Global costs and benefits of reaching universal coverage of sanitation and drinking-water supply

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ABSTRACT

Economic evidence on the cost and benefits of sanitation and drinking-water supply supports higher allocation of resources and selection of efficient and affordable interventions. The study aim is to estimate global and regional costs and benefits of sanitation and drinking-water supply interventions to meet the Millennium Development Goal (MDG) target in 2015, as well as to attain universal coverage. Input data on costs and benefits from reviewed literature were combined in an economic model to estimate the costs and benefits, and benefit-cost ratios (BCRs). Benefits included health and access time savings. Global BCRs (Dollar return per Dollar invested) were 5.5 for sanitation, 2.0 for water supply and 4.3 for combined sanitation and water supply. Globally, the costs of universal access amount to US$ 35 billion per year for sanitation and US$ 17.5 billion for drinking-water, over the 5-year period 2010–2015 (billion defined as 10^9 here and throughout). The regions accounting for the major share of costs and benefits are South Asia, East Asia and sub-Saharan Africa. Improved sanitation and drinking-water supply deliver significant economic returns to society, especially sanitation. Economic evidence should further feed into advocacy efforts to raise funding from governments, households and the private sector.

Key words | benefit-cost ratio, capital cost, drinking-water supply, economic return, recurrent cost, sanitation

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ABBREVIATIONS

BCR	Benefit-Cost Ratio
GDP	Gross Domestic Product
JMP	Joint Monitoring Programme for Water Supply and Sanitation
MDG	Millennium Development Goal
UN	United Nations
UNICEF	United Nations Children's Fund
US$	United States Dollar
VSL	Value-of-a-Statistical Life
WHO	World Health Organization
WSS	Drinking-Water Supply and Sanitation

INTRODUCTION

Globally, large numbers of people remain without access to basic levels of drinking-water supply and sanitation (WSS). According to data compiled by the World Health Organization/United Nations Children's Fund (WHO/UNICEF) Joint Monitoring Programme for Water Supply and Sanitation (JMP), in 2010 2.5 billion people continued to use an unimproved sanitation facility or defecate in the open and 783 million people continued to use unimproved sources to meet their drinking-water needs (Joint Monitoring Programme 2012).

Sanitation and drinking-water share a joint target (target c) in Goal 7 of the UN Millennium Development Goals (MDGs). The target is to halve, by 2015, the proportion of people without sustainable access to safe drinking-water and basic sanitation. The target is measured from 1990 as the baseline year. According to the JMP, the rate of progress towards achieving this target is such that the target will not be reached in its entirety by 2015. While the global drinking-water target was met in 2010, there is significant

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inter-country variation in progress. Sanitation is still considerably off-track, where coverage must increase globally from 63 to 75% between 2010 and 2015 to meet the global target. At the current rate of progress, sanitation coverage is predicted to be 67% in 2015, or 580 million people short of the MDG target.

In 2010, the United Nations General Assembly and the UN Human Rights Council recognized access to safe drinking water and sanitation as a human right (Human Rights Council 2011). The concept of progressive realization inherent to the rights-based approach will result in intensified monitoring to be able to hold governments accountable for meeting their human rights obligations. Those still lacking access tend to be poor and marginalized groups. The JMP progress report showed that, in 2010, households in the lower wealth quintiles have significantly lower access than households in the two highest wealth quintiles (Joint Monitoring Programme 2012).

A comparison of progress in rural and urban areas since 1990 shows that greater progress has been made in expanding water and sanitation services to urban areas. Of the 783 million people still using unimproved drinking-water sources, 83% (653 million) live in rural areas (Joint Monitoring Programme 2012). Of the 2.5 billion people still not served with improved sanitation facilities, 72% (1.8 billion) live in rural areas.

Even if the world were to meet the MDG target for both WSS, 25% of the world's population – 1.8 billion – would remain without access to improved sanitation in 2015 (Joint Monitoring Programme 2012). If current trends in sanitation continue, this figure will be closer to 2.4 billion. At current rates of progress in access to drinking-water supply, 8% (605 million) of the world's population will still be using unimproved sources of drinking-water in 2015. The remaining unserved populations are generally the poorer and marginalized members of society, and thus are harder to reach with services. Equity in achieving the MDG targets is important, not only because the poorest households are least able to invest in their own facilities, but also because they have the most to gain due to their heightened vulnerability to adverse health outcomes. Hence, there are rising expectations for universal access to safe drinking-water and basic sanitation to be adopted as a global development goal, leveraging additional efforts and resources that are targeted to ensure the poorest and most vulnerable are reached.

