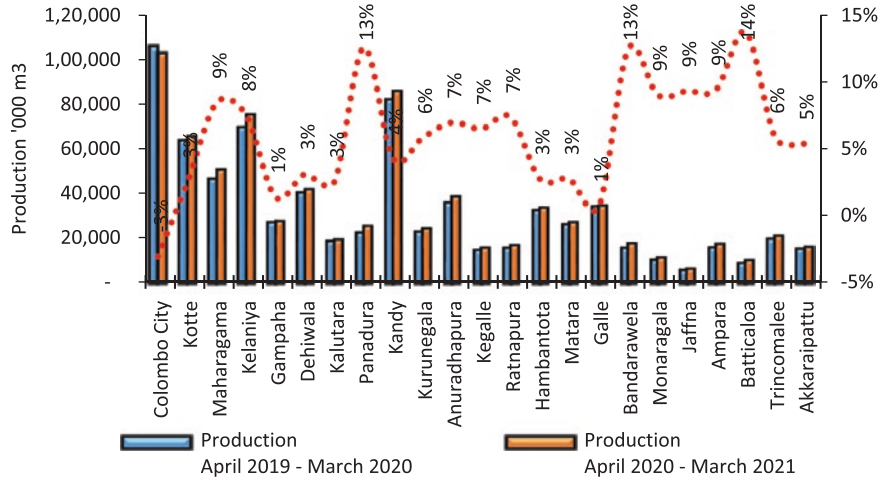

Fig. 9.8 Variation of water production before and during pandemic (Source: NWSDB 2019, 2020c, 2021)

and during (April 2020–March 2021) the pandemic. Consistent with the observations made in the consumption patterns, the production pattern also depicts the geographical variation. In the Colombo city the water production has become lesser than normal indicating the low non-domestic consumption compared with increased water consumption of domestic category. In all other locations the water production has increased in the range of 1–13%. Even though the non-domestic consumption of the Western province has considerably reduced, locations other than the Colombo City show an increase in the production due to increased domestic consumption which can be due to handwashing and improved hygienic practices.

9.6.3 Effect of Water for All and Operation and Maintenance Activities of NWSDB

Having discussed the effects of the pandemic to routine day-to-day life of people related to WASH, this section will discuss the effect on the organizational functions of NWSDB. Three specific parameters are analyzed, connecting new consumers, attending water leaks, and effect to regular water quality monitoring programs. Figure 9.9 gives the performance with respect to the installation of new consumer connections against the target.

Even with the pandemic situation NWSDB was able to achieve a commendable percentage of targeted new connections. At the beginning of 2021 the reported COVID cases were fairly under control and the country was slowly getting back to its normal routine. The stricter restrictions on people movement were re-imposed towards the end of April. The ability to deploy the workforce for essential services at all times enabled the environment for this achievement. As explained above Fig. 9.10 shows that the leak repair process is not much affected owing to subsidize COVID positive rate during this period and the mobility given to essential services.

Performance of water quality monitoring program from March 2020 to March 2021 is shown in Fig. 9.11 shows the number of water quality tests performed is lower compared to the programmed quantity in the first 3 months of 2020 where the country was under its first lockdown period.

COVID-19 will have permanent effects on the way NWSDB work. Construction industry as well as the services sector will have to embrace technology while combating the reduced workforce. New strategies have to be developed to move forward with established plans for WASH services.

The activities undertaken by NWSDB for climate change adaptations with respect to water security is a way forward to combat the detrimental effects to the drinking water and sanitation sector (AusAID-QUT-NWSDB 2014) gives an appropriate platform to move forward through the pandemic.

Drafting a policy framework for an independent water council, National Water Resource Council and formation of the draft Water Resources Act and related background activities were already completed and currently under review. Expediting this process and establishing the policy framework will ensure sustainable water resources and equitable water sharing between multitudes of water users. This will ensure water security for future drinking water schemes.

In parallel with this as well as looking at the future challenges in construction industry, volatility of labor market in the global pandemic,

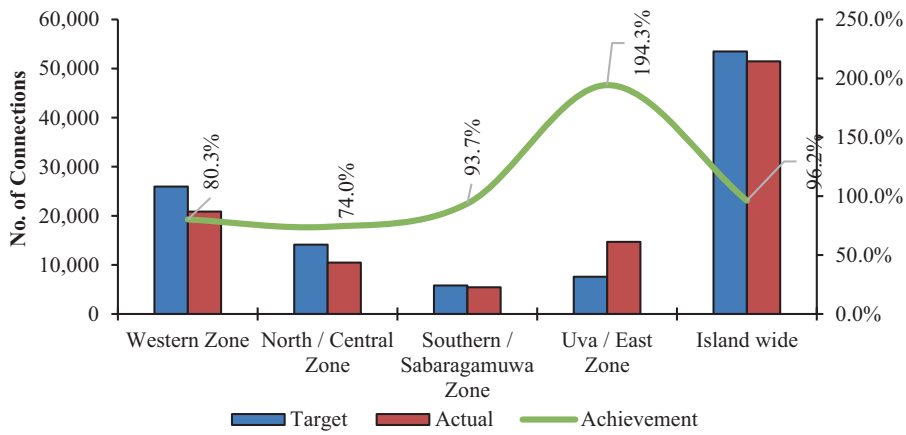

Fig. 9.9 New connection progress of "Water for All" program, first quarter of 2021 (Source: NWSDB 2021)

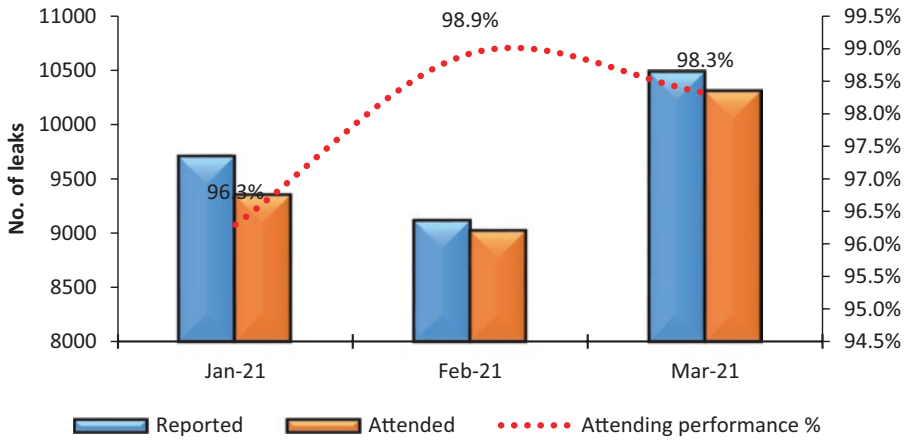

Fig. 9.10 Leak repair performance island wide (Source: NWSDB 2021)

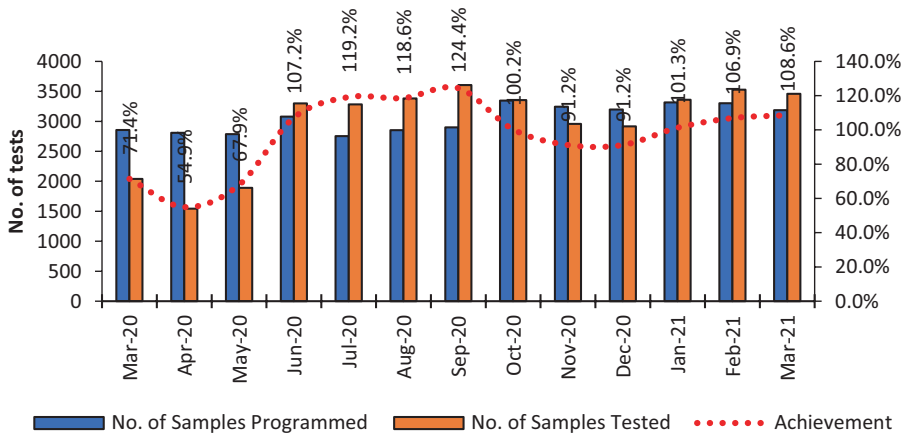

Fig. 9.11 Performance of water quality monitoring (Source: NWSDB 2020c, 2021)

NWSDB has initiated the process of amending the NWSDB Act established in 1974.

Preparation of water safety plans for all existing water supply schemes is partly completed and it is planned to complete the WSP covering all existing water systems from Catchment to Consumer level within this year (2021). The WSP will cover all water quality and water availability aspects. Similarly, sanitation safety plan is being implemented for sanitary systems to ensure the system is managed to meet health objectives (WHO 2016).

New methods and strategies such as establishing suitable private–public partnerships, establishing subsidiary arm to handle some of the activities of NWSDB, research and development and capacity building of all levels of employees as well as outside parties such as plumbers, improvement of contractor and suppliers capacities through constructive engagement with them are underway.

9.7 SDG 3 and SDG 6 Interlinkage

The SDGs are richly interlinked, and understanding these connections is important to maximize the positive outcomes and minimize negative impacts. The need for integration of SDG 3: Good Health and Well-Being with SDG 6: Clean Water and Sanitation is apparent. The "Health"

described by SDG 3 targets to include both personal and environmental health. The extended SDG 3 description states a major risk factor for infectious diseases and mortality is the lack of safe water, sanitation, and hygiene (WASH) services (Department of Economic and Social Affairs 2018). This statement reinforces the connection to SDG 6. The health impact of unsafe water and associated risks of contamination from unmanaged sewage is estimated to cause around 60 percent of deaths from diarrhea globally (WHO 2014).

In this background it would be appropriate to investigate on the improved health practices necessitated by the pandemic. Figure 9.12 gives the occurrence of live discharge of indoor patients of some selected disease reported in Indoor Morbidity and Mortality Report of the Department of Health Sri Lanka (Medical Statistics Unit 2021).

Figure 9.13 shows the mortality rate of diseases related to WASH. The reduction in the live discharges of indoor patients as well as death rate observed during 2020 compared with 2019 can be due to several reasons. Most importantly it has to be noted that the Health Ministry observes that percentage of data received to the eIMMR system up to 29.05.2021 is only 79% compared to 2019. This may be due to the effect of the pandemic for data recording and transmitting. The reduction of admissions to hospitals due to the fear of exposing to COVID and improved sanitation and hygienic practices might have contributed also.

9.7.1 Progress of WASH Program

The JMP service ladders are used to benchmark and compare service levels across countries. These have been updated and expanded to facilitate enhanced global monitoring of drinking water, sanitation, and hygiene (WHO/UNICEP JMP 2020). The Sustainable Development Goals include aspirational global targets to achieve universal access to basic services and to progressively improve the standard of WASH services by 2030 and the JMP is responsible for official reporting on corresponding global SDG indicators related to drinking water, sanitation, and hygiene. The Water, Sanitation, and Hygiene Promotion (WASH) is one of the key sectors in the development and humanitarian programs of all nations (Majeed 2020).

GLAAS has monitored key elements of national drinking water, sanitation, and hygiene (WASH) systems with a focus on governance, monitoring, human resources, and finance (GLAAS 2020). Establishing national targets and milestones towards achieving SDG 6 by 2030 and inclusion of accessibility, availability, and quality as indicators in the National Census to report on the population coverage with

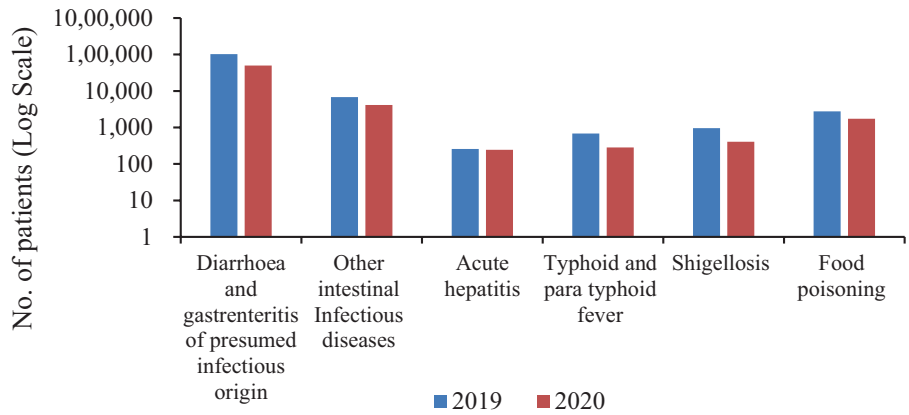

Fig. 9.12 Live discharge of indoor patients of some selected disease in 2019–2020 (Provisional) (Source: Medical Statistics Unit 2020; Medical Statistics Unit 2019). Note: Based on online eIMMR system (Only about 73% data. Manually reported data are not included)

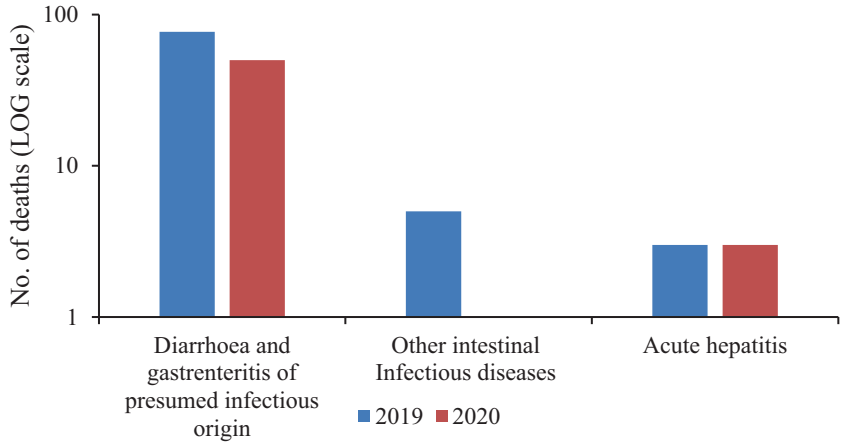

Fig. 9.13 Mortality rate of disease related to WASH (Source: Medical Statistics Unit 2020; Medical Statistics Unit 2019). Note: Based on online eIMMR system (Only about 73% data. Manually reported data are not included)

safely managed services are the key aspects of mainstreaming SDG in the WASH sector.

According to 2018/2019 GLAAS report, Sri Lanka is targeting to reach zero open defecation by 2025 and on target to achieve safely managed sanitation services to 100% of the population by 2030. With regard to urban drinking water, 95% of population is targeted to have access to safe water by 2025 and in the rural sector, 100% is targeted to have access to a safely managed drinking water supply by 2030. The NWSDB 2020–2025 corporate plan states that as a country, Sri Lanka aims to achieve 100% safe drinking water coverage by 2025, while 100% safe sanitation coverage by 2030.

9.8 Discussion and Conclusions

In 2013, the Australian Leadership Award Fellowship (ALAF 12) offered a training program to senior executives, engineers, and chemists of the National Water Supply and Drainage Board (NWSDB) of Sri Lanka, under the title "Water Security, Poverty Alleviation and Rural Development." This professional training scheme was conducted by the Queensland University of Technology (QUT), in Brisbane, Australia. As this was the time when MDGs were about to transition to SDGs, thus could not have been a more appropriate time for the introduction of a program such as this.

By 2015, this Fellowship Program (ALAF 12) helped to lay a good foundation to establish the SGDs by identifying critical activities to be implemented to achieve safe water and sanitation targets. As a result, by December 2019, 74 out of 342 water supply schemes operated by the NWSDB have completed the development of water safety plans.

- *Water supply coverage for the total population*: In 2018, pipe-borne water supply coverage was 50.5% and it was increased to 55% in 2020. It is estimated to be 100% in 2025 by implementing 264 number of small, medium, and large scale water supply projects under NWSDB.
- By 2020, 92.2% of the households had access to *safe drinking water*. This includes piped water systems, protected wells, rainwater systems or water supplied through bowsers and bottled water.
- *Water supply coverage for the urban and rural populations*: In the urban sector, 95% of population is targeted to have access to safe water by 2025.
- In the rural sector, 100% is targeted to have access to a safely managed drinking water supply by 2030.
- *Sanitation coverage*: With sanitation progress, in 2020, about 92% of the population of Sri Lanka had access to safe sanitation out of which 90% are served with onsite facilities

comprising of septic tanks associated with soil absorption systems such as soakage pits and closed pit latrines. While 2.1% was connected to piped sewer system in high population density areas in Colombo, Kandy, Kurunegala, and Kataragama, it is planned to increase the coverage to 97.3% and 100% in 2025 and 2030, respectively. Sri Lanka is targeting to reach zero open defecation by 2025 and on target to achieve adequate and equitable sanitation services to 100% of the population by 2030.

- Sri Lanka is also committed to work on its strategic plan faced with many challenges and difficulties. NWSDB established basic goals to achieve SDG in its 2016–2020 corporate plan. These goals include: (1) Increase the Water Supply and Sanitation Coverage, (2) Improve business efficiency, (3) Ensure greater accountability and transparency, and (4) Ensure safe drinking water supply and sanitation to rural and underserved communities. The aim is to bring water quality testing/surveillance, R&D, and training under one umbrella and harness synergies, by creating a national organization which would eventually become commercially viable and self-sustaining.
- Unfortunately, the global epidemic COVID-19 has delivered a huge setback to the implementation of the corporate Plan. The original work plan of the NWSDB for implementation of "Water for All" program was considerably interrupted due to the current health and economic crisis. The average domestic water consumption throughout the country shows an increase of 11.4% in 2021, compared to the pre-pandemic period. In the Western province, a region with the highest commercial and industrial activity, non-domestic consumption of water has declined by 25–35%. Similarly, water production has become less than normal. This indicates the low non-domestic consumption compared with increased water consumption in the domestic category. In the city of Colombo and in all other locations the water production has increased in the range of 1–13% due to increased domestic consumption which may be due to the handwashing and improved hygienic practices. Even with the pandemic situation NWSDB was able to achieve a commendable percentage of targeted new connections. But leak repairing and number of water quality tests performed is lower compared to the programmed quantity.
- The most recent NWSDB 2020–2025 corporate plan states that Sri Lanka aims to achieve 100% safe drinking water coverage by 2025 and 100% safe sanitation coverage by 2030. With the government's commitment and 2021 budget promise of funding allocations to water and sanitation, despite many economic challenges stemming from COVID-19 pandemic including lockdowns and projected 72% two-dose vaccine coverage by January 2022, it is hoped that Sri Lanka will be able to achieve its SDG 6 targets by 2030 as scheduled.

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10

Readiness of Solomon Islands in Meeting the Sustainable Development Goals (SDGs) in Water and Sanitation

Cyril Bernard Rachman, Leonard Olivera, and Yuyun Qomariyah

Abstract

Water and Sanitation in Solomon Islands is a sector that really needs attention, as water and sanitation services are lacking in many provinces. Some impact stories from the rural development program (RDP) are presented as baseline information.

To support the achievement of SDG 6 targets in "clean water and sanitation," Solomon Islands has introduced the National Water Resource and Sanitary (WATSAN) Policy in 2017 and WATSAN Implementation Plan 2017–2033. The Government of Solomon Islands signed a Financing Agreement for €17.4 million with the European Union for "improving governance and access to water, sanitation and hygiene promotion (WASH) for rural people." As a result, the rural WASH Program, now commonly known as RWASH Program was initiated. Improving health through community participation in RWASH project in Solomon Islands is discussed and achievements in water and sanitation for the period 2016–2020 are presented. In 2020, nationally, the population using an improved drinking water was at 73%, whereas the proportion of the population using an improved sanitation facility was 40.6% in the Solomon Islands.

The Rural WASH Strategic Plan 2015 to 2019 has set targets for improving access to water, sanitation (open defecation free, ODF), and hygiene services and includes both 5-year and 10-year targets. It is apparent now that the water target for 2019 was set too low at 52% but achieved 65.9% already in 2018 but no further progress made throughout 2019 and 2020, remaining at 65.9%. All three of the targets are extremely ambitious for 2024 at 100% or near 100%.

Keywords

Solomon Islands · RWASH · WATSAN achievements · Agenda 2030 readiness

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10.1 Solomon Islands

Solomon Islands is consisting of over 900 smaller islands and six major Islands is located in the South Pacific Oceans on the east of Papua New Guinea, with a total area of 28,370 square kilometers with an Exclusive Economic Zone of 1.3 million square kilometers. The area includes both mountainous and volcanic islands as well atolls and "artificial" islands built by the indigenous people in the lagoons. The large islands and many of the small islands including the atolls and artificial islands are inhabited. Its capital is Honiara, which is situated within the main province of Guadalcanal. There are eight other provinces: Malaita, Western, Rennell and Bellona, Central, Makira-Ulawa, Choiseul, Isabel, and Temotu. It has rich natural resources, in particular forests, freshwater, marine and fishery resources, agricultural land and minerals potential as well as beautiful environment. However, the forest resources are rapidly draining, caused by commercial logging at unsustainable rates (Fig. 10.1).

Total population in Solomon Island in 2019 predicted was 712,455, with the national population density being 24 people per km^2. However, there are parts of the country which are relatively densely populated, such as Central Province (49 people per km^2), Malaita Province (41 people per km^2), and Guadalcanal (29 people per km^2). As the capital city Honiara is the highest density area, with the density level of 5950 people per km^2. Based on the geographical distribution, 24% of the population lives in urban areas and 76% lives in rural areas. Statistic data show that the urban population has been increasing rapidly due mainly to people moving from rural areas to the urban centers, especially Honiara. Table 10.1 provides some data at a glance.

10.2 Water and Sanitation in Solomon Islands

Water and Sanitation in Solomon Islands are a sector that really needs attention as these services are not yet covered to all of the areas in Solomon Islands. The disparity of water and sanitation services between urban and rural areas is very significant. In 2009 approximately 45% of urban households and only 3% of rural households had access to private flushing toilets. In 2016, 80% of rural households (>300,000 people) practiced open defecation. Nearly 13% of rural households (~50,000 people) had access to improved sanitation that hygienically separates human excreta from human contact (SPREP, 2019).

