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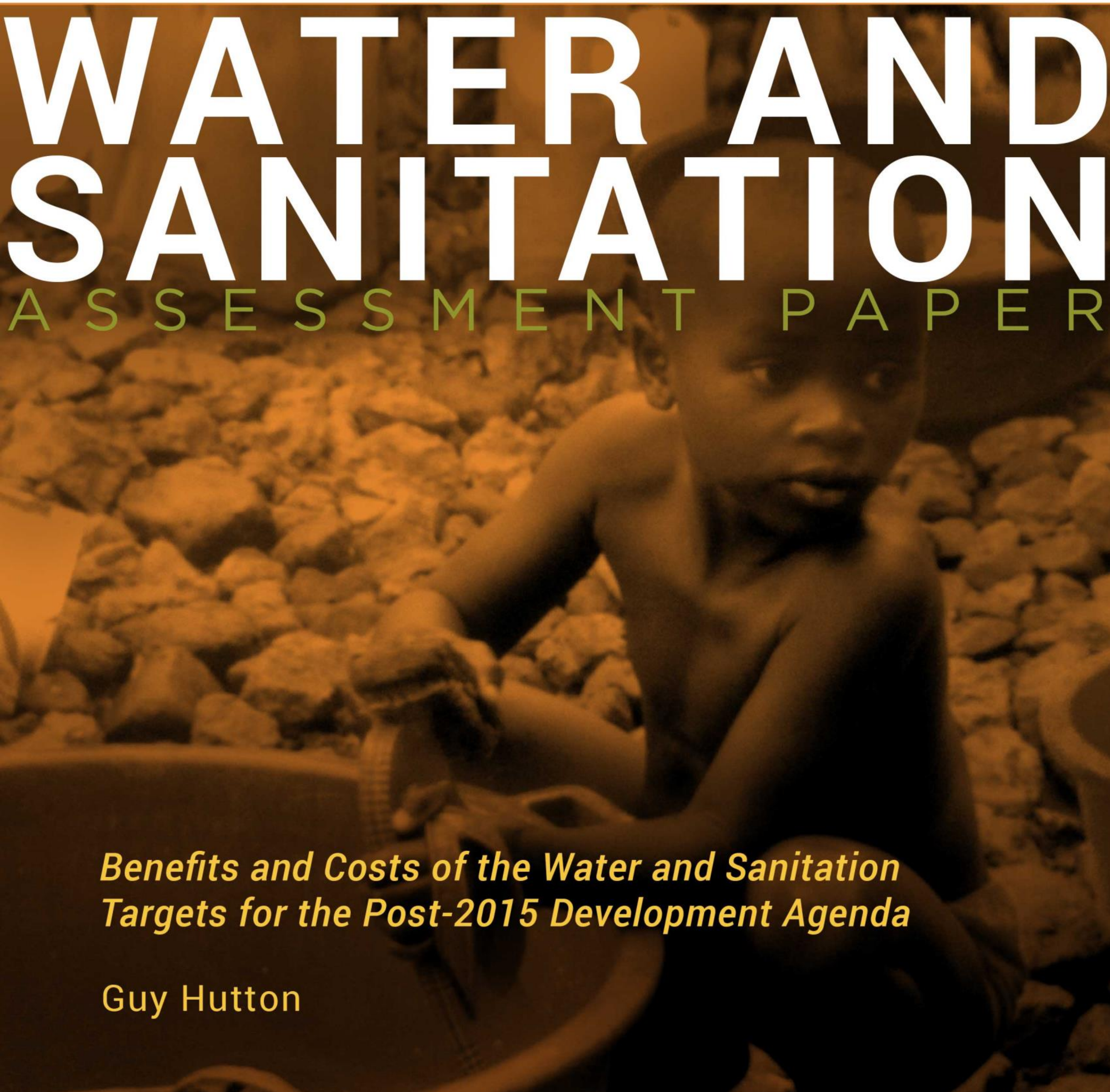

WATER AND SANITATION

ASSESSMENT PAPER

Benefits and Costs of the Water and Sanitation Targets for the Post-2015 Development Agenda

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POST-2015 CONSENSUS

Benefits and Costs of the Water Sanitation and Hygiene Targets for the Post-2015 Development Agenda

Post-2015 Consensus

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Working Paper as of 26 January, 2015

Highlights[1]

Within the area of water and sanitation the target with the highest benefit-cost ratio is:

- Basic water and basic sanitation in rural areas, eliminating open defecation in rural areas

Other valuable targets in this focus area include:

- Basic sanitation and basic water in urban areas

The analysis shows that the following targets are relatively ineffective or there is large uncertainty in the benefit-cost ratio:

- None

[1] This draft report presents selected benefit-cost ratios for basic water and sanitation interventions. It forms an interim output of a larger and longer-term study, and some data sets are still being collected and cross-country extrapolations in data inputs are still to be made. The results presented in this paper are therefore subject to change.

Glossary

BCR	Benefit-Cost Ratio
DALY	Disability-Adjusted Life-Year
DHS	Demographic and Health Survey
GDP	Gross Domestic Product
JMP	Joint Monitoring Programme
MDG	Millennium Development Goal
MICS	Multiple Indicator Cluster Survey
OD	Open Defecation
ODF	Open Defecation Free
SDG	Sustainable Development Goal
UN	United Nations
UNICEF	United Nations Children's' Fund
WASH	Drinking-water, sanitation and hygiene
WHO	World Health Organization

Introduction

With the Millennium Development Goal (MDG) period ending in 2015, a new development period will begin – referred to here as the "Post-2015". A global dialogue is underway on what development framework will succeed the MDG framework. In the post-2015 discussions, a water goal is consistently proposed by a range of groups, including the Open Working Group, the High-Level Panel, UN, development partners and civil society. UN-Water has developed an integrated and broad Water Goal proposal, which has the contribution and buy-in of many governments and sector partners.

On drinking-water, sanitation and hygiene (WASH) specifically, a highly consultative process has been convened by the WHO/UNICEF Joint Monitoring Programme (JMP) since 2011, leading to a series of proposed WASH targets and indicators for the post-2015 period (WHO and UNICEF 2013). These targets expand on the MDG target 7c on improved drinking-water and sanitation:– as well as basic water and sanitation, the targets include hand washing, WASH outside the household, more advanced water and sanitation services, and accelerated coverage for the poor and disadvantaged groups until the target year 2030. An interim target includes ending open defecation by the year 2025.

In the consultations held, stakeholders have repeatedly voiced that the target for basic WASH should be universal access, at the same time cautioning that WASH targets should be realistic – in terms of how fast it is likely WASH services can be scaled up with the available financing and local implementation capacities. Understanding the costs and benefits of the targets in relation to available financing is therefore fundamental for Member States to agree to ambitious WASH targets. Furthermore, the types of benefits (whether private or external in nature) and the rate of return on investments for both service providers and household who are investing own funds, is key to know how these services should be financed and delivered.

Although global costing and cost-benefit studies have been previously conducted (Hutton 2012), and a more recent study examined the approximate costs of an overall water SDG (UNU and UNOSD 2013), a new study is required to understand the overall resources needed to expand and sustainably operate WASH services according to the new service definitions and target dates, as well as the extent to which additional financing can be sourced. Given the large set of development priorities under discussion, and a proliferation of targets to achieve and indicators to monitor, there is a risk the next set of goals will be less smart, and not maximize the potential impact of the next 15 years. Hence, linking to this current project of the Copenhagen Consensus Center, the overall aim of the "Post-2015 Consensus" initiative is **to ensure the final list of goals, targets and indicators gives priority to targets that yield the largest return for human development.** The project's broad vision is to ensure the final post-MDGs incentivize the international community to do the most good. The aim of the research stream of this project is to determine a concise list of targets that maximizes benefit-cost ratio (within feasible parameters) across different development sectors, and specifically this paper on water and sanitation provides an evidence base with which to compare different WASH targets and world regions by benefit-cost ratio.