In order to address these remaining challenges, further evidence is needed to support a higher allocation of resources to WSS by decision makers and to select the most efficient interventions. Economic evidence is recognized as key for the achievement of the drinking-water and sanitation goals. Evidence helps justify increasing investment and expenditure. Evidence also supports the selection of efficient WSS options by explicitly comparing costs and benefits of a range of alternative WSS technologies and service delivery approaches. Previously, economic studies were published evaluating the global costs and benefits of improved drinking-WSS (Hutton *et al.* 2007; Hutton & Bartram 2008). These studies used WSS coverage levels from the year 2004 or earlier. Hence more up-to-date estimates of costs and benefits are needed, drawing on improved methods and newer and expanded data sources.

METHODS

The study aim is to estimate global and regional costs and benefits of sanitation and drinking-water supply interventions to meet the MDG target in 2015, as well as to attain universal coverage. These economic data will provide further evidence to support investment in WSS systems and services, with a focus on services that are both socially efficient and financially sustainable. The results will help donors and governments of low- and middle-income countries to justify allocation of adequate budgets for improved WSS systems and services.

The entire analysis presented in this paper is based on households moving from unimproved to improved technology options of drinking-WSS, as defined by the JMP (Joint Monitoring Programme 2008). The costs and benefits of WSS interventions are estimated under the achievement of the MDG target and universal access by the year 2015, compared to a baseline of no change from the coverage in 2010.

WSS coverage data were sourced from the latest JMP report (Joint Monitoring Programme 2012). The main data points used in this analysis are coverage for the MDG baseline year (1990) and the latest year for which JMP data are available (2010). The 1990 baseline data are required to

estimate the target coverage in 2015, with the global MDG target applied in each country individually.

A quantitative model estimating and comparing the costs and benefits of each intervention was run at country level, and the results aggregated to give nine developing MDG regions and global averages, weighted by country population size. More recently, backward projection of 1990 baselines for more countries has been made by the JMP and hence more low- and middle-income countries have been included in this study than previously, thus better reflecting the global picture (see Annex, available online at http://www.iwaponline.com/jwh/011/105.pdf). Population size for rural and urban areas was sourced from UN Statistics Division for the MDG baseline year (1990) and 2008, as well as projections for 2010 and 2015. The 136 countries included represent 5.6 billion of the world's 6.7 billion population in 2010, and 6.0 billion of the world's projected 7.3 billion population in 2015. In 2010, the urban share of total population of MDG developing regions ranged from under 30% in sub-Saharan Africa, Oceania and East Asia, South Asia and Southeast Asia, to above 60% in Latin America and the Caribbean and West Asia, compared to a global average of 45% living in urban areas.

In meeting the MDG target in every country, the total population benefiting from improved services is 985 million people for sanitation and 215 million people for drinking-water supply. A further 1.89 billion must be covered to reach universal sanitation coverage, and a further 900 million for universal drinking-water access. Rural and urban settings are considered separately, as reported by the JMP. If a country has surpassed its MDG target for urban sanitation but is off-track to meet the target applied to rural areas, the excess urban coverage does not balance out the rural deficit. The effect is that costs of meeting MDG targets are higher for some countries than would be the case if progress were assessed based on aggregate statistics for rural and urban areas combined. This approach ensures greater equity between rural and urban residents.

An incremental cost analysis was carried out, with an estimate of the costs of extending access to WSS for those currently not having access using available data sets (Robinson 2009; Trémolet *et al.* 2010; African Ministers Council on Water (AMCOW) 2011; Hutton *et al.* 2012) and from the WASHCost (Water, Sanitation and Hygiene) project housed at the International Resource Centre (IRC) International Water and Sanitation Centre, the Netherlands. Incremental costs consist of all resources required to put in place, operate and maintain an intervention. However, there were major gaps in unit cost evidence, especially for operations and maintenance costs. When unit cost data were not available for a country, data from the most similar country were extrapolated.

Global cost estimates of attaining universal access carry considerable uncertainty about when countries will attain universal access. To simplify, this study estimated the financial costs of achieving universal coverage in 2015, thus omitting the impacts of continued population growth.

A challenge in modelling the future costs of meeting global WSS targets is that the types of technology, and the way they are delivered or demanded, will vary from country to country, as well as within countries. Due to the global nature of this study, detailed assessments were not possible of the specific types of technology currently applied in different countries. This study therefore uses the simplifying assumption that in rural areas basic sanitation involves an improved wet pit latrine with a lifespan of 8 years, and basic water supply involves a borehole with a lifespan of 30 years. In urban areas, improved sanitation technologies reflect a mixture of septic tank (with and without off-site treatment) as well as sewerage with wastewater management – all with an expected lifespan of 20 years. Improved water sources in urban areas were assumed to be piped household connection to a water treatment plant, with an expected lifespan of 20 years. Given the low rates of capital maintenance throughout the developing world, the conditions are considered to be absent for exploiting the potentially longer lifespans of these technologies.