The treated water supplied by the Solomon Islands Water Authority (SIWA) is only available in the urban area (Figs. 10.2 and 10.3) such as Honiara, Noro Town in the Western Province, Auki Town in Malaita Province, and Tulagi Town in the Central Province. Most of the rural area utilize groundwater and rainwater for their water supply. The rural areas collected water from the dug wells for washing and bathing as the water quality of groundwater is relatively poor due to salinity and they use the rainwater for drinking and cooking.

The water supply systems in urban centers in Solomon Islands consist of the following: (a) Source (Springs or Bores), (b) Pump Facilities, (c) Disinfection Facility, (d) Water Reservoirs, (e) Water Mains, and (f) Water Distributions. Meanwhile for rural area excluding provincial towns and development centers that may be classed as urban; various types of water supply systems have been tried such as: (a) Gravity Feed Systems, (b) Rain Harvesting Systems, and (c) Hand Dug Wells or Natural Water Holes with the use of Hand Pumps, subject to the geographical nature of Solomon Islands. The gravity feed systems are commonplace particularly where rivers, streams, and springs are plentiful and only practicable on the raised islands (main islands). Gravity fed systems are usually used by individual rural villages and sometimes by community villages. At present most rural communities can access water by stand-alone reticulated systems; however, other community villages still rely on unreticulated natural streams and springs.

The freshwater in Solomon Islands is used for:

1. Drinking and household use: both in villages and in urban centers, demand for drinking and household use of water is increasing with the

Fig. 10.1 Map of Solomon Islands (Mishra, Hargreaves, and Moretto, 2010)

population growth, and from this phenomenon usage of water will also increase at a faster rate in the future for urban and rural populations. The purified drinking water in Solomon Islands is still quite expensive compared to other countries in the South Pacific. Urban and peri-urban settlements in Honiara have limited access to water, a study found out that 92% of informal settlements did not have access to water services by Solomon Water as their location is on marginal land including riverbanks, steep gullies, and mangrove swamps. As a result no legal pipe connections are provided to the area and most households cannot afford the connection fees and tariffs as the price of treated water in Solomon Islands is quite high. The average household monthly wage in the settlements is about SI$632 [US$83] and connection fees are between SB$975 and SB$3380 [US$125.98 to US$450], which is significantly more than an entire month's income (Hunterh2o, 2017).

UN-Habitat through the Participatory Settlement Upgrading Program (PSUP) was trying to escalate the water service in the urban areas, and World Vision as one of the NGOs in Solomon Island also assists by providing water in some informal settlements like Burns Creek, but is not active in all settlements. Some NGOs focus on water provision to rural areas because of some problems in the informal settlement in urban area such as social and cultural heterogeneous, densely populated, and also the conflict of land tenure (Hunterh2o, 2017). Solomon Islands Water Authority (SIWA) recently provided the communal connections in at least one informal settlement, on the Burns Creek for 360 households with the three connection communal taps which managed by community leaders and eventually it ended up with the disconnection as the community could not manage to pay the water bills (Hunterh2o, 2017).

Table 10.1 Solomon Islands data at a glance

Variables	Data	Source
Land area	28,370 km^2	
EEZ	1.3 million km	
Population	639,157	National Statistic Office Population Projection 2016
Population growth rate (%)	2.3%	National Statistic Office Population Projection 2016
Population density (people/km^2)	17	2009, National Census Report
Crude birth rate	32.2	2009, National Census Report
Crude death rate	5.6	2009, National Census Report
Fertility rate	4.1	2009, National Census Report
Life expectancy at birth rate	65.8	2010, Solomon Islands MGD Report
Population distribution by broad age group (%)		2009, National Census Report
0–14 years	40.6%	
15–59 years	54.1%	
60+ years	5.2%	
Population of less than 29 years old	70%	
Average household size	5.5	2009, National Census Report
Unemployment rate estimate	10.8%	
Real GDP growth	1.2%	CBSI Annual Report 2019
GDP per capita	SBD 13,433 USD 1612	SINSO 2014
External reserves total	SBD 4937.2 million	CBSI Annual Report 2019
Import cover	USD 592.5 million 11.9 months	CBSI Annual Report 2019
Inflation	7.8%	CBSI April 2020
Government debt	SBD 1012 million USD 121.4 million	Central Bank of Solomon Islands Annual Report 2018
Total % of GDP	11%	

(Solomon Island Government, 2020)

2. Industrial use: Although demands are still relatively small there is considerable potential for future growth, the water quality can be an important factor in industrial uses.
3. Agricultural use: Surface water and groundwater will be the main sources used in the farms in the future, by using irrigation systems. The heavy capital expenditure required for irrigation works makes accurate assessment of the flow from the primary sources very important. While most crops are rainfed and agricultural developments can be seen in Guadalcanal and other high islands in the Solomon Islands.
4. Power generation: The nation's rivers are an important source of renewable indigenous energy. At the moment there is limited hydropower development in Solomon Islands. There is only a single micro-hydropower (150 kW) and about a dozen pico-hydropower installations in the rural areas to date which can sustain a small community.

Pipe sewerage is also not yet covered in all urban areas, some of the residents are using the on-site sanitation facilities, but rely on closed tanks (often intended to be septic tanks, but with inadequate or no drain fields) and pits for containment as the sewerage system only provided for formal areas (Schrecongost et al., 2015). There are two types of wastewater disposal systems identified in urban centers, there are: (1) conventional gravity sewerage system and (2) septic tanks. Flush toilets are used in the urban centers with gravity sewage systems or septic tank systems. Honiara is the only urban area that has a gravity sewerage system with a 30% coverage area. There are 16 sewerage systems, and each system is serviced with an outfall in the ocean. The composition of wastes is mostly domestic. The

Fig. 10.2 Solomon water area of operation (Hunterh2o, 2017)

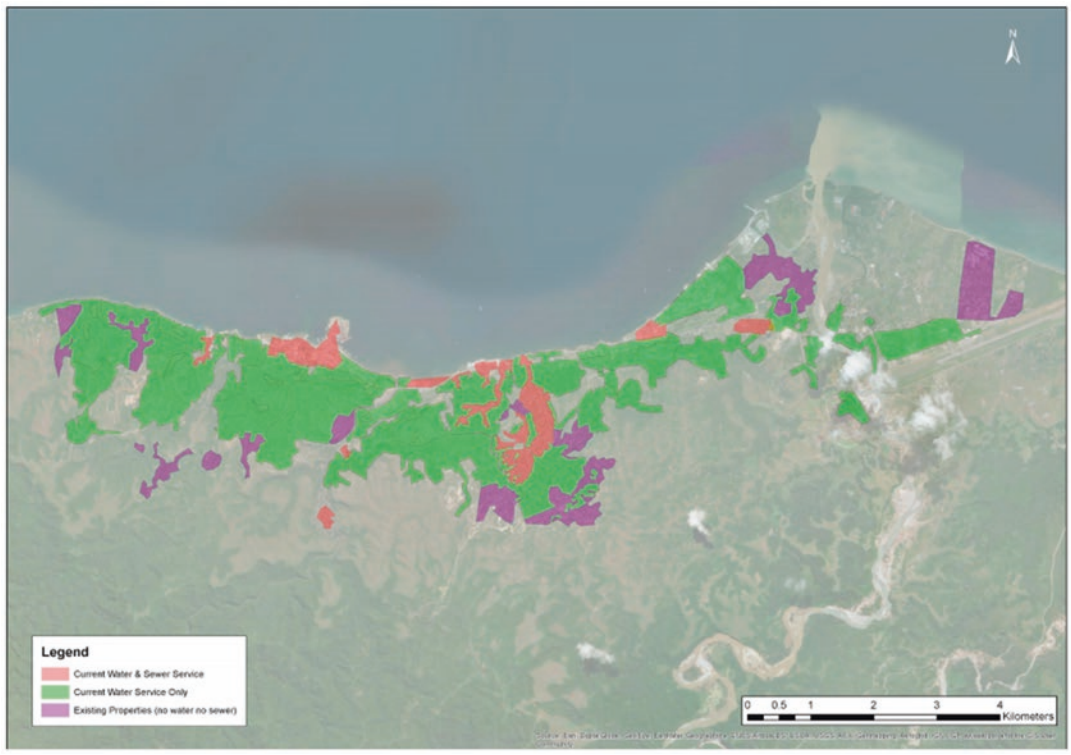


Fig. 10.3 Existing serviced and un-serviced areas by SIWA in Honiara (Hunterh2o, 2017)

Environmental Health Division lacks the political motivation or allocated resources to monitor and enforce the installation or operating standards of these on-site facilities in urban areas. H2o team reported that most settlers depend largely on pit latrines, may have septic tanks, or openly defecate in the bushes, creeks, or the beach. Settlers often buy and build toilets themselves; multiple households may pool resources to build a shared facility. There are no effective guidelines, assistance, or monitoring of these toilets or the installation process. As the sanitation service did not generate revenue it creates the status quo and becomes the marginal service (Hunterh2o, 2017). Rural communities around the Solomon Islands have modest wastewater systems such as soak-pits usually located on-site to drain wastewater at household or public stand taps.

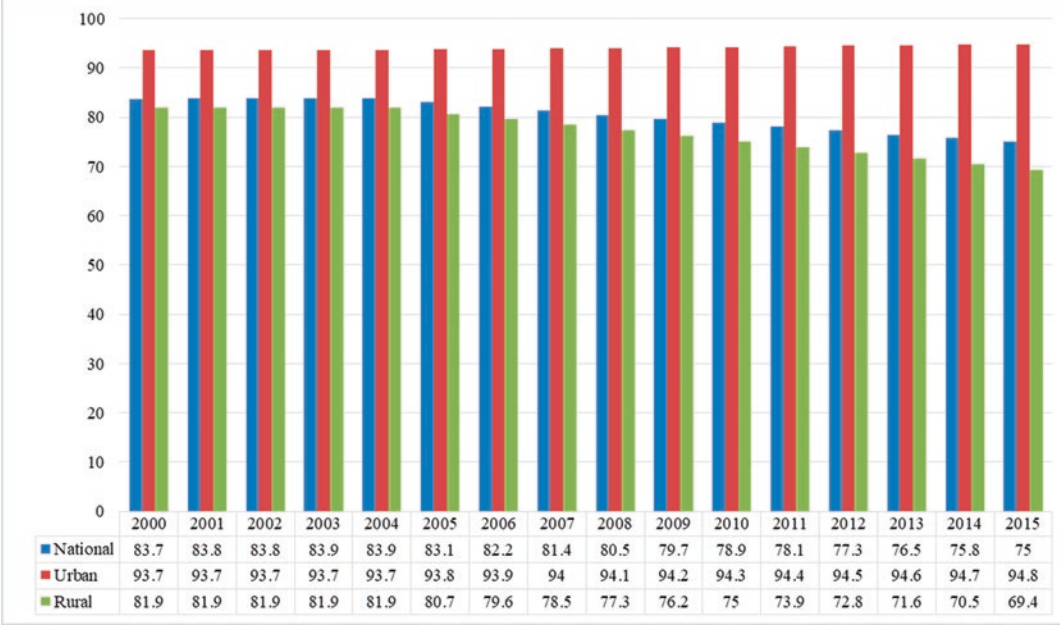
10.3 Baseline Studies of the Wash Indicators in Solomon Islands

Under the MDGs, improved access to safe drinking water and basic sanitation target was divided into two indicators: (1) Proportion of population using an improved drinking water source and (2) Proportion of population using an improved sanitation facility (Mishra, Hargreaves, and Moretto, 2010). Based on the MDG targets (Fig. 10.4), Solomon Islands provided improved drinking water for more than half of the population during 2000–2015, although there has been a 0.58% per year decrease in the coverage at the national level over the 15 years.

In urban areas the proportion of improved drinking water coverage increased marginally by 0.07% per year and the coverage decreased by 0.83% per year in rural areas. Compared to the population growth of 2.3% per year in 2016, Solomon Islands needed to speed up the service of improved drinking water coverage to stay on track with MDG targets.

Figure 10.5 indicates that Solomon Islands has 76–90% coverage for improved drinking water in 2015, higher than Papua New Guinea and Kiribati but still lower than other Pacific Islands' countries.

According to Fig. 10.6, from years 2000 to 2015, Solomon Islands was lagging behind the MDG target 7c for improved sanitation. Nationally, the above data shows that in 2020, only 37.1% of the population had access to an improved



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
National	83.7	83.8	83.8	83.9	83.9	83.1	82.2	81.4	80.5	79.7	78.9	78.1	77.3	76.5	75.8	75
Urban	93.7	93.7	93.7	93.7	93.7	93.8	93.9	94	94.1	94.2	94.3	94.4	94.5	94.6	94.7	94.8
Rural	81.9	81.9	81.9	81.9	81.9	80.7	79.6	78.5	77.3	76.2	75	73.9	72.8	71.6	70.5	69.4

Fig. 10.4 Proportion of Solomon Islands' population using an improved drinking water 2000–2015 (WHO/UNICEF JMP, 2019)

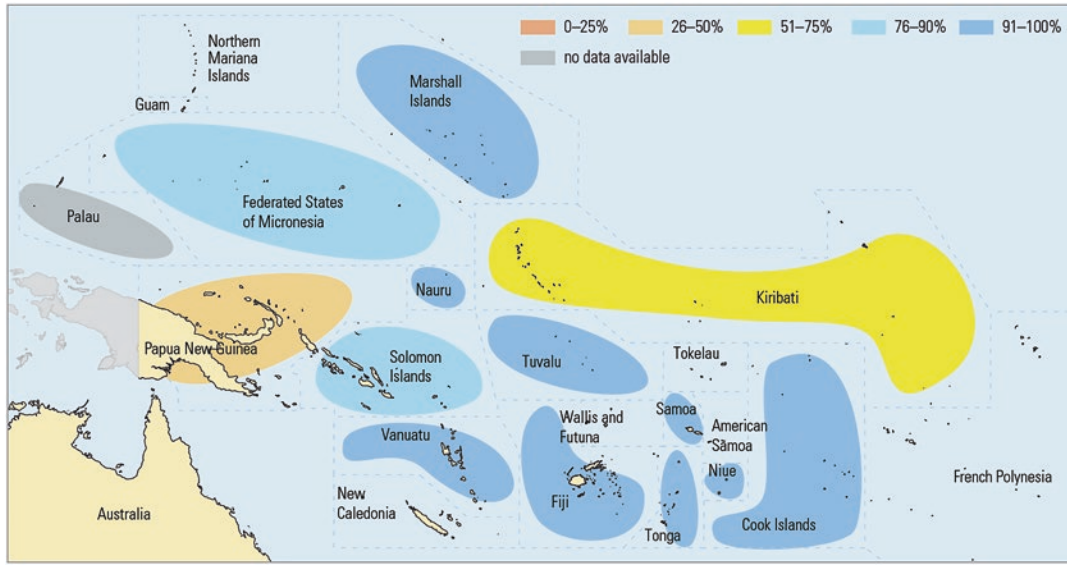
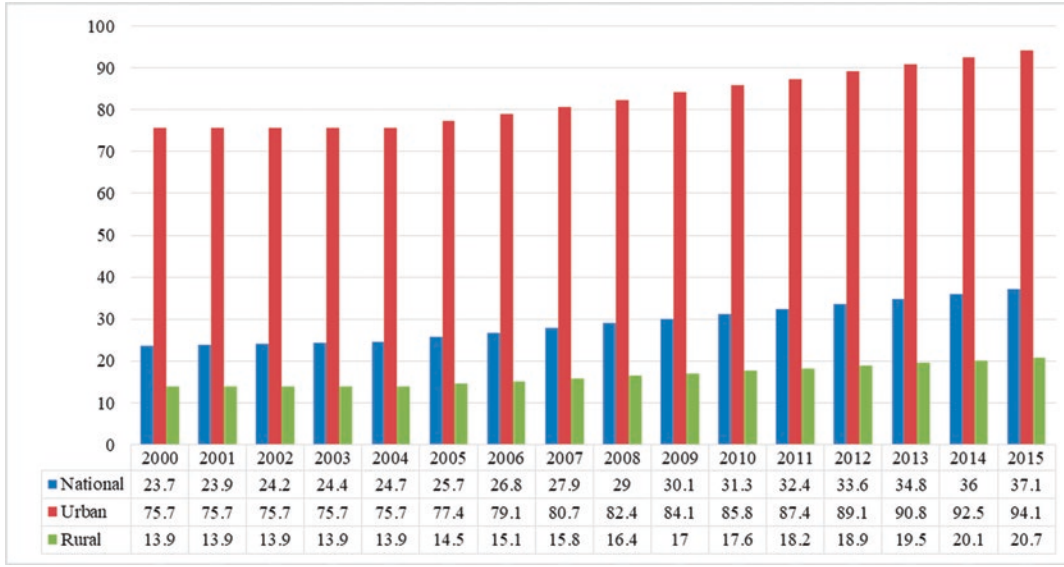


Fig. 10.5 Pacific Island countries: coverage with improved drinking water, 2015 (Country coverage from UNICEF and WHO, 2015 in Pacific, 2016)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
National	23.7	23.9	24.2	24.4	24.7	25.7	26.8	27.9	29	30.1	31.3	32.4	33.6	34.8	36	37.1
Urban	75.7	75.7	75.7	75.7	75.7	77.4	79.1	80.7	82.4	84.1	85.8	87.4	89.1	90.8	92.5	94.1
Rural	13.9	13.9	13.9	13.9	13.9	14.5	15.1	15.8	16.4	17	17.6	18.2	18.9	19.5	20.1	20.7

Fig. 10.6 Proportion of Solomon Islands' population using an improved sanitation 2000–2015 (WHO/UNICEF JMP, 2019)

sanitation service against the targetted 50%. Furthermore, Fig. 10.6 also shows the disparity of improved sanitation service between rural and urban area. About 94.1% of urban population had access to improved sanitation, but in rural areas it was only 20.7% in 2015.

As can be seen in Fig. 10.7, compared to other Pacific Island Countries, the Solomon Islands achievement in provide the improved sanitation was low, with the coverage in the range 26–50%, same level with Kiribati, Nauru and Federation State of Micronesia (FSM). The improved sanita-

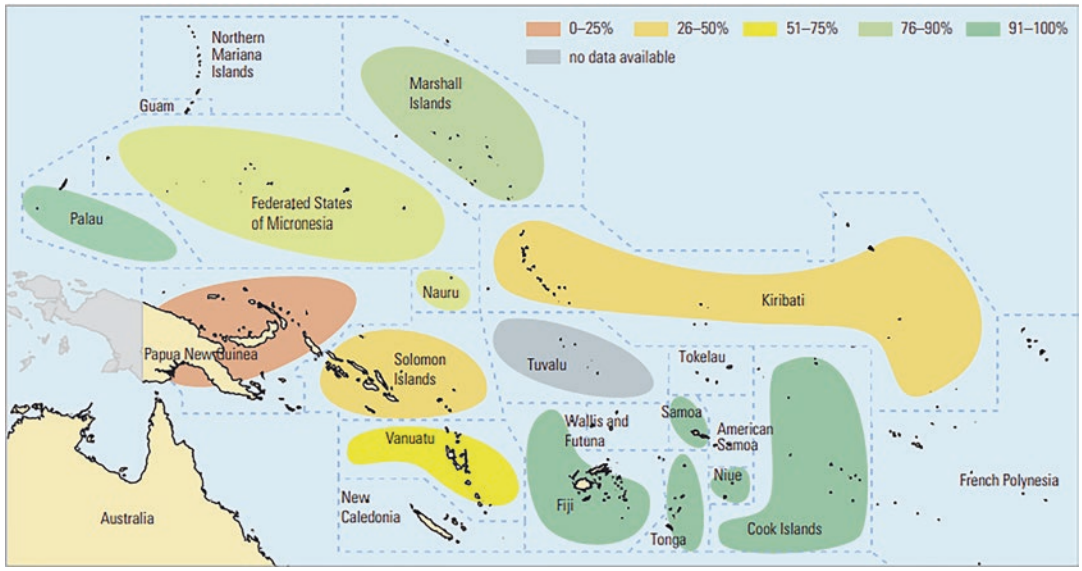


Fig. 10.7 Pacific island countries: improved sanitation coverage, 2015 (Country coverage from UNICEF and WHO, 2015 in Pacific, 2016)

tion coverage of Solomon Island is lower than Fiji, Tongam Samoa, Cook Islands, and Palau.

10.3.1 The Rural Development Program (RDP) and Some Impact Stories

The purpose of Rural Development Program is twofold:

1. Community Infrastructure and Services: To improve basic infrastructure and services in rural areas through community-driven development.
2. Agricultural Partnerships: To strengthen the linkages between smallholder farming households and markets through agriculture partnerships and support.

To date, the RDP has provided funding and technical support to implement more than 1636 projects, activities, and partnerships impacting more than 337,162 Solomon Islanders in rural communities across the country. The program is designed to ensure the inclusion and participation of all community members, with a specific emphasis on women, youth, and people with disabilities. RDP is a government initiative co-funded by the World Bank, Australian Government, European Union, and the International Fund for Agricultural Development.

