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The Costs of Meeting the 2030 Sustainable Development Goal Targets on Drinking Water, Sanitation, and Hygiene

Guy Hutton and Mili Varughese

January 2016

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Acknowledgments

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Executive Summary

A goal dedicated to clean water and sanitation was recently endorsed by the United Nations General Assembly as part of the Sustainable Development Goals (SDGs) framework for 2015–2030 that has followed the UN's Millennium Development Goals (MDGs). Drinking water, sanitation, and hygiene form a central part of the clean water and sanitation goal (SDG 6) and are reflected especially in targets 6.1 to 6.3. They are also recognized for their role in reducing health risks as part of the good health and well-being goal (SDG 3) in targets 3.3 and 3.9.

The means by which the SDGs will be achieved are spelled out in SDG 17 in 19 different targets covering financing, technology, capacity building, trade, and systemic issues. Although these issues are all key interrelated components of the delivery mechanism, each requires a detailed assessment in order for countries to understand how the ambitious goals and targets laid out in the SDGs can be achieved over the next 15 years.

Objective of This Study

This study assesses the global costs of meeting the water, sanitation, and hygiene (WASH)-related targets of SDG 6. It is intended to serve as a vital input to determining the financing needs to achieve them. Two targets are assessed: (1) achieving universal and equitable access to safe and affordable drinking water for all (target 6.1); and (2) achieving access to adequate and equitable sanitation and hygiene for all and ending open defecation (target 6.2). Thus this study presents only a partial analysis of the clean water and sanitation goal, but it can serve as a basis for cost studies of other targets.

Approach

This study estimates the costs of extending two levels of WASH services to unserved households. The proposed indicators for targets 6.1 and 6.2 aspire to "safely managed" WASH services[1]—for water supply this means an on-plot water supply for every household and for sanitation it includes a toilet with safe management of fecal waste. As a step toward safely managed services, the costs of achieving lower-level services are also estimated because many countries still have to provide basic WASH to their populations. Basic water supply includes an improved community water source within a 30-minute round-trip; basic sanitation includes an improved toilet; and basic hygiene includes a hand-washing station with soap and water for every household. The costs of ending open defecation through simple, traditional, lower-cost latrines are also estimated.

Estimates of populations to be served in rural and urban areas by 2030 are based on coverage estimates of WASH services for 2015 (as the baseline year), taking into account population growth and internal migration. The majority of the world's low- and middle-income countries are included, as well as selected high-income countries that have low coverage of basic WASH services. The 140 countries included represent 85 percent of the world's population. The costs estimated are those for capital investment, program delivery, operations, and major capital maintenance to sustain the life span of the infrastructure created. Because this study requires multiple input parameters, each of which has data weaknesses, the resulting estimates carry a high degree of uncertainty. Thus a range is presented on all calculated costs to reflect variations in the selected parameters.

Results

The major results are presented here as three key findings.

Finding 1. Current levels of financing can cover the capital costs of achieving universal basic service for drinking water, sanitation, and hygiene by 2030, provided resources are targeted to the needs.

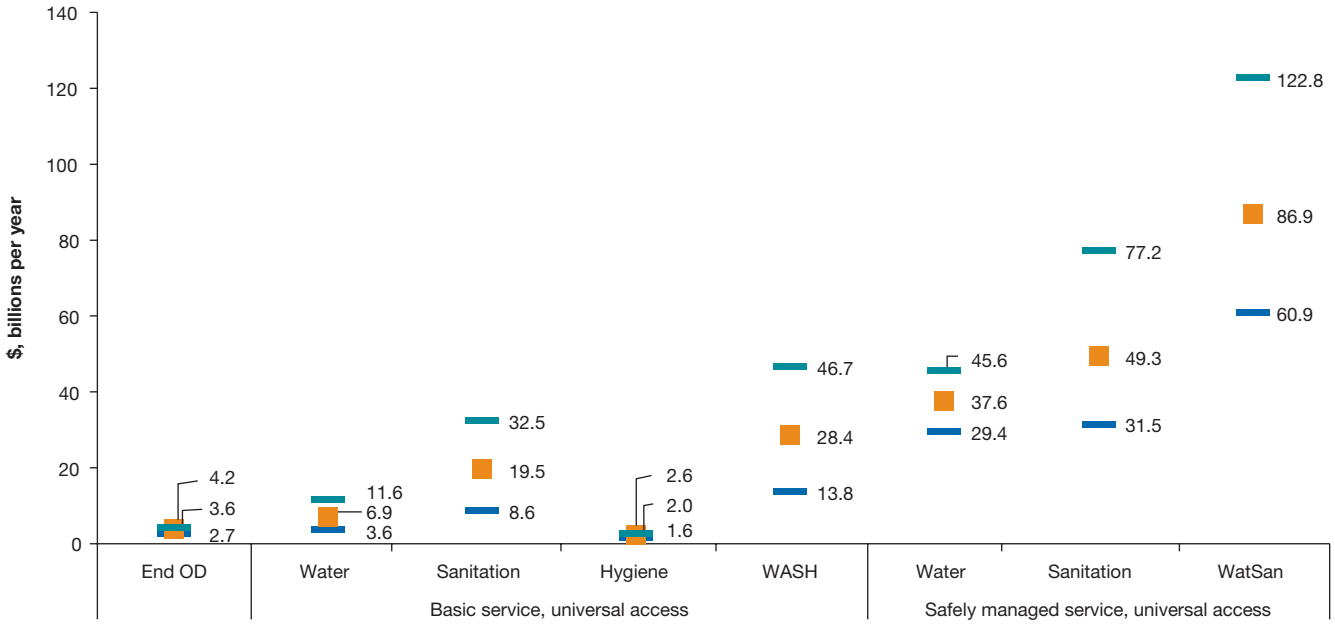
Extending basic WASH services to the unserved will cost $28.4 billion (range: $13.8 to $46.7 billion) per year from 2015 to 2030, or 0.10 percent (range: 0.05 to 0.16 percent) of the global product (GP)[2] of the 140 countries included (GP_{140}). This financing requirement

[1] Because the proposed indicator for target 6.2 includes safely managed sanitation services, the cost estimates of reaching the WASH-related targets cover only the first two water targets (6.1 and 6.2).

[2] Global product is the global equivalent of the gross domestic product (GDP) at the country level.

FIGURE ES.1: COSTS OF SAFELY MANAGED WASH SERVICES EXCEED BASIC SERVICES BY THREE TIMES

Annual Global Capital Costs of Different WASH Service Levels, 140 Countries



Note: Ending open defecation, or open defecation–free, has a target year of 2025. ** Safely managed sanitation costs are those for safe excreta management alone; they exclude latrine costs. WASH = water, sanitation, and hygiene; OD = open defecation; WatSan = water and sanitation.

is equivalent, in order of magnitude, to the 0.12 percent of global product spent to serve the unserved with improved water supply and sanitation during the MDG period. The costs by service are shown in figure ES.1.

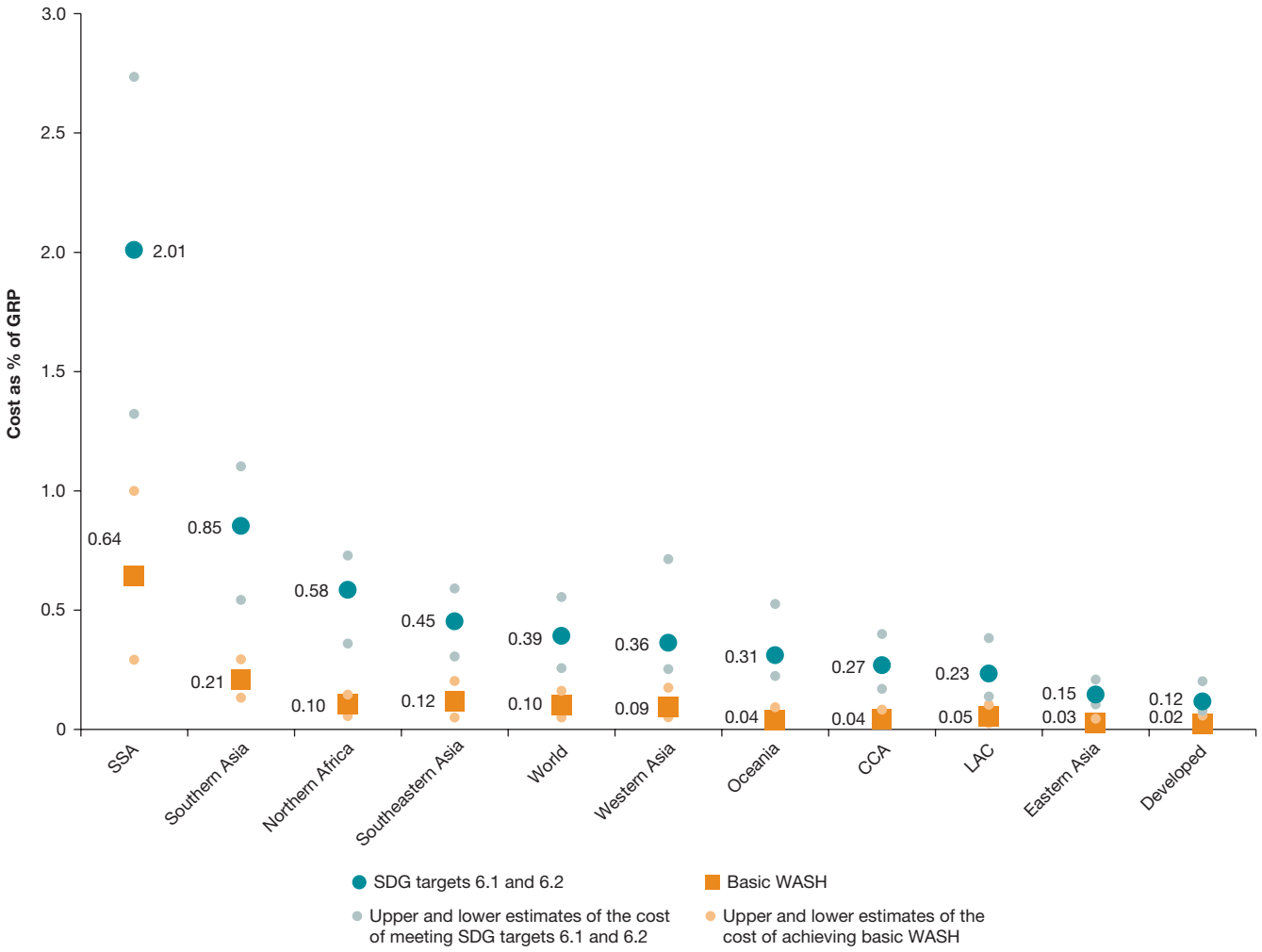
However, this relatively modest average cost as a proportion of global product hides wide variations across countries and income groups. Significantly greater capital spending is needed in Sub-Saharan Africa, where slow progress to date means capital expenditures of 0.64 percent (range: 0.29 to 1.0 percent) of the gross regional product (GRP) would be needed to close the gap, and in Southern Asia, which requires 0.21 percent (range: 0.13 to 0.29 percent) of GRP (shown in figure ES.2). Similarly, some 50 percent of the capital costs of basic water and sanitation and 58 percent of the capital costs of becoming open defecation–free (ODF) needs to be spent on extending coverage to the poorest two wealth quintiles.

Finding 2. The capital investments required to achieve the water supply, sanitation, and hygiene SDGs (targets 6.1 and 6.2) amount to about three times the current investment levels.

The capital financing required to extend safely managed water supply and sanitation services to the unserved is approximately 0.39 percent of GP_{140} (range: 0.26 to 0.55 percent), or a little over three times the historical financing trend of extending access to the unserved (0.12 percent globally). The total capital cost of meeting targets 6.1 and 6.2 is $114 billion per year (range: $74 to $166 billion). This total comprises the annual costs of safe water ($37.6 billion), basic sanitation ($19.5 billion), and safe fecal waste management ($49 billion), plus hygiene ($2.0 billion). It also includes an estimated 50 percent of households first having basic water and simple pit latrines before investing in the higher-level service. Figure ES.1 shows the ranges of these numbers.

FIGURE ES.2: WIDE VARIATION BETWEEN WORLD REGIONS IN CAPITAL COSTS AS A PROPORTION OF GROSS REGIONAL PRODUCT

Costs of Basic and Safely Managed Services as Percentage of Gross Regional Product (GRP) by Region, with Uncertainty Range



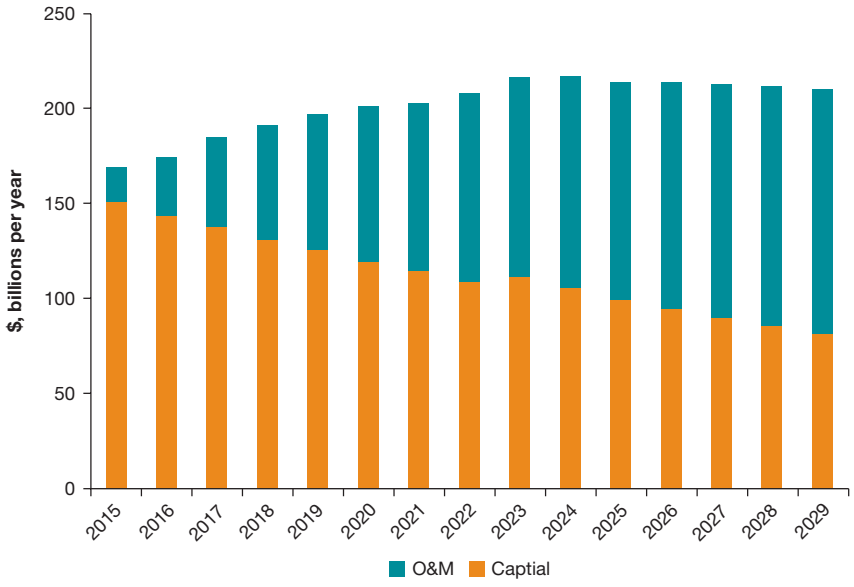
Note: WASH = water, sanitation, and hygiene; SDG = Sustainable Development Goal; SSA = Sub-Saharan Africa; LAC = Latin America and the Caribbean; CCA = Caucasus and Central Asia. See table 2.2 for details on upper and lower values on variables varied in sensitivity analysis. Gross regional product is based on the aggregated GDP of countries in each region. An economic growth rate of 5 percent is assumed across all regions.

Finding 3. Sustained universal coverage requires more than capital inflows: financial and institutional strengthening will be needed to ensure that capital investments translate into effective service delivery.

Although capital costs reflect immediate financing needs and are an urgent priority, it is critical to consider the ongoing finances required to ensure the proper operation of these services because they represent a growing financial commitment over time. As the year 2030 approaches, the costs of operating the new infrastructure built will exceed the annual capital cost requirements to meet those remaining unserved (see figure ES.3). In order to ensure sufficient and quality spending on operations and maintenance, institutions and regulations need to be strengthened. Tariff policies will also need to be strengthened, but affordability will remain a critical issue, especially in low-income countries and communities where even the operational costs of basic WASH can add up to more than

FIGURE ES.3: CONSTANT FINANCING NEEDS: AS INVESTMENT NEEDS DECLINE TO SERVE THE UNSERVED, O&M GOES UP

Time Series of Total Annual Costs to Achieve SDG Targets 6.1 and 6.2, Comparing Capital and O&M Costs: 2015–29



Note: O&M = operations and maintenance.

5 percent of the poverty income levels. If operational costs cannot be covered by tariffs, policy makers and service providers should be aware of the increasing burden on limited grant financing and (cross-) subsidies to operate the services.

Conclusions

The global costs of achieving universal basic WASH by the year 2030 are achievable under current overall sector spending. However, financing challenges remain in some regions and countries where current spending is insufficient to meet the SDG targets by 2030. In particular, resources need to be shifted to basic sanitation and hygiene in countries where the service gap is greatest. Because of the shifts in population to urban areas and the higher unit costs in towns and cities, urban areas account for 70 percent of the capital expenditure requirements to achieve universal access to basic WASH. However, allocations of public funds should be based not only on resource requirements, but also on the proportion of costs that can be recovered from customers, which tends to be greater in urban areas (excluding slums and poor neighborhoods).

Achieving a higher level of service—called here "safely managed" water and sanitation services—requires additional financing on the order of three times current spending. This value only covers extending safely managed services to the currently unserved (in 2015). Although it will be challenging to achieve such financing volumes in many lower-income countries, the significant additional health, service access time, environmental, and economic benefits that result from safe drinking water and sanitation must be taken into account. Additional investments can be well worth their cost if the appropriate hardware and software are chosen.

Because of the lower coverage of WASH services among lower-income groups, a significant share of public funds should target poor and marginalized population groups. Donors should also reconsider which countries they support. Donors and public financiers alike should also rethink which subpopulations and service levels they support, which requires making tough choices between achieving basic WASH for the unserved versus bringing better services to those already with basic services. Meanwhile, national governments should provide the policy environment for equitable tariff structures that strike a balance between securing the additional financing to enable service extension and operations while enabling poorer populations to gain to access services.

The ushering in of the new development framework, the Sustainable Development Goals, has been accompanied by a major new focus on sustainability. Recent documentation and statistics have shone a light on the high levels of breakdown or nonuse of wells, latrines, and piped systems, as well as inefficiently delivered services. Thus financing mechanisms and management approaches should be designed and implemented to ensure the quality

and sustainability of new infrastructure, thereby reducing unit costs.

This report reveals the cost implications of adopting different service levels for both water supply and sanitation. The overall costs are shown to be higher if a household, community, or service area opts to provide lower levels of service before making greater investments to reach a higher level of service. On the other hand, in the short term a lower service level may be the only option because of lack of investment financing in the short or medium term. Infrastructure development should therefore be appropriately sequenced, taking into account the public financing available, the dynamics of urban growth, and the population's demand for services before engaging financiers and providers. Where possible, economies should be sought when combining the delivery of drinking water, sanitation, and hygiene services to reduce the service costs.

Understanding costs is an important part of planning and implementing services to reach universal coverage, but financing should be viewed as part of a broader strengthening of the services system that includes development of technology, private suppliers and providers, policy reform, institutional strengthening and regulation, and improved monitoring and evaluation. These measures will increase the efficiency of services, provide cost savings, raise demand for services, and stimulate the market. These aspects are largely covered under what has been called the "means of implementation," which is covered in SDG 17, but will need further definition of what components are prioritized.

Because of the many uncertainties in the underlying data and methodological choices, the cost estimates reported in this study should be used with caution. The ranges on costs provided should be used alongside the baseline numbers. For national policy making and resource allocation, countries are encouraged to conduct their own costing studies or investment plans based on local unit costs, the mix of technologies, and the program delivery mechanisms likely to be chosen. Numbers should be provided with a geographical breakdown such as by subnational level and rural, urban, and periurban area. Countries should also conduct an in-depth analysis of the specific factors that influence costs such as securing bulk water, providing wastewater drainage as well as sewerage systems, and defining effective behavioral change programs to reach the hard to reach and sustain hygienic practices.

Abbreviations

GDP	Gross domestic product
GP	Gross product
GP_{140}	Combined gross product of 140 countries included in the study
GRP	Gross regional product
JMP	Joint Monitoring Programme for Water Supply and Sanitation (WHO/UNICEF)
LIC	Low-income country
LMIC	Lower-middle-income country
MDG	Millennium Development Goal
MICS	Multiple Indicator Cluster Survey
OD	Open defecation
ODF	Open defecation free
O&M	Operations and maintenance
SDG	Sustainable Development Goal
UN	United Nations
UNICEF	United Nations Children's Fund
WASH	Water, sanitation, and hygiene
WHO	World Health Organization

All dollar amounts are U.S. dollars unless otherwise indicated.

