Discussion paper

Sanitation and economic development

Making an economic case for the MDG orphan

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Summary

It is well known that poor sanitation has a powerful detrimental impact on health. Poor sanitation leads to the spread of diarrheal diseases, as well as schistosomiasis (bilharzia) and other parasites. Diarrheal diseases have an annual health footprint as high as 76 million disability-adjusted life years (DALYs), and kill approximately two million people per year. Children under the age of five make up 90 percent of the mortalities.

To give a sense of perspective, four percent of all deaths, and almost six percent of the total global burden of disease are the result of inadequate sanitation, water and hygiene (WHO, 2003). Poor sanitation also has strong detrimental effects on the environment (Wright, 1997), on women's safety, and on human capital development (Cairncross, 2003).

Photo 1:
The construction of simple latrines such as this one, built with WaterAid's support in Nepal, is vital in the fight against diarrheal diseases that stifle productivity.
Photo: WaterAid/Marco Betti

To combat this enormous, cross-cutting problem, the United Nations seeks to "halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation," as part of the Millennium Development Goals (MDGs), announced in 2000.

Researchers estimate that 2.6 billion people, or 42% of the world's population, lack access to improved sanitation (WHO-UNICEF, 2005). Linear projections to 2015 from actual investment levels 1990-2004 reveal that it will not be possible to reach the MDG goals (Hutton *et al.*, 2006; WHO-UNICEF, 2005). Present levels of investment will likely leave over half a billion people unserved who should receive sanitation under the MDG target (Hutton *et al.*, 2006).

WaterAid's mission is to overcome poverty by enabling the world's poorest people to gain access to safe water, sanitation and hygiene education.

While medical researchers have extensively documented the health implications of poor sanitation, much less is known about its economic consequences. There is only scant understanding of the economic significance of sanitation provision at a global scale.

This report describes advances in knowledge of sanitation costs and benefits, as a handful of health economists have begun the difficult task of translating the global burden of inadequate sanitation into economic terms.

Four main results emerge:

- The absence of adequate sanitation has large, direct economic costs to patients and their families, to employers, to the healthcare sector, and to the economy as a whole. Failure to implement the MDG water and sanitation targets at a global level would have ramifications in the area of $38 billion per year (Hutton and Haller, 2004; Rijsberman, 2004). Sanitation accounts for 92% of this value (Hutton *et al.*, 2006).

- The broad benefits associated with averting mortality and morbidity from poor sanitation far outweigh the costs of implementing and maintaining low-cost sanitation systems. The global return on investments in low-cost sanitation provision may be in the area of $9 for each $1 spent (ibid).

- The existence of several important but currently unmeasured benefits indicates the potential for even larger gains from access to improved sanitation. These include far-reaching economic gains from greater female school attendance due to adequate school sanitation, greater in-school attention by pupils of both genders, and from the prevention of environmental degradation arising from contamination caused by inadequate excreta disposal. Researchers should better quantify some of these impacts in order to highlight the importance of achieving the MDG sanitation target.

- Last, although the results reviewed in this report point to large economic benefits from the achievement of the MDG sanitation target, there remains a number of important unexplored questions. Current estimates not only ignore some unmeasured factors, but also make some assumptions that should be subjected to sensitivity analysis. Also, sanitation is necessary but not sufficient for growth. Its relationship to other growth factors should be more carefully examined. The benefits from a better understanding of the relationship between economic growth and the provision of sanitation are clear. Researchers, advocates and policymakers can use this understanding in order to generate more support for the underlying moral and humanitarian bases for action.

This report, as well as future studies, should guide decisions to allocate resources towards the provision of this vital human need. Given the current state of knowledge, it can be concluded that investments in the provision of sanitation pay off.

1. Introduction

In 2000, the United Nations (UN) announced eight Millennium Development Goals (MDGs). Through these goals the UN has sought to focus the efforts of major international institutions towards the improvement of the health, economic and social wellbeing and environmental conditions faced by the world's poor. Within the seventh goal of "ensuring environmental sustainability" lies a specific target to "halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation" (UN, 2007). Researchers estimate that 2.6 billion people, or 42 percent of the world's population, lack access to improved sanitation (WHO-UNICEF, 2005)

Linear projections to 2015 from actual investment levels 1990-2004 reveal that it will not be possible to reach the MDG goals (Hutton *et al.*, 2006; WHO-UNICEF, 2005). Present levels of investment will likely leave over half a billion people unserved who should receive sanitation under the MDG target (Hutton *et al.*, 2006).

Meeting the MDG sanitation target has important implications for the improvement of global health. It is also strongly linked to efforts to eliminate poverty and hunger, and to ensure environmental sustainability (UN, 2003). Poor sanitation causes diarrheal diseases, as well as schistosomiasis (also known as bilharzia) and a number of other parasites. **Diarrhea kills approximately two million people per year. 90% of the victims are children under the**

age of five. Poor sanitation also has strong detrimental effects on the environment (Wright, 1997), on women's safety, and on human capital development (Cairncross, 2003).

The detrimental effect of poor sanitation on health is now well documented. A landmark study by Prüss *et al.* (2002) reveals that diarrheal diseases primarily caused by poor sanitation and hygiene have annual costs as high as 76 million disability-adjusted life years (DALYs). Poor sanitation, water and hygiene together account for four percent of all deaths, and almost six percent of the total global burden of disease (WHO, 2003). To prevent many of these diseases, the access to sanitation is considered more vital than access to clean water (Esrey *et al.*, 1991).

In Bangladesh's capital city Dhaka 'hanging latrines' discharge into waterways, turning them into open sewers. *Photo: WaterAid/Abir Abdullah*

Much less is known about the economic consequences of inadequate sanitation. Studies of individual interventions often include an estimate of cost-effectiveness or consumers' willingness-to-pay for certain services, but there is relatively scant understanding of the economic significance of sanitation provision on a global scale.

This report describes advances in developing greater knowledge of sanitation costs and benefits, as a handful of health economists have begun the difficult task of translating the global burden of inadequate sanitation into economic terms. Three main results emerge from recent work.

First, the absence of adequate sanitation has large, direct economic costs to patients and their families, to employers, to the healthcare sector, and to the economy as a whole. **Failure to implement the MDG water and sanitation targets at a global level would have ramifications in the area of $38 billion per year** (Hutton and Haller, 2004; Rijsberman, 2004). Sanitation accounts for 92% of this value (Hutton *et al.*, 2006).