10.3.2 Community and Infrastructure Services

RDP supports rural communities to identify, design, and operate their own projects and services. The program builds on existing community resources and capacities and provides training, material, technical, and administrative support to enable communities to complete, operate, and ultimately maintain their chosen projects. Communities are supported in organizing representative village level committees to manage the project, which enhances community ownership and skill development. Additionally, communities contribute a minimum of 15% of

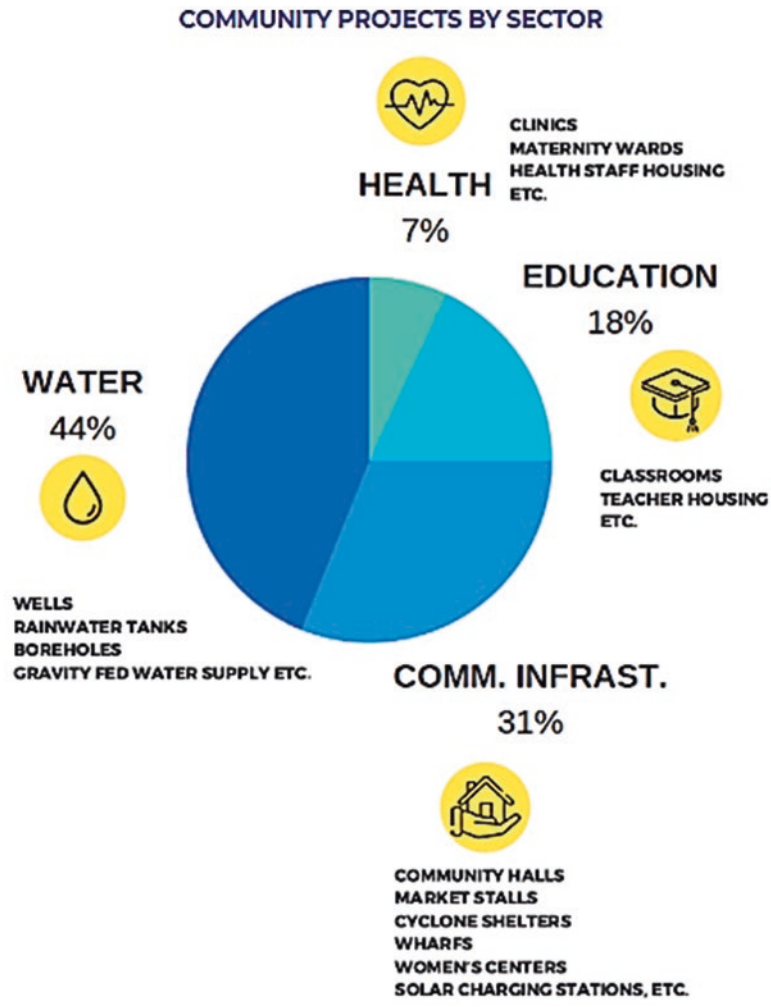


Fig. 10.8 Community projects by sector (http://sirdp.org.sb/stories/community-infrastructure-services/)

the resources (often in the form of gravel, sand, and timber) for a project. To date nearly 500 community projects have been completed across every province in Solomon Islands, with over 200 more projects completed by 2020. Completed community projects by sector is shown in Fig. 10.8.

10.3.3 Water Security in Radesifolamae Village, Malaita Province

In 2016, Radesifolamae water crisis finally came to an end when the Solomon Islands Rural Development Program (RDP) funded the construction of a new water supply scheme. In previous years, four children in the village had died. Two from falling into the village's ground well, and two more from diarrhea caused by unknowingly drinking from the well after it had been contaminated. Today, every household enjoys easy access to clean water, as a rain catchment system now feeds 20 water tanks shared across the 60 homes in the community. In addition to preventing further tragedies, the proximity of a clean water source has dramatically improved day-to-day life for residents of Radesifolamae.

Mothers, or more often their children, previously traveled 45 min by canoe to collect water. The 90-min roundtrip gave families a difficult choice to make. Either parents would have to take

time away from crafting shell money—the primary source of income for Radesifolamae residents—or the kids would have to skip school to fetch water for the family. Selimina, a mother of two, acknowledged the stark reality she was faced with. "If you don't have time to make shell money here, there's no way you can survive," she shared. Selimina's children frequently missed school, as they were tasked with fetching water while she made shell money to support the family. When Selimina instead fetched the water herself so her kids could attend school, her income dropped. It was a precarious position to be in, and one that she is relieved to no longer face.

The security that comes with access to clean water has improved the livelihoods of all 102 families in Radesifolamae. With more time to make shell money and less stress over water, mothers are earning more money for their families. Selimina revealed that her monthly income has increased from SI$500 to SI$1000 per month. Crucially, her children now attend school every day, and village leaders reported that nearly every child attends school on a daily basis. The new water supply has enhanced income and livelihood development and has inspired hope among Radesifolamae residents for continued growth in the future.

10.3.4 Improving Livelihoods Through Access to Clean Water, Komubeti and Gilutae, Guadalcanal Province

KOMUBETI and Gilutae are two rural communities nestled in the plains of Guadalcanal. With fertile soil primed for fruit trees and vegetable gardens, village members subsist primarily on the food they grow on their land. Now with the support of the Solomon Islands Rural Development Program (RDP), they also enjoy an essential human right: access to clean water. RDP facilitated the installation of boreholes and pumps to fill gravity water tanks in Komubeti and Gilutae in 2014, after flash floods had decimated the two villages. The floods washed away homes and gardens and also contaminated the hand-dug wells which previously provided the only source of water. Many children suffered from dysentery and diarrhea in the aftermath of the floods, and the time spent caring for ailing children and bringing them to and from the clinic took parents away from repairing their homes and gardens.

Additionally, villagers faced the challenge of needing to walk as long as 45 min each way to fetch clean water. Such extensive time spent collecting water everyday limited the villages' economic productivity. Today, nearly 50 families in the villages enjoy the benefits of the new water system, with water tanks perched high above ground and safe from contamination delivering clean water to every home. The project's impact on the community has been immediately felt. In Gilutae, Elizabeth captured the profound freedom that a clean and consistent water source has provided for her village.

"Our schedules don't have to revolve around water anymore. We can work in our gardens, take care of our children, even go fishing late at night, and we don't have to worry about having water when we get home." No cases of diarrhea or dysentery have been reported since the completion of the project, and community members also benefit from the time saved by no longer walking far distances to fetch water. The Rural Development Program has brought potable water to over 200 communities across Solomon Islands. Some data from the Komubeti and Gilutae villages are shown in Table 10.2.

10.4 Solomon Islands Preparation Towards Achieving SDG Targets (2016–2030) in Clean Water and Sanitation

Solomon Islands has prepared several policies in facing the 2016–2030 Sustainable Development Goals (SDGs) through The National Development Strategy (NDS) 2016–2035. The Solomon Islands National Development Strategy establishes a vision for the developmet of socio-economic by focusing on creating the change and livelihood environment, the vision is "Improving the Social and Economic Livelihoods of all

Table 10.2 Community partners of RDP-funded water supply

	Komubeti			Gilutae		
Age group	Male	Female	Total	Male	Female	Total
0–4 years old	22	19	41	21	13	34
15–24 years old	10	10	20	15	16	31
25–59 years old	19	18	37	22	20	42
60+ years old	2	2	4	6	5	11
Total	53	49	102	64	54	118

(http://sirdp.org.sb/stories/community-infrastructure-services/)

Solomon Islanders." To support the vision, the Solomon Islands government set a national mission "to create a peaceful, harmonious and progressive Solomon Islands led by ethical, accountable, respected, and credible leadership that enhances and protects peoples' culture, social, economic, and spiritual well-being." This highlights on a direction focused on creating a Solomon Islands that is enriched in its diversity, united, peaceful and stable and led to progression by credible and accountable leadership. Several planning objectives in the NDS are aligned with the SGDs, including water and sanitation which are included in the objective number 2: Poverty Alleviated across the whole of Solomon Islands, basic needs addressed and food security improved; benefits of development more equitably distributed (Solomon Island Government, 2020).

Solomon Islands tries to achieve the global target of SDGs in the field of clean water and sanitation by setting a national target of 60% of the population being able to access safe drinking water by year 2035, this target is inline with the global target 6.1 to achieve universal and equitable access to safe and affordable drinking water for all by 2030. Meanwhile, for the national sanitation sector, the Solomon Islands target is the same as the global target 6.2 to 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. To acchieve the SDGs target 6.1 and 6.2, Solomon Islands developed the Medium Term Strategy (MTS) 2016–2020 by build and upgrade physical infrastructure and utilities with an emphasis on access to productive resources and markets and to ensure all Solomon Islanders have access to essential services (MTS 3), and MTS 5, alleviate poverty, improve provision of basic needs and increase food security (Solomon Island Government, 2020).

To speed up the water and sanitation service in rural areas Solomon Islands Government came up with the Rural Development Program (RDP), an initiative co-funded by the World Bank, Australian Government, European Union, and the International Fund for Agricultural Development. It has reached over 50% of Solomon Islands' population and operates in all 9 provinces and 172 wards of the country, from the atoll of Ontong Java to the north, Rennell and Bellona to the south, Anuta and Te Kopia to the East and Shortlands to the west (Rural Development Program-Solomon Island, 2020). The purpose of RDP is divided into two categories: (1) Community Infrastructure and Services: To improve basic infrastructure and services in rural areas through community-driven development (RDP-1) and (2) Agricultural Partnerships: To strengthen the linkages between smallholder farming households and markets through agriculture partnerships and support (RDP-2). Both of these categories can be seen in Fig. 10.9 with the distribution of water project locations.

The Solomon Islands Government through the Ministry of Development Planning and Aid Coordination is serious to combat the low level of water service in the rural area with the Rural Development Program. This program is participatory program, which the rural community will send the request to the government for the project and manage the project by management and supervision from the RDP team. The number of

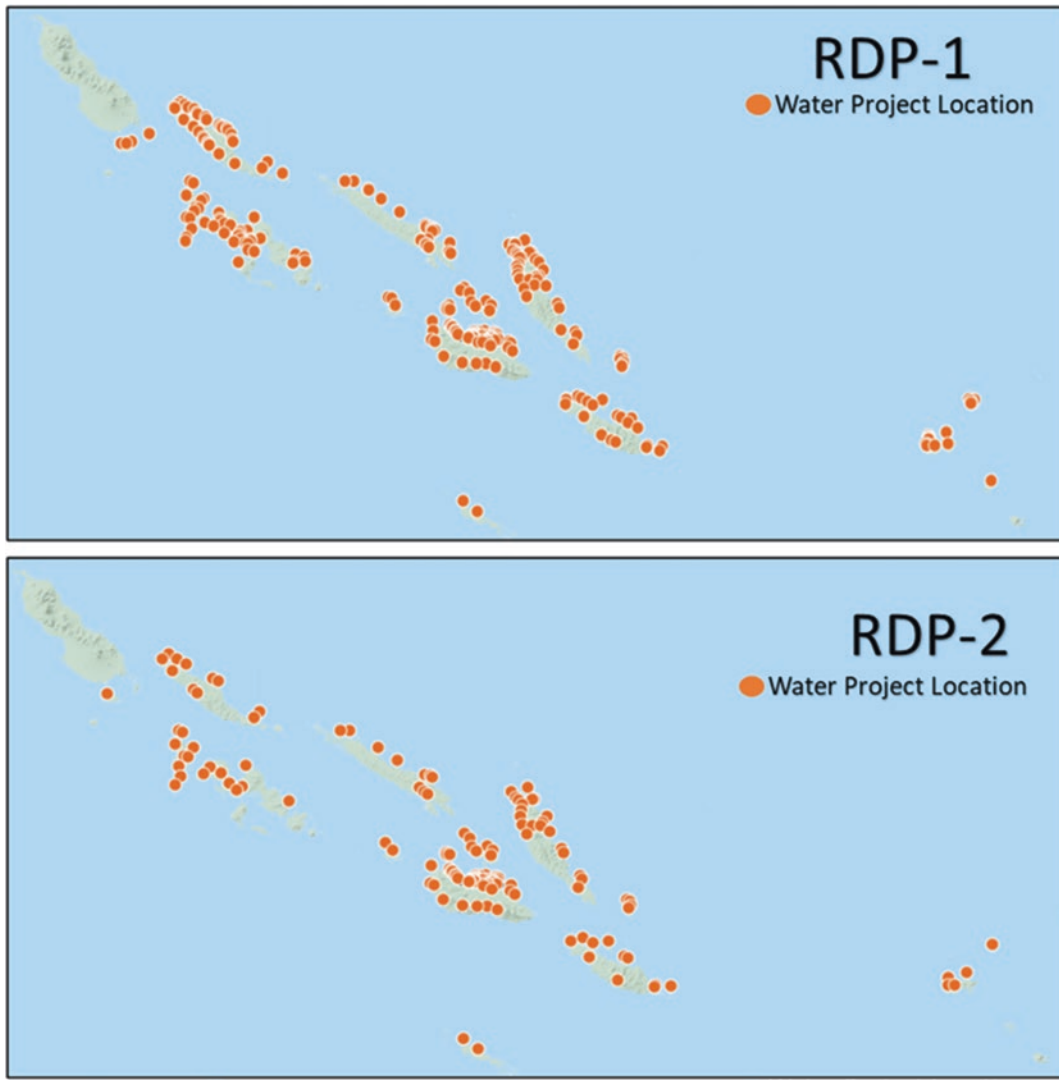


Fig. 10.9 Distribution of rural water project location in Solomon Island (Rural Development Program-Solomon Island, 2020). *RDP = Rural Development Program

projects increased and covered most of the provinces in Solomon Islands.

The RDP sanitation project in Solomon Islands as shown in Fig. 10.10 which is referring to RDP-1 is for the community infrastructure and services. Basically, RDP-1 is to improve the basic infrastructure and services in rural areas through community-driven development.

There are six (6) targets for clean water and sanitation which still yet to be covered in Solomon Islands National Development Strategy are (a) Target 6.3 Improve Water Quality, Wastewater Treatment And Safe Reuse\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 global by 2030; (b) Target 6.4: Increase Water-Use Efficiency And Ensure Freshwater Supplies. 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 suffer-

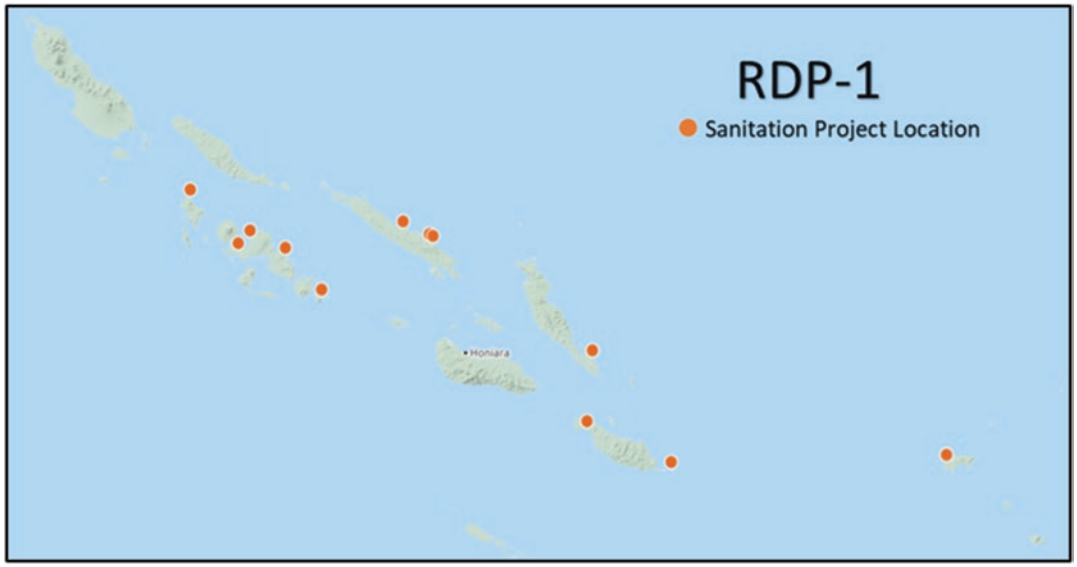


Fig. 10.10 Distribution of sanitation project location in Solomon Island (Rural Development Program-Solomon Island, 2020). *RDP = Rural Development Program

ing from water scarcity; (c) Target 6.5: Implement Integrated Water Resources Management. By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate; (d) Target 6.6: Protect and Restore Water-Related Ecosystems. By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes. (e) Target 6.A: Expand Water and Sanitation Support to Developing Countries. 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; (f) Target 6.B: Support Local Engagement in Water and Sanitation Management. Support and strengthen the participation of local communities in improving water and sanitation management (The Global Goals, 2017).

In order to support the achievement for all the SDGs target 6, which is the Clean Water and Sanitation, Solomon Islands have prepared the National Water Resource and Sanitary (WATSAN) Policy in 2017 (2017a) and WATSAN Implementation Plan 2017–2033 (2017b). The purpose of the WATSAN policy is: to provide the government leadership in the vital water and sanitation sectors and to improve the development opportunities, the health and well-being of all Solomon Islanders; protect the source of water and receiving environment; respond to widespread rural and urban concern about the safety, adequacy, and reliability of water supply and sanitation service; identify the national priority areas and issues which require government and donor intervention in the WATSAN sector, built the WATSAN goals in the NDS and give a clear policy goals and objectives; signal Solomon Islands' priorities in water and sanitation; provide the strategy for adapting to global changes and provide the mechanism for monitoring policy outcomes and reviews (Solomon Islands National Water And Sanitation Implementation Plan, 2017a).

Meanwhile the National Water and Sanitation Implementation Plan is a 12-year integrated whole-of-government plan to implement the goals and objectives of the Solomon Islands National Water and Sanitation Policy (National WATSAN Policy), the sector goals of the National Development Strategy 2016-35 (NDS). It is consistent with other Government initiatives and

strategies, including the Draft Rural Water, Sanitation and Hygiene (RWASH) Policy, National Adaptation Plan of Action, 2009, Draft Medium Term Development Plan, 2013, Solomon Water (SIWA) Development Plan 2013–2015, National Disaster Risk Management Plan 2011, and the water and sanitation sector component of the Draft National Infrastructure Investment Plan 2013 (NIIP) (Solomon Islands National Water and Sanitation Implementation Plan, 2017a).

Some plans that Solomon Islands prepare in order to achieve SDGs target 6 for Clean Water and Sanitation are listed below:

1. Preparing the plans, guidelines, and regulation ordinance for the water resources, water supply, hydropower, and sanitation in urban and rural areas.
2. Skill training program for water and sanitation managers, technical staff, and community operators.
3. Adding the education curricula on water and sanitation, waste management, and hygiene improvement in all levels of education.
4. Public education and campaign awareness in urban and rural area related to good quality water, conservation, water source protection, adequate sanitation, and hygiene.
5. Improve and reliable access to customary-owned public water source.
6. Increase use of household and community rainwater harvesting by preparing the standards and building codes, training for installation, operation, and maintenance.
7. Community participation in non-urban and rural area for water supply system.
8. Increase the use of renewable energy and hydropower generation.
9. Reduce less than 20% of losses water from the pipe by decreasing the illegal connection.
10. Fair, equitable, tiered-water tariff introduced for all urban piped water system to control growth in demand and discourage wastewater.
11. Train the rural communities to use and maintenance of sanitation facilities and hygiene.
12. Sewerage outfalls and waste disposal sites in all urban centers to minimize off-site pollution.
13. Water supply and sanitation system at risk from sea level rise and storm surge; and.
14. Improved urban and peri-urban drainage.

10.5 Water and Sanitation Governance and Access Improvement Progress

10.5.1 Objectives and Purpose of "RWASH" Program in Solomon Islands

The Government of Solomon Islands signed, on 24th July 2014, a Financing Agreement for €17.4 million with the European Union for "*improving governance and access to water, sanitation and hygiene promotion (WASH) for rural people*."

This resulted in a rural WASH Program now known as "RWASH." The RWASH Program has the following objective:

> "To support implementation of the sector policy for the Program of Improving Governance and Access to Water, Sanitation and Hygiene Promotion for Rural People."

The purposes of the contract are:

1. To enable a healthier and safer environment in households, schools, and clinics, particularly for women and children, reducing the impact of water borne diseases and hygiene related illnesses in rural communities and
2. To improve governance and quality of service delivery in the Rural WASH sector in the context of climate change.

Policy Context

The national policy context is relatively clear and shows a documented commitment to increasing WASH coverage to the point where nearly all Solomon Islanders have reasonable access to water and sanitation services by 2024. The current National Development Strategy (NDS) for the period from 2016 to 2035 states that during

the consultations conducted with Provincial stakeholders, water and sanitation were raised as being of the highest priority in rural areas. The NDS includes the objective of providing access to water for all Solomon Islanders by 2030.

The National Health Strategic Plan (NHSP) 2016 to 2020 echoes the NDS and sets access to water, sanitation, and health and hygiene as a priority. This includes a focus on communities and health facilities and recognizes the impact that access to clean water and safe sanitation has on overall community and national health.

The WASH Strategic Plan 2015 to 2019 has set very high targets for improving access to water, sanitation, and hygiene services and includes both 5-year and 10-year targets. It is apparent now that the water target for 2019 was set too low and has been achieved with very little actual progress in coverage. All three of the targets are extremely ambitious for 2024 (Table 10.3).

Improving Health Through Community Participation in RWASH Project in Solomon Islands

Published by the National Newspaper on the second of August 2015, Mr. Charley Piringi reported that the Ministry of Health Officials led by the Research and Training Officer, Mr. Leonard Olivera together with the Solomon Water (SIWA) officers who undertook training in Australia under the title "Improving Health through Community Participation in RWASH Projects in Solomon Islands." The team undertook a month-long training under the Australia Awards Fellowships (AAF 15) Program in Brisbane at the Queensland University of Technology (QUT) and presented their "Action Plan" to the Environmental Health Department. In the presentation, Mr. Oliver said their Action Plan, "The AAF 15 Rural water Supply Sanitation and Hygiene Integrated Strategy Action Plan, RWASH-ISAP aims to improve governance, enhance policy development and implementation, strengthen data collection, information management, and communication, identify appropriate methods and techniques for water treatments, indicate culturally applicable and cost-effective measures to improve hygiene, and to guide professional and technical capacity building."