Methods

Aims

The present paper prepared under the Post-2015 Consensus initiative is part of a larger study being conducted by the World Bank in collaboration with United Nations agencies and other partners. The aims of this larger study are to estimate global, regional and country-level costs, benefits and financing options of drinking-water supply and sanitation interventions to meet the proposed targets (WHO and UNICEF 2013). The larger study only includes the targets for household WASH access and use, and therefore excludes institutional WASH access. The specific targets and definitions of indicators proposed essentially include the universal coverage of households with basic WASH services by 2030, with faster acceleration of access for the population groups currently with lowest access. Once the underlying coverage data sets are available, targets that provide a greater proportion of the overall population with more advanced WASH services will be estimated. The present paper provides benefit-cost ratios for basic WASH services.

The findings of these studies will be used to support the decisions of the UN Member States to include WASH in the Sustainable Development Goals and to help with the advocacy and planning processes required to achieve the targets by 2030, measures which include achieving greater political prioritization, greater allocation and targeting of resources, and strengthened monitoring and accountability.

The estimation model

A model was constructed using Microsoft Excel©, consisting of one major "input-output" worksheet that calculates costs and benefits of WASH interventions at country, regional and global level. This worksheet links to databases on unit costs, coverage, health and economic variables assembled for each country. As the data were assembled from global databases, the worksheet allows for countries themselves at a later date to change country-specific inputs to remodel the outputs.

The basis of all the calculations are two key statistics, one on population numbers over the study period and the other WASH service coverage in the year 2015 under different service definitions. The model moves populations from lower to higher service levels, calculating the costs and benefits of doing so. This is done for each wealth quintile[2] separately, accelerating coverage at a faster rate to those populations with lower coverage.

Countries and world regions included

The quantitative model is run at country level, and the results aggregated to give the regional and global totals or averages, weighted by country population size. Countries classified by the World Bank as high-income countries are excluded from the study, except Equatorial Guinea which was included as it has below 50% sanitation coverage and Russia which has coverage closer to 90% sanitation coverage but due to its population size still has an important number of child deaths attributed to poor WASH. The majority of

[2] 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.

countries excluded are high-income countries (see Annex 1). Several upper-middle income countries were omitted (Hungary, Western Sahara, Palestine and several small-island states) due to lack of mortality data from the most recent burden of disease study from WHO (Prüss-Üstun, Bartram et al. 2014). This leaves a total of 140 countries included in the study. In this current study results are only presented by MDG region (see Annex 1)[3] and globally.

Population estimates

Population size for rural and urban areas was sourced from UN Statistics for the latest year (2012) and UN projected estimates to 2030 by urban and rural areas. The countries included represent 6.12 billion (84%) of the world's projected 7.3 billion population in 2015, and 7.15 billion (85%) of the world's projected 8.4 billion population in 2030[4]. In 2015 43% of the population in these countries will live in urban areas, rising to 56% in 2030. Table 1 shows the population distribution of included countries across MDG regions in 2015 compared with 2030.

Table 1 - Population (000s) included in study by World Region (years 2015 and 2030)

MDG Region	**2015**	**2030**
Latin America and the Caribbean	601,160	685,434
Sub-Saharan Africa	987,655	1,421,913
Northern Africa	176,847	210,325
Western Asia	173,001	216,244
Caucasus and Central Asia	83,078	94,555
South Asia	1,793,616	2,085,479
South-East Asia	626,984	715,713
Eastern Asia	1,429,665	1,483,404
Oceania	2,367	2,767
Developed countries	247,304	229,667
World	**6,121,677**	**7,145,501**

It is recognized that a single 'rural' versus 'urban' breakdown does not reflect the global diversity of settlement types and densities. However, as this present study draws on the only global database of drinking water, sanitation and handwashing coverage – provided by the Joint Monitoring Programme – the study is limited by the singular rural/urban distinction of the JMP's datasets (WHO and UNICEF 2014). Instead, this study explores the potential for cost variation in different technology options, which provide lower and upper estimates for costs. For the health impact analysis, populations are disaggregated into three age groups (0-4 years, 5-14 years and 15+ years) due to the differential information available for these groups on disease incidence.

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[3] (1) Caucasus and Central Asia (CCA), (2) North Africa (N Africa), (3) Sub-Saharan Africa (SSA), (4) Latin America and the Caribbean (LAC), (5) Eastern Asia (E Asia), (6) Southern Asia (S Asia), (7) South-eastern Asia (SE Asia), (8) Western Asia (W Asia), and (9) Oceania.

[4] These figures do not take into account the fact that some countries will have graduated to high income level by 2030, and hence will no longer be classified as a developing country.

Targets

The targets for household WASH services are provided by service type and level in Box 1. Basic access includes eliminating open defecation and achieving universal access to basic drinking water, sanitation and hygiene (targets 1 and 2). The target for higher service levels (target 3) is not universal access, but instead aims to halve the proportion of the population without access at home to safely managed drinking water and sanitation services (not presented in this paper). Cutting across these targets is the aim to progressively eliminate inequalities in access (target 4), so that initial efforts do not focus on the better off segments of society.

Box 1. Proposed WASH targets for the post-2015

1. Eliminate open defecation
2. Achieve universal access to basic drinking water, sanitation and hygiene for households, schools and health facilities;
3. Halve the proportion of the population without access at home to safely managed drinking water and sanitation services; and
4. Progressively eliminate inequalities in access

Service definitions and data sources

Targets need concrete definitions in order to conduct an economic analysis and to monitor them consistently over time. The following is based on the current proposal of the WHO/UNICEF Joint Monitoring Program and partners (WHO and UNICEF 2013).

Eliminating open defecation is a necessary milestone on the way to everyone having basic sanitation. Open defecation is when excreta of adults or children (a) are deposited (directly or after being covered by a layer of earth) in the bush, a field, a beach, or other open area; (b) are discharged into a drainage channel, river, sea, or other water body; or (c) are wrapped in temporary material and discarded (WHO and UNICEF 2006). Note, however, that if sewage is flushed from a toilet to a drain that leads directly to canal, river or open water body without treatment first, it is currently classified by the Joint Monitoring Programme as 'improved' sanitation. Hence (b) above does not apply, although from an environmental standpoint it is effectively open defecation.

- Indicator used for current study: Percentage of population practicing open defecation. Two other proposed indicators are not used due to current lack of global data[5].
- Data source: JMP currently compiles and reports data on open defecation by rural and urban areas, with defecation practice recorded at the overall household level[6]. The latest estimates (2012) are projected to 2015 using current trends.

[5] These include (1) Percentage of households in which no one practices open defecation; and (2) Percentage of children under 5 whose stools are hygienically disposed of.

[6] If the respondent answers that any adult household members are practicing open defecation, then the entire household is classified as practicing open defecation.

- Incremental costs: given that this target does not require 'improved' sanitation (or 'basic' under the new terminology), lower cost options have been selected to meet this target. Hence the calculations assume that the lowest cost options are used to end open defecation – which includes a private or shared traditional latrine in rural areas and private or communal toilets in urban areas. The uptake of private versus shared latrines is based on current coverage, by country. However, note that latrine options with lower capital cost may not last as long as a more expensive option – hence the cost advantage is not so great when considering annual equivalent costs (including renovation or replacement).

Basic drinking water at home. Drinking water is water used by humans for drinking, cooking, food preparation, personal hygiene or similar purposes (WHO and UNICEF 2006). Households are considered to have a 'basic' drinking water service when they use water from a household piped water supply, a protected community source such as a well, spring and borehole, or collected rainwater. In terms of water source type, the previous definition of 'improved' water is the same as 'basic' water, except that the latter requires that the total collection time is 30 minutes or less for a roundtrip.