A large range of economic and social benefits can result from improved WSS services. Table 1 presents the main ones, indicating those that have been included in this study, and those excluded. As is evident from the table, more economic benefits have been excluded than included: for many, the lack of evidence impedes a credible global assessment. Economic values are the sum of financial transactions, hypothetical or actual cash savings, as well as an imputed value for non-market services. Economic values exclude transfer payments such as taxes and subsidies. Once all these values in Table 1 are aggregated, they reflect

Table 1 | Benefits of improved sanitation and drinking-water supply

Benefit	Sanitation	Water
Benefits included in study		
Health	• Averted cases of diarrhoeal disease • Averted cases of helminths • Averted cases of malnutrition-related diseases[a] • Health-related quality of life impacts	• Averted cases of diarrhoeal disease • Averted cases of malnutrition-related diseases[a] • Health-related quality of life impacts
Health economic	• Costs related to diseases such as health care, productivity, mortality	• Costs related to diseases such as health care, productivity, mortality
Time value	• Travel and waiting time averted	• Travel and waiting time averted for collecting water
Benefits not included in study		
Other health	• Dehydration from not drinking due to poor latrine access (especially women) • Less flood-related health impacts	• Dehydration from lack of access to water • Less flood-related health impacts (better water management)
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 and attendance rates • Impact on education of childhood malnutrition	• Improved educational levels due to higher school enrolment and attendance rates • Impact of childhood malnutrition on education
Water treatment	• Less household time and costs spent treating drinking-water due to water sources polluted from poor sanitation	• Less household time and costs spent treating drinking-water due to safer water sources
Water security	• Safe treated wastewater for use in agriculture	
Environment	• Improved quality of water supply and related savings	
Leisure and quality of life/intangibles	• Safety, privacy, dignity, comfort, status, prestige, aesthetics, gender impacts (Hutton *et al.* 2008)	• Leisure and non-use values of water resources and reduced effort of averted water hauling and gender impacts
Reduced access fees	• Reduced payment of money paid for toilets with fee	
Property	• Rise in value of property	• Rise in value of property
Income	• Increased incomes due to more tourism income and business opportunities • Productive uses of re-used urine and excreta	• Increased incomes due to more tourism income and business opportunities • Productive uses of improved water supply

[a]These include malaria and acute lower respiratory infection for morbidity impact; and for mortality impact: malaria, acute lower respiratory infection, measles and perinatal outcomes.

total societal benefit (also termed 'welfare' or 'utility'). Economic values do not reflect the direct financial impact such as the cash impact on the household (e.g. coping costs), on the private sector (e.g. worker productivity), or on the budget of a line ministry (e.g. health care savings). As a purely financial analysis will undervalue water and sanitation services (e.g. excluding mortality impact), the purpose of this study is to better reflect the overall costs and benefits to society – thus informing overall debates on the 'right' level of coverage and resource allocation, and the 'right' technologies.

Over recent decades, compelling evidence has been gathered that significant and beneficial health impacts are associated with improvements in access to safe drinking-water and basic sanitation facilities (Waddington *et al.* 2009). 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, sanitation and hygiene. Moreover, water-borne and water-washed diseases are responsible for the greatest proportion of the direct-effect water and sanitation-related disease burden.

For the purpose of estimating health benefits from improving WSS services, populations are classified into different starting WSS service points, which relate to a given health risk. From a starting point of no improved WSS, improved drinking-water alone has a relative risk of 0.82, sanitation alone has a relative risk of 0.64, and combined WSS has a relative risk of 0.61 (Waddington *et al.* 2009). The relative risks are based on high quality impact assessments only.

In terms of burden of disease, waterborne and water-washed diseases consist mainly of 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 causes the main global burden of disease resulting from poor access to WSS, 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 (Fishman *et al.* 2004), diseases with higher incidence or case fatality due to malnutrition are included using a method previously applied in countries in Southeast Asia (Hutton *et al.* 2008). In this approach, a proportion of cases of respiratory infection and malaria in children 0–5 years old are attributed to poor WSS, based on very severe and moderately severe malnutrition rates in the same age group and determined by region-specific attribution factors estimated by Fishman (Fishman *et al.* 2004). For mortality, the case fatality of respiratory infection, malaria, measles and other infections is affected.