Second, the broad benefits associated with averting mortality and morbidity from poor sanitation far outweigh the costs of implementing and maintaining low-cost sanitation systems. **The global return on investments in low-cost sanitation provision may be in the area of $9 for each $1 spent** (ibid).

Third, the existence of several important but currently unmeasured benefits indicates the potential for even larger gains from access to improved sanitation. These include far-reaching economic gains from greater female school attendance due to adequate school sanitation, greater in-school attention by pupils of both genders, and from the prevention of environmental degradation arising from contamination caused by inadequate excreta disposal. It would be valuable to better quantify some of these impacts in order to highlight the importance of achieving the MDG sanitation goals.

By measuring the burden of poor sanitation in economic terms it may be possible to generate more support for the underlying moral and humanitarian bases for action. A better grasp of the costs and benefits of improved access to sanitation should be used to guide decisions to allocate resources towards the provision of this vital human need.

The remainder of the report is structured as follows. In the following section, the paper sketches current levels of sanitation provision at a global scale. In section 3, it traces the mechanisms through which sanitation affects health,

and current estimates of its global impact. Section 4 outlines the leading approaches taken by economists to evaluate the economic impact of poor health in general, and the disease burden associated with poor sanitation specifically. Section 5 summarizes recent estimates of regional and global economic costs and benefits from moving from present day investments in sanitation to two scenarios: 1) the achievement of the MDG sanitation targets, and 2) universal access to improved sanitation. Section 6 points to directions for future research. Section 7 concludes.

2. Sanitation at a global level

Many developing countries lack widespread provision of safe sanitation facilities.[1] The United Nations (UN) has set MDG targets on the basis of access to 'improved' levels of sanitation. Table 1 defines 'improved' and 'unimproved' for the provision of sanitation.

Table 1. Improved versus unimproved sanitation

Improved	Unimproved
Flush/pour-flush to: • piped sewer system • septic tank • pit (latrine) Ventilated improved pit latrine Pit latrine with slab Composting toilet	Public or shared latrine Pit latrine without slab or open pit Hanging toilet or hanging latrine Bucket latrine No facilities (so people use any area, for example a field)

From WHO-UNICEF, 2005

Tables 2 and 3 present regional needs for both water and sanitation provision, in percentage terms, and in absolute numbers of urban and rural dwellers whose needs must be satisfied in order to achieve the MDG sanitation target.

Sub-Saharan Africa, Asia, and Oceania are the most underserved in percentage terms, and sanitation provision generally lags behind the supply of water. In absolute terms, East and South Asia contain the most individuals living without access to improved sanitation. Almost 80 percent of these individuals live either in China or India (Cairncross, 2003).

Estimates of the extent of the rural/urban nature of this problem vary. The UN data shown in Table 3 indicates that the global burden is roughly evenly split between rural and urban locations. By contrast, a WHO-UNICEF (2006) study finds that two billion of the 2.6 billion people lacking basic access to sanitation in 2004 were located in rural areas.

The balance may increasingly tilt towards the urban unserved as the global trend toward rural-urban migration accelerates (ibid). However, urban areas are also qualitatively different from rural spaces. Urban environments are particularly sensitive to sanitation-related problems and they foster the rapid spread of disease. Health and other effects proliferate quickly among the unserved urban poor, and often spill over to all urban dwellers in the area (Wright, 1997).

Table 2. Percentage of population in 2002 lacking water and sanitation coverage

Region	Water Supply	Sanitation
Western Asia	12%	21%
Latin America and Caribbean	11%	25%
North Africa	10%	27%
South-Eastern Asia	21%	39%
Oceania	48%	45%
Eastern Asia	22%	55%
South Asia	16%	63%
Sub-Saharan Africa	42%	64%

From WHO- UNICEF, 2005

[1] Throughout this report, 'sanitation' is defined as the disposal of excreta and related services and maintenance, as well as hygiene education and promotion.

Table 3. Urban and rural populations to gain access to improved sanitation by 2015 to achieve MDG goals, in millions

Region	Urban	Rural	Total
Africa (sub-Saharan)	178	185	363
Middle East and North Africa	105	34	140
South Asia	263	451	**714**
East Asia and Pacific	330	376	**705**
Latin America and Caribbean	132	29	161
CEE/CIS and Baltic States	24	0	24
Total	1032	1076	2108

From UN, 2003

3. Health and the provision of sanitation

Inadequate disposal of human feces leads to the transmission of five types of disease:

1. fecal-oral diseases
2. soil-transmitted helminths (roundworm, hookworm etc.)
3. beef and pork tapeworms (as animals eat food contaminated with feces)
4. water based helminths (guinea worm and schistomsomiasis)
5. excreta-related insect vectors

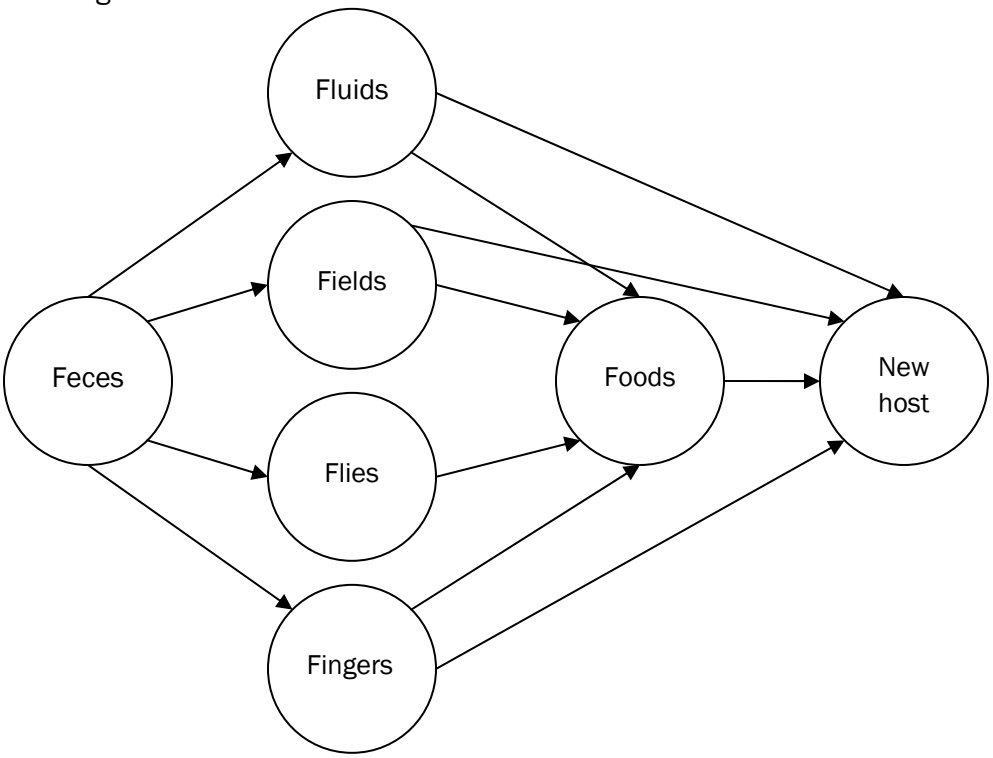
Fecal-oral diseases, primarily diarrheal diseases, cause the greatest harm. Diarrheal diseases represent about 90% of the disease burden from poor sanitation and water supply (Hunt, 2001). This burden is disproportionately borne by the young: 90% of diarrhea-related mortalities are children under five years of age. In fact, diarrhea is a leading cause of morbidity and mortality among children, accounting for approximately 20% of deaths (Kosek *et al.*, 2003).