- Indicator used for current study: Percentage of population using a protected community source or piped water with a total collection time of 30 minutes or less for a roundtrip including queuing.
- Data source: JMP currently compiles and reports data on use of improved sources by urban and rural areas, but with no consideration of the time to source. Hence, using the same data sets which report time to source, an adjustment has been made by JMP to generate the numbers on this indicator. The latest estimates (2012) are projected to 2015 using current trends.
- Incremental costs: this involves estimating the full costs of providing access to a basic source within a 30 minute roundtrip to households currently without access. Basic sources include protected wells and springs sources either available at community or private household level. For estimating costs, the majority of unserved populations are assumed to supplied by a protected community borehole/tubewell (50% of unserved) or a protected dug well (50% of unserved).

Basic sanitation at home. To be counted as 'basic' sanitation, facilities must effectively separate excreta from human contact, and ensure that excreta do not re-enter the immediate environment. The same quality of sanitation facility types as the MDG Target 7c are considered, with the difference that it is adequate if the facility is shared among no more than 5 families or 30 persons, whichever is fewer, and if the users know each other.

- Indicator used for current study: Percentage of population using a basic sanitation facility shared among no more than five families that know each other. A second indicator proposed to monitor post-2015 is not used in this study due to current lack of data on that indicator[7].

[7] Percentage of households in which the sanitation facility is used by <u>all</u> members of household (including men and women, boys and girls, elderly, people with disabilities) whenever needed.

- Data source: JMP currently compiles and reports data on use of improved facility that is owned and used by the household, with rural and urban breakdowns. Use of an improved facility of a neighbor is excluded from the current estimate. Hence, an adjustment has been made by JMP to generate the numbers for the proportion of households that share with less than five other households. The survey question typically only asks how many other households they share their facility with, but do not ask whether they know each other or not. The latest estimates (2012) are projected to 2015 using current trends.
- Incremental costs: this involves estimating the full costs of providing access to basic sanitation (including shared) to households currently without access. For the costing exercise, the mix of basic facilities assumed to be used by households includes a pour-flush pit latrine (50% of unserved) and a dry pit latrine (50% of unserved) in rural areas, and a flush toilet to septic tank (50% of unserved) and any type of pit latrine (50% of unserved) in urban areas. The proportion of households assumed to gain a sanitation option that involves sharing with neighbors is the same proportion that currently use shared sanitation. The average number households sharing a shared facility is assumed to be 2.5.

Progressive elimination of inequalities in access. Future indicators will be disaggregated on the following four dimensions.

1. Income level: by income or wealth quintiles.
2. Geographical setting: urban versus rural areas.
3. Type of urban settlement: slums versus formal urban settlements.
4. Population group: disadvantaged groups versus the general population.

Due to current data constraints, disaggregation in the present study will be made for the first two of these: wealth quintiles and urban/rural area.

Coverage for new population (population growth)

The total population of the 140 countries included in this study is predicted to grow from 6.12 billion in 2015 to 7.15 billion in 2030. Therefore, a coverage assumption is needed for this additional global population of 1 billion. Assuming household sizes stay roughly the same, additions to the population will need to be covered by new dwellings. However, the challenge lies in estimating the incremental costs of investing in improved drinking-water systems and sanitation facilities that are paid for in new dwellings, given that these facilities are difficult to separate from the infrastructure costs of the new dwelling itself. Given the lack of cost data on the additional cost of WASH facilities in new dwellings, the same unit costs are used as for 'adding' WASH services to dwellings currently without them.

Cost estimation

The total intervention cost consists of all resources required to put in place, operate and maintain a WASH service. The terminology of IRC's WASHCost project is used here for investment costs (Capital expenditure = "CapEx"), major maintenance costs (Capital maintenance expenditure = "CapManEx") and regular recurrent costs (Operating expenditure = "OpEx") (Fonseca, Franceys et al. 2010). CapEx ideally includes: planning and supervision, hardware, construction and house alteration, protection of water sources, education and behavior change. CapManEx ideally includes maintenance of hardware and replacement of parts, and renovation or rehabilitation when required. OpEx ideally includes: operating materials to provide a service, regulation, ongoing protection and monitoring of water sources, water treatment and distribution, and continuous education activities. For this study, emptying of septic tanks and latrines is considered as capital maintenance as it is more likely to happen every few years as opposed to every year.

Further disaggregation of costs is possible, but cost data are limited and hence only these three categories are were used[8]. "Direct expenditures" used in IRC's WASHCost are included as software costs in the categories. Due to lack of unit cost data on some cost components, software costs for initial program delivery including behavior change are added as 10% of the CapEx, and CapManEx is estimated at 30% of the CapEx every five years for hardware maintenance, while for safe excreta management the emptying and treatment of septic tanks and pit latrines is considered an additional cost.

In presenting cost estimates, a distinction is made between serving the unserved and sustaining services to the served:

1. Incremental costs of extending WASH services: the capital costs of extending access to basic and safely managed WASH for those currently not having access.
2. Costs of sustaining WASH services: these include the costs of maintaining, renovating and replacing WASH services for all populations with any WASH facility.

These two estimates are aggregated to estimate total costs of both extending and sustaining WASH services to the target populations. To meet coverage targets in the Post-2015 proposals, the cost-benefit analysis presented in this paper focuses on the economic returns of extending access to the unserved (including all cost categories).

Cost data were obtained through an extensive search of the peer-reviewed published literature as well as grey literature (project documents, agency reports) sourced from contacts and the internet. In addition, cost data available were sent to experts in the 40 countries with the highest number of unserved populations for verification and request to provide latest country-based estimates. Basic classification of the technology types are according to service definitions above. The studies obtained, the countries they were conducted in, and what service definitions their data covered will be provided in a future report version. Cost data were available for at least one service definition for at least half the countries. The methodology used by the Disease Control Priorities project (Edition 3) was used to obtain costs in US Dollars in the baseline year, as follows:

- Step 1: data are tabulated in local currency for the year in which they were collected;

[8] For example, IRC'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.

- Step 2: costs are updated to 2015 prices using the GDP deflator for that country[9]; and
- Step 3: costs are converted to United States Dollars using the exchange rate from mid-2014.

For countries without data for a given service type and level, data were extrapolated from a neighboring country with similar economic development level for which data were available. The price observed in the country with data was adjusted for difference in price levels, using GDP per capita expressed at Purchasing Power[10].

Given that cost data between different studies even in the same country can be highly variable, and the major data source being agency reports as opposed to peer reviewed journals, the results of a global costing exercise are highly uncertain. One major source of uncertainty is the quality and representativeness of the cost data sets obtained, given they were extrapolated from single settings to an entire country or to a neighboring country. It therefore required a judgement call on which data most likely represented the average context in each country. A second set of uncertainties relate to what level of service the unit costs refer to, given there are many subtle differences in technologies and management approaches which determine the eventual unit costs. A third uncertainty relates to the expected duration of hardware. Often, due to poor maintenance and lack of spare parts, the actual life span will vary from the expected (engineered) life span. To deal with the latter, this present study opted to use a theoretical engineered life span, using the same assumption of length of life per technology type[11]. In order to provide a service for the entire lifespan, capital maintenance costs required to sustain the services were included. A fourth uncertainty is the present value of future costs, which is calculated using a baseline discount rate of 3%. A final set of uncertainties relate to an uncertain future: population growth and migration being different from those projected, and the impact of a variable and changing climate on the populations access to WASH services thus requiring WASH services to be more resilient. There is limited experience with climate adaptation in the WASH sector, and guidelines on optimal technology options for climate resilience do not yet exist.

This present study explores uncertainty in discount rate, value of prevented deaths, and differences between income groups. In the baseline analysis, a mix of technologies are assumed to be adopted by populations, shown in Table 2. A future publication will examine variations in technology mix, differences in duration of the life of technologies, and low and high unit cost estimates..

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[9] For the years 2013-5 without data, the GDP deflator for 2012 is used.

[10] For example, if the unit cost is US$ 30 in the source country (Country A), with a GDP at purchasing power of $1000, then the extrapolated unit cost to Country B with a GDP at purchasing power of $500 would be US$ 15.

[11] Borehole/tubewell: 20 years; dug well: 10 years; septic tank: 20 years; pit latrine: 8 years.