I. Introduction

The United Nations Conference on Sustainable Development held in Rio de Janeiro in June 2012 sparked a global dialogue on the development framework that will follow the UN's Millennium Development Goals (MDGs). The new Sustainable Development Goals (SDGs) were ratified by UN member states at the UN General Assembly in September 2015 (UN General Assembly 2015). An integrated water goal was developed and promoted by a wide range of stakeholders (UN-Water 2014), and now water is represented in the SDG framework with a dedicated water and sanitation goal (SDG 6), and it is included as well in the health, disaster risk management, and environmental targets of other goals.

In 2011 an ongoing consultative process on water, sanitation, and hygiene (WASH) was convened by the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP). That process led to the proposal of a series of WASH targets and indicators for the post-2015 period (WHO and UNICEF 2013). The targets proposed by WASH sector stakeholders[3] expanded on MDG target 7c on drinking water and sanitation. They called for the elimination of open defecation and universal access to basic drinking water, sanitation, and hygiene services not only at home but also in institutional settings, including schools and health care facilities. They also called for the addition of a higher service threshold relevant to all countries: "safely managed" drinking water and sanitation services. In addition, the JMP proposal integrated aspects of the 2010 UN resolution calling for the human right to clean drinking water and sanitation. Specifically, it called for the progressive elimination of inequalities through faster progress in the delivery of services to the poor and marginalized compared with the general population and for services that are both affordable and sustainable. Most of the key elements of the targets proposed by WASH sector stakeholders have been incorporated into the wording of the SDG targets proposed by UN member states.

For the water goal, the following six time-bound targets have now been adopted by UN member states:

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all.
6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.
6.3 By 2030, improve water quality by reducing pollution, eliminating dumping, and minimizing the release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.
6.4 By 2030, substantially increase water use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.
6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.
6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes.

Indicators for these targets have been proposed to, and evaluated by, an Inter-Agency Expert Group on SDG Indicators (IAEG-SDGs) established by the UN Statistical Commission. Until March 2016, these indicators will be discussed in terms of their achievability and measurability. The coverage calculations used in this report are therefore based on the indicators proposed by the JMP to the IAEG-SDGs as follows:

Target 6.1: Indicator 6.1.1 "Percentage of population using safely managed drinking water services"[4]

[3] http://www.wssinfo.org/fileadmin/user_upload/resources/Fact_Sheets_4_eng.pdf.
[4] UN-Women has proposed a second indicator for review by the UN Statistical Commission: "6.1.2 Average weekly time spent in water collection (including waiting time at public supply points), by sex, age, location and income." This indicator is included in safely managed water services because the service level for indicator 6.2.1 is piped water in the household. Thus the costs of this indicator are not estimated separately.

Target 6.2: Indicator 6.2.1 "Percentage of population using safely managed sanitation services"
Target 6.2: Indicator 6.2.2 "Population with a hand washing facility with soap and water in the household"

Universal access to drinking water, sanitation, and hygiene by 2030 is an ambitious objective in view of the current coverage (UNICEF and WHO 2015). Reducing pollution caused by untreated sewage and poorly managed fecal sludge and increasing the reuse of treated wastewater will require concerted efforts not only in developing countries but also in high-income countries. Furthermore, because the unserved populations are poorer and it is more difficult to reach or to change their behavior, the effectiveness, affordability, and sustainability of reaching these populations remain a massive challenge.

Many factors will influence the planning, financing, and implementation of the large number of goals and targets in the SDG framework, but a good understanding of the costs and financial feasibility of the goals and targets will be a fundamental one in order for member states to support and implement them. Thus this document reports estimates of the costs of achieving the WASH-related targets in the proposed clean water and sanitation goal, using the indicators just listed as well as lower service levels along the lines of the MDG indicators for improved water supply and sanitation. To assess the financing feasibility of the targets, the costs of extending services to meet the targets are compared with the current and future incomes as well as with the historic expenditure to achieve MDG target 7c. To complement understanding of the global costs of the targets, this study presents costs in disaggregated form in order to reveal where the major financing needs are—for example, capital versus recurrent, rural versus urban, water versus sanitation versus hygiene, and by world region and wealth grouping. Estimating the global costs of achieving universal coverage of WASH services is, however, a difficult task and entails a number of uncertainties. Thus the numbers presented here are informed estimates.

II. Approach

To estimate the costs of meeting the water, sanitation, and hygiene (WASH) targets in the Sustainable Development Goals (SDGs), the study combined the unit costs per capita of WASH services with the populations remaining to be served with different service levels. The total population to be served from 2015 to 2030 was broken down into 15 equal annual tranches to allow estimation of a time series of capital investment as well as operations and maintenance (O&M) needs. Population estimates took into account population growth (using the United Nations medium variant on population growth per country) as well as rural-urban migration until the year 2030. The WASH targets included in the study are the following, based on the proposed indicators and service ladder by the Joint Monitoring Programme for Water Supply and Sanitation (JMP) for SDG WASH monitoring:[5]

- *Universal access to basic WASH services.* "Basic" services correspond closely to the existing definitions of "improved" water and sanitation under Millennium Development Goal (MDG) 7c, except that basic drinking water includes only improved sources within a 30-minute round-trip (WHO and UNICEF 2013), and basic hygiene is defined as a handwashing station in the household with soap and water present. This service level is included in the cost study because a large number of countries have still not achieved universal access to basic WASH (UNICEF and WHO 2015).
- *Universal access to safely managed water and sanitation services.* "Safely managed" drinking water is defined as an improved source located on the premises, available when needed, and free of fecal and priority chemical contamination. Safely managed sanitation is defined as an improved facility that is not shared with other households and where excreta are safely disposed of in situ or treated off-site. The safely managed sanitation costs presented are for the service chain from extraction through conveyance to safe treatment and disposal. They exclude latrine costs because the latter are included in basic sanitation.
- *The WASH-related targets within the SDG proposals, based on the proposed indicators just listed*: safely managed water supply (indicator 6.1.1), ending open defecation and providing safely managed sanitation services (indicator 6.2.1), and hand washing[6] (indicator 6.2.2). Target 6.3 is not costed separately because safely managed fecal waste is already proposed in indicator 6.2.1.

Service definitions and indicators proposed for the new WASH targets are provided in appendix A (WHO and UNICEF 2013). Current coverage figures under these definitions and the unserved population to be reached to achieve universal coverage by 2030 appear in table 2.1 (see appendix B for regional estimates). Coverage has been projected to the year 2015 using 2013 estimates and trends under the new definitions.[7]

The 140 countries included in this study represent 6.12 billion (84 percent) of the world's projected 7.3 billion population in 2015 and 7.15 billion (85 percent) of the world's projected 8.4 billion population in 2030. The majority of the world's low- and middle-income countries are included, as well as a few selected high-income countries with low coverage of basic WASH services (see appendix C). In 2015, 43 percent of the population in the included countries live in urban areas, rising to 56 percent in 2030 (based on the UN's medium-variant population projections). Additions to the population through population growth are assumed not to have basic WASH coverage. In line with WASH sector proposals, wealth quintiles with lower baseline coverage in 2015 are

[5] http://www.wssinfo.org/fileadmin/user_upload/resources/JMP-WASH-Post-2015-Brochure.pdf.
[6] Hygiene in the household means hand washing with soap in line with the JMP-led proposal. Menstrual hygiene management is excluded because of the difficulty in estimating coverage levels and intervention costs at the household level.
[7] Coverage data on basic safe water and basic sanitation were available for all countries. For hand washing, coverage data were available for 40 countries and extrapolated to the remaining countries. For safe sanitation data on treated sewage and fecal sludge management, rates were sourced from research studies in selected countries. See appendix A for details.

TABLE 2.1: PERCENTAGE OF POPULATION COVERAGE AND MILLIONS OF PEOPLE TO SERVE TO ACHIEVE UNIVERSAL ACCESS TO WATER, SANITATION, AND HYGIENE BY 2030, 140 COUNTRIES

	Water				Sanitation					Hygiene	
	Basic water		Safely managed water		Any[a]	Basic sanitation		Safely managed sanitation		Hand washing	
	Urban	Rural	Urban	Rural	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Current coverage (percent, 2015)	87	76	68	20	72	76	46	26	34	82	50
Population to serve by 2030 (millions)	1,396	892	1,977	2,554	1,121	1,721	1,727	3,214	2,095	1,674	3,154
	2,278		4,531		1,121	3,448		5,309		4,828	

Source: Joint Monitoring Programme for current coverage, UN Statistics Division for population growth until 2030 (medium variant)
a. Simple or traditional pit latrines to end open defecation. See Annex A for definitions of 'basic' and 'safely managed'.

assumed to be served at a faster rate to achieve universal coverage (WHO and UNICEF 2013).

To achieve universal coverage of basic or safely managed services, populations will be able to choose from different hardware options or technologies. In such a global study, it is not possible to predict exactly which technologies will be chosen by governments and service providers, or by the households they serve. For the purposes of this study, a mix of lower-cost technology options were selected for basic WASH. These included community wells for water supply, improved latrines for sanitation, and a basin with water and soap for practicing hand washing. Higher-cost options such as piped water and sewerage were included as options under safely managed services. Appendix D provides the distributions assumed.

The costs of meeting the WASH-related SDG targets by 2030 will depend on the pathway for scaling up services. Realistically, many households will first become open defecation–free with an unimproved toilet facility and only later upgrade to a latrine that safely isolates waste. However, not all households will pass through a lower service level—for example, in India the major share of households are likely to receive an improved toilet under the national government Swachh Bharat Abiyan (Clean India Mission). Similarly, many households, especially in rural areas, are likely to receive an improved water supply from a community source before being upgraded to a household water supply (for example, piped supply or an on-plot well). Thus the results are presented under lower- and upper-cost scenarios, and in the baseline 50 percent of households are assumed to go straight to a higher level of service, while the remaining 50 percent pass through unimproved sanitation or basic water before a higher-level service is attained.

The total cost estimates include the resources required to put in place, operate, and maintain a WASH service for those without the service in 2015. The costs of maintaining access for those already served by a given service level in 2015 are excluded from the calculations. A distinction is made between upfront capital investment costs, regular operational costs, and major capital maintenance costs. Cost data were obtained through an extensive search of the peer-reviewed published literature, project documents, and agency reports. For larger countries, unit costs were validated by in-country experts and adjusted where a discrepancy was found with the country experience. For countries lacking data on unit costs, cost data were extrapolated from the most similar country with cost data, adjusting for the difference in income level (using purchasing power parities as the basis for adjustment). Appendix D provides further details on the costing methods and costing studies sourced, and appendix E lists the capital costs per person by country for each service.

Because of the large number of variables needed to calculate global costs and weaknesses in the underlying data as well as assumptions, there is considerable uncertainty in the resulting cost numbers. Table 2.2 is a summary of the degree of uncertainty of different parameters or assumptions used in the costing study, and it

TABLE 2.2: VARIABLES DETERMINING COST RESULTS AND THEIR DEGREE OF UNCERTAINTY

Variable	Data or assumption used in baseline	Level of uncertainty[a]
Underlying population and coverage statistics		
1. Population growth, 2015–30	UN's medium variant for rural and urban areas	Moderate uncertainty, including about the level of urbanization
2. WASH service definition	Indicators for each target are still under review. Indicators proposed by the JMP (see appendix A) have been reviewed by the UN Statistics Commission.	Low uncertainty
3. Target levels	Universal coverage of basic and safely managed WASH services, and also reduction by half of those unserved by safe sanitation, reflect the target levels adopted by the UN General Assembly (UNGA).	Low uncertainty
4. Coverage levels in 2015	JMP estimates were projected to 2015 for basic WASH and safely managed drinking water. For safe sanitation, estimates were sourced from literature.	Low to moderate uncertainty for basic water and sanitation. Higher uncertainty for hand washing, safely managed drinking water, and safely managed sanitation.
5. Unserved population to be served	15 equal annual tranches provided with services from 2015 to 2030.	Moderate uncertainty. The rate of progress will vary by country.
6. Technologies used to provide services	One lower and one higher technology assumed for basic WASH and for safe sanitation, with 50 percent of the unserved population assumed to receive each one (see appendix D).	**High uncertainty. Cost range estimated based on 100 percent of population using low-cost technology to 100 percent population of using high-cost technology.**
Cost and economic assumptions (see appendix D for further details)		
7. Costs included	Capital costs, software costs, capital maintenance costs, and operating costs. These costs cover major cost categories, but exclude financing costs (interest charges) and may underestimate the costs of behavior change and of accessing and safeguarding bulk water.	Low to moderate uncertainty.
8. Unit cost data	Cost data available mainly for capital costs for all services and for operating costs for safe water. Assumptions used for capital maintenance costs and for operating costs of basic WASH.	Moderate uncertainty. No range provided because of lack of data on what the range might be per country.
9. Life span of technology	Technology replaced after 8 years (latrines), 10 years (dug wells), and 20 years (septic tank, boreholes, treatment plants, and pipes).	Moderate uncertainty. These life spans are justified by the inclusion of capital maintenance costs.
10. Updating pre-2015 cost data to 2015	First, update costs to 2015 in local currency using inflation rate. Second, convert 2015 costs in local currency to U.S. dollars.	Moderate uncertainty as costs of services may increase at different rate from inflation rate.
11. Discounting of future costs	Discount rate of 5 percent chosen for baseline results because it falls in the middle of range commonly used.	**Moderate uncertainty. Range: 3 to 8 percent used in sensitivity analysis.**
12. Extrapolation of unit costs for countries with no data	Transfer costs using the U.S. dollar as the common currency, adjusting for difference in the gross domestic product (GDP) per capita at purchasing power parity values. This is the preferred method because the major components of WASH services are not imported (labor and locally made materials).	**High uncertainty. Alternative method of adjustment uses differences between countries in absolute U.S. dollar values of GDP per capita.**

Note: WASH = water, sanitation, and hygiene; JMP = Joint Monitoring Programme for Water Supply and Sanitation.
a. Parameters that varied in sensitivity analysis appear in boldface.

highlights three variables (6, 11, and 12) with a moderate or high degree of uncertainty that were varied in a sensitivity analysis. In addition, some costs may have been underestimated because of lack of data on some aspects. For the piped water supply, the cost of accessing bulk water in the future may have been underestimated,[8] as well as the full costs of regulation. Moreover, because of the paucity of cost data on what is needed to change behavior and ensure service sustainability, the software costs used for this study may underestimate the true costs, especially for delivering services to the "last mile" populations (hardest to reach populations).

[8] This is partially because current consumption patterns are at unsustainable levels and because climate change and climate variability will lead to higher future costs of access and storage of bulk water.

III. Results

It is critical that anyone using the results of a global costing study notes the data uncertainties and methodological assumptions involved in producing global results. In addition to indicative "best estimates," this study also presents upper and lower values, taking into account the three methodological uncertainties as shown in bold font in column 3 of table 2.2. Upper values reflect the costs of higher-technology options, using official exchange rates for cross-country cost data extrapolations and a discount rate of 3 percent. Lower values reflect the costs of lower-technology options, using a discount rate of 8 percent. The database of unit costs was not extensive enough to enable selection of reliable ranges on unit costs. Thus this is a further source of uncertainty not taken into account in the ranges presented. It also should be noted that the estimates represent 140 countries and exclude 40 developing countries (mainly with small populations) and 45 developed countries (see appendix C). All the major sources of uncertainty are shown in table 2.2.

Summary of Key Findings

Several key findings emerged from this study:

Finding 1. Current levels of financing can cover the capital costs of achieving universal basic service for water, sanitation, and hygiene by 2030, provided resources are targeted to the needs.

Extending basic water, sanitation, and hygiene (WASH) services to the unserved will cost $28.4 billion (range: $13.8 to $46.7 billion) per year from 2015 to 2030, or 0.10 percent (range: 0.05 to 0.16 percent) of the global product (GP)[9] of the 140 countries included (GP_{140}). This financing requirement is equivalent, in order of magnitude, to the 0.12 percent global product spent to serve the unserved with an improved water supply and sanitation during the Millennium Development Goals (MDGs) period. The costs by service are shown in figure 3.1. This relatively modest average cost as a proportion of the global product hides wide variations across countries and income groups. Significantly greater capital spending is needed in Sub-Saharan Africa, where the slow progress to date means capital expenditures of 0.64 percent (range: 0.29 to 1.0 percent) of the gross regional product (GRP) would be needed to close the gap, and in Southern Asia, which requires capital expenditures of 0.21 percent (range: 0.13 to 0.29 percent) of GRP (shown in figure 3.10). Similarly, some 50 percent of the capital costs of basic water and sanitation and 58 percent of the capital costs of becoming open defecation–free (ODF) need to be spent on extending coverage to the poorest two wealth quintiles.

Finding 2. The capital investments required to achieve the water supply, sanitation, and hygiene Sustainable Development Goals (SDGs)—targets 6.1 and 6.2—will amount to about three times the current investment levels.

The capital financing required to extend safely managed water supply and sanitation services to the unserved is approximately 0.39 percent of GP_{140} (range: 0.26 to 0.55 percent). This represents a little over three times the historical financing trends of extending access to the unserved (of 0.12 percent globally). The total capital cost of meeting targets 6.1 and 6.2 are $114 billion per year (range: $74 to $166 billion). This total comprises the costs of safe water ($37.6 billion per year), basic sanitation ($19.5 billion per year), and safe fecal waste management ($49 billion per year), plus hygiene ($2 billion per year). It also includes the assumption that an estimated 50 percent of households will first have basic water and simple pit latrines before investments are made in the higher-level service in order to take into account likely investments in lower service levels before a higher-level service is attained. Figure 3.1 shows the ranges on these numbers.

Finding 3. Sustained universal coverage requires more than capital inflows; financial and institutional strengthening will be needed to ensure that capital investments translate into effective service delivery.

Although capital costs reflect immediate financing needs and are an urgent priority, it is critical to consider the ongoing financing required to ensure the proper

[9] Global product is the global equivalent of the gross domestic product at the country level.

operations of these services because they represent a growing financial commitment over time. As the year 2030 approaches, the costs of operating the new infrastructure built will exceed the annual capital cost requirements to meet those remaining unserved (see figure 3.13). In order to ensure sufficient and quality spending on operations and maintenance, institutions and regulations need to be strengthened. Tariff policies will also need to be strengthened, but affordability will remain a critical issue, especially in low-income countries and communities where even the operational costs of basic WASH can add up to more than 5 percent of the poverty income levels. If operational costs cannot be covered by tariffs, policy makers and service providers should be aware of the increasing burden on limited grant financing and (cross-) subsidies to operate the services.