Environmental health director at that time, Mr. Nanau, said the report was timely and inclusive. "He commends the team for their job well done. There will be a budget for this report, and its implementation." WASH project is a partnership between the Solomon Islands Ministry of Health and Medical Services (MHMS) and The Solomon Water (SIWA) together with the Queensland University of Technology.

The RWASH Integrated Strategic Action Plan

The RWASH program is a rural innovative program of the Solomon Islands initially known as the rural water supply and sanitation program. Currently the program is supported by DAFT, the European Union, and the Solomon Islands Government. As stipulated in its policy and national strategic plan, the vision is to enable all Solomon Islanders to have access to sufficient quantity of water, appropriate sanitation as well as living in a safe and hygienic environment. Located in the Ministry of Health and Medical Services, the program aims to achieve this goal by 2024.

Table 10.3 RWASH strategic targets in 2014–2024

Target	2014	2019	2024
Communities with improved drinking water supplies	35%	52%	97%
Communities open defection free (ODF)	1%	87%	100%
People handwashing with soap at critical times	5–10%	75%	100%

(Ken, 2018)

The training that was held in Australia has exposed the participants to an intensive learning and interactions with the Queensland University of Technology (QUT), water experts and firms (Seqwater), site visits and study tours to communities in the Far North Queensland (FNQ) in the remote communities of Yarrabah and Hope Vale and introduced to their community water treatment systems. Before returning to the Solomon Islands the final week of the program an Integrated Strategic Action Plan known as a Return-to-Work Action Plan (RTWAP) was developed for participants to implement on their return to Solomon Islands.

While the action plan will serve as a blueprint of the actions to be done, this report is based on the actual encounters while in the process of implementing the action plan. Overall, the award has given the participants some broader views of the RWASH program and the confidence to contribute more effectively to ongoing program in the Solomon Islands. The RWASH Integrated Strategic Action Plan was aimed at making contributions to improve governance, policy, information, communication, methods and techniques and capacity that can be used by RWASH partners to deliver measurable health improvements in rural areas of Solomon Islands. Five broad objectives were identified with strategies to be implemented within certain timeframe as can be sighted in the AAF15 Rural Water Sanitation and Hygiene Integrated Strategic Action Plan which serves as the Return-to-Work Action Plan document. This paper therefore serves to provide an up-to-date report on the performance, achievements, and recommended actions in the way forward towards realizing the objectives of the action plan.

Governance

Regarding the objectives of governance objectives, two broad approaches were developed focusing on program leadership and work plan development and approval. Upon return from the AAF 15 training program in Australia, efforts were taken to improve dialogue between all stakeholders, including the hierarchy of the RWASH sector, the urban water authority and aid partners by disseminating the outcome of the program and where possible develop strategies to be incorporated into the annual departmental operational plans and work activities. The following activities were undertaken to ensure the strategies are implemented as summarized below (Table 10.4).

Ability to Share Knowledge (Corporate Intelligence)

Two key strategies were designed under this objective to be achieved through the development of the RWASH Resource and Information Centre and through data sharing system and protocols.

1. *RWASH Resource and Information Centre*: Development of the RWASH Resource and Information Centre is an ongoing departmental activity and involves the development of a resource and information center for RWASH including environmental health. Activities included infrastructure development components: a room, shelves, tables, chairs and computers, printers and the software components to include books and e-library. Activities namely: (1) Production of RWASH IEC materials and printing completed; (2) Installation of internet facilities also completed; (3) Continue ordering of books and development of Resource Materials which already completed and lastly the promotion of the facility which is still ongoing.
2. *Data Sharing System and Protocols*: A Community Water Supply, Sanitation and Hygiene (WASH) National Survey was conducted to come up with a baseline on RWASH in the Country. The objectives of the community WASH baseline as stated in the plan document are to provide an:
   (a) Understanding of the national coverage on WASH baseline; are services available? (schools, clinics and villages).
   (b) Understanding of the level of access to WASH including operation/functionality/water quality (can people get to or use the services?)
   (c) Initial assessment of governance structures in place at the moment for compari-

Table 10.4 Community partner of RDP-funded

Activity	Participants and stakeholders from	Outcome	Checklist
Conducted a presentation session to the RWASH stakeholders on the training attended and the strategic action plan as well as distribution of the plan copy	Ministry of Health executives, Director of Environmental Health and staff, Solomon Waters, DFAT, national RWASH staff and health promotion department	Acknowledgment and recognition of the award and training plus a consensus made on the activities of the strategic plan to be included and budgeted for in the division operational plan	Completed
Presentation made by the team to Guadalcanal provincial government on the Return-to-Work on the strategic plan	Guadalcanal provincial Government and RWASH Officers	Support gauged for one tap one house (OHOT) policy to be implemented and trailed in Guadalcanal province	Done but OHOT was planned for implementation in the Western province
Provincial Presentations. Similar presentations were done in Malaita, Isabel, and Western provinces on the requirement of the Return-to-Work Strategic plan	Provincial Health Directors, Provincial Executives and RWASH staff	Support gauged for Water Safety plan to be implemented as trial of one project each in those three provinces	Presentations done for Western, Isabel, and Malaita province
Activities Budget Preparation RWASH Team to discuss budget items and figures for 2016 activities as reflected in the strategic plan	RWASH Team in the AAF R15 with Environmental Health Division head of units	A budget document was available for presentation	Budget was prepared
Budget Submission Meeting with the Ministry of Health Executives	Director of Planning and Policy Evaluation, Under Secretary Health Improvement, RWASH technical advisor, Director of Environmental Health	Draft Budget approval at Ministry Executive Level	Budget not approved due to misunderstanding
Presentation to EU	EU Country Project Representative	RWASH Strategic Action Plan Document Submitted	
EHD/RWASH 3 days National Conference	RWASH Provincial staff, Representative of EU, RWASH technical Advisor, Solomon Waters, Community-Based Rehabilitation	Conference completed with report and resolutions for next course of action	Conference completed
National Data and Field Collection of RWASH data in the provinces	Water Aid, UNICEF, DAFT, National and Provincial RWASH, Health Promotion Unit and Vector-borne Control Unit and demographic numerators	Training completed with data collection skills and use of AKWO phone knowledge gained Completion of the survey and data collection	Completed with the availability of Survey Report.
Launching of Handwashing Campaign for Guadalcanal province and Honiara City Council and Training for Baseline Survey	Ministry of Health and Medical Services, WASH stakeholders, RWASH, Health Promotion and Teachers and the Ministry of Education and Human Resources	Joint commitment to the campaign and Preparations for baseline WASH KAP survey of schools	Baseline Survey for WASH in Schools was completed. Baseline survey for wash in schools completed

(AusAid-QUT, 2015, AAF ROUND 15; Improving Health through Community Participation in RWASH Project in Solomon Islands (Progressive Report), n.d.)

son in the future (what support is in place for the services?)

The initiative was jointly supported by Water Aid and UNICEF and currently survey was completed awaiting analysis and compilation of data for publication. It is also anticipated that provinces will be involved in the process through a series of workshops to fully understand the process and the outcome of data survey, analysis, and uses.

Evidence to Ensure New Policies and Programs Is Successful (Evidence for the Rural Water Safety Plan)

The national campaign program for schools' handwashing in the Solomon Islands was launched last year. It started as a trial for 14 schools in Guadalcanal province and Honiara City Council. Activities completed to date were the baseline survey of the 14 schools and now in the process of data analysis. Out of the findings, a detailed strategy for activities will be drawn up and scheduled for implementation this year. The objectives of the program are to position handwashing as a valued behavior and social norm; to support increased adoption of health protective behaviors such as handwashing at key times, support children to become agents of change in relation to wash in schools and communities, finally build a foundation for future C4D initiatives on aligned themes.

Other activities

1. Presentations of survey findings and working with all stakeholders to come up with strategy for the campaign.
2. Production of IEC materials.
3. Running of handwashing campaign in schools.

10.6 Achievements in the WATSAN Sector in Solomon Islands from 2016 to 2020

According to Fig. 10.11, the results show that the percentage of achievements have been maintained at a consistent level. The graph illustrates that there is a high achievement of drinking water improvement for urban area and above 50% for the rural areas. In 2020, nationally, the population using an improved drinking water was at 73%.

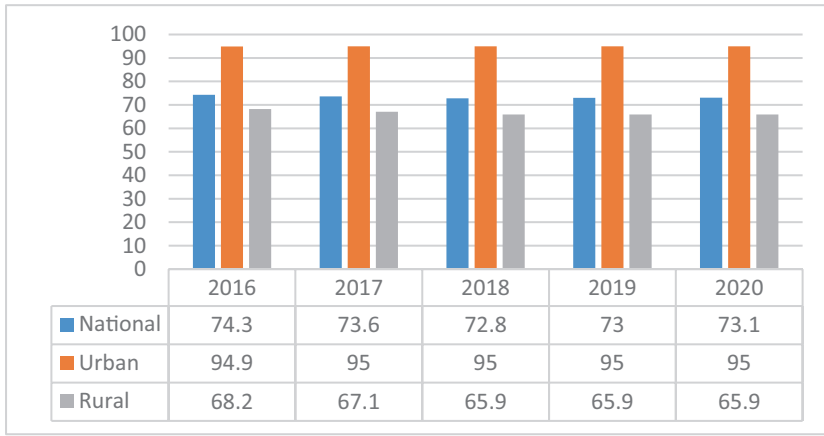
Unfortunately, as for Sanitation, it does not go in line with drinking water improvement. Based on Fig. 10.12, though the Urban Sector shows a consistent improvement of 95% achievement, but for the rural area achievement, the achievement is still under the target of SDGs 6.

Table 10.5 shows the improvement water service level in Solomon Island in 2016 and 2020, at the national level the improved water decline from 2016 (74.3%) to 73.1% in 2020. Conversely, the improved water service in the urban areas increases slightly by 0.1% from 2016 to 2020. As for the rural area, a decrease of 2.3% from 2016 to 2020.

Basically Table 10.6 is towards the urban area. Most of the urban areas are more easily accessed by land transport in which the rural area has difficulty with the access of sea transport. Though the table above shows some improvements in the urban setting, rural setting is still decreasing which is not an encouraging result but an indication of more focus should be towards the rural setting.

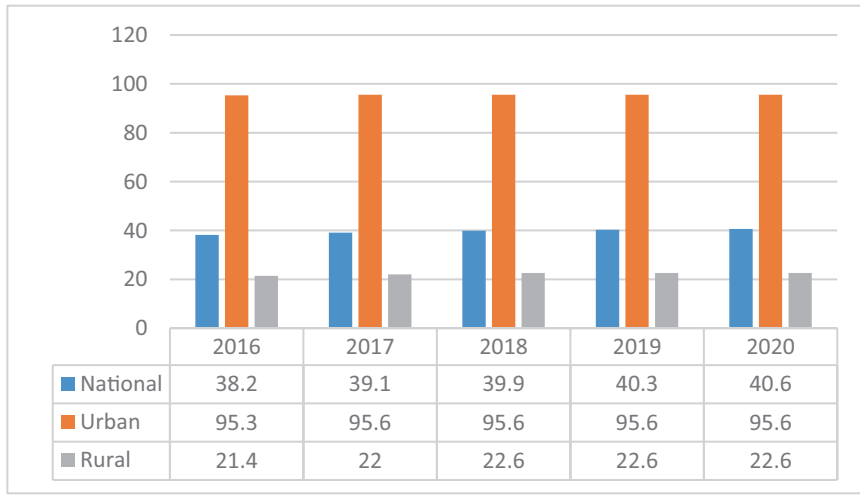
According to Table 10.7, the improved sanitation service in Solomon Island increases from 38.2% from 2016 to 40.6% in 2020 Nationally. However, the table shows no unimproved sanitation and more should be focussed with the rural setting having the case of unimproved sanitation increases by 4.3% from 2016 to 2020 which should not happen.

The proportion of the population using the septic tank as improved sanitation was increased at the national level from 18.5% in 2016 to 20.2% in 2020, but this condition was not applicable in an urban area, as per data in Table 10.8 shows that the proportion of the population using the septic tank declines from 52.7% in 2000 to 43.2% in 2015. The decline in population proportion in urban areas, who using septic tanks may have caused by using the latrines which increased 28% in 15 years. The data in Table 10.8 also indicate that Solomon Islands Water Authority (SIWA) not yet improve the sewer connection to the new development area.



	2016	2017	2018	2019	2020
National	74.3	73.6	72.8	73	73.1
Urban	94.9	95	95	95	95
Rural	68.2	67.1	65.9	65.9	65.9

Fig. 10.11 Proportion of Solomon Islands' population using an improved drinking water 2016–2020 (WHO/UNICEF JMP, 2021)



	2016	2017	2018	2019	2020
National	38.2	39.1	39.9	40.3	40.6
Urban	95.3	95.6	95.6	95.6	95.6
Rural	21.4	22	22.6	22.6	22.6

Fig. 10.12 Proportion of Solomon Islands' population using an improved sanitation 2016–2020 (WHO/UNICEF JMP, 2021)

10.7 Key Constraints

In addition to current targets being high and unattainable within the existing capacity and funding context, there is some uncertainty due to the use of communities and villages when calculating the coverage nationally rather than just using percentage of the total population. The existing WASH Strategic Plan includes targets for how many systems should be constructed both in community wash and for health facilities and schools; however, it is unclear what size these schemes are and what impact they would have on national coverage. While there are 1200 schools and only 346 clinics the target numbers for facilities to be constructed in schools and clinics are the same.

The move by the Ministry of Health and Medical Services (MHMS) to adopt indicators that are closer to global indicators was a good one, but as part of it one of the indictors was changed from the number of communities who are open defecation free, to the percentage of population using basic or safely managed sanitation services. This has caused some confusion given that the starting point for open defecation

Table 10.5 Proportion of drinking water service in urban and rural area by service level in 2016 and 2020 (%)

Year	Setting	Population (1000s)[a]	Improved water	Unimproved water	Surface water	Improved water	
						At least basic (improved within 30 min)	Limited (improved >30 min)
2016	National	619	74.3	19.9	5.8	68.5	5.7
	Rural	478	68.2	24.6	7.2	61.8	6.4
	Urban	141	94.9	4.0	1.1	91.3	3.5
2020	National	687	73.1	21.3	5.6	67.3	5.8
	Rural	517	65.9	27.0	7.1	59.4	6.5
	Urban	169	95.0	3.9	1.1	91.4	3.6

Source: WHO/UNICEF JMP (2021)

[a] Source: UN Population Division

Table 10.6 Proportion population using improved water sources in 2016 and 2020 (%)

Year	Setting	Population (1000s)[a]	Piped	Non-piped	Accessible on premises	Available when needed	Free from contamination	Safely managed drinking water
2016	National	619	47.2	27.1	52.3	37.6	#N/A	#N/A
	Rural	478	40.2	28.0	43.1	54.6	#N/A	#N/A
	Urban	141	70.8	24.1	83.4	#N/A	#N/A	#N/A
2020	National	687	45.7	27.4	51.7	37.0	#N/A	#N/A
	Rural	517	37.5	28.4	41.3	52.8	#N/A	#N/A
	Urban	169	70.5	24.5	83.4	#N/A	#N/A	#N/A

Source: WHO/UNICEF JMP (2021)
Accessible onto premises: point of use located at the household, providing piped water
[a] Source: UN Population Division

Table 10.7 Proportion of Sanitation Service in Urban and Rural Area by Service Level in 2016 and 2020 (%)

Year	Setting	Population (1000s)[a]	Improved sanitation	At least basic (improved and not shared)	Limited (improved and shared)	Unimproved sanitation	Open defecation practiced
2016	National	619	38.2	32.8	5.5	15.1	46.6
	Rural	478	21.4	19.5	1.9	19.6	59.0
	Urban	141	95.3	77.6	17.7	0.0	4.7
2020	National	687	40.6	34.8	5.9	14.6	44.8
	Rural	517	22.6	20.6	2.0	19.4	58.0
	Urban	169	95.6	77.9	17.7	0.0	4.4

Source: WHO/UNICEF JMP (2021)

[a] Source: UN Population Division

Table 10.8 Proportion of population using improved sanitation shared and non-shared in 2016 and 2020 (%)

Year	Setting	Population (1000s)[a]	Population using improved sanitation facilities (including shared):			Population using improved sanitation facilities (excluding shared):
			Latrines and other	Septic tank	Sewer connection	Including: Disposed of in situ; emptied and treated; wastewater treated; and safely managed sanitation
2016	National	619	18.5	13.0	6.8	#N/A
	Rural	478	14.9	4.5	2.0	#N/A
	Urban	141	30.6	41.7	23.0	#N/A
2020	National	687	20.2	13.3	7.2	#N/A
	Rural	517	16.1	4.5	2.0	#N/A
	Urban	169	32.5	40.2	23.0	#N/A

Source: WHO/UNICEF JMP (2021)

[a] Source: UN Population Division

free communities was 0%, and the starting point for sanitation closer to 14%. Currently, there is little other work going on in the sanitation sector and so any improvements in sanitation coverage will be a product of success in ongoing and future Community Led Total Sanitation (CLTS).

While the WASH Strategic Plan appears sensible and encourages a move to a more regulatory function for the RWASH unit, it has not been implemented as intended. There is some disagreement among key stakeholders concerning the strategy and how quickly construction should be outsourced to others rather than completed by the Environmental Health Divisions (EHD) of each province.

Given the current capacity within the Solomon Islands to implement wash activities, particularly in some of the smaller provinces, it would be quite difficult to make significant progress if the provincial environmental health divisions were not doing construction. The strategy suggests that provincial Environmental Health Divisions oversee service delivery partners to monitor their work and ensure they maintain up to date information. However, in some provinces, it has only been the Environmental Health Division who has constructed water supply systems over the past 20 years.

So, while there is not necessarily a reluctance to contract out construction, the structure of provincial divisions is still one that has been developed to do construction rather than monitoring and supervision.

The adoption of CLTS as the only strategy to increase sanitation coverage does not appear to be fully supported at the national level within the EHD. Certainly, the concept of zero subsidy is not fully supported and some senior officers would prefer to have at least a small or smart subsidy, perhaps one that is paid after successful construction of a toilet.

While the strategy includes schools and health facilities as part of the WASH program, it does not include percentage coverage targets and there is little information about current status of clinics. This lack of information and shortage of funds have meant that there has been little done to develop a meaningful implementation plan to increase coverage on schools and clinics, although hopefully new information that is currently being gathered by UNICEF will allow a more strategy approach to be adopted.

Operating in the Solomon Islands across all nine provinces is a complex and logistical challenge. Communications are still poor and internet across often lacking or of poor quality. This coupled with the lack of a clear implementation plan with associated key responsibilities, activities, and dates makes it difficult to operate effectively and contribute to the very slow pace of progress in achieving WASH targets.

There is a range of operational constraints on the RWASH Program. Procurement of both goods and services follows government systems and lengthy approval processes can cause delays to activities. Funding for travel and touring allowances is difficult to secure and can take so long that the planned activities have had to be cancelled.

Procuring materials for construction of projects can be a slow process, and once materials are procured the delivery, storage, and subsequent freighting to project sites are all opportunities for both fraud and delay. Past fraud has made it more difficult to procure and ship materials with increased scrutiny and caution contributing to delays.

The current practice of ad-hoc procurement is not effective and means that the project is always trying to make things happen, but without an agreed plan or timeframe. This makes it difficult to achieve value for money in both the procurement of materials and the shipping of them around the country. Possibly the biggest operational constraint now is the lack of agreement on how the program should be implemented, in terms of doing construction or contracting others to do construction. This has led to a decrease in productivity and increased delays that reflect the differing opinions within the EHD and RWASH Program.

10.7.1 Monitoring and Evaluation (M&E)

Considerable effort has been made over the last 2–3 years to develop an effective M&E system. This system has made some attempts to quantify

the current situation in terms of WASH coverage and to monitor the number of projects that are being constructed. This is an improvement on what existed before but there is still a need to improve the systems for monitoring particularly at the national target level, M&E efforts are focused on developing systems for monitoring the WASH Strategy; however, as outlined above, the WASH Strategy has as its main focus the numbers of projects constructed and includes references to communities and villages rather than % of population.

10.7.2 Funding

There are a number of key constraints holding the WASH sector back. While funding is not a constraint in the very short term, it certainly is in the 2019 to 2025 period. Slow spending of current EU funds has slowed the increase in WASH coverage, but more importantly it has created the misconception that there is sufficient funding in the sector. The RWASH Program currently has targets in the community, schools, and clinics WASH sectors. For significant progress to be made in all of these sectors, significant additional funding will be needed.

10.8 Conclusion

Attempts to get the AAF 15, RWASH Integrated Strategic Action Plan implemented have met certain challenges especially as from the hierarchy of responsibilities in RWASH more often with differing interests and meanings as to what the program is all about. The key challenge in the program will always to be to ensure delivery of safe quality water, sanitation, and hygiene that are sustainable and accessible to ensure health and well-being of Solomon Islanders. While this is a vested responsibility of all partners involved in the RWASH sectors, the onus will always be on Solomon Islanders that is why our participation in the AAF must be always seen as crucial and recommendations must be implemented. While to some extended, awareness on the AAF R15 RWASH was well undertaken, we are expected to do more this year to eventually get the policies and trials implemented as they are steppingstone in the way forward.