Table 2 - High and low cost scenarios for technology options for unserved populations

Location	'Low' cost scenario	Baseline scenario	'High' cost scenario
Basic Water			
All	100% dug well	50% borehole or tubewell and 50% dug well	100% borehole or tubewell
Basic Sanitation			
Rural	100% dry pit	50% pour-flush to pit and 50% dry pit	100% pour flush to pit
Urban	100% any pit latrine	50% septic tank or sewerage with treatment (according to current coverage) and 50% any pit latrine	100% septic tank or sewerage

Benefit estimation

Benefit overview

A large range of economic and social benefits can result from improved WASH services. Table 3 presents the main ones, indicating those that have been included and excluded in this study. As is evident from the table, more benefits have been excluded than included.

While many of these benefits have previously been evaluated in context-specific studies, evidence is lacking from sufficient countries to enable a credible global assessment.

Table 3 - Benefits of drinking water supply, sanitation and handwashing

Benefit	Water	Sanitation
Included benefits		
Health	• Averted cases of diarrhoeal disease • Averted cases of malnutrition-related diseases	
		• Averted cases of helminths
Health economic	• Costs related to diseases such as health care, lost productivity and premature mortality	
Time value	• Travel and waiting time averted when water supply and sanitation access is improved	
Excluded benefits		
Other health	• Dehydration from lack of access to water	• Dehydration from not drinking due to poor latrine access (especially women) • Less flood-related health impacts
Reuse of nutrients		• Use of human faeces or sludge as soil conditioner and fertilizer in agriculture
Energy		• Use of human (and animal) waste as input to biogas digester leading to fuel cost savings and income opportunities
Education	• Improved educational levels due to higher school enrolment, attendance and completion rates • Impact of averted childhood malnutrition on education	
Water treatment		• Less household time spent treating drinking water, including boiling
Water security		• Safe reuse of treated wastewater in agriculture
Environment		• Improved quality of water supply available from surface and groundwater, and related savings
Leisure and quality of life / intangibles	• Leisure and non-use values of water resources • Reduced effort of associated with water hauling and gender impacts	• Safety, privacy, dignity, comfort, status, prestige, aesthetics, gender impacts
Reduced access fees		• Reduced payment of for toilets with entry fee
Property	• Rise in value of property	
Income	• Increased incomes due to more tourist income and business opportunities	

The economic value of benefits is the sum of financial transactions, hypothetical or actual cash savings, as well as an imputed value for non-market benefits, where resources are used in more productive or welfare-enhancing activities as a result of the WASH intervention. Economic values exclude transfer payments such as taxes and subsidies. Once these benefits included in Table 3 are aggregated, they reflect a lower bound on the overall societal benefit or utility gained from implementing an intervention. It is a lower bund because several benefits of WASH services are excluded from the monetary estimates. However, it should be understood that economic values do not necessarily reflect the direct financial impact. For example, the cash impact on the household is influenced by employment opportunities and availability of subsidized healthcare, while the budget impact on a line ministry depends on cost recovery policies (e.g. on healthcare). Economic figures therefore do not allow the private sector to accurately assess the market potential for providing a drinking water or sanitation service –which instead requires willingness to pay or tariff studies. As a purely financial analysis will undervalue water and sanitation services, the purpose of this study is to estimate the overall costs and benefits to society – thus informing overall debates on the 'right' level of coverage, resource allocation and technology choice for different populations.

Health benefit estimation

Over recent decades, compelling evidence has been gathered that significant and beneficial health impacts are associated with improvements in access to safe drinking-water, basic sanitation and handwashing facilities (Freeman, Stocks et al. 2014; Wolf, Prüss-Üstun et al. 2014). The routes of pathogens to affect health via the medium of water are many and diverse. Five different routes of infection for water-related diseases are distinguished: waterborne diseases (e.g. cholera, typhoid), water-washed diseases (e.g. trachoma), water-based diseases (e.g. schistosomiasis), water-related vector-borne diseases (e.g. malaria, filariasis and dengue), and water-dispersed infections (e.g. legionellosis). While a full analysis of improved water and sanitation services would consider pathogens using all these pathways, the present study focuses on water-borne and water-washed diseases. At the household level, it is the transmission of these diseases that is most closely associated with poor water supply and sanitation. Moreover, water-borne and water-washed diseases are responsible for the greatest proportion of WASH-related disease burden. For the purpose of estimating health benefits from improving WASH, populations are classified into different starting WASH service points, which relate to a given health risk, shown in Table 4.

In terms of burden of disease, the most significant waterborne and water-washed disease is infectious diarrhoea. Infectious diarrhoea includes cholera, salmonellosis, shigellosis, amoebiasis, and other protozoal and viral intestinal infections. These are transmitted by water, person-to-person contact, animal-to-human contact, and foodborne, droplet and aerosol routes. As infectious diarrhoea is responsible for a major share of the estimated global burden of disease resulting from poor access to water supply and sanitation (Prüss-Üstun, Bartram et al. 2014), and as there are data for all regions on its incidence rates and deaths, this analysis estimates the reduction in diarrhoea incidence rates and premature mortality from diarrhoea. In addition, given that environmental risk factors are estimated to account for 50% of undernutrition in the developing world, diseases with higher incidence or case fatality due to malnutrition are also included using a method previously applied at country (Hutton, Rodriguez et al. 2014) and global level (Hutton 2012). In this approach, a proportion of cases of respiratory infection and malaria in children 0-5 years old are attributed to poor water supply and sanitation, based on very severe and moderately severe malnutrition rates and determined by region-specific attribution factors estimated by Fishman et al (Fishman, Caulfield et al. 2004). Case fatality is also predicted to be affected by WASH interventions, given that malnourished children are more likely to die when they suffer from respiratory infection, malaria, measles and other infections.

Table 4 - Relative risk reductions in health impacts for WASH interventions

Intervention	Reduction in diarrheal disease (and consequent diseases) compared to unimproved facility	Reduction in helminths compared to no or unimproved facility
Water supply		
Improved community water source	34%	0%
Basic piped water	45%	0%
Piped water, high quality	79%	0%
Sanitation		
Improved on-site sanitation, no formal excreta management (100% coverage)	28%	50%
Improved sanitation with formal excreta management (100% coverage)	69%	100%

Source: Column 2 - Water and sanitation (Wolf, Prüss-Üstun et al. 2014); Column 3 – assumption.

Economic benefits related to health impacts of improved WASH services include three main ones, as previously evaluated (Hutton 2012):

1. Savings related to seeking less health care. Health care savings are estimated as a function of treatment seeking rates, medical practices and unit costs of medical services. Medical practices include the types of treatment given for a disease and the rate of in-patient admission. All these variables fluctuate by disease and country. In addition, patients and their carers incur other treatment-seeking costs such as travel costs.
2. Savings related to productive time losses from disease. Productivity losses are estimated based on disease rates, the number of days absent from productive activities, and the unit value of productive time. Given the extensive surveying required to estimate actual financial losses from lost productive time, an economic value is given instead to time based on the sick person's age using proxies. For adults too sick to carry out normal activities, their time is valued at 30% of the average GDP per capita converted to an hourly rate. For children of school age, and for carers spending time tending sick infants (0-5 years old), their time is valued at 15% of the average GDP per capita converted to an hourly rate. Men's and women's time are given the same value.
3. Savings related to reductions in premature mortality. Mortality is valued using the human capital approach. The human capital approach estimates the total present value of future earnings of productive adults, hence considering their future life expectancy. The GDP per capita is used to reflect the economic contribution of the average member of society. To promote equality within policies influenced by cost-benefit analysis, all people within the same country are given the same value, irrespective of age and wealth quintile.

Table 5 shows the data values, or ranges, for each health variable used in the analysis.