Global Capital Costs

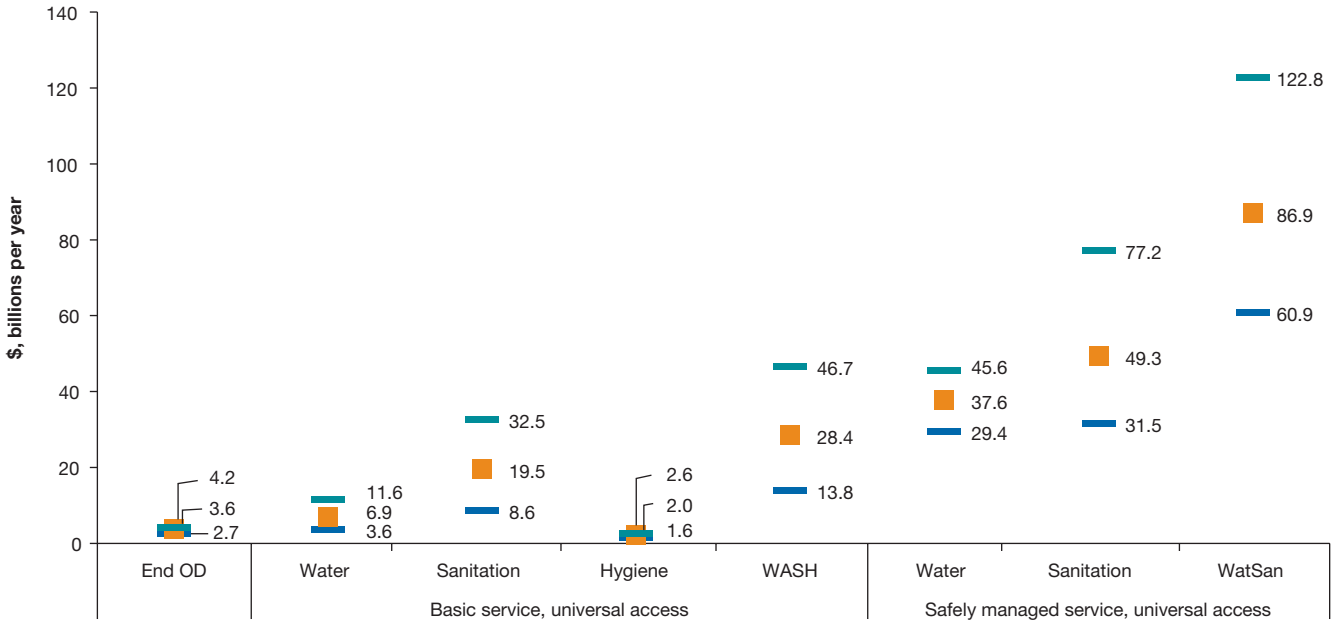
Capital costs are presented by total, urban, and rural breakdowns in figures 3.1, 3.2, and 3.3, respectively. The figures include capital costs, both initial costs and replacement costs at the end of the hardware's life span.

Total Costs

The estimated annual capital costs of extending services to the unserved to achieve universal basic WASH access are $28.4 billion (range: $13.8 to $46.7 billion) per year from 2015 to 2030, or an average of 0.10 percent (range: 0.05 percent to 0.16 percent) of the gross product of the 140 countries included (GP_{140}) over the period 2015–30.[10] The costs of safely managed WASH services are three times the costs of basic services. Details are shown in figure 3.1. Safely managed water and sanitation[11] services would cost an

FIGURE 3.1: COSTS OF SAFELY MANAGED WASH SERVICES EXCEED BASIC SERVICES BY THREE TIMES

Annual Global Capital Costs for Different WASH Service Levels, 140 Countries



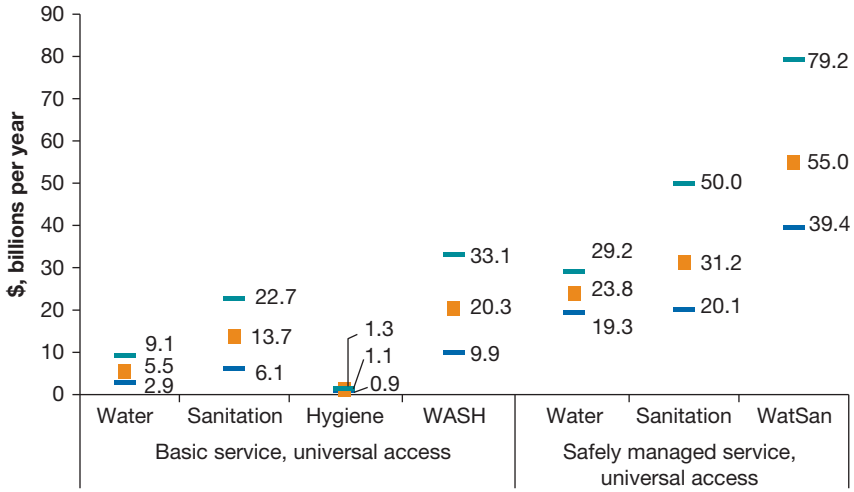
Note: Ending open defecation, or becoming open defecation–free, has a target year of 2025. WASH = water, sanitation, and hygiene; OD = open defecation; WatSan = water and sanitation.

[10] These baseline results of cost as a percentage of the gross product are presented under a realistic assumption of economic growth in low- and middle-income countries of 5 percent. According to the World Bank, in low- and middle-income regions the gross domestic product (GDP) growth rates averaged 5.8 percent from 2000 to 2013. All future costs and GDP are discounted at 5 percent per year.

[11] This includes safe management of fecal waste (safe extraction, conveyance, treatment sanitation), but it excludes latrine costs.

FIGURE 3.2: COSTS OF SAFELY MANAGED URBAN WASH SERVICES EXCEED BASIC SERVICES BY THREE TIMES

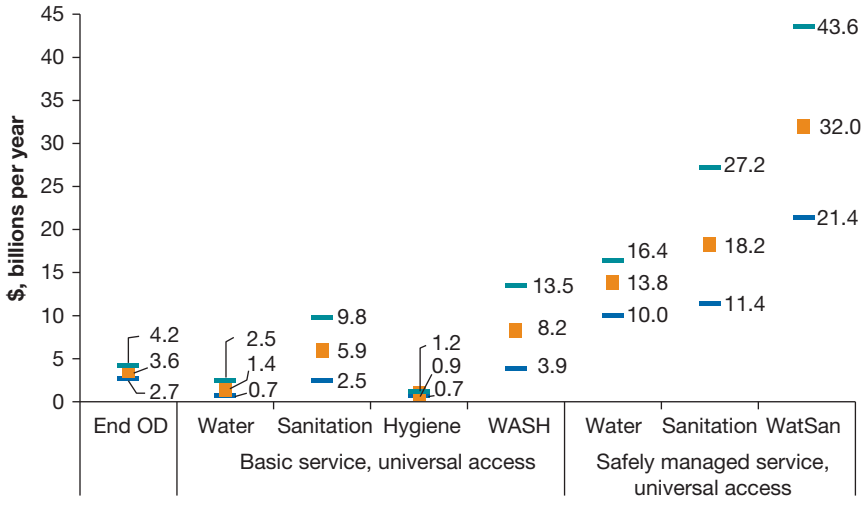
Annual Global Capital Costs for Different WASH Service Levels in Urban Areas, 140 Countries



Note: Safely managed sanitation costs are those for safe excreta management alone; they exclude latrine costs. WASH = water, sanitation, and hygiene; WatSan = water and sanitation.

FIGURE 3.3: COSTS OF SAFELY MANAGED RURAL WASH SERVICES EXCEED BASIC SERVICES BY ALMOST FOUR TIMES

Annual Global Capital Costs for Different WASH Service Levels in Rural Areas, 140 Countries



Note: Ending open defecation, or becoming open defecation–free, has a target year of 2025. Safely managed sanitation costs are those for safe excreta management alone; they exclude latrine costs. See table 2.2 for ranges of the three selected variables. WASH = water, sanitation, and hygiene; OD = open defecation; WatSan = water and sanitation.

additional $86.9 billion (range: $70 to $122 billion) per year, or 0.30 percent (range: 0.21 to 0.40 percent) of GP_{140}.

A large portion of the world's population is still far from having "safely managed" services, and so the costs of achieving safely managed services will depend on the pathway taken to achieve this high level of services. Table 3.1 presents the costs of different pathways to extending safely managed services to achieve SDG targets 6.1 and 6.2. If unserved populations go straight to receiving safely managed services, the cost would be in the range of $71 to $158 billion per year (baseline $108 billion). If all unserved populations pass through lower-level services, the cost would be $11 billion a year more, as high as 0.41 percent of GP_{140} (range: 0.27 to 0.58 percent). Under a baseline assumption halfway between these two extremes, the global costs of achieving targets 6.1 and 6.2 are approximately $114 billion (range: $74 to $166 billion) per year. This corresponds to 0.39 percent of GP_{140} (range: 0.26 to 0.55 percent) or approximately three times the historic spending on extending services to the underserved. If the target for safely managed fecal waste were less ambitious and sought to reduce by 50 percent those unserved by treated wastewater (in line with target 6.3), the costs would be $92 billion (range: $63 to $131 billion) per year or 0.31 percent of GP_{140} (range: 0.21 to 0.45 percent). Thus it will be important to strike the right balance between going straight to higher-level services (which might save some costs in the longer term but will have financial and technical constraints in the shorter term)

TABLE 3.1: ESTIMATED ANNUAL GLOBAL COSTS OF MEETING SDG TARGETS 6.1 AND 6.2

Service-level pathway and target	Unit	Lower	Mid	Upper
1. Direct service pathway to safely managed services for all	$, billions per year	71.1	108.4	157.9
	Proportion of GP_{140}	0.245%	0.373%	0.510%
2. Indirect service pathway via ODF and basic water for all, to safely managed services for all	$, billions per year	77.4	118.9	173.7
	Proportion of GP_{140}	0.267%	0.409%	0.565%
3. Mixture of direct and indirect pathways (50 percent each of nos. 1 and 2) (baseline)	**$, billions per year**	**74.3**	**113.7**	**165.8**
	Proportion of GP_{140}	**0.256%**	**0.391%**	**0.537%**
4. Same as no. 3 except based on a less ambitious target to reduce by 50 percent those without safely managed fecal waste	$, billions per year	62.5	92.4	131.1
	Proportion of GP_{140}	0.213%	0.315%	0.447%

Note: SDG = Sustainable Development Goal; ODF = open defecation–free; GP = gross product.

and going through lower-level services first (which are more affordable and bring socioeconomic benefits).

Urban Areas

In urban areas, the costs of universal basic WASH amount to $20.3 billion (range: $9.9 to $33.1 billion) per year, with roughly two-thirds contributed by sanitation (see figure 3.2). Providing safely managed water and sanitation services to the world's urban population would cost almost three times that of providing basic WASH services at $55 billion (range: $39 to $79 billion) per year. At $31.2 billion per year, the capital costs of universal access to safely managed sanitation (conveyance and treatment of waste) exceed the costs of safely managed water in urban areas of $23.8 billion. The costs of safely managed sanitation are in addition to the costs of basic sanitation—that is, for latrines or toilets. Thus adding the cost of toilets to the cost of safe excreta management yields a total of $44.9 billion (range: $26.2 to $72.7 billion) per year in urban areas. Meeting SDG targets 6.1 and 6.2 in urban areas would cost $72.4 billion a year (range: $48 to $108 billion).

Rural Areas

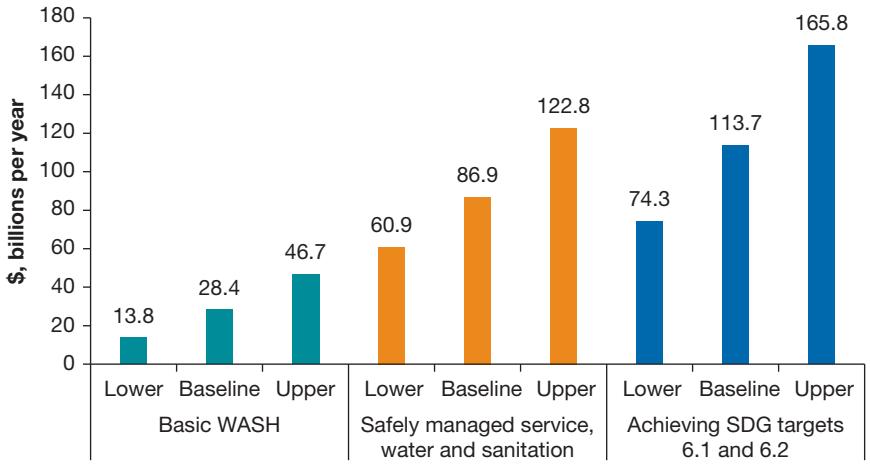
In rural areas, the cost of basic WASH amounts to $8.2 billion (range: $3.9 to $13.5 billion) per year, with over half contributed by sanitation (see figure 3.3). Providing safely managed water and sanitation services to the world's rural population would cost four times basic WASH services at $32.0 billion (range: $21.4 to $43.6 billion) per year. Ending open defecation would cost $3.6 billion (range: $2.7 to $4.2 billion) per year over a shorter time period, until 2025. Similar to urban areas, at $18.2 billion per year, the capital costs of universal access to safely managed sanitation (conveyance and treatment of waste) exceed the $13.8 billion per year needed for safely managed water in rural areas. Together, the cost of toilet and the cost of safe excreta management yield a total of $24 billion (range: $14 to $37 billion) per year in rural areas. Meeting SDG targets 6.1 and 6.2 in rural areas would cost $41.3 billion (range: $26 to $58 billion) per year.

Overall Uncertainty Range

Because of the many uncertainties in the underlying data and methodological choices outlined in table 2.2, these cost estimates should be used with caution. For national policy making and resource allocation, countries are encouraged to conduct their own costing studies or investment plans based on local unit costs and the mix of technologies and program delivery mechanisms likely to be chosen. Figure 3.4 presents the overall results of the sensitivity analysis conducted on global capital costs, showing the upper and lower global cost values for three of the important assumptions known to influence the global cost estimates. When these assumptions are varied over their plausible range, the resulting impact on global capital cost is about 50 percent around the baseline result, from $14 to $47 billion per year for basic WASH. The variation in cost as a percentage of GP_{140} is between 0.05 and 0.16 percent. For safely managed water and sanitation,

FIGURE 3.4: LARGE RANGES RESULT ON CAPITAL COST WHEN ALTERNATIVE INPUT VALUES ARE USED FOR THREE TYPES OF COSTING UNCERTAINTY

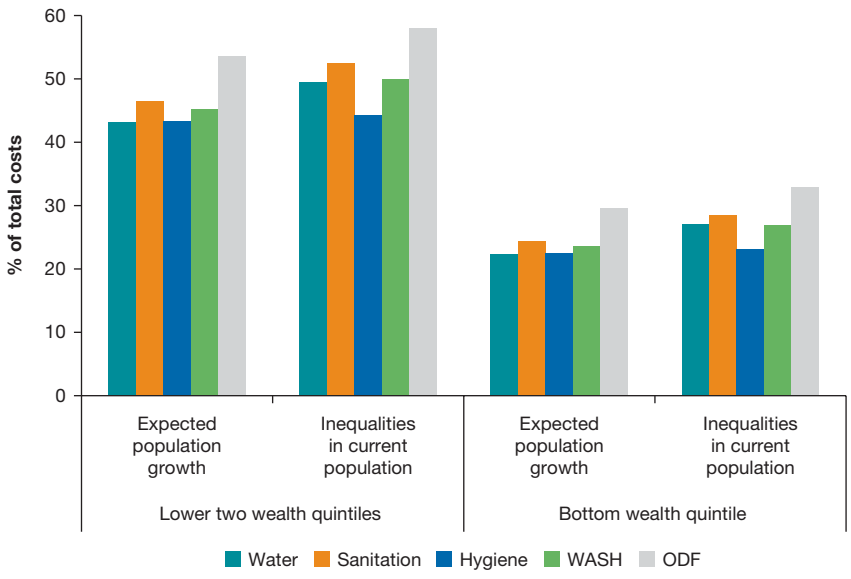
Variations in Baseline Costs for Annual Global Capital Costs



Note: Safely managed sanitation costs are for safe excreta management alone; they exclude latrine costs. WASH = water, sanitation, and hygiene; SDG = Sustainable Development Goal.

FIGURE 3.5: A HIGHER PROPORTION OF GLOBAL COSTS ARE ACCOUNTED FOR BY THE TWO LOWER WEALTH QUINTILES

Proportion of Total Costs of Basic WASH Services Contributed by Lower Two and Bottom Wealth Quintiles



Note: WASH = water, sanitation, and hygiene; ODF = open defecation–free.

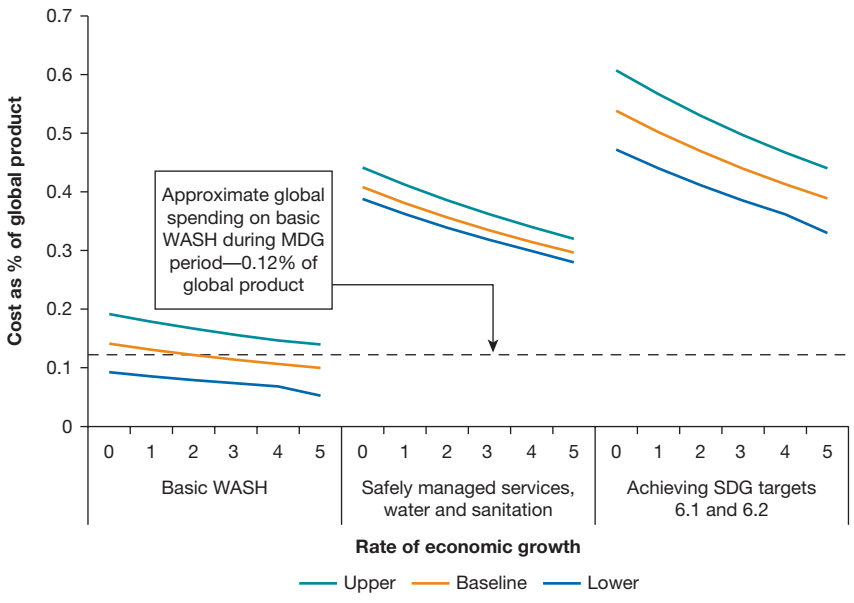
the range is relatively smaller, from $61 to $123 billion per year. The costs of meeting targets 6.1 and 6.2 vary between $74 and $166 billion. However, these ranges reflect the most extreme values these three variables are likely to take.

Cost by Income Quintile

Because coverage data were available by wealth quintile for most countries, the costs of achieving universal access to basic WASH could be compared for wealth groupings. The estimates reflect the same technology choice for the richer and poorer quintiles and therefore the same unit cost. Also, wealth quintiles are defined at the country level rather than the global level. Thus aggregating the bottom 40 percent across countries does not indicate the poorest 40 percent globally. Figure 3.5 shows the proportion of the total costs of basic WASH services contributed by the lower two wealth quintiles. Based on the current inequalities in service distribution, approximately 50 percent of the total costs are incurred providing WASH services to the poorest 40 percent of the population (on a per country definition basis) and 27 percent of the total costs are incurred providing WASH services to the poorest 20 percent of the population. For rural areas becoming open defecation–free, 58 percent of the costs are incurred by the lower two wealth quintiles. Over a 15-year perspective that includes population growth and migration, the proportion of costs required for each wealth quintile balances out because new population is added to each wealth quintile.

FIGURE 3.6: CAPITAL SPENDING REQUIREMENTS AS A PERCENT OF GLOBAL PRODUCT REDUCE UNDER HIGHER ECONOMIC GROWTH SCENARIOS

Global Costs of Achieving Different Service Levels as a Percent of GP_{140} under Economic Growth Rates of 0 to 5 Percent



Note: Safely managed sanitation costs are for safe excreta management alone; they exclude latrine costs.
GP = gross product; WASH = water, sanitation, and hygiene; SDG = Sustainable Development Goal.