Trends indicate that deaths from diarrhea have declined over time. Researchers estimate that approximately 4.6 million children died annually from diarrhea in the 1950s to1970s (Snyder and Merson, 1982). This figure dropped to 3.3 million during the 1980s (Bern *et al.*, 1992). In 2000, it is estimated that around two million children died from diarrhea (Prüss *et al.*, 2002; Kosek *et al.*, 2003). This reduction fits with the broad decline in child mortality across all causes (ibid).

Wagner and Lanoix's (1958) F-diagram (Figure 1) describes pathways of fecal-oral disease transmission. From this diagram, Bateman (1994) distinguishes between **primary** and **secondary** barriers against disease transmission. Safe disposal of feces such that they are removed from human contact are the primary defense against disease transmission, while hygiene practices such as hand-washing can act as secondary barriers (ibid). Primary barriers include various forms of sanitation, such as the use of latrines, sewers and stool burial. If primary barriers were in place, secondary barriers would likely be less important (Curtis *et al.*, 2000).

Women in Tamale, Ghana now filter the water they collect from open sources through nylon mesh to reduce guinea-worm infection. *Photo: WaterAid/Jon Spaull*

Figure 1. The F-diagram of fecal-oral disease transmission



From Wagner and Lanoix (1958)

Since the 1990s, researchers' attempts to quantify the burden of disease resulting from poor sanitation, water quality and personal and domestic hygiene have accelerated and sharpened. Country coverage has expanded to include India and China, which suffer from widespread inadequacy in the provision of sanitation. New methods have been used that foster comparability, particularly calculations in terms of disability-adjusted life years (DALYs). Moreover, researchers and policymakers can now rely on an increasing number of studies of particular interventions in order to more reliably gauge how much of the burden of disease can be alleviated. Overall, this advancing state of knowledge helps in the estimation of sanitation's economic impact.

A recent study by Prüss *et al.* (2002) is widely recognized as the current standard. The authors estimate the region-specific and global disease burden from sanitation, water and hygiene using intervention studies for diarrheal diseases, schistosomiasis, trachoma, ascariasis, trichuriasis, and hookworm disease. They build on work by Esrey *et al.* (1991) that describes the differential health impacts of moving from particular scenarios of water and sanitation provision, for example from basic sanitation with no safe water to basic sanitation with adequate water provision, assigning these scenarios to 14 geographical regions. Table 4 shows selected estimates, confirming that the effect of diarrhea dwarfs that of other sanitation-related diseases. Prüss *et al.* (2002) estimate deaths from diarrhea in 2000 in a range between 1,085,000 (in the most minimal scenario) and 2,187,000 (in a more realistic scenario). Corresponding DALYs lie between 37,923,000 (minimal) and 76,340,000 (realistic).

These figures cannot be attributed *only* to sanitation, but researchers agree that sanitation is among the most important points of intervention, particularly since it represents a crucial, primary barrier against disease transmission. In other words, while poor sanitation may not be the only cause of these diseases, the provision of improved sanitation conditions can go far towards reducing them. Estimates by Prüss *et al.* (ibid) are broadly similar to those found in the World Health Organization's World Health Report 2000 (WHO, 2000), while somewhat smaller than Kosek *et al.*'s (2003) estimate of 2.5 million deaths from diarrhea.

Table 4. Global disease burden from diarrheal and other diseases in 1999, thousands

Disease	Deaths	DALYs
Diarrheal diseases*	2,187	76,340
Schistosomiasis	14	1,932
Trachoma	0	1,239
Ascariasis	3	505
Trichuriasis	2	481
Hookworm disease	7	1,699
Total	2,213	82,196

From Prüss et al., 2002
* 2000 figures

Much of this burden can be alleviated. Esrey *et al.* (1991) performs meta-analysis on 144 rigorous intervention studies and find that interventions in water supply and sanitation can yield a median reduction in morbidity for diarrhea of 26%. Table 5 shows the effectiveness of these interventions across a range of the most burdensome sanitation- and water-related diseases. Fewtrell *et al.* (2005) performed a similar meta-analysis and found broadly comparable results, though there were few sanitation-specific studies.

Table 5. The Effectiveness of Various Interventions

Disease	Median Reduction in Morbidity
Diarrhea	26%
Ascariasis	29%
Dracunculiasis	78%
Schistosomiasis	77%

From Esrey *et al.*, 1991

4. Relating sanitation to economic growth

It has been shown that life expectancy and infant mortality are strongly associated with income growth, whether considering that relationship direct (Sachs, 2001) or through the formation of institutions (Sokoloff and Engerman 2000). Hence, the large negative impact of poor sanitation on health plausibly has significant economic consequences.

Economists have usually considered the relationship to run from income to health, not the other way around. They assumed that consumers with greater income can choose healthier food and purchase better sanitation and water. More recently, a number of scholars suggest that causality also runs in the other direction (Alleyne and Cohen, 2002). For example, Bloom and Canning (2000) argue that healthier people can increase national economic well-being in several ways:

1. ***Productivity:*** Healthy workers are more energetic, take fewer sick days for themselves and to care for ill family members, hence they are more productive
2. ***Education:*** Healthy workers invest more in education, because their longer lives afford them more time to reap its benefits. Children's health also promotes their school attendance and their cognitive abilities
3. ***Physical capital investment:*** longer life expectancy means more savings, especially for retirement. Increased savings means more investment; some of this will be in capital, thereby increasing income. A healthy workforce may also attract foreign investment.
4. ***Demographic dividend:*** low mortality is associated with lower fertility, but the initial baby boom reaps economic benefits from workforce enlargement before parents adjust fertility.