Table 5 - Variables, data sources and values for health economic benefits, for the example of diarrheal diseases

Benefit by sector	**Variable**	**Data source**	**Data values**
Health care costs of disease	Unit cost per treatment	WHO regional unit cost data	Cost per outpatient visit and cost per inpatient day varies by country (source: WHO CHOICE)
	Number of cases of diarrheal disease	DHS, MICS	2 week prevalence varies by country, from 3% to 36%
	Visits or days per case	Previous study	1 outpatient visit per case seeking care (includes return visits) Av. 5 days for hospitalised cases
	Hospitalisation rate	Previous study	10% of ambulatory cases are hospitalised
	Transport cost per visit	Assumptions	US$ 0.50 per visit for outpatient and US$ 1.00 per visit for inpatient (includes accompanying persons)
Welfare gained due to days lost from work avoided	Days off work/ episode	Expert opinion	1 day average per episode of diarrhea, 5 days for ALRI and malaria
	Number of people of working age	UN Statistics	Variable by country
	Opportunity cost of time	World Bank data	30% of hourly monetary income, using GDP per capita as the proxy for time value
Welfare gained due to school absenteeism avoided	Absent days / episode	Expert opinion	1 day average per episode of diarrhea, 5 days for ALRI and malaria
	Number of school age children (5-14)	UN Statistics	Variable by country
	Opportunity cost of time of student	World Bank data	15% of hourly monetary income, using GDP per capita as the proxy for time value
Welfare gained to parents due to less child illness	Days sick	Expert opinion	1 day average per episode of diarrhea, 5 days for ALRI and malaria
	Number of young children (0-4)	UN Statistics	Variable by country
	Opportunity cost of time of carer	World Bank data	15% of hourly monetary income, using GDP per capita to proxy time value

In the health benefit calculations, results are presented by income quintile using two variables for which data are available by income quintile for most countries, namely WASH coverage and under five deaths. The latter variable is used to approximate distribution of deaths and morbidity from WASH-related diseases. All other variables for the health economic estimates are based on averages across the entire population. While the results give an indication of the differences between income quintiles for health economic benefits, it is not known whether true rates would be lower or higher had all the input variables been available by income quintile. The reason for this uncertainty is that other variables could be either higher or lower for poorer people than the non-poor (e.g. health care seeking, health care unit costs, impact on work productivity or income), hence with unknown direction of overall cost.

Time benefit estimation

Table 6 shows the values and data sources for time savings due to closer physical access and less waiting time for water sources and sanitation facilities at home or in the community. For water supply, 2 roundtrips are assumed per household to fulfill their needs for household water supply (min. 20 liters per person per day). Households gaining access to basic improved water supply reduces roundtrip times from 40 to 20 minutes in urban areas and from 60 to 20 minutes in rural areas. The time saving is a combination of closer access and higher number of water points, leading to less queuing time. For sanitation, in the baseline only one trip per day is assumed for defecation.

Table 6 - Variables, data sources and values for 'convenience' time savings

Variable	Data source	Access time	
		Urban areas	Rural areas
Water supply (baseline = distant water source)			
Unimproved source	Expert opinion, and evidence review[1]	40 minutes roundtrip	60 minutes roundtrip
Improved source		20 minutes roundtrip	20 minutes roundtrip
Household piped water		Less than 5 minutes roundtrip	Less than 5 minutes roundtrip
Sanitation (baseline = open defecation)			
Open defecation	Expert opinion, studies from Southeast Asia[2]	15 minutes travel time roundtrip	20 minutes travel time roundtrip
Shared sanitation		5 minutes travel and waiting time roundtrip	5 minutes travel and waiting time roundtrip

[1] See reviewed studies (Hutton and Haller 2004)
[2] From a survey of >5,000 households conducted in six Southeast Asian studies, a single round trip to place of open defecation was found to require up to 15 minutes in urban areas and from up to 20 minutes in rural areas, varying by country (Hutton, Rodriguez et al. 2014).

Sensitivity analysis

One-way sensitivity analysis was performed on the value of death, substituting a cost per DALY of US$ 1,000 and US$ 5,000 in all countries instead of the value of life using the human capital approach. Also, the economic benefits from preventing premature death were estimated using the value-of-a-statistical life instead of the human capital approach. The value of life of US$ 2 million US$ was extrapolated to countries based on the difference in GDP per capita in the USA and the target countries, using purchasing power parity values.

Results

Baseline results

Populations served

This report presents benefit-cost ratios for basic water and sanitation services for rural and urban areas, by MDG region[12]. The results are presented in this section using the human capital approach to value premature mortality at 3% discount rate, while Annex 2 presents at 5% discount rate. The results using DALY rates to value premature mortality are presented in the sensitivity analysis (for 3% discount rate) and in Annex 3 for 5% discount rate.

Based on the new indicator definitions for basic water and sanitation, by 2030 a total of 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 (see Table 7). 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 each of sub-Saharan Africa and South Asia.

Table 7 - Total population to serve from 2015 to 2030 to reach universal access to basic services (million)

MDG Region	**Drinking-water**			**Sanitation**		
	Urban	**Rural**	**Total**	**Urban**	**Rural**	**Total**
Latin America and the Caribbean	114	19	133	127	35	161
Sub-Saharan Africa	417	521	939	431	586	1,017
Northern Africa	34	15	49	35	14	49
Western Asia	44	19	63	41	17	58
Caucasus and Central Asia	11	12	23	9	5	14
South Asia	345	239	584	389	765	1,155
South-East Asia	189	65	254	136	95	230
Eastern Asia	240	0	240	277	3	280
Oceania	0	0	1	0	1	1
Developed countries	2	0	2	3	2	5
World	**1,396**	**892**	**2,287**	**1,448**	**1,523**	**2,971**

Overall results

Table 8 shows the annual costs and benefits for ending open defecation and providing universal access to basic water and basic sanitation. For ending open defecation, only rural figures are presented, while for the basic service rural and urban figures are aggregated. The BCR of ending open defecation is approximately 5.7 at a DALY value of US$ 1,000 and approximately 6.9 at a DALY value of US$ 5,000. At a discount rate of 3%, the benefits vary from US$ 80 billion to US$ 100 billion per year, at DALY values of US$ 1,000 and US$ 5,000, respectively. The annual cost of ending open defecation over a 15 year period from 2015-2030 is between US$ 12 billion and US$ 14 billion.

[12] A later World Bank-UN report will present a fuller set of results that also includes the costs of reaching and maintaining the proposed WASH targets and the options for financing. In addition, hygiene measures (handwashing) and advanced water supply and sanitation will be assessed.

The BCR of providing basic water is 3.3 at a DALY value of US$ 1,000, under both 5% and 3% discount rates. When a DALY has a value of US$ 5,000, the BCR varies from 4.2 to 4.4 under 5% and 3% discount rates, respectively. The benefits of basic water vary from US$ 54 billion to US$ 66 billion per year, at DALY values of US$ 1,000 and US$ 5,000, respectively[13]. The annual cost of providing basic water supply over a 15 year period from 2015-2030 is approximately US$ 14 billion, assuming a phased increase in coverage.

The BCR of providing basic sanitation is 2.9 at a DALY value of US$ 1,000, under both 5% and 3% discount rates, respectively. When a DALY has a value of US$ 5,000, the BCR increases to 3.2 and 3.3, under 5% and 3% discount rates, respectively. The benefits of basic sanitation vary from US$ 80 billion to US$ 90 billion per year, at DALY values of US$ 1,000 and US$ 5,000, respectively. The annual cost of providing basic sanitation supply over a 15 year period from 2015-2030 varies from US$ 28 billion to US$ 33 billion, at 5% and 3% discount rates, respectively.

The number of deaths averted from basic water supply is expected to be 34% of the 500,000 annual deaths, or 170,000 saved lives per year, while for basic sanitation it is expected that 28% of the 280,000 annual deaths, or 80,000 saved lives per year. In addition to these averted deaths, there will be additional averted deaths from indirect pathways that are attributed to poor WASH (acute lower respiratory infection, measles, malaria, and others) which is potentially as many as 100,000 per year.