Comparison with Historical Spending

To assess the feasibility of meeting the WASH targets, this study contrasted these figures with the approximate spending on capital investment globally to extend access during the 15-year MDG period. A previous study that estimated what it would cost to meet MDG target 7c from 2000 to 2015 (Hutton and Haller 2004) assessed alongside the global progress that was made towards the water and sanitation targets in 2015 reveals that about 0.12 percent of GP_{140} was spent annually over the last 15 years on improved water supply and sanitation.[12] Thus from a financial perspective, achieving universal basic WASH within 15 years is feasible based on the financial commitments of the last 15 years and a comparison with the historical capital expenditure. To achieve WASH-related targets 6.1 and 6.2, a little over three times the level of financial commitment would be needed, from 0.12 percent to 0.39 percent (range: 0.26 to 0.55 percent) of GP_{140} – to serve the unserved. This does not equate with three times the level of overall WASH spending because many funds are spent on sustaining access to the population already served, but three times the commitment on extending access to the unserved with "improved' services (according to the MDG definition).

Comparison with GP_{140} at Different Rates of Economic Growth

Costs as a proportion of GP_{140} were estimated over the 15-year period under different rates of economic growth. Rates from 0 to 5 percent are shown in figure 3.6, with ranges based on the variables adjusted in the sensitivity analysis. At 0 percent economic growth, capital costs as a proportion of GDP are 0.14 percent of GP_{140} for basic WASH, falling to around 0.10 percent at 5 percent economic growth. For safely managed water and sanitation, the costs are 0.41 percent of GP_{140} at 0 percent economic growth, falling to 0.29 percent of GP_{140} at 5 percent economic growth. To meet the WASH-related SDG targets, the capital cost falls from 0.54 percent of GP_{140} at 0 percent economic growth (range: 0.47 to 0.61 percent) to 0.39 percent of GP_{140} at 5 percent economic growth (range: 0.33 to 0.44 percent).

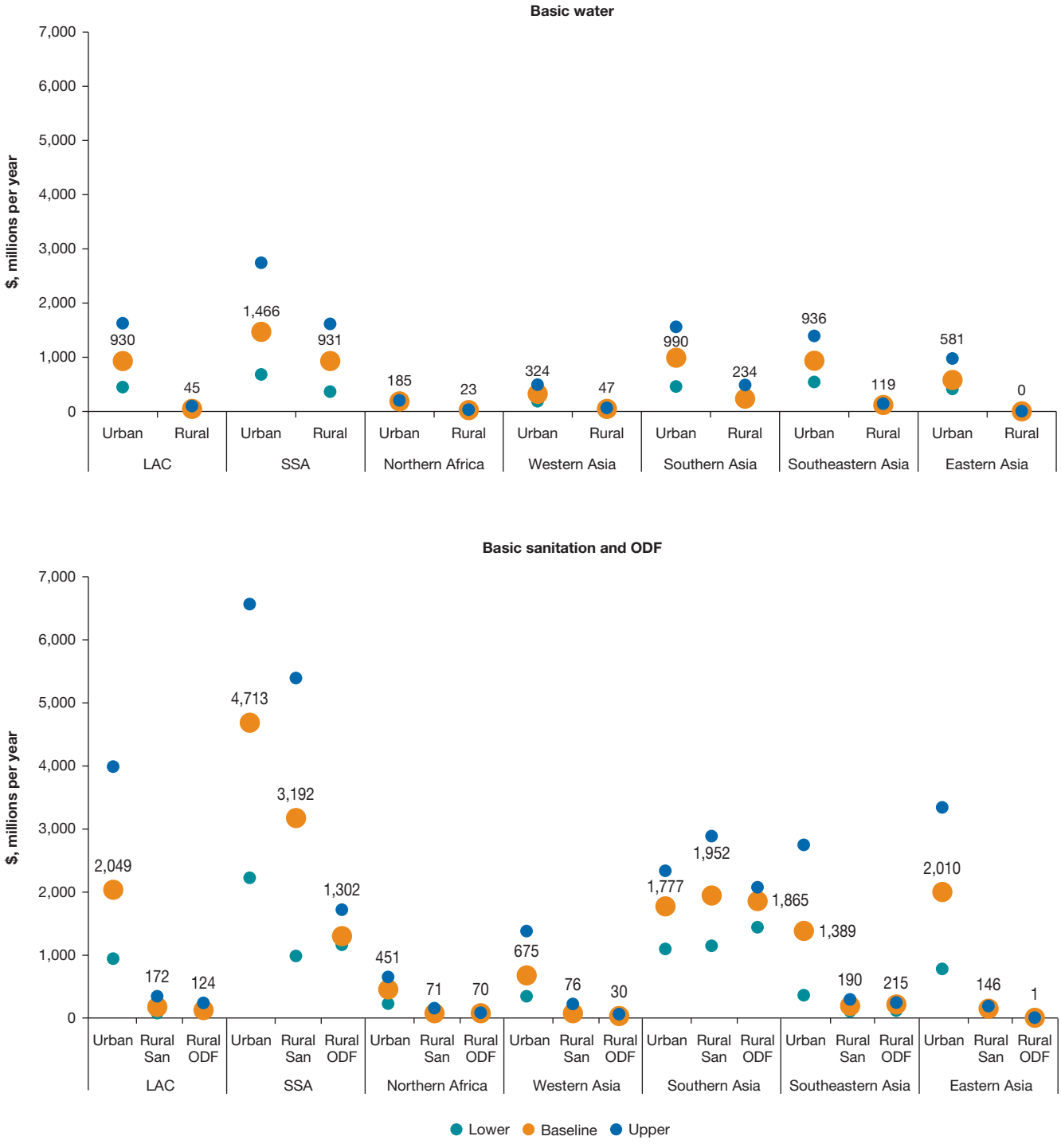
Regional Capital Costs

A regional breakdown provides a greater understanding of the geographical targeting needed for capital investment. Figure 3.7 presents a breakdown of the annual capital costs of basic WASH services by UN regional categorization used for MDG reporting and by urban and rural area. Two regions clearly dominate the capital investment needs for basic WASH in both urban and rural areas: Sub-Saharan Africa accounts for $11.3 billion (range: $5.1 to

[12] The figure 0.12 percent is based on the global progress toward the MDG water supply and sanitation targets, using a previous study that estimated the costs of reaching the targets from 2000 to 2015 (Hutton 2004).

FIGURE 3.7: LARGE REGIONAL VARIATIONS IN COSTS OF BASIC WASH SERVICES

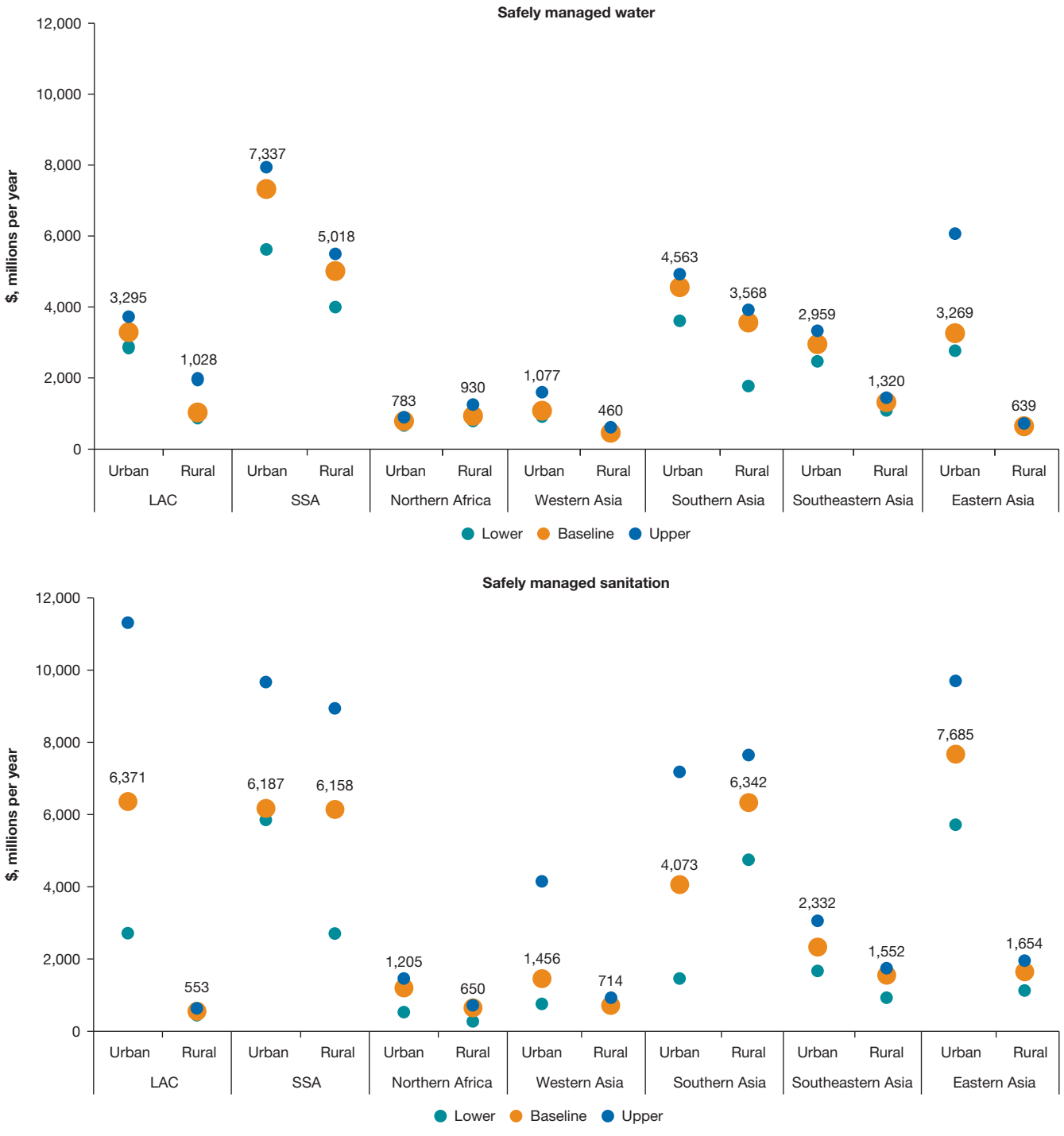
Annual Capital Costs of Basic WASH Services by MDG Region with Urban-Rural Breakdown



Note: Data label refers to baseline estimate. See appendix C for regional abbreviations and groupings. Hygiene costs and some regions with small costs are omitted. WASH = water, sanitation, and hygiene; MDG = Millennium Development Goal; ODF = open defecation–free; LAC = Latin America and the Caribbean; SSA = Sub-Saharan Africa.

FIGURE 3.8: LARGE REGIONAL VARIATIONS IN COSTS OF SAFELY MANAGED WATER AND SANITATION SERVICES

Annual Capital Costs of Safely Managed Water and Sanitation Services by MDG Region with Urban-Rural Breakdown



Note: Data label refers to baseline estimate. See appendix C for regional abbreviations and groupings. Some regions with small costs are omitted. MDG = Millennium Development Goal; LAC = Latin America and the Caribbean; SSA = Sub-Saharan Africa.

$17.6 billion) per year and Southern Asia for $5.7 billion (range: $3.5 to $8.0 billion) per year.[13] However, urban investments are globally important in three other regions—Latin America and the Caribbean, Southeastern Asia, and Eastern Asia—with sanitation dominating water supply.

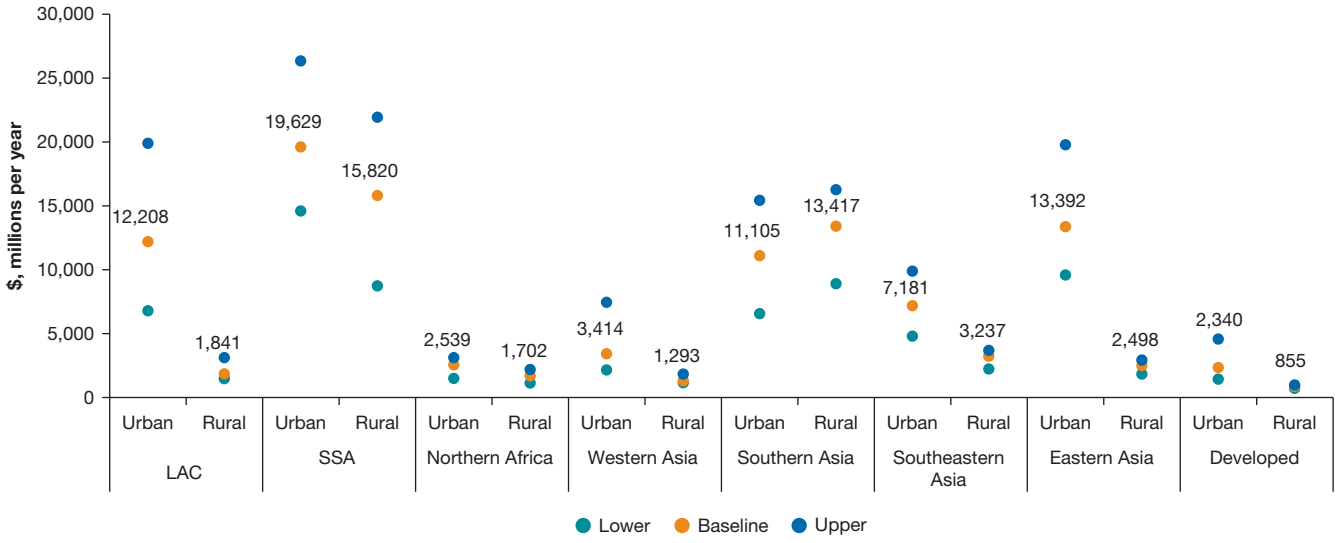
Figure 3.8 is a breakdown by MDG region and urban and rural area for safely managed water and sanitation. Among regions, there is a more equal division compared with that for basic WASH, although, overall, Sub-Saharan Africa and Southern Asia remain the two regions with the highest costs. In Sub-Saharan Africa, the costs of safely managed water and sanitation are $24.7 billion per year and in Southern Asia $18.5 billion per year. The Latin America and the Caribbean and Eastern Asia regions also have very significant urban sanitation capital investment needs, followed by urban water supply.

The annual capital costs of meeting SDG targets 6.1 and 6.2 are shown in figure 3.9. Of the $114 billion overall costs, Sub-Saharan Africa accounts for 31 percent of the global costs of meeting the targets ($35.5 billion per year), followed by Southern Asia with 22 percent ($24.5 billion per year), Eastern Asia with 14 percent ($15.9 billion per year), Latin America and the Caribbean with 12 percent ($14.0 billion per year), and Southeastern Asia with 9 percent ($10.4 billion per year). In terms of rural costs, Sub-Saharan Africa accounts for an even bigger proportion of these costs at 38 percent, followed by Southern Asia at 33 percent. In terms of urban costs, Latin American and the Caribbean and Eastern Asia become relatively more important, although Sub-Saharan Africa still dominates.

When compared with the gross product of each region, the results vary significantly around the global averages. The regional and global costs of basic and safely managed services as a proportion of the gross product are shown in figure 3.10, with an indication of the uncertainty levels

FIGURE 3.9: LARGE REGIONAL VARIATIONS IN COSTS OF MEETING TARGETS 6.1 & 6.2

Annual Capital Costs of Meeting SDG Targets 6.1 and 6.2 by MDG Region with Urban-Rural Breakdown



Note: Data label refers to baseline estimate. See appendix C for regional abbreviations and groupings. Some regions with small costs are omitted. SDG = Sustainable Development Goal; LAC = Latin America and the Caribbean; SSA = Sub-Saharan Africa.

[13] The figures cited include basic hygiene, which is not shown in figure 3.7.

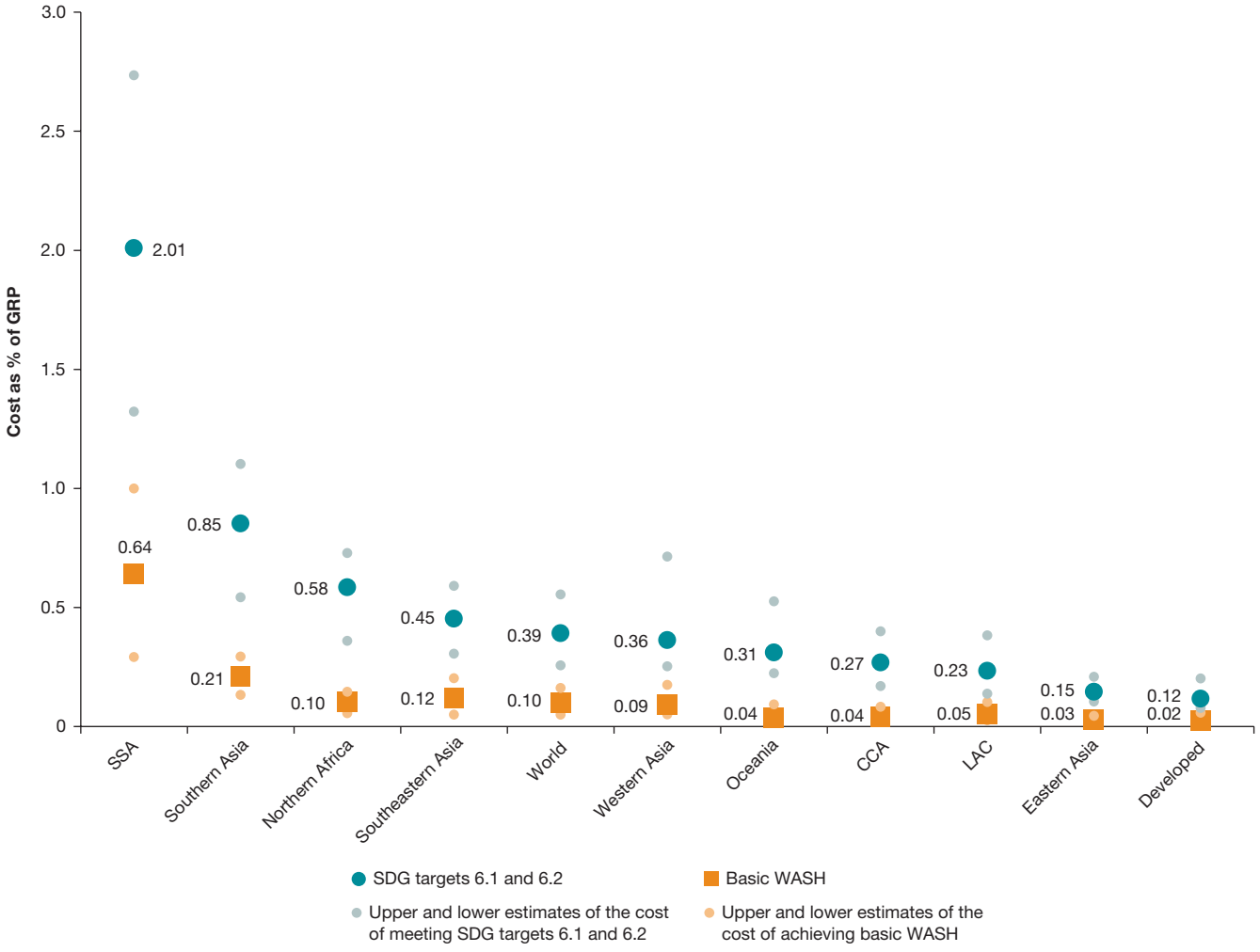
based on changing cost assumptions on three major types of costing uncertainty as previously described (see table 2.2).