The provision of sanitation can affect all four of these factors in particular ways. For example, a reduction in sanitation-related morbidity can increase worker productivity, as caregivers take fewer working days caring for sick infants (Rijsberman, 2004). Moreover, healthcare costs associated with treatment can instead be spent elsewhere, potentially in income-increasing investment. As well, mortality from diarrhea and other diseases reduces the future number of productive members of society.

Wright (1997) highlights the relationship between sanitation, economic welfare and the environment as another dimension to be considered. Poor sanitation can contaminate sources of fresh water, thereby crippling agricultural and industrial efforts (ibid). If untreated sewage infects seafood, additional health costs can be incurred in the form of outbreaks of cholera, hepatitis A and other diseases. In such cases, economic ramifications far exceed the cost of health care (See Box 1 for an example). Moreover, when drinking water is contaminated by fecal matter, the economy must divert otherwise productive resources towards the construction of alternate water supply solutions, as it has in Mexico City, Amman and Jinzhou. Hence, the impact of poor sanitation on the environment has powerful and far-reaching economic consequences.

Box 1: The case of Iquitos and the economics of cholera in Peru

After nearly a century without an epidemic of cholera, a handful of cholera cases were identified in various hospitals in coastal regions of Peru in 1991. By the end of the year, the disease had spread across the country, as well as to Brazil, Colombia, Ecuador, Guatemala and elsewhere. In Peru 300,000 people were afflicted, and 1.3 million people were infected overall (Tickner and Gouveia-Vigeant, 2005).

The outbreak had a large impact on the Peruvian economy, over and above immediate healthcare costs. In fact, a number of studies conducted by the Peruvian government and several private agencies concluded that the economic costs ranged from $233 million to as much as $1 billion, considering losses from diminished exports of food, particularly seafood, tourism, and domestic production (Suarez and Bradford, 1993). A more conservative approach puts the losses, including direct and indirect healthcare costs, as well as non-health effects at roughly $200 million (ibid).

The case of Iquitos in the Amazon jungle demonstrates the important role played by inadequate sanitation and water disinfection in the spread of disease (Tickner and Gouveia-Vigeant, 2005). Residents of Barrio Belen, a large slum in Iquitos, lacked a means of disposing of human waste, which was instead dumped into the nearby Itaya River.

A hospital upstream responsible for caring for the infected contributed to the problem by dumping raw sewage into the same river. The river acted as a water source for the city's poor, and hence as a conduit for the spread of the disease. Tickner and Gouveia-Vigeant note that 60% of the cases of cholera in Iquitos came from poor residents in the shanty towns (ibid).

There are three main strategies used to evaluate the economic significance of health interventions: willingness-to-pay studies, cost-effectiveness analysis, and benefit-cost analysis. There has been insufficient application of these techniques to the issue of sanitation. Moreover, studies have been narrowly focused, in relation to the broad non-health, social and environmental considerations described above.

4.1 Willingness-to-Pay

Many economists favor a *'willingness-to-pay'* approach, which adduces the value of an intervention based on individuals' revealed or stated preferences to consume the treatment to curb illness. This framework is often chosen because it fits with the theoretical basis of welfare economics (Olsen and Smith, 2001). Its appeal also derives from the failure of many supply-side solutions that ignore consumer needs, wants and priorities (Wright, 1997).

Yet studies of sanitation marketing in the developing world posit that potential users have often a limited understanding of its health risks and benefits (Jenkins and Curtis, 2005; Elmendorf, 1980). For example, Manase *et al.* (2001) find that the urban poor in Zimbabwe, Zambia and South Africa demand water provision but do not consider sanitation to be a high priority. Residents' perspectives on sanitation appear to be formed more by culture and community than by a scientific analysis of risk. This means that individuals lack the information required to fully gauge sanitation's value. This market-failure limits the effectiveness of the willingness-to-pay approach. In addition, while there are a number of willingness-to-pay studies of the perceived value of specific sanitation interventions, they are not matched with project costs (Hutton, 2000).

4.2 Cost-Effectiveness Measures

A second evaluation method is *cost-effectiveness* analysis. Economists using cost-effectiveness analysis assess how much health a unit of cost buys in a specific intervention. A cost-effectiveness ratio is calculated following a standard approach proposed by the World Health Organization (Murray *et al.*, 2000), in which the numerator measures the price of a particular health intervention, and the denominator is an indicator of the resulting health improvement. For example, a cost-effectiveness measure for a latrine project would be calculated as follows:

$$CE_1 = \frac{\cos t \ of \ latrines}{DALYs \ averted}$$

Cost-effectiveness analysis has the benefit of avoiding assigning a value to human life (World Bank, 1993). At the same time, it permits comparison across different interventions. For example, a seminal article by Walsh and Warren (1979) found that sanitation and water provision were far less cost-effective than oral-rehydration therapy in the treatment of fecal-oral diseases. Sanitation provision cost $3600 per death averted, while oral rehydration cost only $250 per death averted (in nominal prices).

4.3 Benefit-cost Analysis

Cost-effectiveness analysis works best when there is a clear and relatively singular effect of a specific intervention. In the case of water and sanitation issues however, varied effects arise from a given intervention (Briscoe, 1984). This means that narrow cost-effectiveness can yield misleading conclusions. For example, Varley *et al.*, (1998) repudiate Walsh and Warren's (1979) findings by considering a broader range of economic impacts from fecal-oral disease treatments. The authors argue that Walsh and Warren (ibid) significantly understate the benefits from sanitation provision. Instead Varley *et al.* (1998) find broadly comparable cost-effectiveness ratios between oral-rehydration therapy and sanitation.

Hence, cost-effectiveness calculations ignore a wide range of important considerations beyond the cost associated with health benefits as captured in averted DALYs or mortality. Researchers have recently widened the scope of economic benefits associated with water-related disease. In adopting broader *benefit-cost* techniques, scholars are not repudiating the cost-effectiveness approach, as much as expanding the consideration of what counts as an economic effect. Paul and Mauskopf (1991) for example, recognize that sanitation-related illnesses can profoundly affect a broad range of industrial and agricultural sectors, as well as inflicting important time and social costs. Empirical studies following this approach thus more faithfully approximate theories such as Bloom and Canning's (2000), described above.

