

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

Summary Report

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January 2016

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Abbreviations

GDP	Gross domestic product
GP	Gross product
GP₁₄₀	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)
IRC	International Water and Sanitation Centre
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.

Summary Report

Introduction

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) (UN General Assembly 2015). 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. As a pre-condition for assessing the financing mechanisms and sources for achieving the targets, the costs of meeting the targets need to be better understood.

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 services¹—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. Appendix A provides further details.

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 (see appendix B). Current coverage figures under these definitions and the unserved population to be reached to achieve universal coverage by 2030 appear in table 1. Coverage has been projected to the year 2015 using 2013 estimates and trends under the new definitions (see appendix A).

The costs estimated are those for capital investment, program delivery, operations, and major capital maintenance to sustain the life span of the infrastructure created. The costs include only those of extending services to the unserved in 2015, and exclude the costs of maintaining access for those already served by a given service level in 2015. For the purposes of this study, for basic WASH a mix of lower-cost technology options were selected. 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.

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) and not target 6.3, which focuses on wastewater.

TABLE 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		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, literature sources and author extrapolations 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’.

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. 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.

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).

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. Appendix C provides a list of the variables used

in the analysis, the associated levels of uncertainty of each, and indicates which variables were varied in sensitivity analysis. Further details of the costing methods are provided in a longer version of this report.

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.

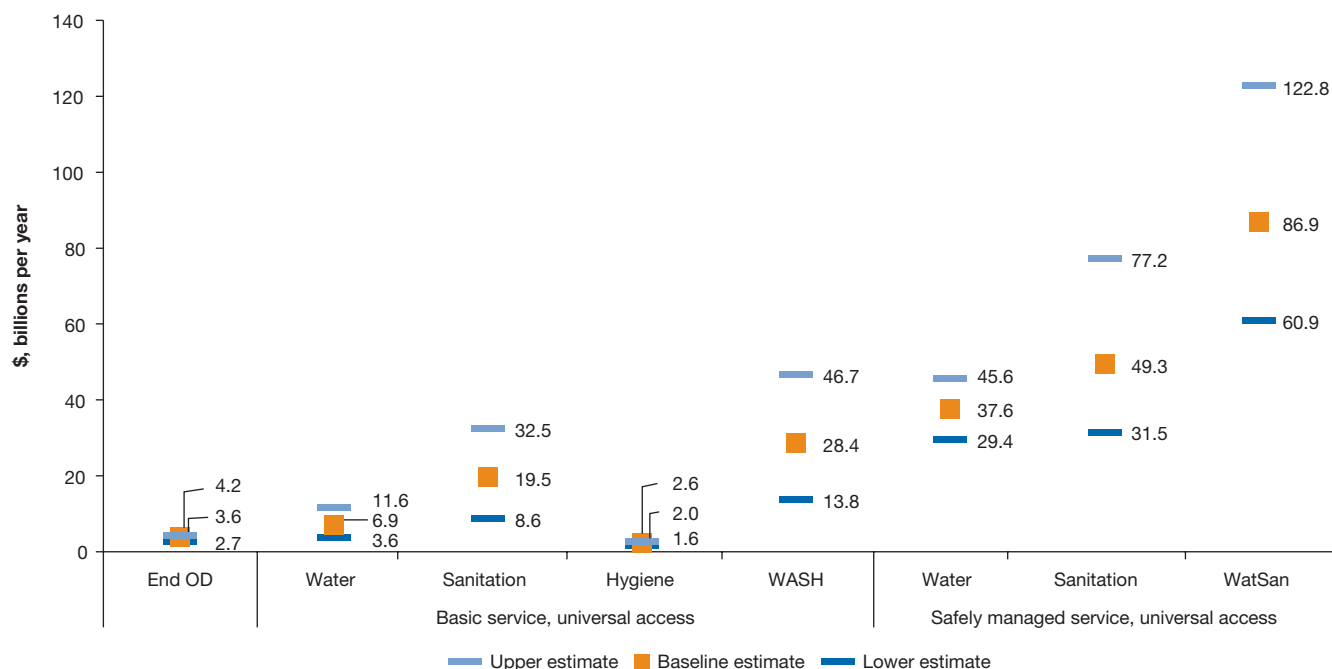
Extending basic WASH services to the unserved will cost \$28.4 billion (range: \$13.8 to \$46.7 billion) per year from 2015 to 2030, or 0.10 percent (range: 0.05 to 0.16 percent) of the global product (GP)² of the 140 countries included (GP₁₄₀). This financing requirement is equivalent, in order of magnitude, to the 0.12 percent of global product spent needed to serve the unserved with improved water supply and sanitation during the MDG period. The costs by service are shown in figure 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

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

FIGURE 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. WASH = water, sanitation, and hygiene; OD = open defecation; WatSan = water and sanitation.

(shown in figure 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.