Equal emphasis needs to be focus on micro planning especially in strengthening mechanisms for provinces in terms of organizational capacity to better communicate and work with communities. Likewise, communities need to be supported too in terms of capacity building to effectively make decisions and manage completed RWASH Projects. The role of monitoring and evaluation of projects therefore is an important component of partnership support to the RWASH program.

The current Australian Government support to RWASH is on improved access to and use of sanitation facilities and hygiene practices in every rural household and community. This is intended to be achieved by the following strategies: no subsidy funding, creating a demand for sanitation; CLTS will be rolled across the country so that individuals will build and use toilets themselves, hygiene communication focusing on people washing their hands with soap at critical times and sanitation marketing by ensuring supply chain is there to support the process.

The roles of the communities must be well established through communicated mechanisms to support these strategies. This would seem a far reached goal, we could assume but the greatest assurance of success on this comes if communities are fully supported in terms of capacity building to RWASH community-based organizations and improved monitoring by provincial RWASH.

Solomon Islands has prepared several policies in facing the 2016–2030 Sustainable Development Goals (SDGs) through The National Development Strategy (NDS) 2016–2035. The Solomon Islands National Development Strategy establishes a vision for the developmet of socio-economic by focusing on creating the change and livelihods environment, the vision is “Improving the Social and Economic Livelihoods of all Solomon Islanders.” To achieve the SDGs target 6.1 and 6.2, Solomon Islands developed the Medium Term Strategy (MTS) 2016–2020 by build and upgrade physical infrastructure and utilities with an emphasis on access to productive

resources and markets, and to ensure all Solomon Islanders have access to essential services (MTS 3), and MTS 5, alleviate poverty, improve provision of basic needs, and increase food security.

According to the RWASH Strategic 2019 targets for rural areas indicated the access to an improved drinking water target to be 52%; however, 65.9% was achieved already in 2018 and remained the same till 2020. Nationally, the achievement was 73.1% (2020) compared to 74.3% in 2016. The urban improved drinking water coverage was 95% throughout 2016–2020. Unfortunately, the 2019 open defecation free target for rural areas was 87% (13% practicing), but in 2020 still 58% was practicing open defecation in the rural. This was only 1% improvement from 2016 (59%).

In addition to current targets being high and unattainable within the existing capacity and funding context, there is some uncertainty due to the use of communities and villages when calculating the coverage nationally rather than just using percentage of the total population.

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11 Poor Water Quality and Related Health Issues in Remote Indigenous Populations of Some of the World's Wealthiest Nations

Jay Rajapakse, Brian Hudson, and Charlotte Brown

Abstract

The water supply and sanitation problems in developing countries have received considerable attention, but for similar communities in wealthier countries living conditions are often overlooked. This is particularly true in remote indigenous communities where water supply and sanitation conditions can be compared with those in poor developing countries. It is estimated that indigenous nations constitute some 370 million individuals, representing more than 5000 distinct peoples, living in more than 90 countries in all inhabited continents. Most of them live in developing countries, but there are also significant groups in countries with advanced economies, such as the USA, Canada, and Australia. Two case studies for each of these countries are presented highlighting the barriers to change and some efforts to overcome them in some of these communities.

Keywords

Remote communities · Indigenous populations · Rich nations · Water quality · Water treatment

11.1 Introduction

Despite the apparent overall success of the MDG program, the published data do not accurately reflect the complete truth about the global water supply and sanitation situation. By employing almost exclusively aggregated targets and indicators, this information is misleading and undermines efforts to provide safe water for the hardest-to-reach remote communities in both developed and developing countries. The water supply and sanitation problems in developing countries have received considerable attention, but for similar communities in wealthier countries living conditions are often overlooked. This is particularly true in remote indigenous communities where water supply and sanitation conditions can be compared with those in poor developing countries. It is estimated that indigenous nations constitute some 370 million individuals, representing more than 5000 distinct peoples, living in more than 90 countries in all inhabited continents (UNDESA, 2009). Most of them live in developing countries, but there are also significant groups in countries with advanced

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economies such as the USA, Canada, and Australia (Jiménez, et al., 2014). This chapter discusses water quality issues and related poor health of indigenous populations in the world's wealthiest nations.

11.2 Water and Health Conditions in Remote Indigenous Populations

Drinking water quality is paramount for human health, be it related to physiological needs or the transmission of numerous infectious diseases and spread of chronic illnesses (Howard, et al., 2020). Microbiological contamination is the main cause of waterborne disease at a global scale. It is linked to diseases such as cholera, diarrhoea, dysentery, hepatitis A, typhoid, and polio (Rasiah, et al., 2020). Perhaps more concerning to developed nations is the level of chemical contents in water supplies when associated with long-term exposure. Examples include effect of disinfection by-products (DBPs) on colon and rectal cancers, high levels of fluoride associated with dental and skeletal impairments, cardiovascular disease and diabetes. High nitrates and arsenic contents are associated with various cancers, suspected chronic kidney disease and diabetes (Benmarhnia, et al., 2018; Rajapakse, et al., 2018; Villanueva, et al., 2014; Kurdi, 2016). To this day many remote indigenous populations in the developed nations of the USA, Canada, and Australia suffer ill health caused by microbiological and chemical contamination in their drinking water.

11.2.1 United States of America

Although some countries record a higher per capita income, the USA is generally recognized as being the wealthiest nation in the world (World Population Review, 2021). At the same time, it has one of the highest rates of income and wealth inequality on earth (Goodman, 2019). This disparity is recognizable between and within many of the country's towns and cities, but it is no more demonstrated than in the contrast between some of the prosperous, urban regions of America, mainly situated on the coast, and the remote, largely inland communities of American Indians and Alaska Natives (AIAN). Many of these peoples were displaced from their native homelands in the nineteenth century and forced to settle in 'reservations' designated by the US government. The Centers for Disease Control and Prevention (CDC) 2017 snapshot highlights the long experienced disparities in health. American Indians and Alaska Natives have a life expectancy that is 4.4 years less than all US races (Office of Minority Health Resource Center, 2021). In addition, they are:

- Almost three times more likely than non-Hispanic white adults to be diagnosed with diabetes
- 50% more likely to be diagnosed with coronary heart disease than their white counterparts
- 50% more likely to have obesity than non-Hispanic white adults
- 20% more likely to have asthma
- More likely to have liver, IBD, stomach, kidney/renal pelvis cancer than non-Hispanic white women and men (2012–2016)
- At greater risk of dying from an infectious disease than non-Hispanic whites.

These disparities are commonly associated with remote and isolated regions, challenged by lack of infrastructure and access to water and sanitation.

Disparities have been further exposed and amplified by COVID-19. Native Americans account for 75% of COVID-19 deaths in New Mexico and 12% in Arizona, despite only accounting for 9% and 4% of the population, respectively. These statistics represent the symptoms of the problem rather than the cause. Although access to health care and socioeconomic factors such as overcrowded housing contribute to these health disparities, deficient hygiene and poor water quality are among the several contributing factors (Jones, 2006; Shah, et al., 2020; National Indian Council on Aging, 2020; Hoover, et al., 2017; Lewis, et al., 2015).

These factors are reflected by WHO 2017 SDG6 data, with 1.75 million people in rural

North America only having access to unimproved water services, which by definition is 'Drinking water from an unprotected dug well or unprotected spring'. The remaining rural population has access to basic services, whilst 99.67% of urban populations enjoy safely managed drinking water services. This indicates that remote communities are greatly disadvantaged by not having access to water on their premises which is available whenever needed, and/or where the water supply is contaminated (WHO/UNICEF Joint Monitoring Programme (JMP), 2017).

According to research performed by the First nation Development Institute, the commonly cited statistic that 72% of American Indian and Alaska Native (AIAN) people live in urban areas is inaccurate. It is reported that 54% of AIAN people live in rural and small-town areas, and 68% live on or near their tribal homelands. In a world that is driven by data-based decision-making, rural AIAN communities are left underfunded by federal agencies and private foundations due to these misunderstandings about the size and significance of their populations. These rural native communities are believed to be the most in need, displaying some of the highest poverty rates in the USA (First Nations Development Institute, 2017). Statistics suggest that AIAN people are disproportionately more likely to suffer a lack of access to safely managed drinking water services.

Several reports have found that Americans have been supplied with water containing contaminants above maximum levels on numerous occasions. In 2015 at least 18 million Americans were served water with lead violations, with excessive levels of lead contamination in almost 2000 water systems in all 50 US states. A study in 2016 found that levels of cancer-linked chemicals, polyfluoroalkyl and perfluoroalkyl substances exceeded MCLs in drinking water supplies for six million people. Another 2016 study determined that chromium-6, a class 1 carcinogen contaminated water supplies affecting at least 250 million Americans in all 50 states (Collaborative on Health and the Environment, 2019). Alarming contamination violations can be found across rural AIAN reservation communities, with some violations lasting over many generations of First Nations people.

The following two examples serve to illustrate the problems experienced by Native Americans who live in areas where the supply of drinking water and the provision of hygiene facilities are below the standard enjoyed by the majority of the US population.

The Navajo Nation

The Navajo Nation (Dine'é) is the largest Indian reservation in the USA, covering an area of about 70,000 km^2 in portions of three states: Arizona (AZ), New Mexico (NM), and Utah (UT). The Navajo Nation is generally sparsely populated and according to the 2010 Census, 173,667 people live on the Navajo Nation (Hoover, et al., 2017). Approximately 30% of Navajo Nation households lack access to a public water system and may consume water from an unregulated source.

Much of the Navajo Nation land was disturbed by surface and underground uranium mining. More than 10,000 abandoned uranium mine waste sites are located throughout the western United States. On Navajo Nation, in the Four Corners region of the South Western United States, 1100 of these sites remain associated with more than 500 abandoned mines containing mixtures of uranium (U), arsenic (As), and other metals.

Individually, arsenic (As) and uranium (U) are known to harm human health. According to Hoover et al. (2017), chronic exposure to As is associated with neuropathy, developmental disabilities, decreased IQ, numerous skin disorders, hypertension, and cancer of the skin, lungs, bladder, and kidney (Abernathy, et al., 2003; Buchet & Lison, 2000; Kapaj, et al., 2006; Kavcar, et al., 2009). Exposure to U through drinking water is another public health concern as it is a known nephrotoxicant (Kurttio, et al., 2006; Vicente-Vicente, et al., 2010).

As and U were detected simultaneously in approximately half of the sources throughout Navajo and were positively correlated throughout Navajo, except in Chinle Agency where no significant correlation was observed. Overall, 3.9%

of the sources simultaneously exceeded both the As and U maximum contaminant levels (MCL); however, the proportion was highest in the Western Agency where more than 7% of sources exceed both MCLs.

Stories of the fatal health impacts of uranium-contaminated water abound. A native American family lived and drank water from a spring located on Navajo Nations in north-eastern Arizona, located near the Claim 28 mine waste site (Blake, et al., 2015). The family claims that seven of the ten children died of a disorder called Navajo neuropathy, which is linked to uranium contamination. Elevated concentrations of uranium, ranging between 67 and 169 μg L^{-1}, were measured in spring water sources on the abandoned mine waste and also 5 km away from the Claim 28 mine waste location. These concentrations are 2–5 times higher than the USEPA of 30 μg L^{-1} for regulated drinking water (Morales, 2017).

Unfortunately, elevated As and U concentrations are regularly observed in unregulated sources, all throughout the Navajo Nation, especially those near abandoned mine sites. The elevated occurrence frequency is concerning because there are several thousand homes located near abandoned mine sites that lack public water access. If people in these areas haul water from unregulated sources located near abandoned mines, like the aforementioned family, there is a greater potential for As and U exposure (Hoover, et al., 2017).

Navajo people have been exposed to these conditions for three generations. Connected to the land by tradition, it is neither culturally nor economically feasible for these families to relocate. With only enough federal funding to clean up 40% of the abandoned mines, it will take generations for the Navajo to be free of uranium contamination (Morales, 2017).

Crow Reservation

The Apsaálooke (Crow) people live in south-central Montana, on a reservation centred in the tribe's original homelands. It is home to nearly 70% of Apsaálooke Tribe's 13,260 members and encompasses 2.2 million acres of traditional territory, including three mountain ranges and three large river valleys. Communities are mainly located along the Little Bighorn River, where the municipal water treatment plant now draws surface water from.

Historically, families drew water directly from the river for both household and ceremonial consumption. For Apsáalooke people, water is imbued with spiritual power—a living force with its own energy. Given their traditional ties to the river, communities observed its visible deterioration in the late 1970s, with the intensification of both ranching and farming, and a growing population. As river water quality worsened, people lost this source of water for domestic, recreational, and ceremonial uses. Rural families switched from collecting river water to relying on their then newly installed home wells for domestic use.

A 2021 study of Apsaálooke people corroborates this, finding that almost all of the participants had home wells, and about only half of them reported that their tap water was drinkable. A Community Engaged Cumulative Risk Assessment showed that approximately 55% of Crow Reservation homes have unsafe well water. Of the home wells tested, 40% were found to be unsafe for lifetime consumption due to the combination of manganese, uranium, arsenic, and/or nitrate contamination. An overlapping 40% were also found to be coliform contaminated, indicating risk of faecal contamination. The majority (93%) of the wells were found to have total dissolved solids exceeding Environmental Protection Agency (EPA) standards from the time they were drilled (Martin, et al., 2021).

Understandably, reservation community members have become concerned that contaminated home well water was contributing to perceived cancer clusters and relatives developing diabetes. Additionally, concerns are being raised over people getting sick from the river water, with it being known to have *H. pylori*, *E. coli*, and *Cryptosporidium* yet still being used in many ceremonies. Such concerns are justified given arsenic is a known carcinogen, uranium can cause kidney failure, manganese is a neurotoxin that can alter brain development and functioning, and

E. coli is a bacterium that can produce acute gastrointestinal symptoms. To avoid health risks and unpalatable tastes, families have to haul drinking water an average of 84 miles and pay up to $300 monthly for clean water. A shocking 80% of families have limited options and are captive to drinking and cooking with untreated well water, despite discolouration, odour, and high level of contaminants (Martin, et al., 2021).

Community concerns, failing water, and wastewater infrastructure led to the development of the independent community entity, Apsaálooke Water and Wastewater Authority (AWWWA) and later the Crow Environmental Health Steering Committee (CEHSC) to reduce health risks and health disparities from unsafe drinking water and contaminated rivers. Since 2004, the AWWWA and CEHSC have been working to improve both drinking water and river water quality. Research beginning in 2005 to understand reservation-wide water contamination and related health issues has concluded that water contamination is the most serious health threat affecting the greatest number of tribal members. The committee has been able to research and document serious microbial contamination of the rivers, a water treatment system in Crow Agency unable to remove all parasites during spring runoff, widespread metals, nitrate, and microbial contamination of home well water and threats to community water supplies (Doyle, et al., 2018).

CEHSC research has further suggested that impacts of water insecurity on community health and well-being were far broader than the quantitative methods captured. For Crow people, the changes in and deterioration and contamination of local ecosystems, including traditional water sources, are impacting not only physical health, but also Tribal emotional and spiritual health, as environmental, tribal, and individual well-being is completely interrelated (Martin, et al., 2021).

The AWWWA and CEHSC continue to work towards improving water and wastewater infrastructure by securing almost 50 federal, state, county, and tribal grants and several loans, totalling more than $20 million. To name a few initiatives, with this funding they have been able to upgrade water and wastewater connections, replace 50% of water lines, and install a 'water salesman' to sell town water at minimal cost to any community member. There is still much progress to be made; however, the strategies and initiatives developed by the AWWWA and CEHSC's provide opportunities for other vulnerable rural communities dealing with similar challenges, especially Native American communities that share unique disadvantages from laws and regulations (or lack thereof) (Doyle, et al., 2018).

11.2.2 Canada

Contiguous with the USA, and sharing a similar culture and standard of living, is Canada, another of the world's richest countries. Like its southern neighbour, Canada, too, has a diverse population that includes a significant indigenous minority. The majority of Canadians live within 300 km of its southern border with the USA, most of the country north of the 50° parallel being very sparsely populated. It is in this vast northern territory that is located the typical settlements inhabited by Aboriginal or First Nations people. Approximately 60% of indigenous Canadians compared to 33% of non-indigenous peoples live in predominantly rural regions. Canada has a system of government established 'Indian Reserves', but most Canadian Aboriginal people live outside these areas, many in communities that are governed by land claims or self-government agreements (Organisation for Economic Cooperation and Development, 2020).

Most Canadians have ready access to sufficient, affordable, and safe drinking water and adequate sanitation, but this is not true for many First Nations indigenous people. In stark contrast, the water supplied to many First Nations communities on reserves is contaminated, hard to access, or at risk due to faulty treatment systems (Patrick, 2011; Human Rights Watch, 2016). In Canada's First Nations communities, 39% of the water systems are considered 'high risk', and First Nations communities have 2.5 times more boil water advisories (BWAs) than non-First Nations communities (Eggertson, 2006; Patrick, 2011; Spence & Walters, 2012; Dupont, et al.,

2014; Wright, et al., 2018a, b). At the end of 2008, close to 20% of all first nations communities across Canada were living with Drinking Water Advisories (DWA), where a DWA is issued as a precautionary measure when specific chemicals or pathogens in a water supply reach high enough concentrations to pose a threat to human health (Eggerston, 2008; Harden & Levalliant, 2008). Most DWAs are boil water advisories reflecting problems with the treatment process or in the distribution system with drinking water supply being potentially unsafe and poses a risk to public health. While DWAs are meant to be a temporary measure to protect public health, many indigenous populations face frequent or long-standing DWAs: between 1995 and 2007, Health Canada reported that the average duration of a DWA in First Nations communities was 343 days, although some communities have faced advisories lasting over 15 years (Government of Canada, 2016; Health Canada, 2009).

The number of waterborne infections in First Nations communities is an alarming 26 times higher than the Canadian national average (Basdeo & Bharadwaj, 2013). This alarming level of drinking water service is corroborated by JMP 2017 SDG6 data, where a reported 76,450 people in rural Canada are living with unimproved water services and the remaining rural population with only basic water services.

These WASH conditions, comparable to developing nations, are a reflection of how the colonial structure of Canada has contributed to the health inequities that exist today. Forced displacement into remote communities and reserves that were barely habitable and lacking in resources, as well as systematic discrimination against all indigenous peoples across social, criminal justice, health care, and employment environments, are cumulative factors to the lower life expectancy rates of indigenous peoples in Canada to that of non-indigenous peoples. In the case of Inuit men, life expectancy is 15 years lower than that of non-indigenous men (Public Health Agency of Canada, 2018).

Across a wide range of indicators, the health of indigenous peoples remains poorer than that of non-indigenous Canadians with higher rates of chronic diseases and infectious diseases, especially for those residing on reserves in rural areas (Richmond & Cook, 2016). The prevalence of arthritis, asthma, diabetes, and obesity is higher among First Nations adults living off-reserve, First Nations adults living on reserve and in northern communities, and Métis adults than among non-indigenous adults. Additionally, the incidence of tuberculosis is 300 times the rate of Canadian-born non-indigenous people for Inuit peoples and 32 times for First Nations people living on reserve (Organisation for Economic Cooperation and Development, 2020; Kim, 2019). A review of the Canadian's Public Health Infobase revealed the following:

- The incidence of Chronic obstructive pulmonary disease (COPD) in seniors for First Nations off-reserve/Inuit/Métis is 1.65 times non-indigenous Canadians.
- The incidence of Asthma in adults for First Nations off-reserve, Inuit and Metis people, is, respectively, 1.63, 1.53, and 1.63 that of non-indigenous Canadians.
- The incidence of diabetes in seniors for First Nations off-reserve, Inuit and Metis people, is 1.61 that of Non-Indigenous Canadians.
- The incidence of decay-missing-filled-teeth for children aged 6–17 years for First Nations off-reserve/Inuit/Métis is 1.53 times the population not identifying as a visible minority (Pan-Canadian Health Inequalities Data Tool, 2017).

The Canada distinctions-based data on indigenous populations is woefully insufficient, as stated in the Annual Report to Parliament 2020. It recognized that to close socioeconomic gaps and achieve substantive equality, more information and data is required to measure progress and identify areas of concern (Indigenous Services Canada; Crown-Indigenous Relations and Northern Affairs Canada, 2020).

Inuit Communities of Labrador

One of the highest self-reported incidence rates of acute gastrointestinal illness (AGI) occurs in Inuit communities in the Canadian Arctic. The Inuit community of Rigolet is in the Nunatsiavut Land Claim Area, along the northeast coast of

Labrador, Canada. Rigolet is a remote community, accessible only by air in the winter or by boat in the summer months. There are no ice roads or groomed trails connecting communities. In 2011, Rigolet had a population of 306 residents, with 85% of individuals self-identifying as Inuit (Wright, et al., 2018a, b).

In 2014 a potable water dispensing unit (PWDU) was installed as a new drinking water source in Rigolet. According to Wright et al. (2018a, b), tap water was available in all households; however, three-quarters of the population now choose to consume water from the PWDU, with 80% of households storing water in containers. Varying types of containers are used, the majority being plastic wide-mouthed buckets or narrow-mouthed jugs. The frequency of container cleaning is low, with 67% of sampled containers cleaned once per month or less; and 43% had never been cleaned. In 25.2% of water storage container samples, and 18.2% of tap water samples total coliforms were detected. Although the presence of total coliforms is not always dangerous to human health, they indicate the presence of other harmful faecal pathogens, such as *Giardia*, *Cryptosporidium*, enterotoxigenic *E. coli*, or other waterborne agents that can cause AGI (Yates, 2007).

This study estimated an AGI annual incidence rate of 2.4 cases per person per year, representing a significant burden of illness in the Rigolet community (Wright, et al., 2018a, b). Like challenges experienced by other international studies, no water-related risk factors were significantly associated with AGI in this study, despite findings of microbial contaminants in stored water (Pickering, et al., 2010).