5. Benefits and costs of the sanitation MDG and universal access.

In a unique project for WHO, Hutton and Haller (2004) estimate broad benefit-cost considerations for the achievement of MDG sanitation and water targets, as well as for universal coverage,[2] using 2000 data as a baseline. The authors examine the impact of diarrheal diseases in 6 non-OECD regions, 15 high-risk countries, and

[2] 'Universal' coverage means providing access to improved sanitation for an estimate of the entire global population in 2015 projected to go without it.

also the global level.[3] An updated study by Hutton *et al.* (2006) compares incremental costs and benefits required to achieve MDG goals to a linear projection from 2005 investment levels to 2015. Because of the authors' attention to regional differences in epidemiology and project costs, their care in evaluating a wide-range of economic benefits, and their global scope, these two studies represent a large step forward in efforts to enumerate the economic benefits from access to improved sanitation. Because of these strengths, it is important to document their methods (in terms of economic benefits and costs) and highlight important findings.

Table 6 below describes the population increment across 6 regions whose sanitation needs will go unmet projecting forward from 2005 investment levels. Sub-Saharan Africa is struggling the most to meet MDG targets, with a projected 315 million people left without access to improved sanitation. Meanwhile, East and South Asia have the greatest gains to make in order reach universal access to improved sanitation. These regions are currently progressing towards the MDG goals in a manner greater than in parts of Africa, however each has very large absolute populations in need of adequate sanitation to reach universal access.

Table 6. Total population needing sanitation intervention by world region, millions

World Region	MDG	Universal
Sub-Saharan Africa	315	486
Arab States	28	73
East Asia and Pacific	64	733
South Asia	129	807
Latin America and Caribbean	27	89
Eastern Europe and CIS	2	37
Total Non-OECD	654	2,226

Hutton and Haller, 2004

A key advance in Hutton and Haller (2004) and Hutton *et al.* (2006) is the authors' evaluation of a broad range of benefits. Benefits, according to the authors, go beyond potential gains from averted DALYs. The authors organize benefits *in excess of* averted DALYs into three groups: (1) Direct economic benefits of avoiding diarrheal disease, (2) Indirect economic benefits related to health improvements, and (3) Non-heath benefits.[4]

5.1 Direct Economic Benefits

In the case of sanitation provision as well as other preventive interventions, direct economic benefits are primarily savings that would otherwise be spent in the treatment of disease. Gold *et al.* (1996) describe direct benefits as "the value of all goods, services and other resources that are consumed in the provision of an intervention or in dealing with the side effects or other current and future consequences linked to it." Depending on local circumstance, these include costs shouldered by patients afflicted with diarrheal and other diseases, by the employer of the patient, or by the government health service. Hutton and Haller (2004) estimate that direct economic benefits from averted diarrheal treatment range between $10 and $23 per case, depending on the geographical location where the illness occurs. Additional direct economic benefits include savings accrued by patients that would otherwise be spent on transportation to and from healthcare treatment, and meals and other costs associated with these visits. They also include the opportunity cost of the time spent traveling to and receiving treatment. Estimates for transportation, meals and other associated costs are $.50 for outpatient services and $2 for inpatient admissions (ibid).

5.2 Indirect Economic Benefits

Gold *et al.* (1996) define indirect economic benefits as productivity gains associated with better health, whether a reduction in deaths or morbidity. For the case of sanitation however, health effects are visited disproportionately upon the very young. Hutton and Haller (2004) assume that children would otherwise be at school and value the opportunity cost of their absenteeism. This affects their education but also stimulates caregivers to take more days

[3] Like most empirical studies in this field, the authors' focus on fecal-oral diarrheal diseases as compared with an approach that considers all of the major health problems associated with poor sanitation. Presumably the basis for this choice is diarrhea's much larger health footprint, but the authors are not explicit.

[4] Benefits assigned to specific societal agents are shown in Appendix A. Numerical estimates of benefits are found in Appendix B.

off work as they care for sick infants. The economic burden of mortality from diarrhea is calculated as a discounted income stream of the individual who would otherwise be deceased, where minimum wage provides the baseline for income. For children below working age, estimation begins from the age at which they would enter the workforce. In both cases, the calculation must also consider life expectancy in the individual's location. Hutton and Haller (ibid) assume 40 years of productive work for those aged 0-4, 43 years for those age 5-14; 25 years for the age group 15-59; and no productive years for the age group over 60 years.

5.3 Non-health Benefits

One major non-health benefit arises from greater access to latrines and reduced wait times at public facilities. Hutton *et al.*, (2006) suggest that these gains can translate into greater productive time, improved education levels or more time for leisure. The authors value this gain monetarily by multiplying the minimum wage rate by an estimate of daily convenience time gained from adequate sanitation provision. The authors estimate 30 minutes per person per day saved (182.5 per person/year) by people with greater access to sanitation. However, there is little or no concrete evidence to support this assumption, as compared with water for which there is a rich tradition of the relationship between time and water.

5.4 Costs in Detail

The cost of implementing a sanitation solution includes the price of materials and equipment used for sanitation itself, as well as labor and equipment required for its installation. Analysts must also consider maintenance costs that vary from place to place. Moreover, interventions themselves operate under different conditions even within a given economy.

Hutton *et al.* (2006) take regional investment cost estimates from WHO-UNICEF-WSSCC (2000) discounted at 3 percent to take account of the opportunity cost of capital, and combine these with estimates of recurrent costs. The authors model recurrent costs in four dimensions: length of life of solution, operational maintenance and surveillance, education, and disposal. Annual per-person estimates for a number of sanitation interventions are shown in Table 7. Annual costs vary from a low of $4.88 per person for a small pit latrine in Africa to $13.38 per year for household sewer connection with partial sewer treatment in Latin America and the Caribbean. Full cost estimates are shown in Appendix B.

Table 7. Annual improvement costs per-person reached, nominal 2000 US$

Intervention	Africa	Asia	LAC
Septic tank	$9.75	$9.10	$12.39
Ventilated improved pit latrine	$6.21	$5.70	$5.84
Small pit latrine	$4.88	$3.92	$6.44
Household sewer connection plus partial sewer treatment (hardware and software[5])	$10.03	$11.95	$13.38
Household sewer connection plus partial sewer treatment (software only)	$4.84	$5.28	$6.46

From Hutton *et al.*, 2006

5.5 Benefit-cost Analysis: Selected Results

Major results of Hutton *et al.*'s (2006) benefit-cost analysis are presented in Tables 8-10 below. Table 8 shows estimates of the number of deaths and diarrheal cases averted by the achievement of the MDG goals and universal access. Over two million cases resulting in 180,000 deaths should be averted in the achievement of MDG goals. Universal coverage would spare almost 600,000 deaths and over six million cases of diarrhea.