Table 8 - Annual costs and benefits to meet and sustain universal access (100% coverage), focusing on the projected unserved population in 2015 (US$ Billions)

Intervention	DALY value	3% Discount			5% Discount		
		Benefit	**Cost**	**BCR**	**Benefit**	**Cost**	**BCR**
Eliminate open defecation (rural only)	1000	81	14	5.8	73	12	6.0
	5000	99	14	7.1	87	12	7.3
Universal access to basic drinking water at home	1000	50	15	3.3	40	13	3.3
	5000	66	15	4.4	54	13	4.2
Universal access to basic sanitation at home	1000	94	33	2.9	81	28	2.9
	5000	107	33	3.3	90	28	3.2

BCR is the amount of times the benefits exceed the costs of an intervention

Water supply

In the following sections, the benefit-cost ratios are presented using human capital approach to value prevented deaths. Overall, this methodology gives slightly higher ratios than using the DALY methodology using US$ 5,000 per DALY averted. However, there is significant variation between regions in the differences between methodologies, given that

[13] Note that the estimated benefits are the same under 3% and 5% discount rate as the health and access time benefits are estimated as a present value in the current year, while costs vary under 3% and 5% discount rate because annualization formula for capital items is dependent on the discount rate.

the HCA values prevented death based on a country's GDP per capita whereas the DALY methodology applies the same value across the world[14].

In urban areas, the benefit-cost ratio for basic water varies between regions 2.2 (South Asia) to 5.4 (Eastern Asia), with a global ratio of 3.4. Ratios are in general higher for poorer populations (see table 9). At 5% discount rate, the global benefit-cost ratio reduces from 3.4 to 3.1. Using the value-of-statistical-life, the global BCR increases to 3.6 at a discount rate of 3%.

Table 9. Benefit-cost ratios for basic water supply in urban areas, by income quintile (3% discount rate)

MDG Region	**Q5 (richest)**	**Q4**	**Q3**	**Q2**	**Q1 (poorest)**	**Total**
Latin America and the Caribbean	2.9	3.1	2.9	3.0	3.1	3.0
Sub-Saharan Africa	2.6	2.9	3.1	3.5	3.5	3.2
Northern Africa	2.3	2.4	2.4	2.5	2.7	2.5
Western Asia	2.6	2.6	2.6	2.7	2.7	2.6
Caucasus and Central Asia	3.1	3.0	3.2	3.2	3.3	3.1
South Asia	1.8	2.2	2.1	2.3	2.4	2.2
South-East Asia	2.4	2.7	2.4	2.5	2.9	2.6
Eastern Asia	5.0	5.4	5.0	5.4	6.2	5.4
Oceania	1.9	1.9	2.2	2.6	3.0	2.3
Developed countries	2.4	2.2	2.4	2.3	2.3	2.4
World	**3.1**	**3.4**	**3.2**	**3.5**	**3.8**	**3.4**

In rural areas, the benefit-cost ratio for basic water varies between regions 4.5 (South Asia) to 16 (Eastern Asia), with a global ratio of 6.8. Again, ratios are higher for poorer populations (see Table 10). At 5% discount rate, the global benefit-cost ratio reduces from 6.8 to 5.7. Using the value-of-statistical-life, the global BCR increases to 7.3 at a discount rate of 3%.

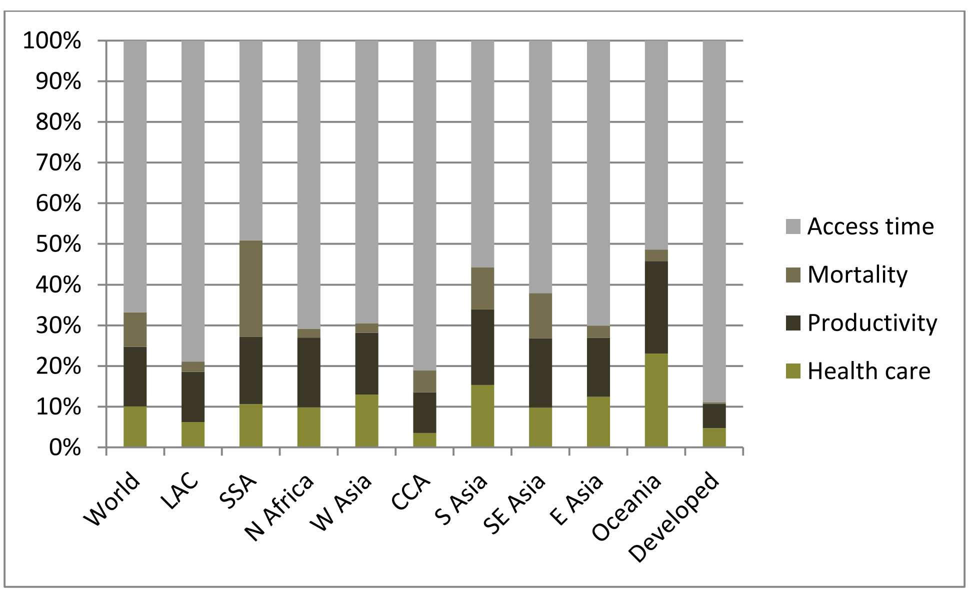
[14] Hence, low-income countries will have a higher BCR under the DALY methodology, whereas middle-income and developed countries in the analysis will have a higher BCR under the HCA methodology.

Table 10. Benefit-cost ratios for basic water supply in rural areas, by income quintile (3% discount rate)

MDG Region	**Q5 (richest)**	**Q4**	**Q3**	**Q2**	**Q1 (poorest)**	**Total**
Latin America and the Caribbean	4.7	5.5	6.7	8.1	10.2	8.2
Sub-Saharan Africa	6.2	6.8	7.2	7.9	8.0	7.3
Northern Africa	8.9	9.1	9.5	9.8	10.4	9.7
Western Asia	6.0	5.6	5.9	5.8	6.4	6.0
Caucasus and Central Asia	9.6	9.1	9.7	9.4	10.1	9.6
South Asia	3.6	4.0	4.4	4.8	5.1	4.5
South-East Asia	6.6	8.4	9.6	9.6	9.8	9.3
Eastern Asia	20.1	20.1	22.1	19.7	11.9	15.9
Oceania	5.1	5.0	5.7	6.8	8.2	6.6
Developed countries	-	-	-	-	15.9	15.9
World	**5.6**	**6.2**	**6.6**	**7.2**	**7.6**	**6.8**

Figure 1 shows the breakdown for different benefits of delivering universal access to basic water supply in urban areas. Globally, the economic value of saved access time account for closes to 70% of the benefits, while health care, health-related productivity and averted mortality each account for between 8% and 14% of the total. Similar proportions were found for rural areas as for urban areas. Across regions there are some differences, such as higher proportion accounted for mortality reduction in sub-Saharan Africa. In both sub-Saharan Africa and South Asia, health benefits accounted for close to 50% of total benefits.

Figure 1. Benefit breakdown for delivering universal access to basic water supply in urban areas



Sanitation

In urban areas, the benefit-cost ratio for basic sanitation varies between regions 1.2 (sub-Saharan Africa) to 5.7 (Oceania), with a global ratio of 2.5. Ratios are marginally higher for poorer populations (see Table 11). At 5% discount rate, the global benefit-cost ratio reduces from 2.5 to 2.3. Using value-of-statistical-life, the global BCR increases to 3.0 at a discount rate of 3%.