Another study by Hanrahan, Sarkar, and Hudson (2014) in Black Tickle, an Inuit community in the province of Newfoundland and Labrador revealed that the chronically and severely compromised water security of the community was linked to poverty, food insecurity, men's health, and mental health. It indicated high levels of *E. coli*, high levels of carcinogenic disinfectant by-products and qualitatively a low perception of water safety and trust of the PDWUs. Gastrointestinal infections were common, with an outbreak in 2012 impacting every household and demographic. Due to a lack of piped sewer system, waste is carried on the same sleds that are used for water retrieval, corroborating Wright et al. (2018a, b), suggesting an increased risk of contamination between source and point-of-use.

The water's high turbidity due to high iron content and/or natural organic matter has made it visually unappealing, resulting in restricted water consumption. This is due to high rates of sugary beverage consumption as an alternative to drinking water. The study showed that parents add Kool-Aid™ to water to encourage children to drink or offer Pepsi™/Coke™ as a cheaper alternative to bottled water. As a result, Black Tickle residents confirmed high rates of diabetes and an estimated obesity rate of 80%. Unfortunately, residents understand the health compromises, however, do not have any other option.

First Nations Communities in the Province of Ontario

Between July 2015 and April 2016, Human Rights Watch conducted research in First Nations communities in the province of Ontario to understand the impacts of the First Nations water crisis. First Nation communities examined included Batchewana, Grassy Narrows, Shoal Lake 40, Neskantaga, and Six Nations of the Grand River First Nations. Contaminants found in drinking water included coliform, *Escherichia coli* (*E. coli*), cancer-causing trihalomethanes, and uranium (Human Rights Watch, 2016). A summary of problems identified for each First Nation community includes:

- Batchewana First Nation: High turbidity, high sulphur content and uranium contamination in the well water.
- Grassy Narrows First Nation: In the 1970s a chemical plant dumped 9000 kg of mercury into its watershed. Wells and the community water system have tested positive for high uranium content and cancer-causing chemicals from a by-product of disinfection.
- Neskantaga First Nation: The indigenous and Northern Affairs Canada funded community water system built in 1991 has been on a boil water advisory since February 1995.

- Shoal Lake 40 First Nation: Relocated to a man-made island in the early 1900s, with running water installed in 1995 and a drinking water advisory imposed in 1997. The community now relies on bottled water transported to the island by barge or an ice road.
- Six Nations of the Grand River (SGNR): Construction of a state-of-the-art water treatment facility in 2013 did not include expansion of the service lines, with the majority of SNGR residents still getting their water from private wells or cisterns.

Whilst waterborne illnesses and related deaths have been mostly avoided through water advisories (alerts), social costs and human rights impacts are considerable. In communities like Neskantaga and Shoal Lake 40 First Nations, where advisories have been in place for 20 years each, a whole generation of children have grown up unable to drink water from their taps.

11.2.3 Australia

Situated on the opposite side of the world from the USA and Canada, Australia nevertheless shares with those North American countries a similar culture and standard of living. Australia has been inhabited much longer than the Americas, and its Aboriginal people form a distinctive minority whose traditional way of life now survives mainly in the sparsely populated interior of the island continent, the Australian 'Outback'. As in North America, the remote indigenous communities in Australia lack the facilities and services normally enjoyed by the majority of the population.

The term Aboriginal Australian is split into two groups, Aboriginal peoples, being those who already inhabited Australia before British colonization in 1788, and Torres Strait Islander peoples, descendent from the residents of the Torres Strait Islands. British settlement brought widespread and fatal diseases, as well as the impoverishment of their communities. Aboriginal Australians continue to endure the impacts of historic human rights abuses or indirectly by the systematic inequalities that they give rise to (Shepherd, et al., 2012). Only in 2008 did the Australian Government issue a national apology and launched the Closing the Gap (CTG) strategy to reduce social disparities between Aboriginal Australians and non-indigenous Australians.

The ongoing poor health status of First Australians reflects the impact of the British settlement and historic marginalization and inaction from the Australian Government. According to the Australian Medical Association (2018), Aboriginal Australians have on average 2.3 times the disease burden of non-indigenous people and lower life expectancies that lessen as remoteness increases whilst remaining comparable for non-indigenous Australians. Poor water quality is one of the causes of this higher disease burden. The following disparities are reported for various health conditions.

- Indigenous Australians were 2.2 times as likely to report having COPD and 1.6 times for asthma as non-indigenous Australians (2018–2019).
- Indigenous adults were 2.8 times as likely to report having diabetes as non-indigenous adults (2018–2019).
- Indigenous Australians were 1.5 times as likely to report having a circulatory condition as non-indigenous Australians (2018–2019).
- The proportion of having long-term kidney disease was 3 times as high as the proportion of non-indigenous people and 2.3 times more likely for those living in remote areas (2018–2019).
- Cancer incidence was higher for indigenous Australians than for non-indigenous Australians (2011–2015).
- By age 14–15, indigenous children had on average, twice as many decayed teeth, 2.8 times the number of missing teeth and 1.4 times the number of filled teeth than non-indigenous children (2010).

(Australian Institute of Health and Welfare, 2021; Australian Institute of Health and Welfare, 2015)

Regrettably, improvements to health disparities between indigenous and non-indigenous and remote and non-remote populations have plateaued since 2006. Preliminary improvements were attributed to targeted health care, but for continued progress, socioeconomic disadvantages, including equal access to safe drinking water, need to be addressed.

Rural and remote communities of Australia do not have the same level of access to safe drinking water services as urban regions. WHO 2017 UNICEF data reports that 100% of the rural Australian population have access to basic drinking water services, whilst this is only 1.2% for urban populations (WHO/UNICEF Joint Monitoring Programme (JMP), 2017). These populations in remote communities endure additional challenges based on Australia's unique geology, weather and environmental conditions found in isolated areas, creating a spatial disconnect between water locations and communities. Evidently, 553,280 rural Australians do not have access to piped water systems, leaving them further exposed to contaminated water that does not meet required drinking water quality standards (Bain, et al., 2014). With approximately one-quarter of Aboriginal people living in remote or very remote areas, compared with only 2% of the non-Aboriginal population, indigenous Australians are statistically more likely to endure the negative flow-on effects of poor water quality on health outcomes (AIHW, 2019).

Although access to safe water has improved in recent years in remote communities, many residents continue to endure challenges with drinking water quality and the associated health issues. As noted by (Hall, et al., 2020) in 2016, a report by the Commonwealth of Australia indicated that remote and very remote locations health outcomes are dictated by a variety of environmental health factors. Health hardware was a major concern, with the quality of supporting infrastructure and services not meeting equivalent standards in non-indigenous communities.

Three WHO 'neglected tropical diseases' primarily found in developing nations and directly related to hygiene and access to clean water remain prevalent in the remote indigenous communities of Australia. Remote indigenous communities of northern Australia have some of the worst rates of scabies worldwide. Soil-transmitted helminthiases are also of concern in some indigenous communities, particularly in Queensland, Northern Territory, Western Australia, and New South Wales. Australia is also the only developed country where Trachoma eye infections have not been eradicated and are endemic in the indigenous communities. Infection of each of these conditions is correlated with a range of WASH-related factors including limited access to clean water and crowded housing, contributing to unhygienic practices. The presence of both trachoma and skin infections is indicative of the ongoing need to provide access to clean water supplies. Numerous case studies of indigenous communities' evidence the exceedances of Australian water quality standards, particularly in Western Australia and the Northern Territory where high levels of nitrates and uranium have been found in drinking and household water supplies (Hall, et al., 2020).

Goldfields of Western Australia

Many Australians living in remote communities are subject to unhealthy and sometimes illegal levels of contaminants in their drinking water. Very few remote communities in Western Australia have access to treated drinking water and most remote communities rely on raw groundwater commonly containing uranium and nitrates with concentrations several times that of the Australian Drinking Water Guideline values (Rajapakse, et al., 2018).

Similarly, a report published in 2020 on The Western Desert Kidney Health Project (WDKHP) included six remote Aboriginal homeland communities with populations between 15 and 200 people and five small outback towns with populations from 180 to 900 people in the Goldfields and the Western Desert. Approximately 80% of the Aboriginal population participated in the study on the prevalence and risk factors of type 2 diabetes (T2DM) and kidney disease. It concluded that drinking water quality in this remote

area is known to be poor and is likely a significant contributing factor (Jeffries-Stokes, et al., 2020).

The WDKHP found that 66% of Aboriginal women, 46% of Aboriginal men, and 46% of Aboriginal children had some degree of haematuria, suggesting irritation or inflammation in the renal tract. Uranium ingestion is a common cause of renal inflammation and damage and is further exacerbated by the presence of nitrate and the formation of uranyl nitrate.

The study also found that 70% of participants had a urine pH of 6 or less. This suggests a renal response to metabolic acidosis. Metabolic acidosis negatively impacts human health through a variety of pathways. It stimulates the kidneys hydrogen ions excretion, known as an acid load, leading to increased pituitary adrenocorticotropic hormone production, which in turn increases cortisol. Excess cortisol contributes to the development of insulin resistance and T2DM through an increase in visceral fat. Additionally, it causes a decrease in total body potassium, stimulating insulin secretion and reduces skeletal muscle sensitivity to insulin, contributing to insulin resistance and T2DM.

Metabolic acidosis also increases the risk of renal stones, which is found to be highly prevalent in the Australian Aboriginal people, especially children, from remote areas. As the body tries to maintain blood pH through the acid load, the mitochondrial function in cells is impacted, shortening the life span of cells, and in particularly kidney cells, contributing, ultimately, to renal failure.

Chronic metabolic acidosis is likely a result of the presence of potentially toxic contaminants, such as chloramine, nitrate, and uranium in the water of remote town and communities. The drinking water in the majority of the study was heavily contaminated with nitrates and, in at least one community, uranium. Eleven regional towns in Western Australia have been exempt from the Australian drinking water guidelines for 10 years due to excessive nitrate contamination. The water from bores is often not filtered of the naturally occurring uranium and nitrate contamination. Metabolic acidosis is influenced by nitrate and nitrite ingestion, which has also been associated with increased risk of cancer, thyroid disease, T2DM, birth defects, non-alcoholic steatohepatitis (fatty liver), Alzheimer's disease, hypertension, and cardiovascular disease.

Goldfields and Western Desert remote communities water quality challenges are not isolated incidences. In 2015, a Western Australian Government report revealed a failure to supply safe drinking water to remote Aboriginal communities in various parts of the state (AHCWA, 2015; Office of the Auditor General, 2015). In more than 90 communities the quality of drinking water was often below official Australian standards. Testing over 2 years ending in June 2014 detected either *E. coli* or *Naegleria* microbes in at least one community every month.

In the same period, four communities were found to have water supplies containing unsafe levels of uranium, while 14 communities had water containing a concentration of nitrates above the safe level for bottle-fed babies under 3 months old. Similarly, groundwater chemical analysis by RPS (2015) at Wiluna showed 83% of nitrate-N and 79% of uranium samples exceeding WA guidelines (Rajapakse, et al., 2018).

A case that attracted media attention is the remote settlement of Buttah Windee and its success in implementing a safe water supply for its community. This small community of 50 residents is located 3 km from the town of Meekatharra, beyond its reticulated water supply system. Buttah Windee relies on bore water, which was suspected by a local Yamatji man, Andrew Binstar, to be contaminated when all the fish in his backyard koi pond died. He twice sent a sample of the water away to be tested, and twice was informed that it contained uranium levels of 0.04 mg/L, more than twice the official maximum safe level (See ABC News).

Appeals to the State Government for a safe water supply were rejected on the grounds of expense. Faced with the problem of undrinkable tap water, most of the 50 residents of Buttah Windee moved away. The official policy was to close what it regarded as unviable small remote communities and to house their residents in larger settlements. Unwilling to expose his community

to what they saw as the social problems there, Mr. Binstar rejected the offer and installed a 9000-L tank on each of his community's four houses. The tanks were filled with tap water from the town supply for drinking and cooking (Allam & Wahlquist, 2018). The relatively short distance between Buttah Windee and the town of Meekatherra makes possible the trucking of water as a solution, but for many remote communities, this would be too expensive. At Buttah Windee, however, a more viable solution was implemented, offering hope for even the remotest small settlement in an arid region.

In 2018, Mr. Binstar began a fundraising effort to provide a safe water supply for his community. This achieved a generous public response, and funds raised were used to construct a reverse osmosis water treatment plant. This removes all contaminants from the water and introduces vital minerals necessary for human health. The campaign came to the attention of the Director of Wilco Electrical, a Perth based majority Aboriginal-owned company. This led to the installation at Buttah Windee of six solar hydro panels which capture up to 900 L of pure water per month from the air for the residents (Bayens, 2019).

The case of Buttah Windee provides hope for the many remote Aboriginal communities without access to clean drinking water in Western Australia. However, at current most remote Western Australian communities continue to rely on raw groundwater to supply domestic water, often without treatment. Corroborated by chemical analysis of groundwater consumed by indigenous Australians living in remote communities; it is likely these communities are unwittingly ingesting high levels of nitrates and uranium. The negative flow-on effects of poor water quality are reflected through the higher disease burden experienced by the Aboriginal populations in these communities.

Desert Communities of Northern Territory

A review of Power and Water's annual report on the water quality in remote communities for 2016–2017 and 2015–2016—the most recent publicly available versions—has identified an increase in the elevated uranium levels of three remote Northern Territory Aboriginal communities. Laramba water had levels of 0.047 mg/L, Willowra's 0.033 mg/L, and Wilora 0.023 mg/L. Willowra and Laramba have had elevated levels of uranium at least as far back as 2008. In addition to 17 or fewer other remote communities, depending on the parameter, Wilora also has drinking water above the thresholds for chloride, hardness levels, iodine, sodium, and total dissolved solids (Power and Water Corporation, 2018; Davidson, 2018).

Similarly, the community of Alpururrulam is another example of poor water quality in the Northern Territory. Their water has levels of hardness and total dissolved solids like potassium, calcium, magnesium, chloride, sulphate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate, and phosphate well above the Australian Drinking Water Guidelines (ADWG). Dr. Lawton a kidney specialist and clinician in the Northern Territory has noted that people in these communities with early-onset kidney disease tend to have much faster rates of progression towards losing kidney function entirely and ending up on dialysis or needing a kidney transplant. However, there is a lack of data to confirm Lawson's and the community's concerns. To determine a possible relationship between drinking water and chronic kidney disease, Lawson is commencing research in 80 Northern Territory communities, studying de-identified blood and urine tests and water quality testing conducted over 17 years (ABC News, 2021).

11.3 Challenges to Progress – Lack of Funding and Political Will

Historically, the key challenge to clean water and sanitation has often been the lack of funding and political will for action by key decision-makers. Investing in water quality and water quantity is important in protecting public health in communities. Communities must also have the will, and

the financial and management capabilities to be able both to operate and maintain water projects, and to put into practice their understanding of the concepts of hygiene and disease transmission.

The issue of water quality has been discussed at length in the previous sections. As a response to water quality problems, the need for appropriate and sustainable water treatment solutions are discussed in Sect. 11.4. When it comes to water quantity, according to the World Health Organization (WHO), between 50 and 100 L of water per person per day (L/p/d) are needed to ensure that most basic needs are met to avoid major health concerns. However, in more developed countries and particularly in arid climates water demand can rise to 250 L/p/d or even higher.

The provision of adequate water supplies varies not only between different countries but also between regions within individual states. In some rich countries there are communities where standards of supply are comparable with those typical of the poorest parts of the world. Some examples of regulatory and funding issues, cases demonstrating the lack of political will, together with some success stories as a result of good stakeholder relationships, are discussed below with reference to three of the world's richest nations.

11.3.1 United States of America

Researchers in the USA have discussed the challenges and opportunities in access to safe public drinking water to vulnerable communities in the USA with particular reference to Crow Tribe. They observed that rural tribal communities, especially those with limited economic opportunities, face multiple challenges in funding, building, and successfully operating water and wastewater infrastructure. All this contributes to health disparities and environmental injustice for these communities (Doyle, et al., 2018).

For decades the Crow community was aware of the deterioration of water quality, but lacked data to support successful infrastructure grant proposals. To overcome this challenge, the Crow community partnered with researchers at Montana State University Bozeman (MSU) and Little Big Horn College (LBHC) to secure research funding, obtain access to laboratory facilities, and conduct water quality research. As a result, the team was able to gather surface and groundwater quality data to support successful infrastructure grant proposals and also inform the community of health risks of using polluted water sources. In this process, the community in collaboration with tribal college science majors have gained research experience, building the tribe's capacity to conduct research with academic partners. This is an excellent recent example of successful community/academic partnership for all remote communities around the world.

Additional challenges faced by the community include the complex jurisdictional issues. These affect many aspects of fundraising, design, contracting, construction, and the necessity to deal with physical and fiscal problems arising due to inadequate infrastructure planning. For instance, housing has been built where there is insufficient water pressure in the distribution system to accommodate more homes; the lift station serving the south end of Crow Agency was built in the flood zone and it was so damaged in the 2011 flood that wastewater service was shut down for a couple of weeks.

The authors concluded that ensuring safe public drinking water for tribal and other disadvantaged communities throughout the USA will require comprehensive, community-engaged approaches across a broad range of stakeholders to successfully address these complex legal, regulatory, policy, financial, and capacity challenges.

11.3.2 Canada

In December 2020, the Canadian Government allocated CAD$1.5 billion to accelerate work to lift long-term drinking water advisories faced by First Nations on reserves. After the advisories are lifted, the government will provide an additional

CAD$616.3 million over 6 years, and CAD$114.1 million per year ongoing thereafter to support daily operations and maintenance. This is to provide safe and sustainable drinking water to these communities. It is intended that this funding will also support training for water operators and help communities to better retain qualified operators for years to come (Canada, 2020).

In March 2016, Prime Minister Justin Trudeau announced a CAD$4.6 billion to be invested in infrastructure, including for water and wastewater systems for indigenous communities over the next 5 years. The Human Rights Watch (HRW) (Human Rights Watch, 2016) raised an important point that financial commitment alone, however, will not solve the water and wastewater crisis on First Nations reserves. HRW commented that, *'Along with infrastructure investments, the government should remedy a range of problems that contribute to the water crisis. These include: the lack of binding regulations on water quality on First Nations reserves; persistent underfunding and arbitrary budgeting for water system costs, including capital, operation, and maintenance costs; lack of support for household water and wastewater systems; worsening conditions of source water; and lack of capacity and support for water operators'*.

The HRW further states that the federal government has committed funds for water and sanitation infrastructure over several decades in these communities, but the problem persists. Investments of billions of dollars over decades have not translated into safe drinking water for First Nations living in these communities.

Regulatory and funding problems have been identified as the main issues.

- One of the main barriers was that the provincial and territorial regulations governing safe drinking water and sanitation, which protects the public health of most Canadians, do not extend to First Nations reserves. In other words, '*Systems have been designed, constructed, and operated on reserves without the kind of legal standards and protections that the government has adopted for all other Canadians'*.
- The second main issue noted by the HRW was that the federal government funds only a portion of operations and maintenance costs for First Nations' water and sanitation systems. This leaves a standard 20% deficit for the First Nations to cover, despite their limited community resources. Moreover, the indigenous and Northern Affairs Canada (INAC)—the federal department with jurisdiction over reserves, consistently struggled to spend budgeted funds and sent millions of dollars funds back to the Treasury Board as 'surplus'. This means promised dollars were unspent.
- Other challenges identified include the lack of source water protection. Often commercial activities that impact the traditional territories and waters such as lakes, rivers, and streams that contribute to the source water for these communities have deteriorated because of pollution from industry and urban development.
- Importantly, there is a lack of government support for private water and sanitation service providers. Due to inadequate government funding to upgrade, operate, maintain, or monitor these private systems are often in worse conditions than the publicly operated systems.

11.3.3 Australia

Similarly, James Horne has highlighted the lack of funding to address water quality issues for Australian remote indigenous communities. He notes that substantial public funds have been wasted 'legitimately' as responses to political decisions to satisfy political needs rather than to boost water security or sustain economic performance. Over the past two decades governments have shown little interest in addressing the issues, and political rhetoric has dominated effective action (James Horne, 2020). Horne proposes that

the Council of Australian Governments (COAG) should endorse substantial new funding underwritten by national and state governments over 5 years. This financial boost is about AU$500 million which would be used to deliver projects with good benefit-cost ratios. Horne emphasized that above all, for the successful implementation of such projects, it requires genuine political leadership with the commitment by state water service providers, state governments, the national government and most importantly community participation. Direct involvement by communities in maintenance of services and behavioural change for good hygiene practices was essential. Importantly, indigenous communities need to replace the 'free water' mindset by paid water services.

According to the United Nations, '*The right to water requires water services to be affordable for all and nobody to be deprived of access because of an inability to pay. As such, the human rights framework does not provide for a right to free water. However, in certain circumstances, access to safe drinking water and sanitation might have to be provided free of charge if the person or household is unable to pay for it*' (UN-OHCHR, 2010).

South Africa offers a useful example. The Free Basic Water (FBW) policy introduced in 2001 allowed at least 6 m^3 of free water per month for a family (i.e. 40 L/capita/day for a family of five or 25 L/capita/day for a family of eight). Interestingly, a recent study by (Thakur et al., 2019) found that the daily water consumption among indigent residents is about 286 L per person compared to the international norm of 173 L per person, therefore, putting the right to safe clean water into practice is somewhat more challenging. This study has shown that the ability of the state to effectively manage water resources in low-income areas remains a huge challenge due to poor water conservation behaviour on the part of inhabitants. The study found that this was the result of poor engagement between the municipality and the community.