The region with the highest capital costs to achieve universal basic WASH as a proportion of gross regional product (GRP) is Sub-Saharan Africa, with basic WASH costing 0.64 percent (range: 0.29 to 1.0 percent) of GRP. The other region well above the world average is Southern Asia, with capital costs of 0.21 percent (range: 0.13 to 0.29 percent) of GRP for basic WASH. For countries contributing the largest share of global costs, the estimated capital costs of basic WASH in the first year as a proportion of current GDP vary: 0.035 percent, China; 0.078 percent, Mexico; 0.19 percent, Indonesia; 0.27 percent, India; 0.63 percent, Nigeria.

Meeting the WASH-related SDG targets will require considerably more capital resources in all regions. In some regions, the capital cost seems feasible, varying from

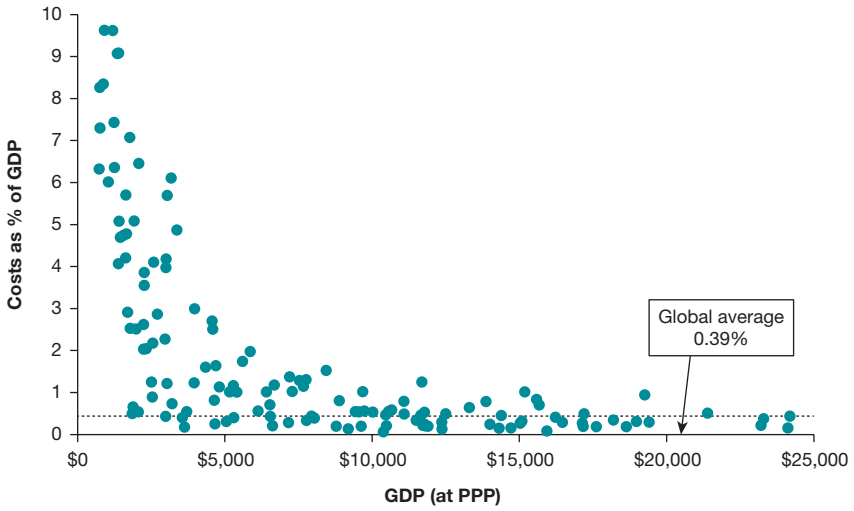
FIGURE 3.10: WIDE VARIATION BETWEEN WORLD REGIONS IN CAPITAL COSTS AS A PROPORTION OF GROSS REGIONAL PRODUCT

Costs of Basic and Safely Managed Services as a Percentage of Gross Regional Product (GRP) by MDG Region, with Uncertainty Range



Note: Data label refers to baseline estimate. MDG = Millennium Development Goal; WASH = water, sanitation, and hygiene; SDG = Sustainable Development Goal; SSA = Sub-Saharan Africa; LAC = Latin America and the Caribbean; CCA = Caucasus and Central Asia. See table 2.2 for details on upper and lower values on variables varied in sensitivity analysis. Gross regional product is based on the aggregated GDP of countries in each region. An economic growth rate of 5 percent is assumed across all regions.

FIGURE 3.11: STRONG RELATIONSHIP BETWEEN COUNTRY INCOME LEVEL AND THE COST OF ACHIEVING SDG TARGETS 6.1 AND 6.2 AS A PERCENTAGE OF GDP



Note: SDG = Sustainable Development Goal; GDP = gross domestic product; PPP = purchasing power parity.

0.12 percent of GRP in countries classified as high income, 0.15 percent of GRP in Eastern Asia, to 0.23 percent of GRP in Latin America and the Caribbean (see figure 3.10 for ranges). However, in some regions considerably more funds as a proportion of gross income are required, mainly in Asia (0.45 percent of GRP in Southeastern Asia to 0.85 percent of GRP in Southern Asia) and in Africa (0.58 percent of GRP in Northern Africa to 2.0 percent of GRP in Sub-Saharan Africa). Even these regional averages hide considerably greater variation at the country level. Figure 3.11 shows that the costs of achieving SDG targets 6.1 and 6.2 as a proportion of GDP at the country level. Each country is represented by a point. All countries with costs in excess of 3 percent of GDP are in Africa. For countries contributing the largest share of global costs, the capital costs of meeting SDG targets 6.1 and 6.2 in the first year as a proportion of current GDP is estimated to vary: 0.20 percent, China; 0.27 percent, Brazil; 0.29 percent, Mexico; 1.0 percent, India; 1.7 percent, Nigeria.

Distribution of Costs among Country Income Groupings

After looking at reporting by the MDG regions, which are geographical, it is useful to look at how the costs of basic WASH services are distributed among countries by income grouping. Figure 3.12 shows the distribution of the global costs of providing basic WASH services and of meeting SDG targets 6.1 and 6.2 by World Bank income grouping. Interesting to note is that for all services, except urban water supply, the costs of serving populations in lower-middle-income countries dominate the costs of serving the populations in all other income groupings. The costs of serving the population in low-income countries account for 23 percent of the global costs of basic WASH and 18 percent of meeting targets 6.1 and 6.2. On the other hand, rural costs have a higher share in low-income countries: 45 percent of global basic rural water supply costs. Because the majority of developed countries are excluded, they are underrepresented in this study.

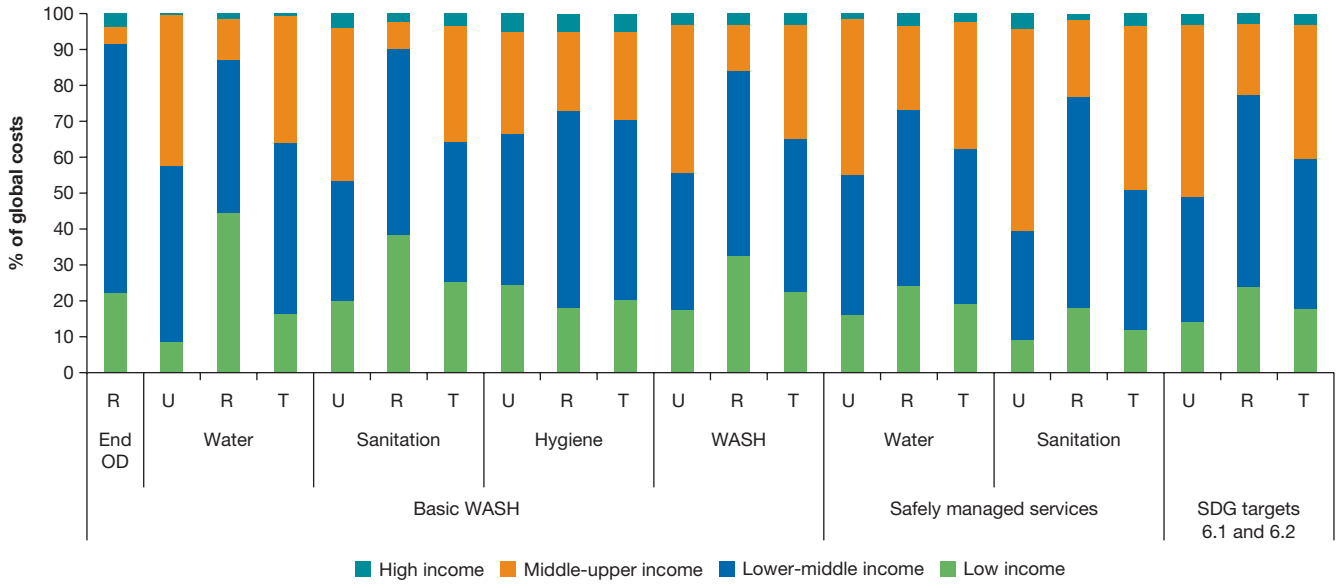
Costs of Operating and Sustaining Services

In addition to progressive investment in capital over the 15-year period to 2030, significant funds are needed to operate and maintain water and sanitation services. Indeed, the financing required for operations and maintenance (O&M) increases over time as the capital stock is extended. Figure 3.13 shows indicative spending on capital investment compared with that on the increasing O&M required to provide basic and safely managed services from 2015 to 2030. The estimates are based on linear growth in coverage, with 15 equal tranches of unserved population gaining access each year.

A major observation is that, despite the discounting of future costs at 5 percent per year, the spending requirements are increasing over time because of the growing needs for O&M as infrastructure is added and more services are provided. For basic WASH, the global O&M costs increase gradually from $4.2 billion (range: $3.1 to $5.6 billion) in 2015 to $31.1 billion (range: $14.3 to $55.3 billion) in 2030 (see left-hand graphic in figure 3.13). To achieve SDG targets 6.1 and 6.2, the global O&M costs must increase gradually from $18.0 billion (range: $14.0 to $23.6 billion) in 2015 to

FIGURE 3.12: LOWER-MIDDLE INCOME COUNTRIES DOMINATE GLOBAL COSTS, FOLLOWED BY MIDDLE-INCOME COUNTRIES

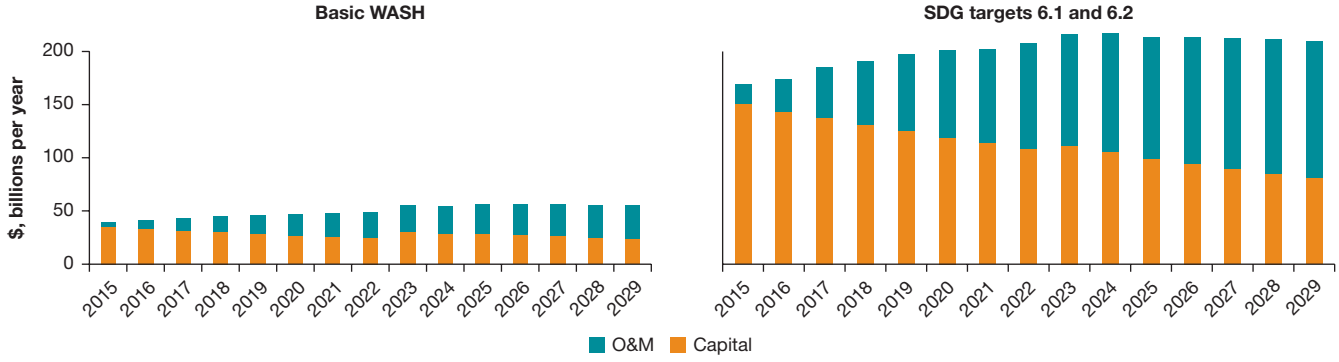
Distribution of Costs of Providing Water and Sanitation and Meeting SDG Targets 6.1 and 6.2 by Income Grouping with Urban-Rural Breakdown



Note: Safely managed sanitation costs are for safe excreta management alone; they exclude latrine costs. SDG = Sustainable Development Goal; R = rural; U = urban; T = total; OD = open defecation; WASH = water, sanitation, and hygiene.

FIGURE 3.13: CONSTANT FINANCING NEEDS: AS INVESTMENT NEEDS TO EXTEND SERVICES DECLINE, O&M GOES UP

Time Series of Total Costs from 2015 to 2029 to Achieve SDG Targets 6.1 and 6.2, Comparing Capital and O&M Costs



Note: SDG = Sustainable Development Goal; O&M = operations and maintenance; WASH = water, sanitation, and hygiene.

$128.8 billion (range: $96.7 to $166.7 billion) in 2030—see right-hand graphic in figure 3.13. By 2029, spending on O&M for the newly served from 2015 to 2029 will outweigh capital costs by 1.4 times for basic WASH and 1.6 times for safely managed WASH services.

Thus it is critical when choosing capital investments to take the financing of O&M costs into account. Although ideally O&M costs will be covered by tariffs paid by households, not all populations will be able to afford such tariffs, and thus targeted financing will be needed for those households (see next section on affordability). According to data extracted from the International Benchmarking Network for Water and Sanitation Utilities (IBNET) database,[14] there is globally a very large spread of rates of cost recovery on operating costs. In 2012, of 839 utilities with an operating cost ratio of between 0 and 2.0, 43 percent did not fully recover their costs—that is, they had an operating cost ratio of between 0 and 0.99. Of these, 73 utilities had a ratio of less than 0.50, 102 utilities had a ratio of from 0.50 to 0.79, and 184 utilities had a ratio of from 0.80 to 0.99. The remaining 57 percent of utilities had operating cost ratios of between 1.0 and 2.0. Although the IBNET database is more representative of middle-income countries than low-income countries, it does indicate very diverse practices related to cost recovery.

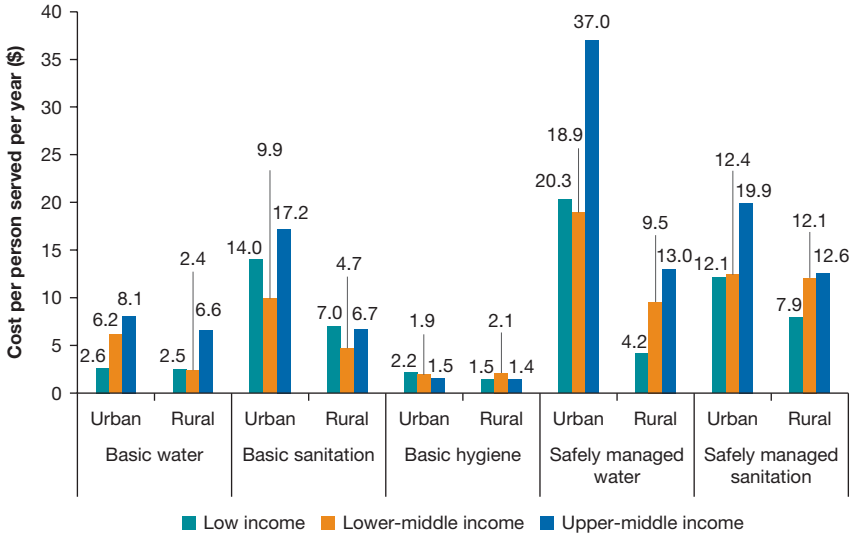
Service Affordability

Global costs give the major financiers insights into where the financing priorities are, whereas the cost per person served indicates the likely affordability to the population of different service levels. Countries can have very different policies on financing the capital and recurrent costs of water supply and sanitation services, and these policies can also differ among geographical areas and population groups within the same country. Larger capital expenditures do tend to be financed from public or donor funds, but households are likely to pay part or the full cost of the recurrent (O&M) costs.

As shown in figure 3.14, annual costs per person are strongly related to a country's income level. Urban areas also have a higher cost per person than rural areas. For sanitation, this is partly explained by the assumed higher-technology requirements in urban areas. Figure 3.14 also shows that the costs of basic sanitation exceed those of basic water, especially in urban areas. Hand washing is the lowest-cost service. In rural areas, the annual cost per person of basic WASH is approximately $11 in low-income countries (LICs) and $9 in lower-middle-income countries (LMICs), whereas in urban areas the costs are approximately $19 in LICs and $18 in LMICs. A cost of $11 for basic WASH corresponds to less than 2 percent of the average income in low-income countries. However, because of the highly

FIGURE 3.14: COST PER PERSON SERVED IS STRONGLY RELATED TO INCOME AND SERVICE LEVEL

Costs of Water and Sanitation per Person Served per Year (Capital and O&M) by Service and Country Income Grouping

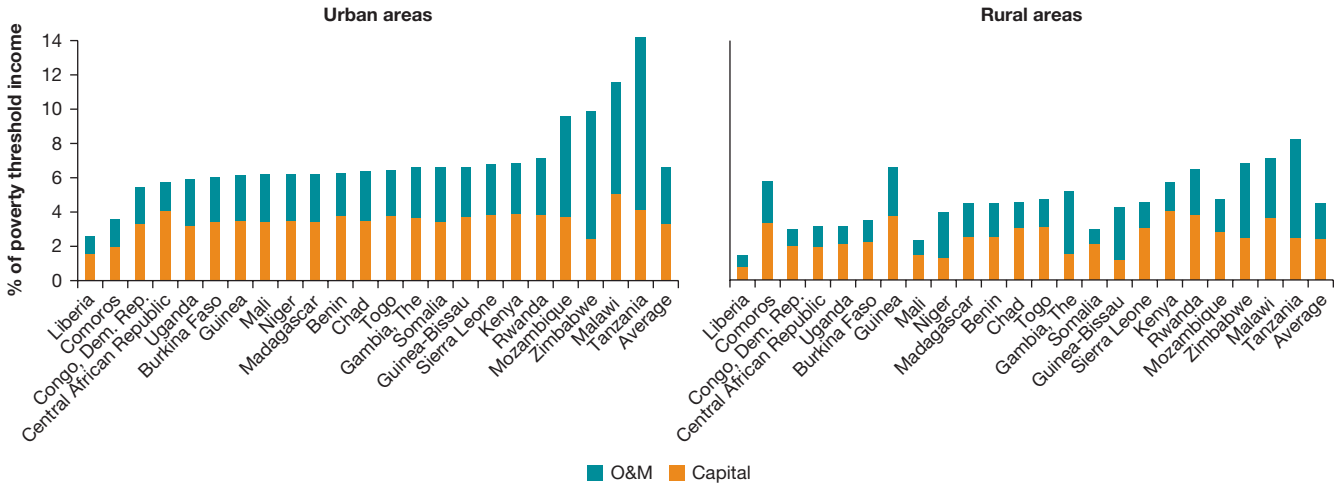


Note: O&M = operations and maintenance.

[14] The IIBNET collects data on a wide range of performance indicators from over 1,000 utilities across over 100 countries (http://www.ib-net.org).

FIGURE 3.15: WIDE VARIATION OF COST OF BASIC WASH SERVICES AS A PROPORTION OF POVERTY INCOME LEVEL

Proportion of Poverty Threshold Income Spent on Basic WASH in Low-Income Sub-Saharan Africa, Separating Capital and O&M Costs and with Urban-Rural Breakdown



Note: WASH = water, sanitation, and hygiene; O&M = operations and maintenance. Poverty income of $1.90 at purchasing power parity (PPP, 2011) adjusted to 2015 and compared with cost per person expressed in PPP.

unequal distribution in incomes, the affordability of WASH services needs to be assessed, specifically for the poor.

Figure 3.15 shows the annual costs of basic WASH services as a proportion of the World Bank's lower poverty income threshold ($1.90 at purchasing power parity – PPP – in year 2011[15]), comparing annual spending requirements on capital versus O&M costs. The calculations are based on the low-technology cost option for basic services, and include water supply, sanitation, and hand washing. When estimated in annual equivalent values, the capital costs are slightly higher than the O&M costs in the urban areas of most countries. In rural areas, the capital costs constitute an even larger share. In the majority of the low-income African countries, the capital and O&M costs combined exceed 5 percent of a poor person's annual income in urban areas. In rural areas, capital costs account for at least 2 percent of the poverty percent of poverty income. If higher-technology options are chosen for basic WASH, the percentages are a multiple of those shown in the figure 3.15. For safely managed water and sanitation, the services are considerably less affordable for poor households.[16]

An affordability analysis carried out using globally available data and internationally defined poverty thresholds does not allow specific conclusions for individual countries, but it does indicate that affordability is likely to be a concern if households are expected to pay the full costs of basic WASH services themselves. For some countries, the O&M costs alone might not be affordable for poor households. Thus, although the results of this analysis are largely illustrative, they do indicate that country- and location-specific analyses will be required to inform policy makers about which populations might find affordability an issue. In view of the concerns highlighted here, poor people need to be better targeted with public funds and require a better selection of quality and affordable technology options than they now have.

[15] These values have been updated to 2015 using the average growth of the poverty threshold from 2005 (when it was $1.25 per capita per day) to 2011.
[16] Not shown in figure 3.15.

IV. Conclusions and Recommendations

This study has presented global cost estimates for achieving universal access to basic and safely managed water, sanitation, and hygiene (WASH) services, and it has included selected cost breakdowns to illustrate the geographical distribution of costs. Although the costs are susceptible to significant uncertainties, indicative ranges have been provided. The overall cost numbers suggest that basic WASH services can be provided under current financing levels, whereas to achieve safely managed services under Sustainable Development Goal (SDG) targets 6.1 and 6.2 significantly augmented financing will be needed. The global numbers presented hide significant variation among regions (see figure 3.10), and the regional averages hide significant variations among individual countries (as indicated in figure 3.11).