Table 11. Benefit-cost ratios for basic sanitation in urban areas, by income quintile (3% discount rate)

MDG Region	Q5 (richest)	Q4	Q3	Q2	Q1 (poorest)	Total
Latin America and the Caribbean	3.2	3.3	3.3	3.3	3.4	3.3
Sub-Saharan Africa	1.1	1.1	1.2	1.2	1.2	1.2
Northern Africa	2.1	2.1	2.2	2.2	2.3	2.2
Western Asia	3.0	3.0	3.0	3.1	3.1	3.0
Caucasus and Central Asia	3.3	3.2	3.3	3.4	3.4	3.3
South Asia	2.6	2.7	2.9	3.0	3.1	2.9
South-East Asia	2.4	2.5	2.5	2.6	2.7	2.5
Eastern Asia	3.8	3.9	3.9	4.1	4.4	4.0
Oceania	5.3	5.3	5.6	6.0	6.1	5.7
Developed countries	3.4	3.4	3.4	3.5	3.7	3.5
World	**2.4**	**2.5**	**2.5**	**2.5**	**2.7**	**2.5**

In rural areas, the benefit-cost ratio for basic sanitation varies between regions 3.8 (sub-Saharan Africa) to 47 (Oceania), with a global ratio of 5.2. The BCR is higher for the bottom quintile at 5.8 compared to the highest quintile at 4.6 (see Table 12). At 5% discount rate, the global benefit-cost ratio reduces from 5.2 to 4.8. Using value-of-statistical-life, the global BCR increases to 5.9 at a discount rate of 3%.

Table 12. Benefit-cost ratios for basic sanitation in rural areas, by income quintile (3% discount rate)

MDG Region	Q5 (richest)	Q4	Q3	Q2	Q1 (poorest)	Total
Latin America and the Caribbean	6.9	7.5	7.9	8.2	8.6	8.1
Sub-Saharan Africa	3.8	3.6	3.7	3.9	3.9	3.8
Northern Africa	5.4	5.6	5.8	5.9	6.0	5.8
Western Asia	6.6	6.6	6.8	7.3	8.0	7.3
Caucasus and Central Asia	19.0	19.4	19.5	19.8	21.3	19.9
South Asia	4.9	5.1	5.4	5.7	5.9	5.5
South-East Asia	16.5	18.0	18.0	18.0	17.8	17.8
Eastern Asia	2.9	3.0	3.2	3.2	23.5	12.9
Oceania	44.9	44.9	46.8	50.2	48.1	47.2
Developed countries	33.2	33.3	33.3	33.5	33.8	33.4
World	**4.6**	**4.6**	**5.0**	**5.3**	**5.8**	**5.2**

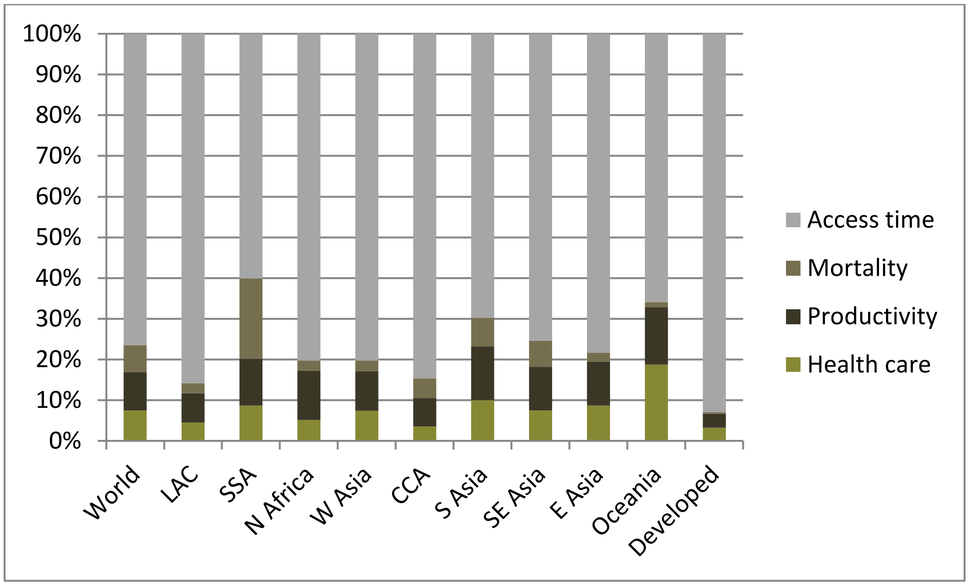
To eliminate open defecation, simpler sanitation options are feasible. However, these options have a shorter lifespan and require continued software to motivate communities to remain ODF and repair or replace or their latrine when it stops functioning. Also, one pit is assumed per household, unlike with the basic sanitation intervention (above) where a proportion of new latrines are assumed to be shared between more than one household (an average of 2.5 households is used). When the lifespan of a simple or traditional latrine is assumed to be one year only, the benefit-cost ratio is 6.0 globally, varying from 3.9 (sub-Saharan Africa) to 33 (Oceania) (see Table 13). The results are highly sensitive to the assumptions on how long the hardware and software last for – if these are increased to 2 years then the benefit-cost ratios are double those values in Table 13. At 5% discount rate, the global benefit-cost ratio stays the same at 6.0. Using the value-of-statistical-life, the global BCR increases to 6.5, at a discount rate of 3%.

Table 13. Benefit-cost ratios for eliminating open defecation in rural areas, by income quintile (3% discount rate)

MDG Region	**Q5 (richest)**	**Q4**	**Q3**	**Q2**	**Q1 (poorest)**	**Total**
Latin America and the Caribbean	9.1	9.9	10.3	10.6	11.0	10.5
Sub-Saharan Africa	3.6	3.7	3.9	4.1	4.2	3.9
Northern Africa	5.9	6.2	6.4	6.5	6.7	6.4
Western Asia	7.8	7.8	8.0	8.6	9.5	8.6
Caucasus and Central Asia	15.5	15.7	15.9	16.1	16.8	16.1
South Asia	6.0	6.3	6.7	7.0	7.3	6.7
South-East Asia	13.7	14.2	14.4	14.5	14.9	14.2
Eastern Asia	4.2	4.3	4.5	4.5	21.2	13.5
Oceania	31.6	31.6	32.8	35.2	33.3	32.7
Developed countries	22.2	22.3	22.3	22.4	22.6	22.4
World	**5.1**	**5.4**	**5.9**	**6.3**	**6.8**	**6.0**

Figure 2 shows the breakdown for different benefits of delivering universal access to basic sanitation in urban areas. Globally, the access time accounts for over 70% of the benefits, while mortality accounts for a little over 20% and both health care and health-related productivity each account for less than 5%. Similar proportions were found for rural areas as for urban areas. Across regions there are some differences, such as higher proportion accounted for access time in developed countries.

Figure 2. Benefit breakdown for delivering universal access to basic sanitation



Sensitivity analysis

The results of the analyses where premature mortality is converted to DALYs lost and valued at US$1,000 and US$5,000 per DALY across all countries, is presented in Table 14 and Table 15, respectively. Globally the benefit-cost ratios are lower than the main baseline results (using the human capital approach) when valued at US$1,000 (Table 14) and slightly higher than the baseline when valued at US$5,000 (Table 15). The overall benefit-cost ratios (in Table 8) are closer to the urban BCRs in Tables 14 and 15 because the costs are heavily weighted towards urban areas where the intervention costs are estimated to be about twice the costs in rural areas. While the difference in DALY value is five times, the impact on benefit-cost ratios is not that significant because the majority of benefit comes from time savings. The same tables are presented at a discount rate of 5% in Annex 2.