[5] Hardware refers to the physical equipment, while software includes sanitation marketing, hygiene promotion and other educational programs.

Table 8. Predicted diarrheal cases and deaths averted from sanitation coverage scenarios.

World Region	MDG		Universal	
	Deaths	Diarrheal Cases	Deaths	Diarrheal Cases
Sub-Saharan Africa	113,865	113,000,000	249,213	247,400,000
Arab States	10,197	10,100,000	25,891	25,600,000
East Asia and Pacific	16,757	24,000,000	124,063	194,700,000
South Asia	31,157	32,6000,000	167,471	175,100,000
Latin America and Caribbean	7,582	9,000,000	21,970	26,200,000
Eastern Europe and CIS	624	1,900,000	3,732	4,100,000
Total Non-OECD	180,182	218,100,000	592,339	673,100,000

From Hutton *et al.*, 2006

Benefit-cost estimates of averting this mortality and morbidity are shown in Table 9. The most striking conclusion is that the benefits from low-cost interventions to achieve improved sanitation **strongly and consistently outweigh the costs**. This fact holds for both MDG targets, as well for the more ambitious universal coverage scenario. According to Hutton *et al.*, (ibid), **the global return on low-cost investments that achieve access to improved sanitation is approximately $9 for each $1 spent in the MDG scenario**. Returns are still higher for universal coverage.

Table 9. Benefit-Cost Ratios for MDG and Universal targets for Sanitation.

World Region	MDG	Universal
Sub-Saharan Africa	6.6	6.5
Arab States	5.3	12.7
East Asia and Pacific	12.5	13.8
South Asia	6.9	6.8
Latin America and Caribbean	37.8	39.2
Eastern Europe and CIS	27.8	29.9
Total Non-OECD	9.1	11.2

From Hutton *et al.*, 2006

The authors also find that benefit-cost ratios for sanitation are consistently higher than for the achievement of the MDG water supply target. In fact, **the global return on water is only half as high as for sanitation**. This is because improved sanitation has a greater impact on health than improvements in the supply of water (ibid).[6] **Sanitation contributes 92% of the combined economic benefit from the achievement of MDG water and sanitation goals.**[7]

Table 10 shows annual benefits and costs in absolute figures for the MDG sanitation target. The total annual incremental cost over and above current sanitation investments for the provision of improved sanitation for non-OECD countries is approximately $3.8 billion. Expected annual benefits from this outlay are roughly $34 billion.

Table 10. Annual benefits and costs for MDG Sanitation target, $US millions.

World Region	Costs	Benefits
Sub-Saharan Africa	$2,185	$14,359
Arab States	$188	$1,005
East Asia and Pacific	$399	$5,003
South Asia	$802	$5,507
Latin America and Caribbean	$219	$8,287
Eastern Europe and CIS	$19	$542
Total Non-OECD	$3,813	$34,703

From Hutton *et al.*, 2006

[6] Full benefit-cost ratios for water as well as sanitation are found in Appendix B.
[7] This figure indicates an estimate of the lowest cost investment that achieves the standard of 'improved' sanitation. Household connection to a sewerage system is not considered in this study, but some estimate is made in Hutton and Haller (2004)

Table 11 provides estimates of expected annual benefits in terms of per capita income, applied to the entire population of the specified region.[8] It is intended merely as way to gauge the economic gains at a per person level.

Table 11. Annual per capita benefit from MDG and Universal access to sanitation, $US.

World Region	MDG	Universal
Sub-Saharan Africa	$16.4	$25.6
Arab States	$2.2	$14
East Asia and Pacific	$2.4	$29.3
South Asia	$2.9	$18.8
Latin America and Caribbean	$12.9	$45.9
Eastern Europe and CIS	$1.6	$21.5
Non-OECD	$5.5	$26.3

Adapted from Hutton *et al.*, 2006

Figure 2 shows the regional distribution of annual benefits from the MDG sanitation target. Of the economic benefits, 41% accrues to Sub-Saharan Africa. The next-largest gain is earned by Latin America and the Caribbean (24%), followed by South Asia (16%).

Figure 2. Regional shares of annual economic benefit, MDG sanitation goal

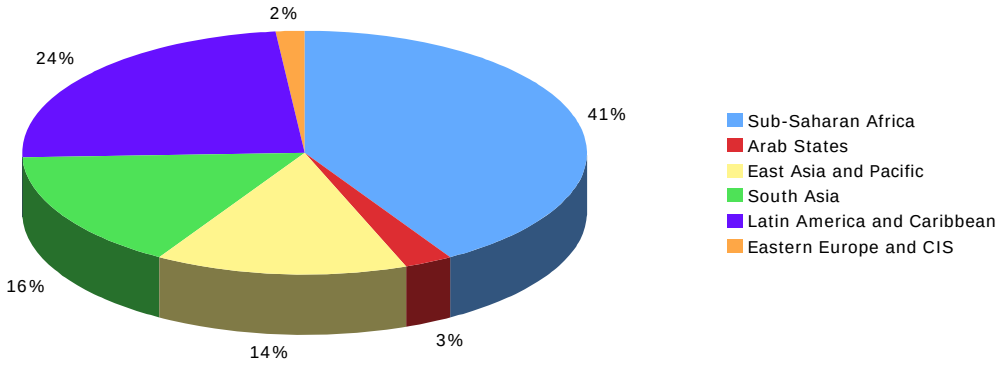
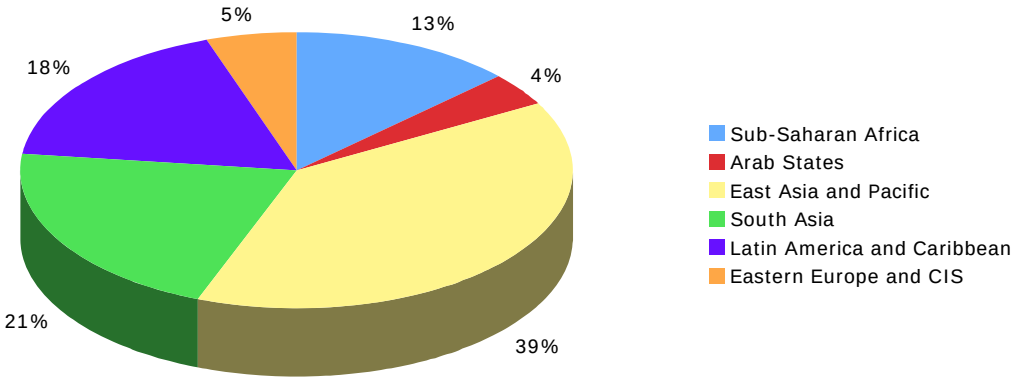


Figure 3 below displays the results from the achievement of universal access to improved sanitation. East Asia enjoys the largest share of annual gains with 39%. South Asia (21%) is second, followed by Latin America and the Caribbean (18%). This fits with evidence that suggests the importance of meeting China and India's sanitation needs.