Economic benefits related to health impacts of improved WSS services include three main ones:

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 or referral. All these variables fluctuate by disease and country. In addition, patients and their carers incur 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 stringent data requirements to estimate specifically financial losses from lost productive time, an economic value is given instead to each day of a sick person's time lost. To promote gender equity, men's and women's time is given the same value. The opportunity cost of time is valued at 30% of the hourly gross domestic product (GDP) per capita for adults, and 15% for children.
3. Savings related to reductions in premature mortality. Mortality is valued using the human capital approach to estimate the value of a premature death averted.

Time savings are enjoyed due to closer physical access and less waiting time for improved WSS services. The amount of time savings is based on reviews conducted in previous economic studies (Hutton *et al.* 2007) and more recent surveys on sanitation practices in Southeast Asia (Hutton *et al.* 2012). Water collection time saved per household per day for better external access is 0.5 hours per day per household (1 hour for sub-Saharan Africa). Water collection time saved per household per day for piped water is 1 hour per day per household (1.5 hours for sub-Saharan Africa). Sanitation access time saved per person moving from open defecation to private latrine is 0.5 hours per day per person. Open defecation is the use of field, bush or directly to surface water. The value of the opportunity cost of time is the same as for health-related time losses.

One-way sensitivity analysis was performed on five key variables determining the cost-benefit values:

1. The value for averted premature deaths: high value is obtained from value-of-statistical life (VSL) method; low value is half the baseline value of the human capital approach. The VSL method compares the risks that people are voluntarily willing to take and how much they must be paid for taking them; this method produces a value that is often significantly more than the human capital approach.
2. Opportunity cost of time: high value is 100% of the hourly value of GDP per capita for adults and 50% for children; low value is 15% of GDP per capita for adults and zero for children.
3. Gains in time (minutes) for improved WSS services: the high value is double the baseline value; the low value is half the baseline value.
4. Unit costs of WSS services, covering investment and recurrent costs: rising high and low values from the literature review.
5. Discount rate on future costs and benefits: baseline (8%); high value is 12%; low value is 3%.

RESULTS

Benefit-cost ratios (BCRs) for attaining universal access to sanitation are shown in Table 2. The BCR for interventions ensuring universal access to sanitation facilities varies from 2.8 in sub-Saharan Africa to 8.0 in East Asia. South Asia, where more than 400 million people still need to be served with sanitation to reach the MDG target, has a BCR of 4.6. The average global economic return on sanitation spending is US$ 5.5 per US dollar invested.

BCRs for attaining universal access to drinking-water are shown in Table 3. The BCR for interventions ensuring universal access to drinking-water varies from 0.6 in Oceania to 3.7 in South Asia. The sub-Saharan Africa region – with still over 130 million people to be served with water for individual countries to reduce by half those unserved in 1990 – has a BCR of 2.5. The average global economic return on water expenditure is US$ 2.0 per US dollar invested. BCRs for combined WSS interventions are shown in Table 3. The BCR varies from 2.0 in Oceania to over 5.0 in Latin America and the Caribbean and East Asia. The global return on WSS spending to reach universal access is US$ 4.3 per US dollar invested.

Table 2 | Benefits and costs of universal sanitation access – annual values (US$[a])

	Total benefit					Total cost			
World region[b]	Benefit value (US$ millions)	% health care	% productivity	% mortality	% time savings	Value (US$ millions)	% rural	% capital	Benefit-cost ratio[c]
CCA	1,278	9	3	2	86	266	26	57	4.8
N Africa	3,029	9	4	2	85	703	28	60	4.3
SSA	25,013	12	6	20	62	8,968	50	85	2.8
LAC	27,362	7	4	1	88	3,746	19	66	7.3
E Asia	68,981	8	5	0[d]	87	8,648	24	39	8.0
S Asia	47,077	7	5	17	72	10,134	59	66	4.6
SE Asia	13,159	7	5	3	85	2,658	43	61	5.0
W Asia	8,724	10	4	2	85	1,421	23	56	6.1
Oceania	236	9	5	4	82	65	70	61	3.6
WORLD	194,857	8	5	6	81	35,227	39	62	5.5

[a]United States Dollars (US$) are expressed in 2010 prices.
[b]N Africa – Northern Africa; SSA – Sub-Saharan Africa; LAC – Latin America and the Caribbean; CCA – Caucasus and Central Asia; E Asia – Eastern Asia; S Asia – Southern Asia; SE Asia – Southeast Asia; W Asia – Western Asia. http://mdgs.un.org/unsd/mdg/Host.aspx?Content=Data/RegionalGroupings.htm. For countries included, see Annex (available online at http://www.iwaponline.com/jwh/011/105.pdf).
[c]Expressed as the monetary return per currency unit spent.
[d]Percentage is rounded to nearest round number. Actual percentage is 0.45%.