11.3.4 COVID-19 Impacts – The Latest Challenge for All

The pandemic has increased awareness of both the extent and consequences of the water access gap in developed nations. It has also inhibited progress in meeting the global Sustainable Development Goal 6—clean water and sanitation for all. The restrictions due to COVID-19 on movements of goods, materials, equipment, and essential consumables, along with personnel have resulted in significant impacts to the water, sanitation, and hygiene (WASH) services.

The immediate impacts include:

- Access decline and price increase in WASH commodities and services, such as water treatment chemicals due to global supply chain damages, impacting continuity of services.
- Quantity and quality deterioration of WASH commodities and service delivery as restricted or no movements limit due diligence and quality assurance by essential staff.
- The inability of personnel to provide face-to-face handwashing and cleaning education in water-stressed communities.
- Reduction in federal and donor funding of ongoing WASH initiatives to support other COVID-19 responses (Global Wash Cluster (GWC), 2020).

Longer-term impacts will also inhibit the achievement of SDG6 by 2030, as well as other inter-connected SDGs. These impacts include a decline in the financial viability of WASH services due to loss of revenue and subsidies, and income loss by households, limiting the ability to pay for WASH commodities and services. Revenue losses by water utilities also affect their ability to make critical infrastructure investments. COVID-19 may also result in a decline in the government's ability to deliver WASH services, due to the inability to pay for loans and resulting in the diversion of domestic funding away from the WASH sector. If not managed,

these secondary COVID-19 impacts will increase the risk of further spreading waterborne and associated diseases and illnesses, disproportionately impacting the indigenous communities (The World Bank, 2020).

11.4 Water Treatment Solutions – A Key to Progress

One of the major recommendations in the effort to improve water quality in remote communities in developed or developing countries, is the implementation of effective and appropriate water treatment solutions.

Given the establishment of an effective administrative framework, there are several different technical solutions that may be implemented to provide a safe water supply to remote communities. The widespread distribution of indigenous communities means one approach is not likely to fit all. In selecting appropriate technologies for remote communities (ATRC), the following are some of the factors that need to be considered: size of communities, remoteness, access to spare parts and affordability by the communities, technologies appropriate for cultural and social conditions, locally available professionals, particularly in relation to standard operating and maintenance issues. The concept of appropriate technology (AT) evolved from the Schumacher's book *small is beautiful*, to describe more labour-intensive technologies in low-income countries, as advanced, capital-intensive technologies from industrialized developed countries were considered inappropriate for low-income countries. As Junmin Lee (2018) pointed out AT has expanded beyond developing countries to include developed nations and the definition of AT provided by Mihelcic and Hokanson, as '*the use of materials and technology that are culturally, economically, and socially suitable to the area in which they are implemented*' could still be valid (Mihelcic & Hokanson, 2005).

Thus, in the context of remote communities in developed countries, the concept of ATRC could equally apply to advanced or capital-intensive technologies, as long as technologies are appropriate for remote community applications. In the developed countries discussed above, the remoteness in one country may be different from the remoteness in another. The timeframes for initial installation and delivery of spare parts for repairs and maintenance will depend on site access. Sometimes, technologies developed with good intentions could fail to serve the intended purpose to the end-users in a remote location. For example, the provision of a Supervisory Control and Data Acquisition (SCADA), a computer-based system for gathering and analysing real-time data to monitor and control a conventional water treatment system is quite common and useful. The experience has shown that even the replacement of a simple spare part or fixing a simple software issue for a SCADA may take some days or weeks depending on remoteness. Therefore, most importantly, the chosen technology must be robust enough to produce safe drinking water in all conditions at local level. It should be easy to maintain and repair by locally trained professionals at minimum cost and repair time. Selection of a particular technology should not be primarily based on technical insight but should also integrate the human aspects such as cultural acceptability, available workforce skills, employment opportunities, and other environmental considerations such as energy use and waste disposal. The delicate balance associated with these attributes differs by community, region, and country. Selecting a sophisticated treatment system for a community with low-income families may place undue financial hardship on them (Helen E. Muga, 2008). The capital cost of construction of a water treatment system can vary significantly depending on the quality of the source water, expected treated quality, efficiency, reliability, and the source of energy for operating the system. For example, a system serving a small community of 100–200 population could vary from as low as $50,000 to as high as $500,000 based on the above factors.

Water treatment in some remote communities requires overcapitalization as it is an energy-intensive process, typically designed assuming a high-grade grid-based power supply. Without connections to the main power grid, they require

their own generators just to provide small-scale drinking water supplies. High turnover of staff limits the community's ability to maintain infrastructure and monitor water quality. The distance and limited transport availability for sampling inhibit the frequency and accuracy of monitoring to the standard of ADWG. Lack of infrastructure maintenance, such as corroded storage tanks, also results in high microbial risks (Briggs, et al., 2020).

Unfortunately, conventional solutions to the provision of utilities are expensive. For example, the Australian government spent AUD 13 million on transportation of drinking water to regional communities in 2016 (Productivity Commission, 2016). Some of the recent developments suitable for remote community water treatment are discussed here demonstrating cost of solutions of these kinds. Project Gilghi aims to address this cost–benefit challenge with an environmentally sustainable solution. Gilghi was developed by Aurecon and Ampcontrol for Ingkerreke Resource Services and made possible through Municipal and Essential Services Special Purposes Grant from the Northern Territory Government. Gilghi, first installed at the Gillen Bore outstation in 2019, provides a self-sufficient (solar-powered and off-grid) water treatment plant (WTP). The process used here involves pretreatment by media filtration (sand, carbon, and softener), a reverse osmosis (RO) unit comprising cartridge filters and final UV disinfection. Gillen Bore community relied on continued transport of drinking water due to high salinity, hardness, and low pH levels in their bore water. Gilghi now achieves potable water for less than one cent per litre with each unit capable of producing 28 kL per day from either the bore or other water sources of poor quality (Briggs, et al., 2020). The 28 kL per day system costs AU$400,000 to be delivered to Gilghi site/installed/commissioned and an additional $100k for civil works which includes the foundations for the Gilghi 20 ft container and construction of a suitable brine evaporation pond. The annual maintenance cost is around AU$10,000. A system with a capacity of 28 kL per day can provide populations of 112 (@250 L/p/d) to 280 (@100 L/p/d).

Providing clean water for Aboriginal communities is a significant step in bridging the gap. Water not only is crucial for health but also acts as a significant role in indigenous culture, clean water ensures that communities continue to care for their country and partake in cultural activities. The success of Project Gilghi provides an opportunity for wide-scale deployment across rural and remote Australia, relieving other remote communities suffering from similar challenges.

For brackish water, such as that which occurs in some remote communities, the Capacitive deionization (CDI), an upcoming desalination technology is being increasingly considered to be a simple and cost-effective solution as opposed to its greatest rival, reverse osmosis (RO). CDI is a non-thermal process that removes charged species from water using an electrical potential difference (electrical driving force on the ions) between a pair of electrodes often made of porous carbon. The membrane free structure or absence of hydraulic pressure means low energy consumption (<1.8 V), with substantial water recovery in the order of 70–80% (Bales, et al., 2020; Wimalasiri, et al., 2018). Detailed costs of these systems are yet to be established through fully operational plants.

For the treatment of surface waters (without salinity) or pre-treatment for advanced technologies treating source waters with or without salinity, simple technologies such as pebble matrix filtration (PMF) combined with slow sand filtration (SSF) are available at far less costs. This technology has been tested successfully in laboratory and field trials. Both PMF and SSF use locally available filter media such as sand and pebbles or alternative media such as crushed glass and handmade clay balls. Due to its media configuration, PMF provides low energy losses resulting longer filter run times without the need for frequent cleaning. SSFs have been in use for over 100 years due to their simplicity in design, construction, and operation. Although very reliable in removing *E. coli*, there is this misconception among some decision-makers that simple technologies such as

slow sand filters are 'old fashioned', 'inferior technology' and do not produce 'a good image for the organization'. Yet, even today, UK's Thames Water operates 114 slow sand filters to treat 70% of London's water supply, and can be successfully used in remote community applications. In 2014, there have been 2400 SSFs in use in Japan, of which small scale SSFs were dominant (Yamamura, 2014). Based on pilot trials in Papua New Guinea, the cost of a PMF/SSF system (excluding storage) comprising filter tanks made of galvanized culvert rings was estimated (2010 prices) at around AU$15,800, 29,000, and 41,000 for serving (@100 L/p/d) populations of 200, 500, and 1000, respectively (Rajapakse, et al., 2014; Rajapakse & Fenner, 2011).

11.5 Conclusion

The countries discussed in this chapter, while physically different in many ways, have one important characteristic in common: they all have highly advanced economies and are generally recognized as among the richest nations in the world. Most of their inhabitants enjoy a standard of living that is far above those less fortunate people who form the majority of the population in the world's less developed countries. Statements such as this are supported by published official statistics which provide data on a wide range of subjects for every country in the world. Unfortunately, these indicators of national wealth and quality of life often hide another characteristic that the countries discussed in this chapter have in common: disparity of income and quality of life within each nation. In the cases of the USA, Canada, and Australia, the diverse population is preponderantly of European origin, but there is substantial indigenous minority. Many of these people live in remote communities which typically lack the number and quality of services that are found in the metropolitan and other urban areas. A particularly disturbing aspect of this situation is the difference in the standard of health, including morbidity and mortality rates, and the life expectancy between the indigenous and the rest of the population. Among the most important causes of this disparity is the difference in the quality of water supply between well-serviced communities, largely in or close to urban centres, and more remote small settlements lacking in some important services relating to the maintenance of good health.

The quality of the water used for domestic purposes such as drinking, personal hygiene, cooking and cleaning, depends partly on its source, drawn directly from the ground, as in a well, or from a surface water body such as a stream or pond. In all of these cases, the natural chemical and organic qualities of the local geology and soils play an important role. In addition to natural factors such as these are several human factors including the means of collection, storage and distribution, and, importantly, impacts of human activity on the local environment such as disturbance by activities such as farming, mining, industrial development and construction, and waste disposal. These can cause pollution of water sources directly, as in wastewater discharge pipes or indirectly through seepage into the soil.

Since 2020, the water problems identified and discussed in this chapter have been exacerbated by the COVID-19 pandemic which has put greater demands on the supply of safe water, as well as adding to the burden on public health facilities. Together with the current and growing impacts of global warming, the threat of continuing COVID outbreaks and other diseases foreseen and unforeseen must be taken into account when considering our response to the problems of safe water supply and health.

Safe water supply and associated public health issues in remote indigenous populations have been much studied by official international organizations, government institutions and other research bodies. There is now abundant information available to identify the nature of the challenge presented to national, regional, and local authorities in the search for solutions. In most cases the technology exists to solve the problems, even in remote areas where limited finance may appear to be an obstacle to progress. Due to large variation in surface and groundwater quality due to natural and anthropogenic factors, combined with differences in accessibility mean that no

single technical solution is applicable to all communities, but appropriate systems exist to meet all challenges.

In the richest countries in the world, it is now necessary to prioritize the needs of those people who form the least privileged of society, notably the indigenous populations living in remote communities. With political will and appropriate technologies these problems can be solved.

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12 Common Themes, Accelerating Progress and Beyond 2030

Richard Fenner

12.1 Recognising System Interactions

None of the Sustainable Development Goals (SDGs) should be considered in isolation, as they are intricately linked in a complex system of interdependent targets and consequent actions (Cernev and Fenner, 2020). Attaining improvement toward one SDG by 2030 may come at the expense of another (Barbier & Burgess, 2017), whilst progress in one goal may be a pre-requisite to achieving success in others.

In a comprehensive analysis of the system interactions between the SDGs, Zhang et al. (2016) developed a conceptual representation based on a causal loop diagram validated from the literature and iterated with experienced practitioners. This study qualitatively identified key leverage points as: gender equality, sustainable management of water and sanitation, alternative resources, sustainable livelihood standards and global partnerships. It is an example of how this approach can be used to establish which SDGs are precursors—necessary for others to be achieved. For example, developing resilient infrastructure (SDG 9) can enhance water (SDG 6) and energy (SDG 7) provision leading to wide improvements in well-being (SDG 3), education (SDG 4), gender equality (SDG 5), sustainable cities (SDG 11), as well as stimulating economic growth (SDG 8) and so enabling more investment in resilient infrastructure. Zhang's study is critical of reductionist approaches in development, as this often prevents the interlinkages between goals being realised.

With respect to SDG 6 the potential complexity of interactions has been captured in a causal loop diagram produced by Nikolova (2016) showing the myriad of relationships between all the SDGs (Fig. 12.1). In this example SDG 6 is the specific focus of interest providing both the means for development and preservation of natural processes as well as an enabler of human well-being and sustainable development. The diagram was based on an analysis of the interlinkages of SDG 6 and the targets of the other 16 SDGs using a comparative SDG targets matrix.

An important component that physically links the SDGs is infrastructure. Thacker et al. (2019) argue that there is a synergistic feedback mechanism between the SDGs and infrastructure systems which enables the delivery of the goals (whilst the targets provide a checklist to guide the provision of infrastructure so itself is sustainable).

Cernev and Fenner (2020) classify the SDGs into the following 4 distinct groupings arguing that when progress is measured towards meeting the targets in the human and physical asset goals the impact on the four outcome/foundational

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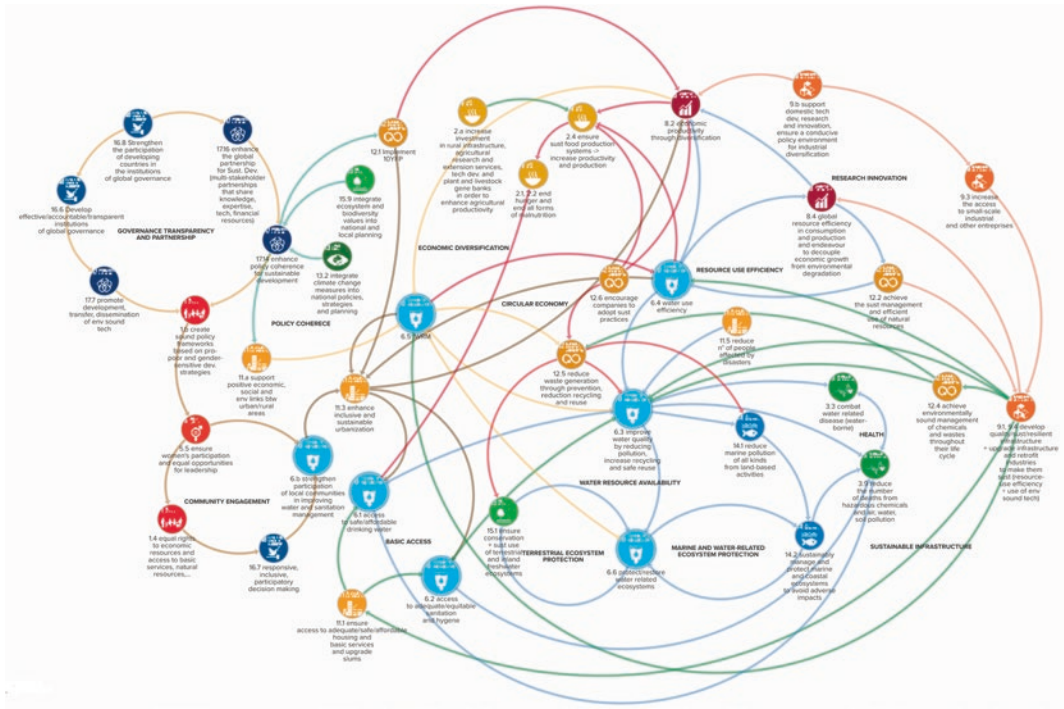

Fig. 12.1 UN Escap Visualisation map of the interlinkages between SDG 6 and the other SDGs. (Source: Nikalova A (2016))

goals must also be reported, to safeguard the integrity of the whole system.

1. *Outcome/foundational goals*

   SDG 1 (No poverty), SDG 3 (Good Health and Well-Being), SDG 14 (Life Below Water) and SDG 15 (Life on Land). These are considered to represent social and environmental improvements directly resulting from making progress towards the other goals. They are also considered foundational as regression in these goals restricts and limits the human and ecological resources required to support a safe planetary system.
2. *Human input goals*

   SDG 2 (Zero Hunger), SDG 4 (Quality Education), SDG 5 (Gender Equality), SDG 10 (Reduced Inequality), SDG 13 (Climate Action) SDG 16 (Peace, Justice and Institutions). These goals directly represent the means and capacity which may underpin (or undermine) the ability to meet the other goals.
3. *Physical assets goals*

   SDG 6 (Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation and Infrastructure), SDG 11 (Sustainable Cities) and SDG 12 (Responsible Consumption and Production). These relate to the engineered infrastructure systems needed to power and deliver essential services.
4. *Enabling goals*

   SDG 8 (Decent Work and Economic Growth) and SDG 17 (Partnership for Goals). In particular SDG 8 is considered by many to be a necessary pre-cursor to investment in other goals (e.g. Zhang et al., 2016) whilst at the same time it may indirectly create negative tradeoffs with other goals through leading to adverse consequences such as the generation of pollution (Pradhan et al., 2017).

UN Water (2016) give examples of synergies arising from increasing access to water supply, sanitation and hygiene (WASH) [targets 6.1, 6.2] in homes, healthcare facilities, schools and work-

places, complemented by wastewater treatment [target 6.3], as a way to reduce risk of waterborne disease [targets 3.1–3.3, 3.9] and malnutrition [target 2.2]. Delivering on WASH commitments also supports education [targets 4.1–4.5] and a productive workforce [targets 8.5, 8.8] and addresses poverty [targets 1.1, 1.2, 1.4], gender inequality [targets 5.1, 5.2, 5.4, 5.5] and other inequalities [targets 10.1–10.3]. Other examples of interdependencies with SDG 6 include sustainable food production systems [target 2.4], decoupling economic growth from environmental degradation [target 8.4], sustainable infrastructure and industry [target 9.4], reducing the per capita environmental impact of cities [target 11.6] and sustainable consumption and production [target 12.1–12.8].

Target 1.4 of SDG 1 No Poverty includes having equal access to basic services with the related indicator of the population living in households with access to basic drinking water, sanitation and hygiene. The inclusion of these basic water services among SDG 1 targets highlights the importance of safe drinking water and sanitation has in ending poverty. Similarly target 11.1 of SDG 11 on Sustainable Cities and Communities requires access to adequate safe and affordable housing with basic services such as sufficient drinking water and sanitation facilities.

Conversely UN Water (2016) also point to some targets related to development, such as those to double agricultural productivity [target 2.3], ensure energy for all [target 7.1], or sustain economic growth—at least 7% gross domestic product growth in least developed countries [target 8.1], which could potentially lead to negative impacts on water resources and water-related ecosystems unless linkages are understood and managed. Target 6.5 which relates to Integrated Water Resources Management requires many of these linkages to be addressed by balancing the needs of different sectors and stakeholders.

Adopting a systems approach which looks across all sectors including poverty reduction, equality and governance [SDG 1, SDG 10, SDG 16], agriculture [SDG 2], health [SDG 3], education [SDG 4], gender [SDG 5], energy [SDG 7], the economy and infrastructure [SDGs 8–12], climate change and resilience [SDG 13] and the environment [SDG 14, SDG 15] is critically important in understanding the opportunities and barriers to making progress in delivering SDG 6 and meeting its eight targets.

12.2 Emerging Themes

The chapters in this book have extensively explored the actions that are being taken across many geographical regions to address SDG 6. They reveal many of the system dependencies discussed above. This section draws together some of the key themes the book captures, contrasting the issues faced and approaches taken across regions.

12.2.1 South America

Starting in South America (Chap. 2), appeals are being made for greater intersectoral collaboration beyond WASH to tackle open defecation, calling for innovative public–private partnerships, intersectoral alliances, innovative financing mechanism and capacities to engage communities with sanitation and behaviour interventions. The latter is clearly linked to SDG 4 Quality Education. In several South American countries the differences in access to piped water between households whose head had full university education were more than 20% higher than households where the head had less than primary education. With respect to sanitation this gap was even larger with seven countries having a gap larger than 43%. The proportion of the population without water on their premises was extremely high in Peru, El Salvador, Honduras and Jamaica, with adult women usually responsible for water collection in Peru and children for fetching water in Honduras, with clear links here to SDG 5 on Gender Equality.

With regard to comparisons of inequality across South American countries, great regional heterogeneity has been observed. This ranged from around 1% difference across subgroups in Argentina for access to water supply services, in contrast to 41%

in Haiti, where water access was exclusive to only certain segments of the population. This has a direct impact on SDG 10 Reducing Inequalities. Affordability is another pervasive factor in restricting access to water and sanitation services in South America and needs to be addressed by making parallel progress in SDG 8 improving Decent Work and Economic Growth. However in many countries, such as Argentina, key statistical data is missing or not available, reflecting a lack of capacity in being able to collect it, an issue which has been made considerably worse as a result of the COVID-19 pandemic.

12.2.2 Small Island Developing States

Small Island Developing States such as those in the Caribbean face particular issues in meeting SDG 6, and these are described in Chap. 3, where all resource sectors are constrained by their geography. Although the Caribbean has islands ranging from those that are water resource rich, such as Trinidad, to those that suffer from water resource scarcity such as Barbados, most Caribbean countries have sufficient water resources to satisfy demand. It is the infrastructure, management and institutional frameworks that are lacking, with attention most needed with respect to service efficiency and infrastructure operation. Most governments in the region rely on a top-down approach to water management planning, creating dependencies on the capacity to make informed and rational political/policy decisions and their administrative capacity to execute these decisions.