Figure 3. Regional shares of annual economic benefit, universal sanitation



[8] Hence, this calculation merely spreads the benefits across the full population despite the fact that only some members of each region will actually be provided with new access to sanitation.

6. Issues for future research

Results from Hutton *et al.* (2006) and from future studies in this vein should still be interpreted with some caution. This is the case for three main reasons. First, results are dependent on a number of assumptions that should be explored via deeper sensitivity analysis. Second, studies currently leave important dimensions of the sanitation problem unmodeled. Third, future work needs to clarify the manner in which sanitation is contingent upon a host of other growth fundamentals.

6.1 Deeper Sensitivity Analysis

As Hutton *et al.* (ibid) themselves discover, estimates of benefits are highly susceptible to assumptions that may not be entirely sound, and do not similarly hold across different locales. The authors perform sensitivity analysis, constructing conservative, moderate and optimistic scenarios. They find that **while benefits still outweigh costs in the most pessimistic scenarios, there remains a wide degree of variance between more and less generous assumptions**. The basic lesson from this work holds, which is that the benefits from the provision of sanitation outweigh the costs. However, the precise level at which they do so is less clear. Taking results at a global or regional level and applying them uncritically to the national and subnational level is inadvisable.

Sensitivity analysis is an important first step towards determining how benefits and costs are altered by different behavioral, economic and epidemiological assumptions, and how well the assumptions made by Hutton *et al.* (2006) hold up in reality. For example, the authors make some unsubstantiated assumptions regarding the role of convenience time in sanitation provision, and this turns out to be an important economic contributor. But there is little evidence presented to back up the role of this factor. This kind of work needs to be performed in a more specific and narrow context, providing further detail to be aggregated subsequently into a more nuanced global picture. There are many useful case studies to be performed in this respect.

One important area that demands greater contextual sensitivity is the difference between urban and rural locales. Differences between urban and rural settings should affect costs and benefits. Poor urbanized areas are growing fast throughout the developing world and have often little to no adequate means for the disposal of excreta. These shantytowns present particular and heightened dangers in sanitation-related disease transmission (Wright, 1997). Particular settings may also demand different solutions with distinct economic impacts. Systematic economic measurement of these differences is warranted at this time.

Future studies should also consider greater nuance in the choice of sanitation hardware and software. Estimates in section 5.4 (from WHO-UNICEF-WSSCC, 2000) indicate that the cost of specific interventions varies from place to place, but there is a lack of information on cross-country differences in the benefits from these diverse choices. One weakness of the Hutton and Haller (2004) and Hutton *et al.* (2006) studies is that the authors assume that all forms of 'improved' sanitation are equal; hence the most affordable method to reach that target in a given locale is the best choice. However, it is apparent that not all 'improvements' are equal, in both health and economic terms. Analysis to clarify these differences should proceed from careful study of benefits and costs at local levels, using common methodology of the kind laid out in Hutton (2001). Without these guidelines, existing studies suffer from diverse viewpoints (the health care system, society, etc.), and idiosyncratic consideration of costs and benefits, making both comparison and aggregation difficult.

WaterAid's Community Led Total Sanitation approach motivates householders to build latrines using low cost local materials. *Photo: WaterAid/Juthika Howlader*

6.2 Including more indirect benefits in the equation

A number of indirect benefits from sanitation that are recognized in the literature have not yet been included in cost calculations. For example, Hutton *et al.* (2006) do not consider sanitation provision's distinctly gendered effect. As Cairncross (2003) observes:

> "In many parts of Asia, women seem to be 'imprisoned by daylight' because they feel that they can only leave the home to defecate during periods of darkness, either in the very early morning or late at night. Thus, during the hours of daylight if the family does not have a latrine, or access to one, women are restricted, which can lead to all sorts of negative consequences. In rural and in some urban societies sexual harassment and rape are real threats when women are going to or returning from the area chosen to relieve themselves." (pp.124-125)

Moreover, sanitation in schools has been shown to stimulate girls' school attendance. A UNICEF project in Bangladesh found that the installation of school latrines increased girls' enrolment by 11% (UNICEF, 1999). It has been shown that better sanitation provision can liberate women during daylight hours to contribute economic value, and should promote the development of their human capital in schooling. Scholarship by Hill and King (1995), Klasen (2002), and Lagerlöf (2003) demonstrates that international differences in GDP levels and growth rates are partly explained by differences in women's ability to increase their human capital through schooling. Klasen (2002), for example, estimates that cross-national differences in educational gender gaps explain between 0.4 and 0.9% of annual per capita GDP growth rates. This work should be connected to the provision of sanitation to help capture a broader range of economic benefits.

School, sanitation and economic development are interrelated in other ways as well. A lack of adequate sanitation hinders school achievement across genders (Drake *et al.*, 2000; Del Rosso and Marek, 1996). Rigorous studies of schoolchildren in Tanzania and elsewhere have shown how water-related diseases such as schistomiasis impede learning and child development, and hence have long term impacts on their ability to contribute productively as working adults (Bhargava *et al.*, 2005). School can also be an efficient focus for sanitation and hygiene marketing programs, and exposure to latrines early in life helps to promote acceptance later on.

The provision of latrines at schools, such as this one in Nigeria, boosts attendance by the pupils, particularly teenage girls. *Photo: WaterAid/Suzanne Porter*

Environmental impacts from sanitation also need to be better integrated into economic analysis. As discussed earlier, the economic costs from water contaminated by untreated sewage can be very high in excess of health costs, as its effects spill over to agricultural and industrial products that rely on clean water. The risk of contamination is greater with 'self-service,' in which the urban poor take matters into their own hands to compensate for inadequate or nonexistent public provision (Wright, 1997).