Table 3 | Benefits and costs of universal drinking-water supply access – annual values (US$[a])

	Total benefit					Total cost			
World region[b]	Value (US$ millions)	% health care	% productivity	% mortality	% time savings	Value (US$ millions)	% rural	% capital	Benefit-cost ratio[c]
CCA	371	15	5	4	76	354	43	70	1.0
N Africa	2,594	9	3	2	86	1,060	24	65	2.4
SSA	8,215	17	7	28	48	3,263	55	79	2.5
LAC	5,462	10	6	2	83	2,313	14	63	2.4
E Asia	7,994	10	6	1	84	4,944	19	63	1.6
S Asia	3,887	14	9	31	45	1,038	60	45	3.7
SE Asia	2,170	13	8	5	73	2,549	26	72	0.9
W Asia	3,725	13	4	2	81	1,615	17	64	2.3
Oceania	61	24	13	12	52	95	79	83	0.6
WORLD	34,479	12	6	10	71	17,476	28	66	2.0

[a]United States Dollars (US$) are expressed in 2010 prices.
[b]N Africa – Northern Africa; SSA – Sub-Saharan Africa; LAC – Latin America and the Caribbean; CCA – Caucasus and Central Asia; E Asia – Eastern Asia; S Asia – Southern Asia; SE Asia – Southeast Asia; W Asia – Western Asia. http://mdgs.un.org/unsd/mdg/Host.aspx?Content=Data/RegionalGroupings.htm. For countries included, see Annex (available online at http://www.iwaponline.com/jwh/011/105.pdf).
[c]Expressed as the monetary return per currency unit spent.

The total economic benefits of achieving universal sanitation are 195 billion US dollars per year, while achieving universal access to drinking-water delivers benefits of 35 billion US dollars per year. Compared with coverage levels in the year 2010, attaining universal WSS access will lead to over US$ 230 billion in benefits annually. Regions with economic benefits above 10 billion US dollars per year are East Asia (the highest with over 75 billion US dollars annually), South Asia, sub-Saharan Africa, Latin America and the Caribbean, and Southeast Asia. Globally, the major contributions to the economic benefits of sanitation shown in Table 2 are access time savings (81%), followed by health care (8%), mortality (6%) and health-related productivity (5%). For drinking-water, the access time savings contribute slightly lower at 71% of the total benefits, followed by health care at 12% (Table 3). Inter-regional differences exist, with a higher contribution of health savings in sub-Saharan Africa and South Asia, where mortality savings are particularly significant.

The economic benefit calculations are based on total estimates of economic loss due to inadequate WSS. The total economic losses associated with inadequate WSS were estimated at US$ 260 billion annually, or 1.5% of GDP of the countries included in this study. Economic losses as a proportion of GDP are provided by world region in Figure 1. The losses vary between 0.5 and 4.3% of GDP, the highest impact being in sub-Saharan Africa. Note that these figures include the impacts of inadequate drinking-water supply; hence the figures are not directly comparable with estimates from country-level studies that focus on inadequate sanitation alone (Hutton *et al*. 2008).

The costs of attaining universal sanitation and drinking-water access are presented in Tables 2 and 3, respectively. Attaining the goal of universal coverage will have different time horizons in different countries; hence to simplify the analysis the costs of achieving universal access from 2010 to 2015 are estimated. Globally, the costs of universal access amount to US$ 35.2 billion per year for sanitation and US$ 17.5 billion for drinking-water, over the 5-year period 2010–2015. The costs are spread across the regions based on numbers of population still unserved, with South Asia, East Asia and sub-Saharan Africa accounting for roughly US$ 37 billion of the combined WSS annual total of 53 billion. About two-thirds (62%) of WSS spending is on capital costs, while globally rural areas are in need of 39% of sanitation funds and 28% of water supply funds. South Asia and sub-Saharan Africa are two regions where rural spending exceeds urban spending needs. Globally, sanitation spending requirements exceed those of drinking-water by between five and six times. However, in Southeast