Provision of wastewater services frequently lags behind drinking water supply with limited sewage treatment leading to significant water quality issues and high groundwater pollution. Issues that need to be overcome include financial constraints, inadequate legal and regulatory frameworks, fragmented approaches to and responsibility for wastewater management, together with limited and technical and operational capacity, and knowledge and awareness of low-cost wastewater treatment technologies. These experiences are echoed specifically in both Trinidad and Barbados with both islands showing good progress against targets 6.1 and 6.2 (with more than 93% of the population using safely managed drinking water and sanitation services) but with much lower success in meeting the other SDG 6 targets, such as introducing Integrated Water Resources Management. Water pricing needs to reflect production and transmission costs and scarcity whilst also ensuring that equity in access to potable water is met. Chapter 3 argues this region needs to overhaul the management approach currently in use, with too much focus on supply-led responses to meeting basic water needs, instead of a more balanced approach using demand management strategies too. The lack of this balance is claimed to have compromised the Caribbean islands ability to achieve more of the SDG 6 targets.

12.2.3 Africa

In Africa (Chap. 4) the challenges in achieving the targets for SDG 6 have been categorised under two interlinked areas: physical water scarcity and economic water scarcity, with progress lagging behind other regions. Monitoring progress is again significantly handicapped by the lack of comprehensive data (for example, in the lack of water quality monitoring programmes). Yet African countries recognise water as a fundamental human right, and whilst this is reflected in national policies, many African governments consider water and sanitation services an issue of local government delegating responsibility down to frequently ill-equipped regional levels. As a result many Sub-Saharan African countries may not be able to achieve even the target of at least basic water and sanitation services by 2030. In 2017 Sub-Saharan Africa had the lowest proportion of population with access to basic services with 61% with access to basic water supply (compared to 90% globally) and 31% for sanitation compared to >84% globally. There are also significant inequalities between rural and urban access to these services, with only 51% of rural

populations having access to improved water sources and 29% being able to access sanitation facilities.

Physical water scarcity will be exacerbated by climate change where reductions in rainfall amounts will reduce the water available to feed rivers and recharge groundwater, and temperature rises will drive water loss from surface sources through evaporation. The link with SDG 13 on Climate Action is clear, highlighting the notion that progress in other goals is critical to maintain progress in SDG 6. In addition many water resources are becoming polluted with much untreated wastewater entering the environment from industry and other sources. Therefore efforts to address targets 6.3 (improving water quality), targets 6.4 (improving water use efficiency) and target 6.5 (implementing integrated water resources management) need also to be simultaneously addressed, but the urgency here appears even less.

It is estimated in Chap. 4 that the total capital costs of improving basic sanitation are almost five times that of meeting basic water needs across the African continent, with an estimated total budget required in the region of $228 billion. However at present a daunting financial gap is exacerbated by rapid rates of population growth, rapid urbanisation and economic development, growing water scarcity and increasing costs of infrastructure involvement. It has been shown that in terms of infrastructure provision transport has the top priority across governments, followed by energy with water's share of national budgets across 48 African countries being only 18% between 2014 and 2018. As transport and energy contribute significantly to regional economic integration they have greater potential to attract private capital and foreign direct investment than water. Africa needs to do more to attract the private sector finance to the water and sanitation sectors.

An excellent illustration of the practical solutions needed to meet SDG 6 targets and advice on how things need to be done is provided in Chap. 5 which explores how safe water and sanitation are being provided in remote parts of Ghana. Similar to many countries in the Sub-Saharan region, the Ghanaian Government's attempts to provide rural communities with manually pumped boreholes are hampered by limited resources of finance, lack of local expertise and specialist equipment for drilling as well as personnel to supervise and measure installations. Estimates suggest that 2000 boreholes are still required in Northern Ghana to bring safe water to around 1.2 million people, whereas providing 10 boreholes a year at a cost of $50,000 is challenging and highlighting that meeting SDG 6 by 2030 is indeed a daunting task.

However important advice is provided in Chap. 5 for successful methods of working which reflect and respect the *wider socio-technical system* within which the provided interventions must operate; in this Ghanaian case: boreholes and pit latrines. Co-generation of solutions should be developed by listening carefully to community leaders, from which ideas are worked out together so that from the outset projects are owned, valued, operated and cared for by the community through a culture of personal ownership of projects. Importantly, uncomplicated interventions are sought which work with traditions and cultures rather than aiming to change them. A systems thinking approach which embraces all these wider constraints is a vital component in ensuring sustained operation and use of the hardware provided. Part of identifying such system constraints is to ask members of each community and to listen carefully to stories and opinions. Measurable indicators are then needed to assess the extent to which safe water and sanitation interventions actually are adding to achieving SDG 6. These should relate first to the extent to which people receive access to safe water, second the extent to which illnesses from water-borne diseases are reduced and third the extent to which the burden of responsibility for water collections falls on women and sometimes children.

Of course many boreholes and pit latrines still fail or fall out of use, and the reasons for this are expertly summarised in Chap. 5, including carrying out drilling at the wrong time of year and to insufficient depth and allowing water to be extracted without supervision and without monitoring yield. Therefore it is important to appoint a specialist drilling contractor with knowledge of

the local hydrology and experience of the drilling area. Common causes of abandonment arise from damage to the hand pump brought about by over-enthusiastic use of the pump in attempts to fill containers before the yield drops to zero, with damage commonly being caused to fixings of the pump on the concrete base as well as physical damage to the level and fulcrum mechanism of the pump.

12.2.4 Russia

In contrast to Africa and Latin America, Russia is described in Chap. 6 as having strong systems in place with an emphasis on comprehensive and reliable data collection. The extent of Russian statistics has enabled the adoption of a wider set of indicators than those specified under SDG 6, in particular related to housing improvement. This reflects important system inter-dependencies where shortfalls in more than one sector can be tackled simultaneously, with water services being improved through increasing the housing stock. Another example provided in Chap. 6 is how the development of the digital economy and telecommunications infrastructure has an impact on reducing inequalities, such as SDG 3 (Good Health and Well-Being) and is interconnected with SDG 6 and SDG 4 (Quality Education). Nevertheless intensification of joint efforts across the state, business and society is still needed.

The rates of freshwater withdrawals and use in Russia have been decreasing, explained by the introduction of water saving technologies. However runoff and water quality has been impacted by a combination of agricultural practices, urbanisation, irrigation and flow regulation by reservoirs and the discharge of contaminated water into water sources. To solve some of these problems modernisation and construction of water facilities are required, and current water management practices are undergoing a transition to more flexible systems and adaptive management strategies. Challenges remain in implementing SDG 6 arising from underfunding in some areas, coupled with a slowdown in economic growth and the coronavirus pandemic.

12.2.5 China

China ranks 110th globally with regard to its per capita water resource availability and although it is generally rich in water resources, they are unevenly spread across the country. Cities in the eastern region have over 90% water use penetration rates compared with around 40% in the central and western regions. Progress in improving rural water supply is by centralised water supply schemes and distribution through pipe networks with the aim of supplying tap water to every household whilst encouraging changes in water use habits of the rural population. In urban areas the use of bottled water has been popularised and forms a key form of supply for many urban residents. Chapter 7 reports a toilet revolution in China, driven (as in other areas) by a series of action plans. Emphasis is also placed on public toilets, reflecting a cultural approach which sees "public toilets as the epitome of a city's civilisation". Clearly China has good intentions in "Building a Water Saving Society" and captures progress through such similar slogans.

12.2.6 Sri Lanka

The potential role for governments to take a lead in ensuring SDG 6 targets are met is exemplified in Chap. 9 with respect to Sri Lanka. The country is on track to meet SDG water supply and sanitation targets by 2030 with the best access to improved water and sanitation in South East Asia, although progress towards adopting Integrated Water Resource Management is still not well institutionalised in Sri Lanka. Nevertheless national policies and strategies have been aligned specifically to facilitate the achievement of the SDGs by 2030. Initiatives include the establishment of a dedicated ministry for Sustainable Development as the focal point for coordinating, facilitating and reporting on the implementation of the SDGs, together with the establishment of a Parliamentary Select Committee to provide the necessary political leadership. A new "Ministry of Water Supply" together with "National Water Supply and

Drainage Board" and "Department of National Community Water Supply" are currently responsible for policy implementation in the drinking water and sanitation sector in Sri Lanka. A programme has been developed to improve water supply coverage through short term, medium term and long term projects through increasing capacity of existing treatment plants, laying new distribution pipes, developing new water supply and sewerage projects and encouraging efficiency improvements.

However many challenges remain in supplying safe drinking water in Sri Lanka, such as the impact of climate change on water scarcity, the quality of public point sources, community engagement, inadequate treatment, limitations in the distribution network and production capacity, water resource stress, partial treatment and water quality deterioration, saline intrusion and borehole and tube well depletion. Additionally these challenges have been exacerbated by the COVID-19 pandemic quickly transforming a health crisis into a social and economic crisis leading to adverse effects across the country, including the interruption to the "Water for All" programme.

New strategies were found to move the programme forward by using data analytics which led to better informed decision-making. It is likely many countries will have been unable to respond in this way, causing a significant setback in achieving SDG targets in those areas most at need, not least to be able to provide sufficient water for hygiene to tackle the pandemic. Thus at this system level SDG 3 (Good Health and Well-Being) needs to be vigorously integrated with SDG 6, as clearly a major risk factor for infectious diseases and mortality is the lack of safe water, sanitation and hygiene services

12.2.7 Indigenous Communities

Despite progress shown throughout this book towards meeting SDG 6 on Clean Water and Sanitation, published data often does not provide a complete picture as aggregated data and national statistics conceal failures to provide WASH services to the hardest-to-reach communities, even in the world's most developed countries. Chapter 11 highlights this problem by exploring the water-related health issues suffered by indigenous communities in the USA, Canada and Australia. Often located in remote and isolated regions, considerable problems arise from the lack of infrastructure and access to water and sanitation.

In the USA such rural communities are left underfunded by federal agencies often because of misunderstandings about the size and significance of their populations. In Canada the water supplied to many First Nation communities on reserves are contaminated, hard to access or hazardous due to faulty treatment systems, with 39% of water systems considered "high risk". Alarmingly, water-borne infections in these First Nation communities is 26 times higher than the Canadian National average. Similarly in Australia indigenous communities are exposed to a range of "neglected tropical diseases" directly related to hygiene and lack of access to clean water. Very few remote communities in Western Australia have access to treated drinking water and rely on groundwater commonly containing high levels of uranium and nitrates. In appraising progress towards achieving SDG 6 it is vital that these "invisible "communities are not forgotten and left behind

Traditional solutions for providing adequate treatment however requires high grade grid-based power supplies. Without connections to the main power grid, generators need to be owned by communities just to provide small scale drinking water supplies. There are also limitations on remote communities' ability to maintain infrastructure and monitor water quality, often limited by distance and transport availability.

Chapter 11 provides details of an alternative solution based on a self-sufficient solar power (off-grid) reverse osmosis water treatment plant. This can deliver potable water for less than 1 cent per litre with each unit capable of producing 28 kL a day from water sources of poor quality. This is an area that should be the focus for further innovation and development.

12.3 Actions to Accelerate Progress

In early 2020 Antonio Guterres (UN Secretary General) pointed out that "Sustainable Development Goal 6 is badly off track". The United Nations in *The Sustainable Development Goals Report 2019* observed that: "It is abundantly clear that a much deeper, faster and more ambitious response is needed" (United Nations 2020a), and that "action to meet the Goals is not yet advancing at the speed or scale required" (United Nations, 2020b).

These observations were made before the COVID-19 pandemic, which not only stopped work towards some of these goals but have largely shifted the immediate focus of international agencies such as the United Nations and the World Health Organization towards dealing with the threats of the coronavirus. It is therefore reasonable to assume that after the COVID-19 pandemic has passed the ability to deliver the SDGs will have been severely compromised, such that many goals may not be achieved by 2030. As new inequalities and imbalances emerge between regions, successfully completing the SDG agenda may be set back indefinitely.

The SDG 6 (Clean Water and Sanitation) Global Acceleration Framework seeks to deliver faster results to countries in line with the SDG 6 targets, as it is essential in slowing the transmission of COVID-19 that people have access to quality sanitation facilities (Department of Global Communications, 2020). In July 2021 UN Water published an update on progress towards achieving SDG 6 (UN Water, 2021). This reported that two billion people (26% of global population) lacked access to safely managed water services in 2020, and 3.6 billion people (46% of the world's population) lacked safely managed sanitation services. In 2020 2.3 billion (29% of global population) lacked a basic handwashing facility with soap and water at home. Globally 44% of household water is not safely treated, and that water quality data is lacking for over three billion people. Since 2015, water use efficiency has increased by just 9% and 2.3 billion people live in water stressed countries. 107 countries are not on track to have sustainably managed water resources by 2030 and only 24 countries report transboundary cooperation for rivers, lakes and aquifers they share with their neighbours. One-fifth of the world's river basins are experiencing rapid changes in the area covered by surface waters. Moreover official development assistance commitments to the water sector has increased by only 9% between 2015 and 2019 and only 14 countries report high levels of community participation in water and sanitation decision-making. These startling statistics confirm the world is not on track to achieve SDG 6.

Progress on drinking water and sanitation coverage across different geographic regions between 2015 and 2020 is shown in Fig. 12.2.

Since 2015 over 600 million people have gained access to safely managed drinking water but the data shows too many others are being left behind, with most regions off track, and in Sub-Saharan Africa people lacking access to safe water has *increased* by more than 40% since 2000. UN Water estimate that achieving universal access to safely managed water by 2030 will require a fourfold increase in current rates of progress, including a substantial increase in current levels of investment. Similarly nearly half of the global population lacked access to safely managed sanitation 2020, with a similar fourfold increase in progress, with open defecation practised by nearly 500 million people still a big problem.

More detailed data is needed to guide planning with information gaps resulting from too little technical capacity and too few human and financial resources. Policy and institutional fragmentation across scales, stakeholders and discrete sectors mean that decisions taken in one area (e.g. energy, health, farming, environment) often do not consider impacts on water availability and water quality, requiring greater thinking at the wider system level. The SDG 6 Acceleration Framework requires action in the following areas: optimised finance, improving data and

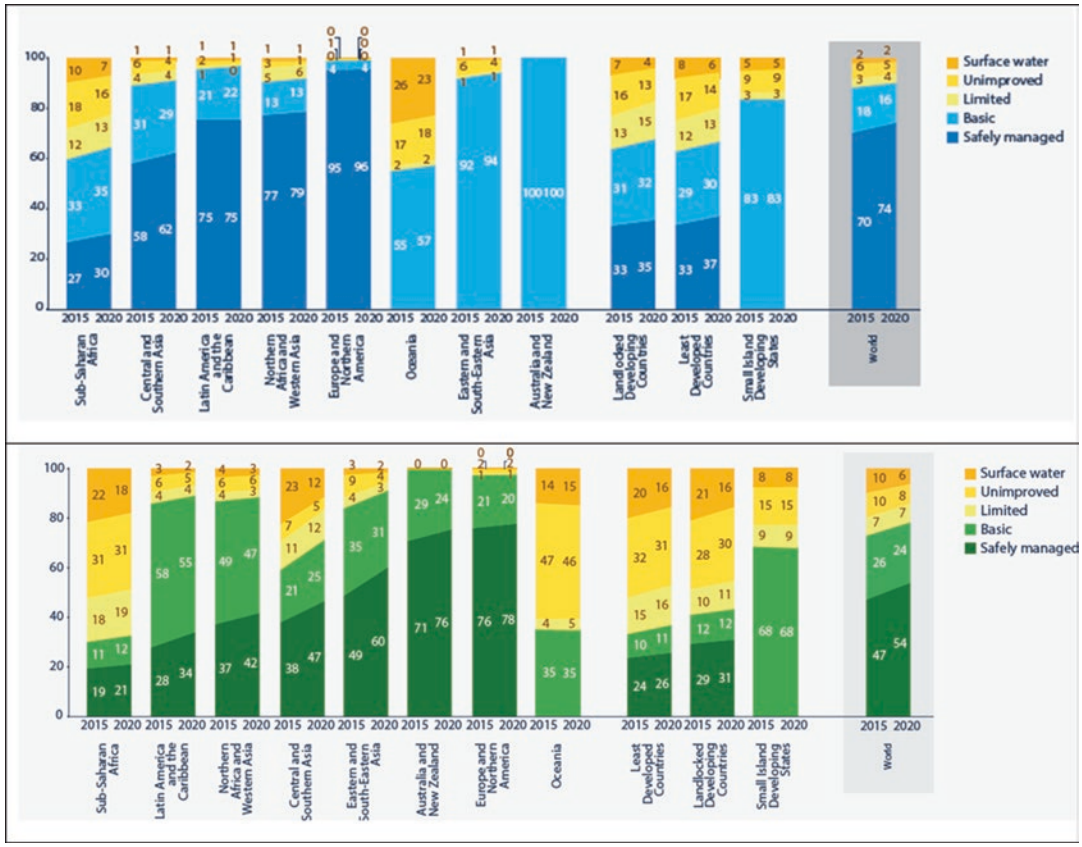

Fig. 12.2 Progress on drinking water (top) and sanitation (bottom) coverage 2015–2020 (UN Water 2021)

information, capacity development for a skilled workforce in the water sector, innovation in scaleable technologies and improved governance through institutional strengthening.

This overall picture clearly suggests efforts need to be re-doubled. The chapters in this book provide some further evidence as to what needs to be done to accelerate progress, including the following:

- Data collection, for example, seeking information on water quality, must urgently be improved.
- Policies should be followed that stimulate progress simultaneously in multiple SDGs.
- Progress is simultaneously needed in other goals, such as SDG 4 Education, SDG 5 Gender Equality and SDG 10 Reducing Inequalities to improve equity of access to all water services.
- Management and institutional frameworks need improving and reinforcing so areas with good water resources can ensure they are utilised effectively.
- Dependencies on often weak administrative capabilities to implement centralised policies need to be reduced.
- The lag between water supply initiatives and wastewater treatment provision needs to be addressed and shortened.
- More focus is needed on targets 6.3 (water quality), 6.4 (efficiency) and 6.5 (Integrated Water Resources Management) to rebalance

the headline efforts on water supply and sanitation provision.
- Emphasis should move from a supply led focus to greater attention to demand management strategies.
- Water pricing should balance cost recovery for distribution with equity in access.
- Water projects should seek more support from national budgets to move in line with expenditure in transport and energy sectors.
- Solutions should be co-generated with user communities within prevailing cultures.
- Specialist contractors should have local knowledge and the necessary skills base for satisfactory implementation.
- Greater emphasis is needed on the modernisation of existing facilities.
- Stronger awareness is required of remote communities which exist within—and are masked by—national statistics and databases.
- Innovations in scalable treatment technologies based on renewable energy sources are required to serve these remote communities.
- Flexible and adaptive management strategies should replace more rigid and out of date water management practices.
- Change in water use habits should be encouraged.
- A wider set of indicators should be reported which measure how improvements in SDG 6 targets translate into progress to meeting other goals.
- Stronger dialogue is needed across sectors to identify and address increased water demands (unexpectedly) arising from diverse sources.
- Political will at all levels of government must be reinvigorated with regard to the urgency needed to meet the SDG 6 targets by 2030, with government leading the co-ordination of the necessary disparate tasks, including the harmonisation of short, medium and long term plans.

12.4 Beyond 2030

Not all of the Sustainable Development Goals will be met at the same rate, either globally or across geographic regions. Whilst the emphasis up to 2030 is on catching up, by bringing services where none existed before, the emphasis beyond will be on stewardship to maintain the environmental integrity of the planet.

There is a need for simplicity in any future United Nations Sustainable Development programme, as despite not universally achieving the Millennium Development Goals, which only consisted of 17 targets across eight goals (United Nations Development Programme, 2018; UNICEF, 2014), the SDGs have been framed to be even more ambitious with 169 targets over 17 goals. Whilst this level of achievement is necessary, having so many targets over so many goals is excessively complicated and has led to many not being on track to be achieved by the 2030 deadline. Thus, any new agenda which may emerge following an appraisal of the impact of the current pandemic should aim to be simple, with fewer targets across fewer.

The SDGs have been criticised as being contradictory, whereby progress towards targets in one particular goal inhibits the success of another goal (Carant, 2017) and there has been strong criticism that not enough priority is placed on environmental targets (Kopnina, 2016).

In reappraising the progress towards achieving the SDGs, taking into account the possible new circumstances which will emerge from the current pandemic, planetary and human health should become the key focus. New timelines should be considered, whereby instead of rolling 15 year timelines for achievement of the MDGs and now the SDGs, new ambitions should be framed around shorter staged intermediate timelines with an urgent need for completion and frequent review and assessment occurring.

The development of the new agenda must also give consideration to milestone checking and overall completion dates. From criticisms of the United Nations SDGs and Millennium Development Goals, the new agenda needs to be easily monitored. For example, the target for reducing poverty overall in line with the other goals to be achieved in a 15 year timeframe should be broken down into three 5-year phases, with distinct milestones to be reached every 5 years. By following such an approach, it would

be easier to identify components in society or the environment that are making the achievement of a target difficult to achieve.

However, whilst there has been extensive discussion criticising the SDGs, and offering ways in which they could be better managed, suggestions about proposing entirely new agendas, whether in regard to a post-COVID-19 or a post-2030 world have not been not extensive. Themes of planetary stability, poverty eradication and human health should be emphasised together with the need for goal measurability and an acknowledgment of planetary boundaries.

This book demonstrates a growing array of best practices and how and where challenges must and can be overcome in the critical need to deliver water services. These experiences can be built on and taken forward and used to leverage success for 2030 and beyond. Despite setbacks the agenda is clear, progress can be accelerated, and momentum can be regained for the benefit of all.

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