The cost breakdowns provided in this study have shown where financing is needed. The provision of basic WASH services will require 70 percent of the capital expenditure in urban areas compared with 30 percent in rural areas. Sixty percent of basic WASH costs are required for basic sanitation compared with 30 percent for basic water supply. Urban sanitation alone accounts for 44 percent of the capital costs of basic WASH globally. Meanwhile, at least half of the resources need to be spent on the bottom 40 percent of the population. Thus the allocation of public and donor finances should be decided based on where the costs are, the ability of households to pay, and the poverty status of the unserved populations.

When affordability is considered from the household perspective, even meeting operations and maintenance (O&M) costs alone can place a significant burden on a poor household's income. Because of affordability concerns and the lower coverage of basic WASH services among the lower-income groups, a significant share of public funds should target poor and marginalized population groups. Donors also have to reconsider which countries they support. All this rethinking will require tough choices between achieving basic WASH for the unserved versus bringing better services to those already with basic services.

With the ushering in of the new development framework, the Sustainable Development Goals, there is a major new focus on sustainability. Recent documentation and statistics have shone a light on the high levels of breakdown or nonuse of wells, latrines, and piped systems, as well as inefficiently delivered services. Thus financing mechanisms and management approaches should be designed and implemented to ensure the quality and sustainability of new infrastructure. In order to ensure sufficient and quality spending on operations and maintenance, institutions and regulations need to be strengthened. In addition, national governments should provide the policy environment for equitable tariff structures that strike a balance between securing the additional financing needed to enable service extension and operations while enabling poorer populations to access services. Where possible, economies should be sought when combining the delivery of drinking water, sanitation, and hygiene services to reduce the service costs.

This study has revealed the cost implications of adopting different service levels for both water supply and sanitation. The overall costs are higher if a household, community, or service area takes the pathway of seeking lower levels of service before making greater investments to reach a higher level of service (see table 3.1). On the other hand, in the short term a lower service level might be the only option because of lack of investment financing. Therefore, before engaging financiers and providers, infrastructure development should be appropriately sequenced, considering the public financing available, the dynamics of urban growth, and the population demand. Whichever choice is made, WASH services should not be delayed as they are accompanied by significant health, time, environmental, and economic benefits that result from safe water and sanitation. If the right intervention is selected and delivered efficiently, these additional investments are well worth their cost (Hutton 2012).

Although understanding costs is an important part of planning and implementing WASH services to reach universal coverage, financing is only part of broader systems

strengthening that includes technology development, private suppliers and providers, policy reform, institutional strengthening and regulation, and improved monitoring and evaluation. Measures in these areas will increase the efficiency of services, provide cost savings, raise the demand for services, and stimulate the market. These aspects are largely covered under what has been termed "means of implementation" in SDG goal 17, but they will require further definition of what components are prioritized.

Because of the many uncertainties in the underlying data and methodological choices associated with this study, the cost estimates reported should be viewed with caution. The ranges on costs provided should be used with the baseline numbers. For national policy making and resource allocation, countries are encouraged to conduct their own costing studies or investment plans, based on local unit costs and the mix of technologies and program delivery mechanisms likely to be chosen. Numbers should be provided with geographical breakdown such as by rural or urban area and subnational level, as well as an in-depth analysis of the additional costs required to secure bulk water for drinking and domestic water purposes, to provide wastewater drainage as well as sewerage systems, to implement behavioral change programs to reach the hard to reach, and to sustain hygienic practices. A simple tool is available from the World Bank to allow these assessments to be made based on the same methodology described in this report, with adjustment of input data possible.[17] These assessments should include, where possible, the following components: (1) estimation of the costs of different service options and levels, including the extent to which efficiency savings can be made, such as economies of scale; (2) assessment of the benefits received per population subgroup with a distinction between private benefit and social benefit, including willingness and ability to pay for benefits; (3) an assessment of financing options and an overall financing strategy; and (4) a concrete investment plan to reach universal access. In the investment plan, public and private components should be linked, and the plan should be based on the public financing available and the ability of populations to pay for services. Efforts should be made to "crowd-in" private investment, including realistic market assessments to determine which market segments are viable for involvement by the private sector.

[17] Visit www.wsp.org

Appendix A: Service Indicators and Data Sources

TABLE A.1: DATA SOURCES FOR LEVELS OF WASH SERVICES

Service	First-level service ("basic WASH")	Higher-level service ("safely managed")
Water	Percentage of population using a protected community source or piped water with a total collection time of 30 minutes or less for a round-trip, including queuing. Data available for all countries from nationally representative surveys (JMP).	Percentage of population using safely managed drinking water services. Corresponds to population using an improved drinking water source located on the premises, available when needed, and free of fecal and priority chemical contamination (WHO and UNICEF 2012).[a] Data available on piped water for all countries from nationally representative surveys (JMP). Data adjusted downward for quality (proportion of piped sources unsafe based on published studies).
Sanitation	Percentage of population not practicing open defecation. Percentage of population using a basic private sanitation facility. Data available for all countries from nationally representative surveys (JMP).	Percentage of population using safely managed sanitation services. Data available on sewerage for most countries from a published paper (Baum, Luh, and Bartram 2013) and on fecal sludge management from on-site systems for 12 countries (Peal et al. 2014).
Hygiene	Percentage of population with hand-washing facilities with soap and water at home. Data available from 42 countries from nationally representative surveys (JMP).	

Source: WHO and UNICEF 2013.
Note: WASH = water, sanitation, and hygiene; JMP = Joint Monitoring Programme for Water Supply and Sanitation.
a. Regarding "safely managed" drinking water, the following criteria are stated either in the target or the definition proposed by JMP and its partners: (1) improved drinking water source, (2) on the premises, (3) available when needed, (4) free of fecal and priority chemical contamination. For the purposes of this study, data on on-plot water supplies were sourced from nationally representative surveys and adjusted by the expected proportion of household connections not providing safe water. Thus criteria 1, 2, and 4 are met, whereas criterion 3 is presumed. (On criterion 2, because the question does not ask whether the water source is actually in the household or on-plot, the at-home household supply counts any household that answers that the round-trip is less than five minutes.) More detailed surveys will be needed to ascertain the extent to which these are true. On criterion 4, estimates were adjusted for water quality using results from the study by the World Health Organization (WHO) on the rapid assessment of drinking water quality and from other surveys that report on the proportion of improved water sources (by type) that do not meet WHO guideline for *E. coli*, fluoride, and arsenic. An assessment of cost against income of different wealth groups enables assessment of affordability, which was conducted in this study (see section "Service affordability"). However, the estimates of water supply coverage presented here did not take into account affordability. Because estimates are not based on adjustments for all criteria, the estimates used for safely managed drinking water services are therefore likely to be optimistic.

Appendix B: WASH Service Coverage Levels by MDG Region

Current service coverage is shown in table B.1.

TABLE B.1: PROJECTED WASH SERVICE COVERAGE IN 2015 FOR PROPOSED POST-2015 SERVICE-LEVEL DEFINITIONS WITH URBAN-RURAL BREAKDOWN

Percent

	Water				Sanitation					Hygiene	
	Basic		Safely managed		ODF	Basic		Safely managed		Hand washing	
MDG region	Urban	Rural	Urban	Rural	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Latin America and the Caribbean	95	83	88	48	88	87	64	35	34	92	85
Sub-Saharan Africa	60	42	25	2	66	40	23	33	34	40	16
Northern Africa	94	88	82	48	95	94	87	50	34	92	88
Western Asia	96	79	84	54	100	94	76	41	34	97	92
Caucasus and Central Asia	93	81	75	20	100	95	94	35	34	92	77
Southern Asia	85	83	48	9	51	65	33	6	34	85	49
Southeastern Asia	70	81	46	12	84	81	65	37	34	93	79
Eastern Asia	98	87	90	45	98	86	64	24	34	83	44
Oceania	88	87	69	22	76	84	56	35	34	92	88
Developed countries	98	95	90	54	100	86	79	21	34	99	97
Total (140 countries)	**87**	**76**	**68**	**20**	**72**	**76**	**46**	**26**	**34**	**82**	**50**

Source: Unpublished estimates from the Joint Monitoring Programme for Water Supply and Sanitation (JMP) and published studies, using definitions of access for post-2015 WASH monitoring (see appendix A).

Note: WASH = water, sanitation, and hygiene; MDG = Millennium Development Goal; ODF = open defecation–free.

Population size is shown in table B.2, broken down by rural and urban area.

TABLE B.2: POPULATION BY MDG REGION, 2015 AND 2030, WITH URBAN-RURAL BREAKDOWN
Millions

	Total			Urban			Rural		
MDG region	2015	Growth	2030	2015	Growth	2030	2015	Growth	2030
Latin America and the Caribbean	601	84	685	478	90	568	123	–6	118
Sub-Saharan Africa	988	434	1,422	372	270	642	616	165	780
Northern Africa	177	33	210	98	28	127	79	5	84
Western Asia	173	43	216	114	39	152	59	5	64
Caucasus and Central Asia	83	12	95	36	8	44	47	3	50
Southern Asia	1,794	292	2,085	624	251	875	1,169	41	1,210
Southeastern Asia	627	89	716	296	101	396	331	–12	319
Eastern Asia	1,430	53	1,483	797	222	1,019	633	–168	464
Oceania	2	0	3	1	0	1	1	0	2
Developed countries	247	–17	230	172	–5	167	75	–13	63
Total (140 countries)	**6,122**	**1,024**	**7,146**	**2,988**	**1,003**	**3,991**	**3,134**	**20**	**3,154**

Source: UN Statistics Division.
Note: Rural and urban numbers may not add up due to rounding. MDG = Millennium Development Goal. Some numbers may not add up due to rounding.

Population to serve[18] is based on the new indicator definitions for basic water and sanitation. By 2030, 2.3 billion additional people will need to be covered with basic water and 3 billion additional people will need to be covered with basic sanitation. For water supply, over 900 million of the unserved reside in Sub-Saharan Africa, while for sanitation over 1 billion of the unserved reside in of Sub-Saharan Africa and 1 billion in Southern Asia (see table B.3).

TABLE B.3: TOTAL POPULATION TO SERVE FROM 2015 TO 2030 TO REACH UNIVERSAL ACCESS TO WATER SUPPLY WITH RURAL-URBAN BREAKDOWN

Millions

	Basic water—universal			Safely managed water—reduce by 50 percent			Safely managed water—universal		
MDG region	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Latin America and the Caribbean	114	19	133	112	32	145	148	61	209
Sub-Saharan Africa	417	521	939	302	385	687	550	767	1,317
Northern Africa	34	15	49	35	26	60	46	47	93
Western Asia	44	19	63	43	19	63	57	34	92
Caucasus and Central Asia	11	12	23	11	21	32	17	41	58
Southern Asia	345	239	584	345	555	900	576	1,103	1,679
Southeastern Asia	189	65	254	155	142	298	263	281	544
Eastern Asia	240	0	240	258	78	335	308	195	503
Oceania	0	0	1	0	1	1	0	1	2
Developed countries	2	0	2	7	13	20	12	24	36
World	**1,396**	**892**	**2,287**	**1,268**	**1,271**	**2,540**	**1,977**	**2,554**	**4,531**

Note: Data are based on coverage (Table B1) and population size (Table B2). Rural and urban numbers may not add up due to rounding. MDG = Millennium Development Goal.

[18] These estimates different from those in the latest JMP estimates from the JMP 2015 report, because of the difference in service definitions in the 2015 JMP report (UNICEF and WHO 2015) and the ones used in this report. Also, the JMP 2015 report includes additional data sets that may lead to different estimates for 2015.

Table B.4 shows the population to be reached with sanitation services at the home. Because open defecation is largely a rural phenomenon[19] and low-cost toilets are less feasible in urban areas, the analysis focuses exclusively on rural areas.

TABLE B.4: TOTAL POPULATION TO BE REACHED FROM 2015 TO 2030 WITH SANITATION SERVICES WITH URBAN-RURAL BREAKDOWN

Millions

	ODF	Basic sanitation—universal			Safely managed sanitation—reduce by 50 percent			Safely managed sanitation—universal		
MDG region	Rural	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Latin America and the Caribbean	18	157	40	197	215	37	252	400	76	476
Sub-Saharan Africa	340	493	639	1132	301	314	615	520	572	1,092
Northern Africa	9	34	16	50	46	29	75	78	57	135
Western Asia	5	45	20	65	60	23	83	106	44	149
Caucasus and Central Asia	3	10	6	16	17	18	35	32	34	66
Southern Asia	626	473	832	1,305	426	415	840	836	815	1,651
Southeastern Asia	60	159	117	276	162	102	263	286	207	493
Eastern Asia	0	329	50	379	440	97	537	826	251	1,077
Oceania	0	0	0	0	0	1	1	1	1	2
Developed countries	0	20	7	27	65	17	81	130	37	168
World	**1,062**	**1,721**	**1,727**	**3,448**	**1,733**	**1,051**	**2,784**	**3,214**	**2,095**	**5,309**

Note: Data are based on coverage (Table B1) and population size (Table B2). Rural and urban numbers may not add up due to rounding. MDG = Millennium Development Goal; ODF = open defecation–free.

[19] In 2012, according to the JMP, 4 percent of urban households in developing regions practiced open defecation compared with 29 percent of rural households.

Table B.5 shows the number of people targeted to practice hand washing by 2030. Although the rates of hand washing were not available from the large majority of countries, the table shows the best available current estimates. Currently over 2.5 billion people do not wash their hands at critical times—in particular, after defecation.

TABLE B.5: TOTAL POPULATION TO REACH FROM 2015 TO 2030 WITH UNIVERSAL HAND-WASHING PRACTICE WITH URBAN-RURAL BREAKDOWN
Millions

	Basic hygiene		
MDG region	Urban	Rural	Total
Latin America and the Caribbean	131	15	146
Sub-Saharan Africa	498	681	1,179
Northern Africa	36	15	51
Western Asia	42	11	53
Caucasus and Central Asia	11	14	25
Southern Asia	464	634	1,098
Southeastern Asia	125	64	189
Eastern Asia	415	185	600
Oceania	0.3	0.3	1
Developed countries	1.3	0	1.3
World	**1,673**	**1,620**	**3,293**

Note: Data are based on coverage (Table B1) and population size (Table B2). Rural and urban numbers may not add up due to rounding. MDG = Millennium Development Goal.

Appendix C: Countries Included in This Study

TABLE C.1: COUNTRIES INCLUDED IN THIS STUDY BY MDG REGION AND WORLD BANK INCOME LEVEL

	Included countries by World Bank income level				
MDG region	Low income	Lower-middle Income	Upper-middle Income	High income	Excluded countries
Latin America and the Caribbean	Haiti	Bolivia, El Salvador, Guatemala, Guyana, Honduras, Nicaragua, Paraguay	Argentina, Belize, Brazil, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, Grenada, Jamaica, Mexico, Panama, Peru, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Venezuela, RB		Anguilla, Antigua and Barbuda, Aruba, Barbados, British Virgin Islands, Cayman Islands, Chile, Falkland Islands (Malvinas), French Guiana, Guadeloupe, Martinique, Montserrat, Puerto Rico, St. Kitts and Nevis, The Bahamas, Turks and Caicos Islands, Uruguay, Virgin Islands (U.S.),
Sub-Saharan Africa	Angola, Benin, Botswana, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Democratic Republic of Congo, Eritrea, Ethiopia, Gabon, Gambia (The), Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Rwanda, Sierra Leone, Somalia, Togo, Uganda, Tanzania, Zimbabwe	Cameroon, Cape Verde, Congo, Côte d'Ivoire, Djibouti, Ghana, Lesotho, Mauritania, Nigeria, São Tomé and Príncipe, Senegal, South Sudan, Sudan, Swaziland, Zambia	Mauritius, Namibia, Seychelles, South Africa	Equatorial Guinea	Mayotte, Réunion
Northern Africa		Arab Republic of Egypt, Morocco	Algeria, Libya, Tunisia		Western Sahara (territory)
Western Asia		Syrian Arab Republic, Republic of Yemen	Iraq, Jordan, Lebanon, Turkey		Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates, West Bank and Gaza
Caucasus and Central Asia	Tajikistan	Armenia, Georgia, Kyrgyz Republic, Uzbekistan	Azerbaijan, Kazakhstan, Turkmenistan		
Southern Asia	Afghanistan, Bangladesh, Nepal	Bhutan, India, Pakistan, Sri Lanka	Islamic Republic of Iran, Maldives		

TABLE C.1: (CONTINUED)

	Included countries by World Bank income level				
MDG region	Low income	Lower-middle Income	Upper-middle Income	High income	Excluded countries
South-eastern Asia	Cambodia, Myanmar	Indonesia, Lao People's Democratic Republic, Philippines, Vietnam	Malaysia, Thailand, Timor-Leste		Brunei Darussalam, Singapore
Eastern Asia	Democratic People's Republic of Korea	Mongolia	China		Hong Kong SAR, China, Macao SAR, China, Republic of Korea
Oceania		Federated States of Micronesia, Kiribati, Nauru, Niue, Papua New Guinea, Samoa, Solomon Islands, Vanuatu	Cook Islands, Fiji, Marshall Islands, Palau, Tonga, Tuvalu		American Samoa, French Polynesia, Guam, New Caledonia, Northern Mariana Islands, Tokelau
Developed countries		Moldova, Ukraine	Albania; Belarus; Bosnia and Herzegovina; Bulgaria; Serbia; Macedonia, the former Yugoslav Republic of	Romania, Russian Federation	Andorra, Australia, Austria, Belgium, Bermuda, Canada, Channel Islands, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Faroe Islands, Finland, France, Germany, Greece, Greenland, Hungary, Iceland, Ireland, Isle of Man, Israel, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Montenegro, Netherlands, New Zealand, Norway, Poland, Portugal, San Marino, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States

Note: Classification using gross national income per capita based on *World Bank Atlas* method. Low-income: <$1,046; lower-middle income: $1,046–$4,125; upper-middle income, $4,125–$12,745; high income, >$12,746.

Appendix D: Cost Estimation Methods

A quantitative cost model was run at the country level for 140 low- and middle-income countries.[20] The results were then aggregated to yield the regional and global totals or averages, weighted by country population size. The model also generated separate estimates for rural and urban areas,[21] as well as by wealth quintile.[22] In line with the post-2015 proposal, wealth quintiles with lower starting coverage in 2015 were assumed to be served at a faster rate to achieve universal coverage by 2030.

The total intervention cost consists of all the resources required to put in place, operate, and maintain water, sanitation, and hygiene (WASH) services. A distinction is made between upfront investment or capital costs ("CapEx"), major capital maintenance costs ("CapManEx"), and regular recurrent costs ("OpEx") (Fonseca et al. 2010).[23] CapEx includes planning and supervision, hardware, construction and house alteration, protection of water sources, education, and behavioral change. CapManEx includes maintenance of hardware and replacement of parts and renovation or rehabilitation when required to extend the life of the hardware to its expected life span (see table D.2). OpEx includes the operating materials needed to provide a service, regulation, ongoing protection, and monitoring of water sources, water treatment and distribution, and continuous education activities. In the baseline results, only the incremental costs of extending and operating WASH services to those unserved in the baseline year (2015) are presented.