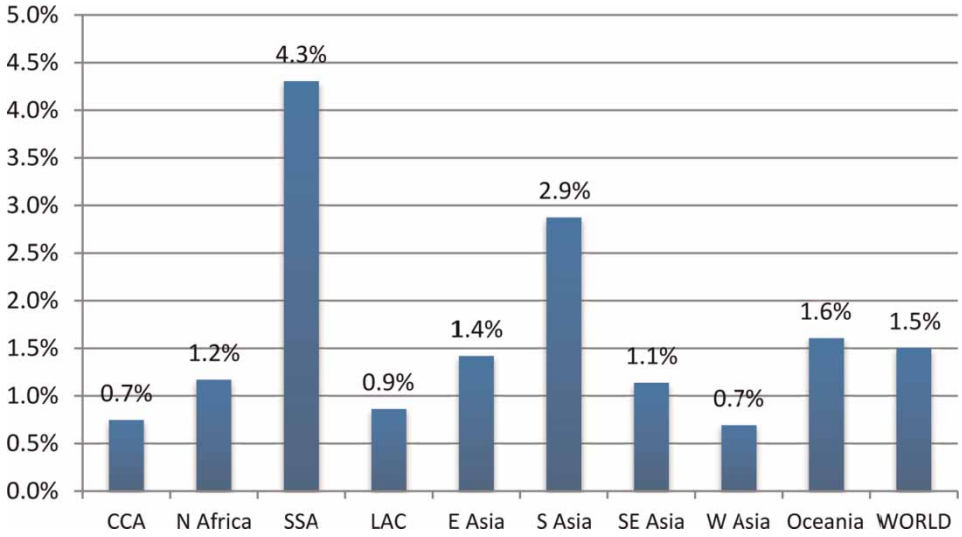

Figure 1 | Economic losses associated with inadequate water supply and sanitation by region, as a percentage of GDP.

Asia, West Asia, and Latin America and the Caribbean water spending needs are more balanced with sanitation spending needs.

The costs of achieving the MDG target are presented in Table 4. To expand access to sanitation to meet the target, US$ 128 billion is needed, or US$ 25 billion per year. To expand access to drinking-water supply in those countries where the target is not met, US$ 33 billion is required, or US$ 6.5 billion per year. However, to meet the MDG target, continued spending is required for those households already with improved coverage. Taking into account the investment needs, operations and maintenance for those households currently with access, a further US$ 330 billion for sanitation and US$ 550 billion for drinking-water supply is required. A significant proportion of these costs are being assured from financially sustainable WSS services; however,

Table 4 | Costs of meeting the MDG target for 5 years from 2010 to 2015 (US$ millions[a])

	Sanitation			Drinking-water			Sanitation and drinking-water			
World region[b]	Expand access	Maintain access	Total	Expand access	Maintain access	Total	Expand access	Maintain access	Total	Benefit-cost ratio[c]
CCA	1,049	7,915	8,964	1,029	10,684	11,713	2,079	18,598	20,677	2.6
N Africa	1,041	19,535	20,576	4,656	27,049	31,705	5,697	46,583	52,280	3.3
SSA	46,108	33,293	79,401	9,741	27,229	36,970	55,849	60,522	116,371	2.7
LAC	10,455	71,525	81,980	3,319	112,081	115,400	13,773	183,606	197,380	5.2
E Asia	23,596	72,806	96,402	20	217,603	217,623	23,617	290,409	314,026	5.3
S Asia	38,785	48,462	87,247	984	28,330	29,315	39,769	76,792	116,561	4.5
SE Asia	4,010	34,281	38,291	7,536	64,432	71,968	11,546	98,713	110,259	2.9
W Asia	3,053	40,445	43,498	5,237	58,473	63,710	8,290	98,918	107,208	4.2
Oceania	354	552	905	385	633	1,019	739	1,185	1,924	2.0
WORLD	128,451	328,813	457,264	32,908	546,514	579,422	161,359	875,327	1,036,686	4.3

[a]United States Dollars (US$) are expressed in 2010 prices.
[b]N Africa – Northern Africa; SSA – Sub-Saharan Africa; LAC – Latin America and the Caribbean; CCA – Caucasus and Central Asia; E Asia – Eastern Asia; S Asia – Southern Asia; SE Asia – Southeast Asia; W Asia – Western Asia. For countries included, see Annex (available online at http://www.iwaponline.com/jwh/011/105.pdf).
[c]Expressed as the monetary return per currency unit spent.

in countries and settings where there is still no private and sustainable financing mechanism, further public spending is needed beyond that currently budgeted. Data are lacking on what these values might be. However, it is likely that public funding requirements to maintain those already with coverage may exceed the sums needed to provide services to unserved households to meet the MDG target.

One-way sensitivity analysis illustrates the sensitivity of the base-case results to key areas of uncertainty. Figure 2 presents a summary of the results of the one-way sensitivity analysis conducted on the global BCRs for sanitation and drinking-water.