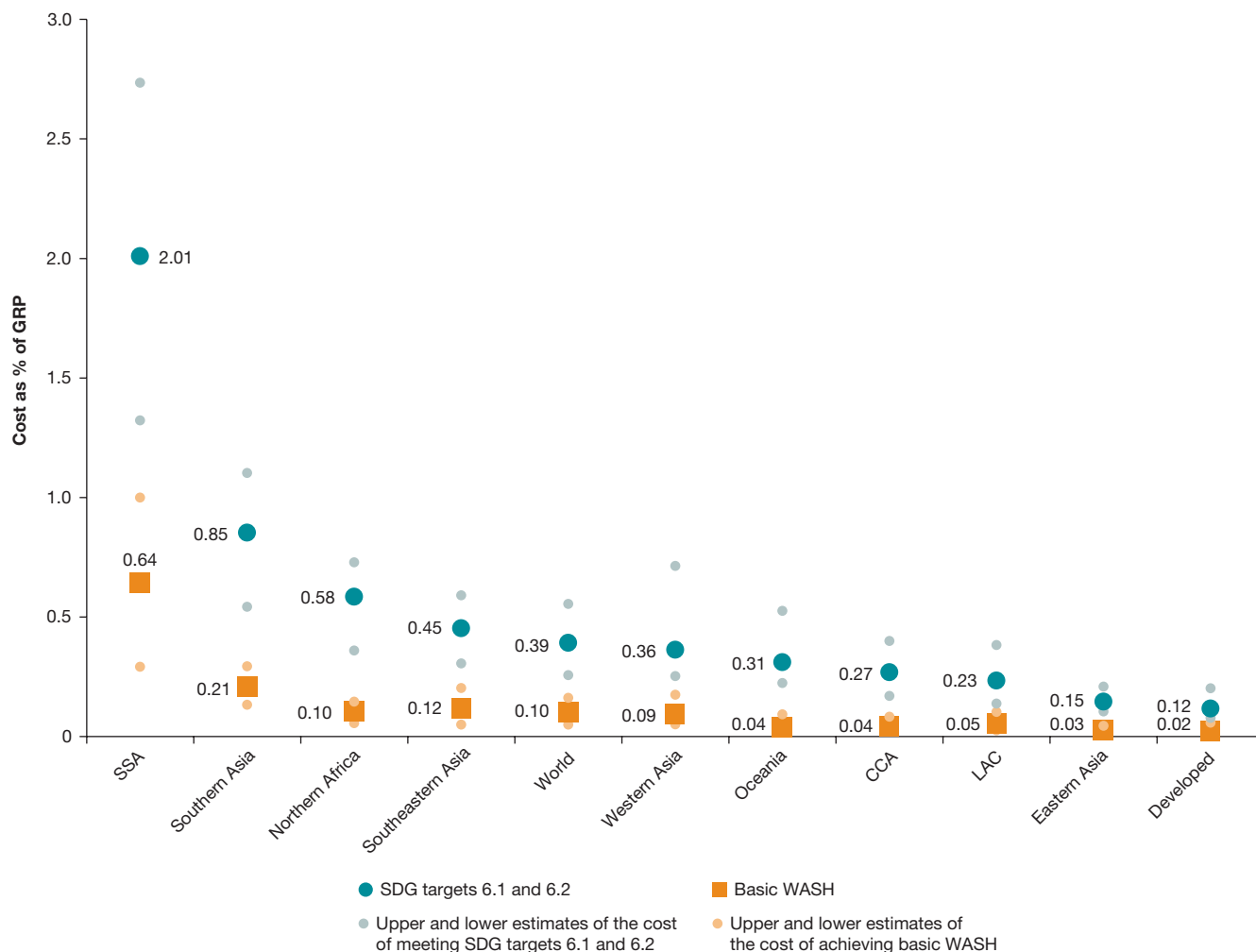
The capital financing required to extend safely managed water supply and sanitation services to the unserved is approximately 0.39 percent of GP_{140} (range: 0.26 to 0.55 percent), or a little over three times the historical financing trend of extending access to the unserved (0.12 percent globally). 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 1 shows the ranges of these numbers.

Table 2 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

FIGURE 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.

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 GP₁₄₀ (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) and going through lower-level services first (which are more affordable and bring socioeconomic benefits).

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

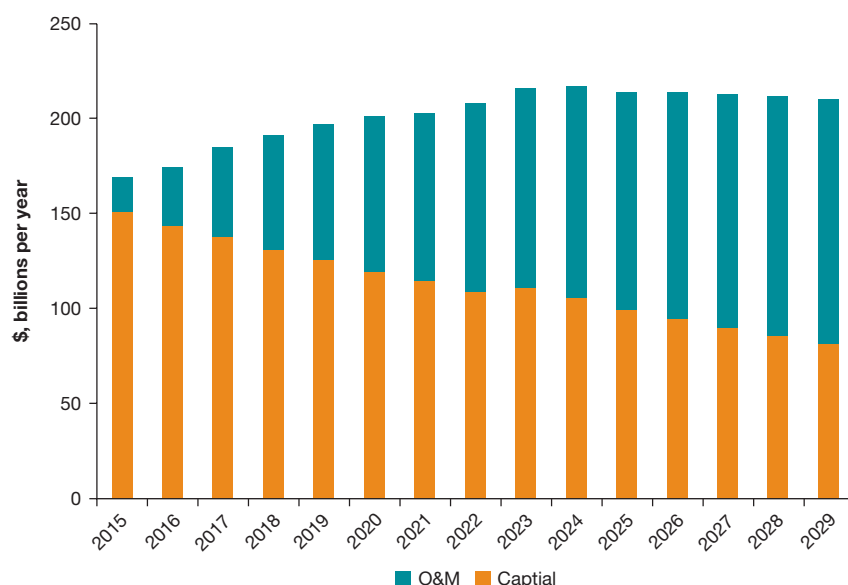
TABLE 2: ESTIMATED ANNUAL GLOBAL COSTS OF MEETING SDG TARGETS 6.1 AND 6.2