To achieve universal coverage, populations will be covered by some form of basic or safe service that can be achieved with a number of different hardware options or technologies. In such a global study, it is not possible to predict what technologies will be chosen by governments and service providers, or the households they will serve. For monitoring the Millennium Development Goal (MDG) target on water and sanitation, the Joint Monitoring Programme on Water Supply and Sanitation (JMP) defined "improved" versus "unimproved" technology or service options. For the purposes of this study, for basic WASH supply a mix of lower-cost technology options were selected (see table D.1). They included community wells for water supply, improved latrines for sanitation, and the components needed for practicing hand washing (basin with soap and water). Higher-cost options such as piped water and sewerage were included as options under "safely managed" services. Therefore, because many households will choose piped options to gain a service, not least because they are in the coverage area of a utility, the basic WASH costs will underestimate the likely spending to even meet a basic service standard.

The proposed indicator for Sustainable Development Goal (SDG) target 6.2 is safely managed sanitation. The additional cost of providing services to safely manage excreta includes the costs of safe extraction or conveyance, treatment, and disposal.

Cost data were obtained by means of an extensive search of the peer-reviewed published literature as well as project documents and agency reports sourced from contacts and the Internet (see reference list at the end of this appendix). In addition, the cost data available were sent to experts in 40 countries in order to verify the estimates found and to request the latest cost estimates available at

[20] See appendix C for a list of countries. Countries classified by the World Bank as high income are excluded from the study, except Equatorial Guinea, which was included because it has below 50 percent sanitation coverage, and the Russian Federation, which has closer to 90 percent sanitation coverage but because of its population size still has an important number of child deaths attributed to poor WASH. Several upper-middle-income countries or territories were omitted (Hungary, Western Sahara, the West Bank and Gaza, and several small island states) because of lack of mortality data from the World Health Organization's most recent burden of disease study.

[21] It is recognized that a single rural versus urban breakdown does not reflect the global diversity of settlement types and densities. However, because this study draws on the only global database of drinking water, sanitation, and hand-washing coverage (provided by the Joint Monitoring Programme), it is limited by the singular rural-urban distinction of the JMP's data sets.

[22] Wealth quintiles are created when populations are split by five equal groups according to their wealth level, which is approximated by a household asset index from survey data.

[23] The International Water and Sanitation Centre's WASHCost project distinguished between (1) capital expenditure, (2) operational costs, (3) capital maintenance, (4) direct support costs, (5) indirect support costs, and (6) loan interest. In this study, direct support costs are included under (1), and (5) and (6) were excluded because of lack of data.

TABLE D.1: TECHNOLOGY OPTIONS MODELED UNDER BASELINE AND IN SENSITIVITY ANALYSIS BY SERVICE

		Sensitivity analysis	
Service	Baseline technology assumption	Low-cost	High-cost
Basic water	• 50 percent protected community borehole/tube well • 50 percent protected dug well	100 percent protected dug well	100 percent protected community borehole or tube well
Safely managed water	• Piped water supply on-plot		Increased bulk water supply costs
Open defecation–free, rural	• Simple or traditional latrines		
Basic sanitation, urban	• 50 percent flush toilet to septic tank • 50 percent any type of pit latrine	100 percent any type of pit latrine	100 percent flush toilet to septic tank
Basic sanitation, rural	• 50 percent pour-flush pit latrine • 50 percent dry pit latrine	100 percent dry pit latrine	100 percent pour-flush pit latrine
Safely managed sanitation	• 50 percent sewerage with treatment • 50 percent FSM with treatment	100 percent FSM with treatment	100 percent sewerage with treatment
Hand washing	• 100 percent with mix of hand-washing basin options (varying by region)		

Note: FSM = fecal sludge management.

the country level.[24] Technology types were classified according to the service definitions in Table D.1. Cost data (cost per person or per household) were available for at least one service definition for at least half the countries. All unit cost data were updated to 2015 prices in U.S. dollars from their reported year using the three-step methodology of the Disease Control Priorities project (edition 3):

- Step 1: Data were tabulated in local currency for the year to which they refer.
- Step 2: Costs were updated to 2015 prices using the annual gross domestic product (GDP) deflator for that country.[25]
- Step 3: Costs were converted to U.S. dollars using the exchange rate from early January 2015.

For countries without data for a given service type and level, data were extrapolated from a neighboring or similar country with comparable price levels or economic development. The price observed in the country with data was adjusted for the difference in price levels using GDP per capita expressed at purchasing power parity (PPP).[26] Purchasing power parity as opposed to absolute GDP per capita was used as the basis for conversion because it is assumed that the majority of inputs are local labor and locally produced goods. To test the impact of this assumption, costs are presented under a scenario of extrapolation using difference in GDP per capita at official exchange rates. Unit costs for capital items (including software) are presented in appendix E.

Because cost data can be highly variable between different studies even in the same country, the results of such a global costing exercise can lead to significant uncertainties in the cost results. Only cost studies were considered that detailed the costing methods and indicated adequate data collection, sampling approach, and inclusiveness of major cost

[24] These countries were selected as representing the highest number of unserved populations for basic water and basic sanitation services. See the acknowledgments for a list of those responding.
[25] For the years 2013–15 without data, the GDP deflator for 2012 was used.
[26] For example, if the unit cost is $30 in the source country (country A) with a GDP at PPP of $1,000, then the extrapolated unit cost to country B with a GDP at PPP of $500 would be $15. The extrapolation process identified the nearest countries with similar price levels to reduce to the maximum degree possible the distorting effect of the price level adjustment.

TABLE D.2: ASSUMPTIONS USED TO FILL GAPS IN COST DATA AVAILABLE BY WASH SERVICE

Service	Life span of capital items (years)	Time until capital maintenance (years)	Software (as % of hardware)	Capital maintenance (as % of initial capital)	Operating costs (as % of initial capital)
Water supply					
Safe household piped	20	10	10%	30%	NR
Basic household piped	20	10	5%	30%	NR
Borehole or tube well	20	10	5%	30%	NR
Dug well	10	5	5%	30%	NR
Sanitation					
Septic tank, sewerage, treatment facilities	20	10	10%	30%	NR
Urban basic pit latrine	8	4	10%	30%	5%
Rural basic pit latrine	8	4	20%	30%	5%
Rural traditional pit latrine (for ODF)	2		5% of cost of a basic pit latrine	0%	5% of cost of a basic pit latrine
Hygiene					
Hand washing	1–5[a]	Half life span	Estimated separately	30%	NR

Note: WASH = water, sanitation, and hygiene; NR = no assumption required because data are largely available on these items, ODF = open defecation–free.
a. Variable, depending on type of hardware chosen.

items in order to give greater confidence on the accuracy of the resulting unit cost estimates.

The unit cost data on capital hardware costs were widely available and reasonably robust. On the other hand, fewer data were available for four items: (1) life span of hardware and software interventions; (2) program management and behavioral change intervention costs ("software" costs) at the initial stages and the recurrent costs to sustain the behavioral change; (3) capital maintenance (both in terms of the costs required and how often it is needed); and (4) operating costs, in particular for hygiene interventions and for rural sanitation. The assumptions used to fill these cost data gaps are presented in table D.2. In addition to these uncertainties in cost data, uncertainty applies to the lack of information about changes from 2015 to 2030. Three main items are largely unknown: (1) changes that might occur in the unit cost of service delivery over time because of changes in population density (e.g., population growth and migration); (2) changes in the environment (e.g., climate change and overuse of water resources); and (3) changes in technological solutions.

For a utility-run piped water supply, the cost of accessing bulk water may have been underestimated because the cost data accessed are likely to have underestimated future costs.[27] Moreover, because of the paucity of cost data on what it takes to change behavior and ensure service sustainability, the software costs used may underestimate the true costs, especially for delivering services to the "last mile" (hardest to reach populations).

The annual costs were estimated by assuming 15 equal population groups for each quintile to reach the target by 2030. The CapEx costs were then estimated for each year, and the annual operations, capital maintenance, and replacement costs were estimated for all the new population with service until 2030. To estimate the present value

[27] This is in part because current consumption patterns are at unsustainable levels and because climate change and climate variability will lead to higher future costs of access and storage of bulk water.

of achieving the target by 2030, the costs for each year were aggregated following discounting of future costs to the year 2015 using a discount rate of 5 percent. The sensitivity analysis included the discount rate was adjusted from 3 percent to 8 percent.

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Appendix E: Unit Costs by Country

TABLE E.1: CAPITAL COSTS PER PERSON SERVED IN 2015, INCLUDING HARDWARE AND SOFTWARE, WITH URBAN-RURAL BREAKDOWN

U.S. dollars

	Water						Sanitation									Hand-washing station, soap, water	
	Basic				Advanced		Unimproved	Basic improved				Advanced—full excreta management (incremental off-site)					
	Urban		Rural		Urban	Rural	Rural	Urban		Rural		Urban		Rural			
Country	Tube well/ borehole	Dug well	Tube well/ borehole	Dug well	Piped on-plot	Piped on-plot	Unimproved pit latrine	Latrine with septic tank	Wet pit latrine	Wet pit latrine	Dry pit latrine	Sewerage with treatment	Septic tank with FSM	Pit latrine with sewerage and treatment	Pit latrine with FSM	Urban	Rural
Afghanistan	30.2	8.7	19.0	11.8	215.0	77.0	4.4	29.7	20.5	20.5	8.6	50.4	13.5	63.2	49.5	1.7	0.6
Albania	156.1	62.4	39.1	19.5	176.7	39.1	23.4	286.4	22.2	22.2	17.7	135.3	103.9	101.2	66.6	1.3	1.1
Algeria	56.4	79.2	49.5	17.2	306.2	306.2	29.7	376.2	129.7	129.7	22.4	508.7	131.8	128.4	166.6	1.7	1.4
Angola	112.2	32.6	250.1	26.9	216.3	398.8	16.8	243.3	40.6	40.6	23.0	351.6	238.6	642.4	94.4	0.9	0.8
Argentina	245.9	87.6	106.9	19.0	263.4	338.7	32.8	416.1	101.1	101.1	24.8	562.6	145.8	142.0	93.5	1.8	1.5
Armenia	33.0	23.2	33.0	23.2	156.1	108.5	17.3	197.3	29.5	29.5	12.1	308.5	247.5	75.0	97.4	1.0	0.8
Azerbaijan	286.4	102.0	63.8	22.2	288.7	63.8	38.2	468.0	36.2	36.2	28.9	221.1	169.8	165.4	214.6	2.2	1.8
Bangladesh	38.9	11.2	24.4	17.5	276.3	98.9	5.7	132.0	6.9	6.9	5.7	64.8	17.3	81.2	63.6	2.2	0.8
Belarus	294.3	104.9	65.6	22.8	405.4	405.4	39.3	481.0	37.2	37.2	29.7	227.2	174.5	170.0	111.9	2.2	1.8
Belize	544.8	36.5	387.2	36.5	908.1	817.2	18.8	200.0	100.4	100.4	14.2	318.3	83.6	453.2	105.7	1.1	0.9
Benin	49.4	23.5	114.9	5.0	60.9	17.8	10.0	57.8	34.5	34.5	11.2	151.2	56.7	310.0	44.5	12.4	12.4
Bhutan	116.5	22.9	32.5	22.9	263.5	296.6	17.1	86.6	60.7	60.7	33.2	194.3	51.9	243.5	190.7	6.6	2.4
Bolivia	102.4	26.5	26.0	18.3	109.7	141.1	13.7	68.4	42.1	42.1	9.6	121.7	195.2	59.2	38.9	0.8	0.6
Bosnia and Herzegovina	160.9	57.3	35.9	17.9	221.7	221.7	21.5	263.0	20.4	20.4	16.2	124.2	95.4	93.0	61.2	1.2	1.0
Botswana	261.9	93.3	113.8	20.3	489.7	225.4	20.0	505.9	227.0	227.0	113.6	591.0	155.3	1,335.9	196.3	2.0	1.6
Brazil	251.2	89.5	56.0	19.4	346	346	33.5	425.1	103.3	103.3	25.3	574.8	148.9	145.1	95.5	1.9	1.6
Bulgaria	266.3	94.9	59.4	20.6	366.9	366.9	35.5	435.3	33.7	33.7	26.8	205.6	157.9	153.9	101.2	2.0	1.7
Burkina Faso	45.1	21.5	62.8	4.6	75.6	114.9	10.2	41.9	31.5	31.5	10.2	138.0	51.7	421.6	40.6	12.4	11.3
Burundi	31.9	3.2	31.2	2.2	49.2	127.5	1.5	62.0	19.4	19.4	10.5	218.8	24.4	133.4	19.2	4.2	2.2
Cambodia	23.7	18.0	23.7	18.0	132	39.5	5.6	50.8	22.6	22.6	11.2	282	85.2	45.1	75.6	0.4	0.3
Cameroon	101.8	35.6	88.4	9.7	243.4	106.4	15.2	87.5	61.7	61.7	49.0	147.5	85.8	469.3	67.4	18.8	0.9
Cape Verde	27.2	19.1	27.2	22.9	218.0	63.9	14.3	325.8	124.7	124.7	31.1	311.2	199.0	546.5	159.4	48.8	4.7
Central African Republic	25.0	2.5	24.5	1.7	124.7	113.9	5.3	102.4	11.6	11.6	10.6	51.0	19.1	104.5	15.0	10.8	1.7
Chad	112.4	27.4	84.3	5.9	429.9	392.6	11.7	58.8	40.1	40.1	28.4	175.7	65.9	360.2	51.7	15.8	0.7
China	50.5	35.5	44.3	15.4	200.5	61.5	26.5	155.0	43.5	43.5	36.1	197.4	154.9	176.5	75.6	1.5	1.2

Colombia	206.7	73.6	46.1	16.0	284.7	284.7	27.6	349.8	85.0	85.0	37.5	161.8	122.6	119.4	78.6	1.6	1.3
Comoros	43.0	20.5	44.9	39.4	342.1	235.1	3.5	50.3	30.0	30.0	16.8	641.3	49.3	269.9	38.8	6.0	0.8
Congo, Dem. Rep.	30.9	3.1	51.4	2.1	154.3	30.9	10.1	280.7	71.0	71.0	10.2	335.4	23.6	129.3	18.6	13.4	2.1
Congo, Rep.	161.9	77.1	194.7	20.9	168.3	310.4	20.0	189.4	147.8	147.8	29.6	319.2	185.7	500.0	145.9	32.0	2.8
Cook Islands	39.0	27.4	39.0	27.4	365.7	365.7	20.5	251.0	34.9	34.9	14.4	364.7	91.1	136.3	115.1	1.2	1.0
Costa Rica	231.8	82.6	51.7	25.8	319.3	282.9	30.9	328.7	165.0	165.0	23.4	2,149.1	137.4	744.8	173.7	1.7	1.5
Côte d'Ivoire	113.1	39.6	242.7	10.8	455.1	394.4	15.2	151.7	75.9	75.9	15.2	455.1	95.3	521.4	74.9	20.9	20.9
Cuba	196.0	69.8	49.8	35.0	222.5	239.2	15.0	302.3	31.7	31.7	19.8	153.5	371.3	113.2	74.5	1.5	1.2
Djibouti	112.5	39.4	76.0	10.7	546.8	121.6	6.7	81.9	57.8	57.8	18.7	277.9	1,399.4	519.0	74.5	11.5	1.5
Dominica	167.6	59.7	460.0	43.4	1,078.9	971.0	22.4	258.4	79.9	79.9	16.9	131.2	99.4	538.4	125.6	1.3	1.0
Dominican Republic	195.4	69.6	536.4	50.6	1,258.1	1132.3	26.1	301.3	93.2	93.2	19.7	447.2	115.9	627.9	146.5	1.5	1.2
Ecuador	174.9	62.3	39.0	19.5	240.9	240.9	23.3	123.4	83.4	83.4	17.6	400.3	103.7	101.0	66.5	1.3	1.1
Egypt, Arab. Rep.	185.2	66.0	41.3	14.3	255.1	255.1	24.7	313.4	108.1	108.1	18.7	423.8	109.8	107.0	328.7	1.4	1.2
El Salvador	500.9	33.6	356.0	33.6	457.7	751.5	17.3	183.9	92.3	92.3	13.1	660.4	247.2	664.2	97.2	1.0	0.8
Equatorial Guinea	563.4	200.7	125.2	43.6	1,146.3	335.9	20.0	920.7	181.6	181.6	102.9	435.0	334.1	500.0	422.3	4.2	3.5
Eritrea	73.9	15.7	30.3	4.3	218.0	48.5	6.7	449.4	290.7	290.7	48.5	110.8	558.0	206.9	29.7	4.6	0.3
Ethiopia	83.7	17.8	34.3	4.8	246.9	54.9	7.6	508.9	329.2	329.2	54.9	125.5	631.9	234.4	33.7	7.4	0.3
Fiji	33.7	34.4	33.7	14.8	316.2	316.2	17.7	175.0	30.2	30.2	13.4	315.4	78.7	117.8	99.5	1.0	0.8
Gabon	286.7	114.6	628.0	24.9	654.7	191.9	20.0	621.6	103.7	103.7	58.8	898.3	190.8	1,034.0	241.2	2.4	2.0
Gambia, The	46.0	21.9	22.3	4.7	111.3	44.5	9.3	95.3	17.8	17.8	8.1	152.9	52.7	288.5	41.4	12.7	1.2
Georgia	30.4	21.4	30.4	21.4	143.9	100.0	16.0	181.8	27.2	27.2	21.7	284.3	228.1	69.2	89.7	0.9	0.7
Ghana	149.2	52.3	72.6	14.2	268.2	250.4	3.5	311.7	109.1	109.1	7.0	335.6	125.8	688.1	98.8	27.5	27.5
Grenada	192.1	49.8	42.8	49.8	678.0	264.6	25.6	272.4	91.6	91.6	19.4	439.6	113.9	617.3	144.0	1.4	1.2
Guatemala	121.9	43.4	27.2	13.6	167.9	167.9	16.3	101.7	47.2	47.2	12.3	278.9	232.3	391.6	91.3	0.9	0.8
Guinea	77.6	16.5	40.9	4.5	323.6	156.0	7.0	36.6	38.2	38.2	6.1	60.9	39.0	217.3	31.2	9.6	0.9
Guinea-Bissau	76.8	16.3	40.5	4.4	320.3	154.4	7.0	36.2	37.8	37.8	6.0	60.3	38.6	215.1	30.9	9.5	0.9
Guyana	109.5	28.4	27.8	19.6	386.3	150.8	14.6	185.2	45.0	45.0	10.2	250.5	208.6	63.2	41.6	0.8	0.7
Haiti	28.4	7.4	7.2	5.1	183.1	164.8	3.8	43.9	32.8	32.8	6.3	263.8	47.7	91.4	21.3	0.2	0.2
Honduras	296.3	19.9	247.0	49.4	493.9	444.5	10.2	118.3	102.9	102.9	7.7	711.3	128.6	246.5	57.5	0.6	0.5
India	82.2	23.7	19.3	10.1	107	32.8	11.7	61.1	42.8	42.8	23.4	137.1	36.6	171.8	134.5	4.7	1.7
Indonesia	142.3	56.9	35.6	17.8	161	35.6	21.3	261.0	20.2	20.2	16.1	123.3	94.7	141.7	119.7	1.2	1
Iran, Islamic Rep.	232.0	92.8	58.0	29.0	429.2	429.2	34.7	425.6	32.9	32.9	28.5	395.0	105.4	494.9	387.5	13.4	4.9
Iraq	226.1	90.4	56.6	28.3	418.2	418.2	33.9	414.7	148.1	148.1	27.8	384.9	150.5	482.3	377.6	13.1	4.8

table continues next page

TABLE E.1: (CONTINUED)