The sensitivity analysis shows that the results are most sensitive for the approach chosen to value time. When time is valued at 100% of the GDP per capita instead of 30%, the global BCR increases to 16.6 for sanitation and to 5.5 for drinking-water supply. This variable is important because a large proportion (71–81% globally) of the quantified economic benefits are the opportunity costs of time spent to access WSS services. The BCR results are also sensitive to the unit costs of WSS services, with BCRs varying between 4.8 and 10.9 for sanitation and between 1.6 and 4.1 for drinking-water supply. The value of life has a smaller impact on BCRs, with BCRs varying from 5.4 to 6.6 for sanitation and from 1.9 to 2.7 for drinking-water supply. Variations in the discount rate for future costs and benefits from 3 to 12% had an even smaller impact. In no cases does the uncertainty in a single parameter lead to a BCR of below 1, at which point the intervention would fall below the return to make it economically viable. However, given the benefits omitted, it is unlikely – even under pessimistic values for several parameters simultaneously – that the interventions would become economically unviable.

DISCUSSION

This study provides new estimates of the costs and economic returns on basic sanitation and drinking-water supply interventions. The economic returns of sanitation and drinking-water supply are more conservative than those observed in previous global economic studies (Hutton *et al.* 2007). Globally, the BCR for drinking-water supply has declined from 4.4 in a previous study to 2.0 in this study, and from 9.1 to 5.5 for sanitation. This has occurred chiefly because of the higher investment cost estimates in this new study, and the more complete inclusion of operation and maintenance costs; in addition, the assumption for the economic value of time – at 30% of the GDP per capita – is more conservative than that used in previous analyses which valued time at 100% of the hourly GDP per capita for adults (Hutton *et al.* 2007). Therefore, these new values – 2.0 for water supply and 5.5 for sanitation – are based on more conservative estimates of some model parameters, and are hence more

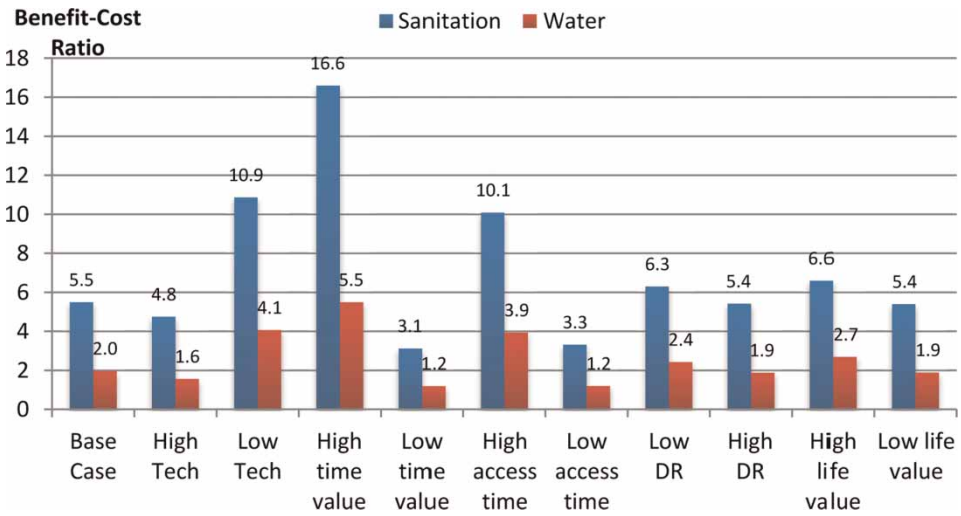

Figure 2 | Variation in global benefit-cost ratios (expressed as the monetary return per currency unit spent) for sanitation and drinking-water supply under different input values and assumptions. DR – discount rate (used for valuing future costs and benefits in current prices).

likely to be bare minimum estimates of economic rates of return. Hence, advocacy messages can confidently state that economic returns are at least two-fold for investments in drinking-water supply and at least five-fold for investments in sanitation.

With high economic returns shown in this study, economic arguments remain relevant in assisting the majority of low- and middle-income countries to further expand WSS coverage to reach universal access. Many countries have not yet met the MDG target – neither the drinking-water nor the sanitation components of the target (Joint Monitoring Programme 2012). Many countries are on course to meet both sub-components of the target, mainly in Latin America and the Caribbean, North Africa, Southeast Asia and East Asia. Some countries are on track to meet the drinking-water component of the target but not its sanitation component, such as countries in South Asia. Other countries, mainly in sub-Saharan Africa and some in Caucasus and Central Asia, are unlikely to meet either component at current rates of progress. Only a small number of countries in the MDG developing regions have achieved universal coverage of both sanitation and drinking-water supply services, mainly small island states. In other countries where there is close to universal access there are still some pockets of populations without access, such as slum areas, ethnic groups and migrant populations. For all countries, therefore, economic arguments can continue to be used in support of greater resource allocations and strengthened WSS policies. This study has further underlined and confirmed that drinking-WSS continue to be economically viable.