Table 14. Benefit-cost ratios when premature mortality is valued at US$1,000 per DALY averted (3% discount rate)

MDG Region	Basic Water		Basic Sanitation		ODF
	Urban	**Rural**	**Urban**	**Rural**	**Rural**
LAC	3.0	8.0	3.3	8.0	10.4
SSA	2.1	4.5	0.9	2.7	3.7
Northern Africa	2.4	9.5	2.2	5.8	6.4
Western Asia	2.6	5.8	3.0	7.2	8.5
Caucasus and Central Asia	2.9	9.0	3.2	19.6	15.9
South Asia	2.0	4.2	2.8	5.3	6.4
South-East Asia	2.4	8.8	2.5	17.2	13.8
Eastern Asia	5.3	14.4	4.0	12.7	13.4
Oceania	2.3	6.5	5.7	46.9	32.5
Developed	2.3	15.8	3.5	33.4	22.3
World	**3.1**	**5.1**	**2.4**	**4.5**	**5.8**

Table 15. Benefit-cost ratios when premature mortality is valued at US$5,000 per DALY averted (3% discount rate)

MDG Region	Basic Water		Basic Sanitation		ODF
	Urban	**Rural**	**Urban**	**Rural**	**Rural**
LAC	3.0	8.2	3.3	8.1	10.5
SSA	4.0	8.6	1.3	4.0	5.5
Northern Africa	2.5	9.9	2.2	5.9	6.4
Western Asia	2.7	6.5	3.0	7.6	8.9
Caucasus and Central Asia	3.0	9.5	3.3	20.0	16.2
South Asia	2.9	5.8	3.2	6.2	7.5
South-East Asia	2.6	9.5	2.5	17.8	14.3
Eastern Asia	5.4	14.8	4.0	12.8	13.5
Oceania	2.5	7.0	5.8	49.3	34.1
Developed	2.4	15.8	3.5	33.4	22.3
World	**3.7**	**7.9**	**2.6**	**5.6**	**7.1**

Overall findings

In summary, the main findings are as follows:

1. Water supply and sanitation give significant economic returns to society. However, several impacts were excluded due to difficulty in monetizing benefits (see Table 3), such as environmental benefits and the greater privacy and dignity associated with improved sanitation. In addition, indirect health impacts including health externalities of communicable diseases were not fully accounted for. Hence if all the benefits could be monetized, the benefit-cost ratios would be significantly higher than those presented.
2. Higher benefit-cost ratios in lower income quintiles, accounted for by the higher health impacts in these population groups (due to worse baseline situation, hence

higher capacity to benefit). This is an interesting finding – and one compelling reason to serve the poorest first.

3. Higher benefit-cost ratios in rural areas than urban areas, accounted for by lower unit costs and higher capacity to benefit from health and access time savings.
4. Higher benefit-cost ratios for water supply than for sanitation. Overall, water supply has higher ratios than in previous global cost-benefit studies (Hutton, 2012), due to developments in the underlying evidence (see conclusions for more comment).
5. The decrease in benefit-cost ratio when using a higher discount rate (of 5% instead of 3%) is only marginal in most cases, because both costs and benefits are (almost) equally incurred in future years.

Conclusions

This study has confirmed that drinking water supply and sanitation both generate high economic returns to society, with returns exceeding costs for all interventions at both 3% and 5% discount rates. The study showed that economic returns varied between different regions of the world. This variation is partly expected due to different relative price levels of water and sanitation services, and different capacity to benefit (such as existing disease rates). The variation is also likely to be due to weak data for some regions and countries (e.g. unit costs of services for Central Asia, Oceania, North Africa, Western Asia and developed countries). Furthermore, the assumptions on time savings may be less applicable for some regions where there have been no studies on time savings. On the other hand, the most data were available for costs and benefits for countries with the highest numbers of unserved population. Despite the variation, economic returns remain above unity for all regions and interventions.

The results vary compared to previous global studies. The main variance is for water supply, where the benefit-cost ratios presented in this study are at least twice as high compared with the most recent global study. This is partly due to higher health benefits, resulting from an updated meta-analysis on the health impact of basic water supply (34% instead of 18% reduction in diarrheal disease). It is also due to an updated unit cost database, which has lower unit costs than used in previous studies. A third reason is that in this study some populations receive a lower cost technology (divided between borehole and dug well) than in the previous study which assumed only borehole.

The benefit-cost ratios are also marginally lower for sanitation, comparing the global BCR of 5.5 in the previous study with 3.4 (urban) and 6.8 (rural) in the present study. Updated data or different assumptions were used in this present study, and ongoing work will lead to final estimates being published later in 2015.

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Annex 1. Countries included and excluded in study, by MDG Region

MDG Region	Included	Excluded
LAC	Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Venezuela	Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, British Virgin Islands, Cayman Islands, Chile, Falkland Islands (Malvinas), French Guiana, Guadeloupe, Martinique, Montserrat, Caribbean Netherlands, Puerto Rico, Saint Kitts and Nevis, United States Virgin Islands, Uruguay, Turks and Caicos Islands
SSA	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Swaziland, Togo, Uganda United Republic of Tanzania, Zambia, Zimbabwe	Mayotte, Réunion
Northern Africa	Algeria, Egypt, Libya, Morocco, Tunisia	Western Sahara
Western Asia	Iraq, Jordan, Lebanon, Syrian, Arab, Republic Turkey, Yemen,	Bahrain, Kuwait, State of Palestine, Oman, Qatar, Saudi Arabia, United Arab Emirates
Caucasus and Central Asia	Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan	
South Asia	Afghanistan, Bangladesh, Bhutan, India, Iran (Islamic Republic of), Maldives, Nepal, Pakistan, Sri Lanka	
South-East Asia	Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Thailand, Timor-Leste, Viet Nam	Brunei Darussalam, Singapore
Eastern Asia	China, Dem. People's Republic of Korea, Mongolia	Hong Kong (China), Macao (China), Republic of Korea
Oceania	Cook Islands, Fiji, Kiribati, Marshall Islands, Micronesia (Fed. States of), Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu	American Samoa, French Polynesia, Guam, New Caledonia, Northern Mariana Islands, Tokelau
Developed (upper-middle income)	Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Republic of Moldova, Romania, Russian Federation, Serbia, TFYR Macedonia, Ukraine	Hungary
Developed (high income)		Andorra, Australia, Austria, Belgium, Bermuda, Canada, Channel Islands, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Faroe Islands, Finland, France, Germany, Greece, Greenland, Iceland, Ireland, Isle of Man, Israel, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Montenegro, Netherlands, New Zealand, Norway, Poland, Portugal, San Marino, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States of America

Annex 2. Results using DALY values for premature death at 5% discount rate

Table 16. Benefit-cost ratios when premature mortality is valued at US$1,000 per DALY averted (5% discount rate)

MDG Region	Basic Water		Basic Sanitation		ODF
	Urban	Rural	Urban	Rural	Rural
LAC	2.9	7.8	3.3	8.1	10.2
SSA	1.9	4.3	0.9	2.6	3.6
Northern Africa	2.4	9.3	2.2	5.8	6.3
Western Asia	2.5	5.7	3.0	7.3	8.3
Caucasus and Central Asia	2.8	8.8	3.3	19.7	15.6
South Asia	1.9	4.1	2.8	5.2	6.3
South-East Asia	2.3	8.6	2.5	17.3	13.6
Eastern Asia	5.1	14.1	4.0	12.8	13.2
Oceania	2.2	6.4	5.7	47.1	31.9
Developed	2.3	15.5	3.6	33.6	22.0
World	**2.9**	**4.8**	**2.4**	**4.5**	**6.0**

Table 17. Benefit-cost ratios when premature mortality is valued at US$5,000 per DALY averted (5% discount rate)

MDG Region	Basic Water		Basic Sanitation		ODF
	Urban	Rural	Urban	Rural	Rural
LAC	2.9	8.0	3.3	8.2	10.3
SSA	3.5	7.6	1.2	3.8	5.1
Northern Africa	2.4	9.6	2.2	5.9	6.3
Western Asia	2.6	6.2	3.0	7.6	8.6
Caucasus and Central Asia	2.9	9.2	3.3	20.1	15.9
South Asia	2.6	5.4	3.1	6.0	7.2
South-East Asia	2.5	9.2	2.6	17.8	14.0
Eastern Asia	5.2	14.4	4.0	12.9	13.3
Oceania	2.4	6.8	5.8	49.1	33.2
Developed	2.3	15.5	3.6	33.6	22.0
World	**3.4**	**7.1**	**2.6**	**5.4**	**7.3**

This paper was written by Guy Hutton, Senior Economist, at the Water and Sanitation Program (WSP), World Bank. Mili Varughese, Operations Analyst at WSP, provided research assistance. The project brings together 60 teams of economists with NGOs, international agencies and businesses to identify the targets with the greatest benefit-to-cost ratio for the UN's post-2015 development goals.

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