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.

FIGURE 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.

operating the new infrastructure built will exceed the annual capital cost requirements to meet those remaining unserved (see figure 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 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 commonly higher service 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 potential to achieve cost recovery 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 in 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 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 access to 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 costs in the long-run.

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. 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, and the mix of technologies and program delivery mechanisms likely to be chosen. Numbers should be provided with a geographical breakdown such as by subnational level and rural, urban, and peri-urban 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.

Appendix A: Service Indicators and Data Sources

Service	First-level service (“basic WASH”)	Higher-level service (“safely managed”)
Water	<p>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.</p> <p>Data available for all countries from nationally representative surveys (JMP).</p>	<p>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</p> <p>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).</p>
Sanitation	<p>Percentage of population not practicing open defecation.</p> <p>Percentage of population using a basic private sanitation facility.</p> <p>Data available for all countries from nationally representative surveys (JMP).</p>	<p>Percentage of population using safely managed sanitation services.</p> <p>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).</p>
Hygiene	<p>Percentage of population with hand-washing facilities with soap and water at home.</p> <p>Data available from 42 countries from nationally representative surveys (JMP).</p>	

Source: WHO and UNICEF 2013; UN-Water 2014.

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: Countries Included in This Study

CROSS-TABULATION BY MDG REGION AND WORLD BANK INCOME LEVEL

MDG region	Included countries by World Bank income level				Excluded countries
	Low income	Lower-middle Income	Upper-middle Income	High income	
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		

MDG region	Included countries by World Bank income level				Excluded countries
	Low income	Lower-middle Income	Upper-middle Income	High income	
Southeastern 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 C: Variables Determining Cost Results and Their Degree of Uncertainty

Variable	Data or assumption used in baseline	Level of uncertainty ^a
<i>Underlying population and coverage statistics</i>		
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.
<i>Cost and economic assumptions (see appendix D for further details)</i>		
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.

References

- Baum, R., J. Luh, and J. Bartram. 2013. "Sanitation: A Global Estimate of Sewerage Connections without Treatment and the Resulting Impact on MDG Progress." *Environmental Science and Technology* 47 (4): 1994–2000.
- Fonseca, C., R. Franceys, C. Batchelor, P. McIntyre, A. Klutse, K. Komives, et al. 2010. *Life-cycle Costs Approach. Glossary and Cost Components*. WASHCost Briefing Note 1. The Hague: International Water and Sanitation Centre.
- Hutton, G., L. Haller. Evaluation of the Non-Health Costs and Benefits of Water and Sanitation Improvements at Global Level. Report undertaken for the Evidence and Information for Policy Department, in collaboration with the Department for Protection of the Human Environment, World Health Organization. WHO/SDE/WSH/04.04, 2004.
- Hutton, G. *Global Costs and Benefits of Drinking-Water Supply and Sanitation Interventions to Reach the MDG Target and Universal Coverage*. 2012. Report No. WHO/HSE/WSH/12.01. Geneva: World Health Organization.
- Peal, A., B. Evans, I. Blackett, P. Hawkins, and C. Heymans. 2014. "Fecal Sludge Management: A Comparative Analysis of 12 Cities." *Journal of Water, Sanitation and Hygiene for Development* 4 (4): 563–75.
- UN General Assembly. 2015. Transforming Our World: The 2030 Agenda for Sustainable Development. Resolution adopted by the General Assembly on 25 September 2015. A/RES/70/1. New York: United Nations.
- UNICEF and WHO (UN Children's Fund and World Health Organization). 2015. Progress on Drinking Water and Sanitation: 2015 Update and MDG Assessment. WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation. Geneva: WHO.
- UN-Water. 2014. A Post-2015 Global Goal for Water: Synthesis of Key Findings and Recommendations. New York: United Nations.
- WHO and UNICEF (World Health Organization and UN Children's Fund). 2012. Rapid Assessment of Drinking-Water Quality (RADWQ): A Handbook for Implementation. Geneva: WHO; New York: UNICEF.
- _____. Post 2015 WASH Targets and Indicators. 2013. WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation. Geneva: WHO; New York: UNICEF. In collaboration with the Water Supply and Sanitation Collaborative Council, Geneva.