Due to insufficient progress towards the sanitation component of the MDG target, annual financing requirements have increased over time. While the water component of the global MDG target was achieved in 2010, a country-by-country analysis of the target indicates significant investments are still needed in expanding access to drinking-water to meet the MDG target in a large number of countries. A previous global cost study estimated the total costs of extending coverage to meet the MDG target to be US$ 184 billion, or US$ 18 billion per year from 2005 to 2015 (Hutton *et al.* 2008). This previous estimate compares with the current study's results of US$ 145 billion capital cost and US$ 16 billion recurrent cost, to be spent in the period 2010–2015, or US$ 161 billion total. Hence, in total value terms, the global price tag has reduced over the intervening period 2005–2010. However, in annual terms, the amount has increased, from US$ 18 billion to US$ 32 billion per year. This increase is partly due to the slow progress, especially in sanitation; it is also due to the higher unit costs used in the present study. On the other hand, the cost estimates for many countries may still be conservative (i.e. low) values: recurrent costs are not fully inclusive of all the costs necessary for regulated water supply and wastewater systems, including capital maintenance. Also, for those countries with growing populations, the costs of new facilities required each year for the population increments have not been fully included. For community water sources, it means greater pressure on these sources, and eventually – as pressure becomes too great – investment is required in new infrastructure. For new dwellings with piped water and sanitation facility, it means higher housing prices paid for by the house owners. Furthermore, in the coming decades it will become increasingly important to invest in more climate-resilient WSS systems, hence further increasing the investment and recurrent costs of WSS.

Considering the massive financing needs just to meet the MDG target, it is perhaps premature to start talking about universal drinking-water and sanitation coverage as a global policy target. Clearly there has to be a longer time horizon for attaining universal access. An additional US$ 390 billion are required to meet the capital costs of the unserved having access to sanitation and drinking-water supply. In the short term, arriving at this funding volume is not feasible, nor would recipient countries be able to absorb this level of capital influx. However, over 20 or 30 years, universal access may be feasible with progressive coverage increases supported by economic growth, a growing tax base for the poorest countries and successful advocacy efforts to divert public resources to poor households. Over 20 years, for example, it requires US$ 20 billion annually to extend coverage. However, this does not take into consideration further population growth, price increases above the average rate of inflation, and the expectations of populations for 'higher' levels of service than those assumed in the baseline assessment of this present cost study.

Various caveats should be noted to appropriately interpret a global analysis. The analysis utilizes coverage definitions of the JMP, and a single rural-urban distinction.

This introduces some issues of interpretation of cost estimates, which will need to be dealt with at country level based on each country's own definitions of improved versus unimproved WSS services, and the extent to which they diverge from the JMP definitions. For example, some national authorities consider adequate certain types of pit latrine or shared toilets that are categorized as 'unimproved' by the JMP. On the other hand, some types of basic facility that fall within the JMP's 'improved' category may be considered inadequate according to some national standards. Furthermore, a single rural versus urban area breakdown does not reflect the diversity of settlement types and densities, which call for different sanitation and drinking-water supply solutions. The impact of different unit costs on BCRs was explored in sensitivity analysis, showing that WSS services remain economically viable at global level.

A global study with disaggregation at country level will be imprecise, unless considerably more resources are put into collecting more detailed input data for each and every country. However, a global study such as this one can be used to motivate countries to generate their own estimates of economic return and financial cost of increasing investments in WSS. National studies should be conducted within the context of national policy processes, demanded by – even contracted by – the users of the information, to ensure that the studies generate policy-relevant information. Clearly large research gaps remain at global as well as national levels, including, among others: health impacts of different sub-types of WSS technology and service, including shared latrines, wastewater management options and household water treatment; economic values associated with health gains; reuse and energy benefits obtainable from sanitation; intangible benefits such as private and social benefits; and environmental benefits of averted pollution due to improved sanitation and wastewater management.

CONCLUSIONS

Improved sanitation and drinking-water supply deliver significant economic returns to society, especially sanitation. The major impacts include not only the economic value of access time and health savings which were quantified in this study, but also other social, environmental and broader economic impacts that will accrue to society from improved sanitation and drinking-water supply services. Economic evidence can feed into advocacy efforts to raise funding from governments and households, and, once the private sector is convinced these players are ready to invest, the diverse funding sources and innovative capacity of the private sector can be unleashed. Effective programme designs are needed to implement affordable sanitation and drinking-water supply interventions, and ensure sustained financing and household use, in order to capture the major benefits that accrue from these services. Further national studies are needed to validate findings of this global study and convince decision makers of the considerable economic returns of sanitation and drinking-water supply services.

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DISCLAIMER

The author, Mr Guy Hutton (independent consultant), alone is responsible for the views expressed in this publication and

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