	Water						Sanitation									Hand-washing station, soap, water	
	Basic				Advanced		Unimproved	Basic improved				Advanced—full excreta management (incremental off-site)					
	Urban		Rural		Urban	Rural	Rural	Urban		Rural		Urban		Rural			
Country	Tube well/ borehole	Dug well	Tube well/ borehole	Dug well	Piped on-plot	Piped on-plot	Unimproved pit latrine	Latrine with septic tank	Wet pit latrine	Wet pit latrine	Dry pit latrine	Sewerage with treatment	Septic tank with FSM	Pit latrine with sewerage and treatment	Pit latrine with FSM	Urban	Rural
Jamaica	573.7	38.5	407.7	38.5	956.3	860.6	19.8	229.0	199.2	199.2	15.0	339.9	88.1	477.3	111.3	1.1	0.9
Jordan	175.4	70.1	43.9	15.2	324.4	324.4	26.3	321.7	114.9	114.9	21.6	298.6	116.7	374.1	292.9	10.1	3.7
Kazakhstan	98.4	69.3	98.4	69.3	466.1	324.0	51.7	633.6	88.1	88.1	42.5	299.3	229.9	224.0	147.4	2.9	2.4
Kenya	62.5	29.8	42.8	8.1	116.1	43.9	24.4	671.0	43.6	43.6	24.4	158.6	70.3	392.1	56.3	8.7	1.1
Kiribati	22.3	14.9	28.6	21.0	96.9	73.8	4.1	40.9	13.8	13.8	5.6	73.6	18.4	27.5	23.2	0.2	0.2
Korea, Dem. People's Rep.	28.7	8.3	29.1	16.2	98.5	56.5	4.2	47.9	35.8	35.8	30.8	69.6	24.5	28.0	46.9	0.2	0.2
Kyrgyz Republic	25.0	19.0	25.0	19.0	139.4	41.7	7.2	87.7	23.9	23.9	9.7	118.6	90.0	102.0	79.9	0.4	0.3
Lao PDR	57.9	38.6	57.9	38.6	177.6	96.5	10.7	46.3	23.4	23.4	5.3	177.6	134.8	71.3	119.6	0.6	0.5
Lebanon	286.9	102.2	63.9	22.2	472.8	472.8	38.3	468.8	167.4	167.4	28.9	435.1	170.1	545.2	426.9	14.8	5.4
Lesotho	97.1	34.0	74.4	9.2	567.4	390.1	14.5	83.5	49.8	49.8	10.3	261.6	81.8	447.6	64.3	9.9	1.3
Liberia	36.3	3.6	80.5	2.5	226.3	109.1	4.9	346.6	26.7	26.7	3.5	469.1	27.8	152.0	21.8	6.1	6.1
Libya	357.5	127.4	155.4	27.7	405.8	436.3	50.0	605.0	208.7	208.7	36.0	818.1	212.0	679.5	634.5	2.7	2.2
Macedonia, FYR	175.7	70.3	44.0	15.3	271.6	271.6	26.3	322.3	24.9	24.9	19.9	152.2	116.9	113.9	75.0	1.5	1.2
Madagascar	38.5	18.3	40.2	2.6	306.0	210.4	7.8	70.9	31.9	31.9	15.0	141.1	44.1	241.4	34.7	5.4	0.7
Malawi	32.3	3.2	23.3	2.2	103.6	31.1	4.4	129.5	35.1	35.1	12.9	221.4	24.7	135.0	19.4	14.0	2.2
Malaysia	346.8	138.7	86.8	30.1	467.9	325.3	51.9	636.1	88.4	88.4	36.4	300.5	230.8	345.4	291.7	2.9	2.4
Maldives	173.5	69.4	43.4	15.1	234.1	162.7	26.0	318.2	44.2	44.2	18.2	295.3	78.8	370.1	145.9	10.0	3.6
Mali	45.3	21.6	91.7	4.6	229.3	172	9.2	80.3	34.4	34.4	9.2	114.7	50.9	284.2	40.8	12.5	1.2
Marshall Islands	44.6	29.8	28.9	22.0	147.6	147.6	8.3	81.7	14.1	14.1	5.8	147.2	36.8	55.0	46.5	0.5	0.4
Mauritania	84.0	40.0	164.9	10.9	425.0	257.7	17.1	154.6	51.5	51.5	20.6	516.6	94.4	526.7	75.6	23.2	2.2
Mauritius	256.1	102.4	64.1	32.0	289.7	240.1	38.3	469.6	65.3	65.3	26.9	648.5	170.4	1,465.8	427.6	2.2	1.8
Mexico	275.1	98.0	61.3	21.3	713.8	335.7	36.7	390.0	106.5	106.5	27.7	215.3	163.1	158.9	104.6	2.1	1.7
Micronesia, Fed. Sts.	42.8	28.5	27.7	21.1	141.6	141.6	7.9	78.4	13.5	13.5	5.6	141.2	35.3	52.8	44.6	0.4	0.4
Mongolia	140.4	56.1	35.1	17.6	158.9	131.7	21.0	257.6	34.5	34.5	15.9	156.4	122.7	139.9	59.9	1.2	1.0
Montenegro	239.2	85.2	53.3	18.5	329.5	329.5	31.9	391.0	30.3	30.3	24.1	184.7	141.9	138.2	90.9	1.8	1.5

Morocco	107.2	42.9	30.5	21.5	424.6	697.1	40.4	203.6	70.2	70.2	11.2	275.3	229.3	228.6	213.5	0.9	0.8
Mozambique	42.2	26.4	30.1	26.4	229.4	157.7	5.9	42.2	86.0	86.0	11.3	430.1	33.1	181.0	26.0	4.0	2.9
Myanmar	52.3	34.9	52.3	34.9	160.4	87.1	9.7	110.2	32.3	32.3	16.0	160.4	43.0	138.0	108.0	0.5	0.5
Namibia	144.2	57.7	70.3	34.6	277.9	512.4	21.6	312.6	52.2	52.2	29.6	365.1	96.0	825.4	121.3	1.2	1.0
Nauru	28.1	19.8	28.1	19.8	263.5	263.5	14.8	180.8	25.1	25.1	10.3	262.7	65.6	98.2	82.9	0.8	0.7
Nepal	34.1	9.8	86.8	19.3	77.1	86.8	5.0	61.3	42.6	42.6	36.6	56.9	15.2	142.5	55.8	1.9	0.7
Nicaragua	295.0	19.8	245.9	49.2	491.7	442.5	10.2	160.8	140.0	140.0	80.0	708.1	128.1	245.4	57.2	0.6	0.5
Niger	37.8	3.8	91.8	2.6	188.6	172.2	5.1	25.8	57.4	57.4	28.7	77.1	28.9	158.0	22.7	6.3	0.3
Nigeria	154.6	44.9	20.8	20.0	190.4	55.8	20.0	180.8	118.6	118.6	59.8	304.7	177.3	477.3	139.3	38.8	1.9
Niue	44.0	31.0	44.0	31.0	413.3	413.3	23.2	283.6	39.4	39.4	16.2	412.1	102.9	154.0	130.1	1.3	1.1
Pakistan	71.4	26.9	16.8	32.2	161.4	181.7	4.3	53.1	48.4	48.4	8.6	119.1	31.8	149.2	116.8	4.0	1.5
Palau	224.7	89.8	56.2	19.5	600.5	600.5	33.6	412.1	57.3	57.3	23.6	598.8	149.5	223.8	189.0	1.9	1.6
Panama	289.0	115.5	72.3	36.1	368.1	395.8	43.3	500.1	133.4	133.4	32.7	415.4	192.3	187.4	123.3	2.4	2.0
Papua New Guinea	37.8	15.1	39.1	28.8	101.0	101.0	5.7	55.9	9.6	9.6	4.3	1,102.3	25.1	37.6	31.8	0.3	0.3
Paraguay	134.4	34.8	30.0	15.0	185.1	185.1	17.9	227.4	130.6	130.6	13.5	159.7	79.7	77.6	51.1	1.0	0.8
Peru	175.3	51.0	43.9	15.2	271.0	271.0	26.2	131.4	80.9	80.9	19.8	233.8	116.7	113.7	74.8	1.5	1.2
Philippines	27.7	19.5	27.7	19.5	131.2	91.2	10.2	178.4	24.8	24.8	10.2	259.2	208	96.9	193.7	0.8	0.7
Moldova	56.2	37.5	56.2	37.5	172.3	93.6	10.4	127.5	36.9	36.9	20.2	172.3	130.8	45.1	29.7	0.6	0.5
Romania	311.4	110.9	69.4	24.1	428.9	428.9	41.5	508.8	68.1	68.1	56.5	240.4	184.6	179.9	118.4	2.3	1.9
Russian Federation	359.1	143.6	89.8	31.2	555.1	491.8	53.8	658.6	190.8	190.8	73.1	311.1	239.0	232.8	153.2	3.0	2.5
Rwanda	60.1	19.1	70.3	4.1	92.6	152.4	8.1	175.9	62.1	62.1	9.1	187.6	45.9	251.3	36.1	7.9	0.3
St. Lucia	157.2	62.9	39.3	19.7	243.0	243.0	23.5	250.2	84.2	84.2	17.8	1,636.0	104.6	566.9	132.2	1.3	1.1
St. Vincent and the Grenadines	158.7	63.5	39.7	19.9	245.4	245.4	23.8	252.6	85.0	85.0	18.0	1,651.9	105.6	572.5	133.5	1.3	1.1
Samoa	60.8	40.5	77.9	57.3	201.1	201.1	11.3	111.3	19.2	19.2	8.5	200.5	50.1	74.9	63.3	0.6	0.5
São Tomé and Príncipe	111.5	39.1	96.9	10.6	266.7	116.6	6.6	95.9	67.6	67.6	53.7	161.6	94.0	514.2	73.8	20.6	1.0
Senegal	122.5	29.8	181.1	8.1	316.9	237.7	11.7	66.1	44.1	44.1	11.0	110.1	70.4	392.7	56.4	17.3	1.7
Serbia	184.2	73.7	46.1	16.0	284.8	284.8	27.6	337.9	26.1	26.1	20.8	159.6	122.6	119.4	78.6	1.6	1.3
Seychelles	102.6	72.2	102.6	72.2	485.8	337.7	53.9	660.5	91.8	91.8	40.7	911.9	239.6	2,061.4	601.4	3.0	2.5
Sierra Leone	104.1	25.3	153.8	5.4	496.7	239.4	7.7	230.7	58.6	58.6	7.7	307.6	61.0	333.5	47.9	14.7	1.4
Solomon Islands	31.4	12.3	31.9	23.4	82.3	82.3	4.6	45.5	7.9	7.9	3.5	82.1	20.5	30.7	25.9	0.3	0.2
Somalia	28.2	9.0	17.3	2.4	124.4	102.9	3.8	115.7	17.4	17.4	2.0	63.2	21.6	118.1	17.0	2.6	0.3
South Africa	186.1	74.4	90.8	44.6	390.6	179.8	50.0	201.1	181.1	181.1	90.6	471.4	123.9	1065.6	156.6	1.6	1.3

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TABLE E.1: (CONTINUED)

	Water						Sanitation									Hand-washing station, soap, water	
	Basic				Advanced		Unimproved	Basic improved				Advanced—full excreta management (incremental off-site)					
	Urban		Rural		Urban	Rural	Rural	Urban		Rural		Urban		Rural			
Country	Tube well/ borehole	Dug well	Tube well/ borehole	Dug well	Piped on-plot	Piped on-plot	Unimproved pit latrine	Latrine with septic tank	Wet pit latrine	Wet pit latrine	Dry pit latrine	Sewerage with treatment	Septic tank with FSM	Pit latrine with sewerage and treatment	Pit latrine with FSM	Urban	Rural
South Sudan	125.9	30.6	22.3	8.3	180.9	94.5	6.7	65.9	59.3	59.3	6.7	301.1	73.7	403.4	57.9	12.7	1.1
Sri Lanka	147.9	58.0	34.7	18.1	192.5	135.9	21.7	109.9	64.8	64.8	42.1	246.7	65.9	309.2	121.9	8.4	3.0
Sudan	126.6	44.3	60.3	12.1	615.0	136.7	18.9	95.4	85.8	85.8	9.7	1,019.9	106.7	583.8	83.8	18.4	1.6
Suriname	271.1	96.6	60.4	21.0	373.4	373.4	36.2	458.8	111.5	111.5	27.3	620.4	160.8	871.1	203.2	2.0	1.7
Swaziland	99.5	39.8	48.5	23.9	208.8	96.1	37.5	107.5	96.8	96.8	48.4	676.2	211.5	569.6	166.2	25.7	3.2
Syrian Arab Republic	55.9	47.0	55.9	47.0	128.0	128.0	10.4	126.9	45.3	45.3	8.5	117.8	130.2	147.6	115.5	4.0	1.5
Tajikistan	38.2	11.0	24.0	17.2	86.3	97.1	5.6	63.7	18.7	18.7	4.6	92.7	70.4	79.8	62.4	0.3	0.3
Tanzania	49.0	23.3	71.4	44.8	428.3	85.7	9.9	142.8	54.0	54.0	19.1	503.8	56.2	307.2	44.1	6.8	0.9
Thailand	214.2	85.7	53.6	18.6	624.4	186.9	32.1	365.1	106.9	106.9	53.0	185.6	142.6	213.4	180.2	1.8	1.5
Timor-Leste	282.2	52.0	282.2	52.0	563.4	282.2	5.0	61.2	60.9	60.9	3.8	207.8	22.2	33.2	28.1	0.3	0.2
Togo	38.4	18.3	73.8	3.9	93.8	87.6	7.8	166.5	42.3	42.3	41.3	117.4	44.0	240.7	34.6	9.6	9.6
Tonga	63.8	42.5	81.7	60.1	211.0	211.0	11.8	116.8	20.1	20.1	8.9	210.4	52.5	78.6	66.4	0.7	0.6
Tunisia	165.1	66.0	41.3	14.4	255.3	255.3	24.7	313.6	108.2	108.2	18.7	424.1	109.9	164.5	138.9	1.4	1.2
Turkey	317.1	113.0	70.7	24.5	522.5	522.5	42.3	518.1	185.1	185.1	32.0	480.8	188.0	602.6	471.8	16.3	5.9
Turkmenistan	59.4	41.8	59.4	41.8	281.2	195.5	31.2	382.3	110.8	110.8	25.6	180.6	138.7	135.1	88.9	1.8	1.5
Tuvalu	54.1	21.7	28.3	21.5	144.7	144.7	8.1	80.1	13.8	13.8	6.1	144.3	36.0	53.9	45.5	0.5	0.4
Uganda	38.9	18.5	27.2	6.5	76.9	113.1	7.9	158.6	42.9	42.9	15.2	182.2	44.6	244.1	35.1	7.7	0.3
Ukraine	105.7	52.3	32.7	16.4	242.0	242.0	19.6	239.9	69.5	69.5	14.8	113.4	87.1	84.8	55.8	1.1	0.9
Uzbekistan	62.2	41.4	79.7	58.6	269.8	154.8	11.5	131.1	19.6	19.6	8.1	130.9	144.8	164.1	128.5	0.6	0.5
Vanuatu	44.5	17.8	46.1	33.9	119.0	119.0	6.7	65.9	11.4	11.4	5.0	118.7	29.6	44.3	37.5	0.4	0.3
Venezuela, RB	304.0	108.3	67.8	23.5	418.7	418.7	40.6	514.5	125.0	125.0	30.6	695.6	180.2	175.6	115.5	2.3	1.9
Vietnam	63.7	42.5	81.6	60.0	276.4	158.6	11.8	134.3	69.8	69.8	5.7	192.6	148.3	168.1	131.6	0.7	0.6
Yemen, Rep.	47.6	40.0	47.6	40.0	109	109	8.8	108.1	38.6	38.6	6.7	100.3	110.9	125.7	98.4	3.4	1.2
Zambia	119.4	41.8	89.6	11.4	698.0	479.8	15.0	102.7	72.8	72.8	15.0	321.8	100.7	550.6	79.1	17.4	1.5
Zimbabwe	63.8	22.4	40.3	6.1	378.4	252.3	3.4	68.8	40.1	40.1	6.8	172	53.8	294.3	42.3	9.3	0.8

Note: FSM = fecal sludge management

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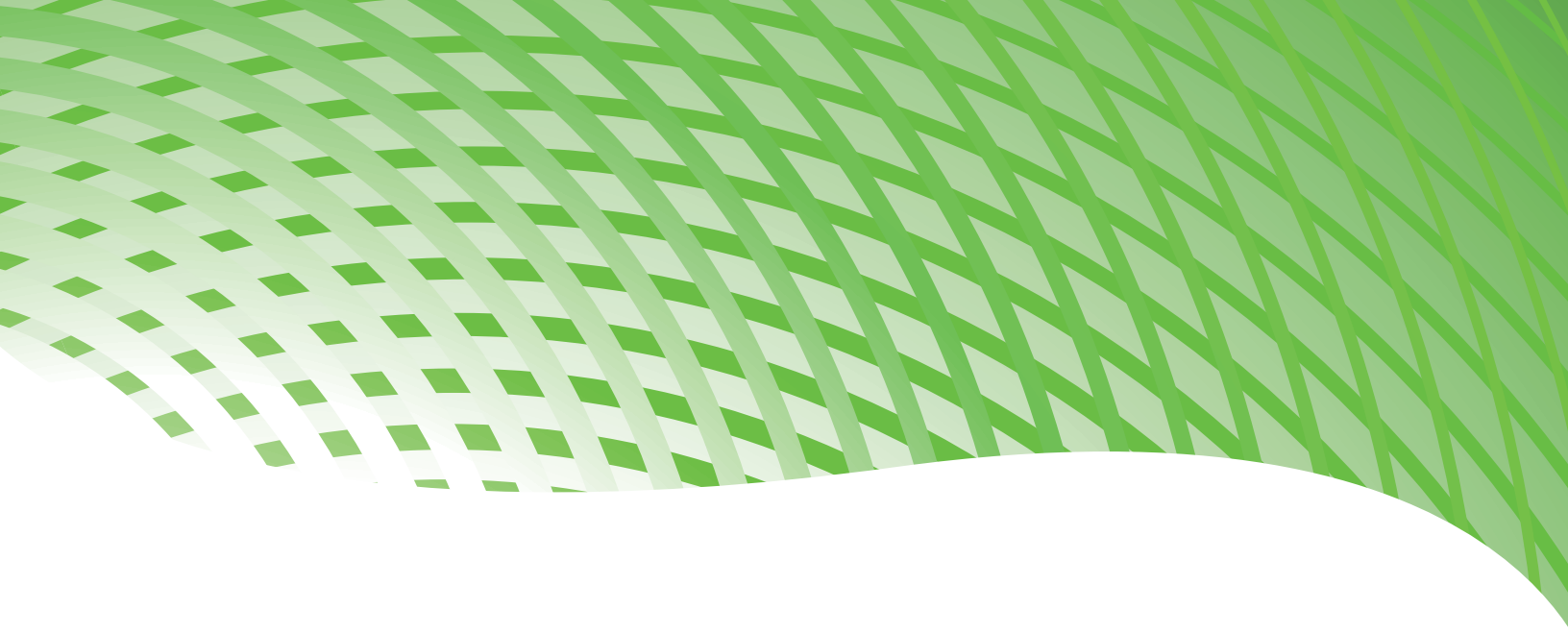

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