These are perhaps the largest among a number of unmodeled non-health benefits from the provision of sanitation that likely have far-reaching impacts on development and economic growth. Under Bloom and Canning's (2000) hypothesized relationship between growth and health, one should also consider effects on capital investment as well as the possible ramifications of a demographic dividend from diminished diarrheal child mortality.

Scholars should begin to estimate the economic impact of these dynamics. This is an admittedly difficult task. But current studies that do not model these issues are insufficiently grounded in theory. They also likely underestimate sanitation's full economic benefits.

6.3 Exploring the relationship between sanitation and other growth factors

Third, economists increasingly agree that there is no 'magic bullet' for economic growth. There is a great volume of research that demonstrates a strong, positive cross-national correlation between health and subsequent macroeconomic growth (for example: Sachs and Hamoudi, 1999; Barro, 1997; Fogel, 1994; Bhargava *et al.,* 2000; Bloom and Canning, 2000). Broadly confirming theory, better health and lower mortality encourages greater accumulation of physical and human capital (Bhargava *et al.*, 2000). Barro (1997) finds that a 10% increase in life expectancy should spur a 0.4% annual increase in growth rates. Strauss and Thomas (1998) show that US workers who are better fed earn higher wages, and are therefore considered to be more productive. This regularity is even stronger in the developing country context. However, this association does not imply the direction of causality. Moreover, Strauss and Thomas (ibid) observe that health measurement is both difficult and multidimensional. Nutrition and life expectancy are the most commonly used indicators of health in this work. At this time, no cross-country regression studies were found that test the relationship between widespread access to sanitation and economic growth.

Even when provided with such studies, drawing a straight line between sanitation and macroeconomic growth is difficult. A reduction in diarrhea should likely yield a great number of positive economic effects beyond simply fewer trips to the doctor, as documented throughout this report. However, productivity effects from time savings and other benefits are also mediated by a range of factors such as the quality of economy governance, the unemployment rate, geographical proximity to existing economic centers, population size, the trade regime, and the extent of human capital development.[9]

Therefore, satisfying the MDG sanitation goals may not translate *automatically* into economic growth. **Sanitation, access to safe drinking water and personal and domestic hygiene are arguably necessary conditions for sustained increases in economic welfare, but they are insufficient** (Vaux, 2004).

For this reason, it is difficult to conclude the precise nature of the benefits yielded by the achievement of the MDG sanitation target, or universal access. This doesn't render futile the goal of better estimation, but it signifies that such studies should be nuanced and receptive to a myriad of local differences, while maintaining an explicit, shared approach. It also means that policymakers should take care not to apply studies such as Hutton *et al.* (2006) out of context. One important area for future research is to study sanitation interventions while explicitly modeling political-economic arrangements, to shed light on the relationship between growth and these two sets of variables.

7. Conclusion

Recent refinement in the study of sanitation has clarified its key role in promoting health. Building on this work, scholars are translating this health burden into economic terms. Health economists believe that health and economic welfare are inextricably related. Healthy workers are more productive. But health also shapes economic growth through effects on human capital development, environmental security, demographic change, and a host of other factors.

This complexity makes precise estimation a challenge, and demands approaches that consider a wide range of issues outside of strict cost-effectiveness. Current estimates indicate that a failure to provide adequate access to sanitation has a massive economic footprint. This failure may create economic losses in the area of $30-40 billion per year.

Scholars considering a broad relationship between benefits and cost demonstrate that investment towards the MDG

[9] In fact, a number of researchers have shown that the statistical association between health (described as part of the concept of 'geography') and economic growth is much less important than the relationship between growth and institutions of economic governance (Rodrik *et al.,* 2004; Acemoglu *et al*., 2002)

sanitation target are merited. Benefits far outweigh costs when the definition of 'benefits' includes: direct health gains such as healthcare costs averted; indirect health benefits, productivity gains associated with reduced morbidity and mortality; and non-health benefits such as increased convenience time. Hutton *et al.*'s (2006) unique study indicates that together these benefits outweigh implementation, maintenance and education costs by a factor ranging from five in the Arab States, to as much as 38 in Latin America and the Caribbean. At a global scale, economies can expect a $9 return on every $1 spent in the achievement of the MDG sanitation target.

At the same time, more research is needed to strengthen the robustness of these results. Researchers should build on recent work by incorporating wider sensitivity analysis, considering different choices of technology, and further investigating the role of convenience time. They must also include other important indirect benefits, such as girls' school participation and environmental effects. Moreover, researchers and policymakers must acknowledge that greater access to improved sanitation alone cannot spur growth. Economic growth is contingent on a host of factors, and research seeking to address the relationship between growth and sanitation should bring these contingent factors directly into the analysis.

Providing access to improved sanitation promises to not only save lives, but also to stimulate gender equality, to support environmental safety, to bolster education, and not least to provide a foundation for economic growth. With the knowledge that exists, it is clear that the achievement of the UN MDG target with respect to sanitation makes sound economic sense. Policymakers should act now with moral and economic conviction.

Schoolchildren use a latrine block, which is decorated with hygiene education murals, built with WaterAid support in south India. *Photo: Martin Argles*

Appendix A

Table A1. Benefits beyond averted DALYs

Beneficiary	Direct economic benefits of avoiding diarrheal disease	Indirect economic benefits related to health improvements	Non-heath benefits
Health sector	-Less expenditure on treatment of diarrhea	-Fewer health workers falling sick with diarrhea	
Patients	-Less expenditure on treatment of diarrheal disease and less related costs -Less expenditure on transport in seeking treatment -Less time lost due to treatment seeking	-Value of avoided days lost at work or at school -Value of avoided time lost of parent/ caretaker of sick children -Value of loss of death avoided	
Consumers			-Time savings related to accessing sanitary facilities
Agricultural and industrial sectors	-Less expenditure on treatment of employees with diarrheal disease	-Less impact on productivity of ill health of workers	

From Hutton *et al.*, 2006

Appendix B – Cost and Benefit Estimates

Table B1. Total annual cost estimates for achieving MDG target and universal access to sanitation, $US millions

World Region	MDG	Universal
Sub-Saharan Africa	$2,185	$3,379
Arab States	$188	$492
East Asia and Pacific	$399	$4,576
South Asia	$802	$5,033
Latin America and Caribbean	$219	$734
Eastern Europe and CIS	$19	$292
Total Non-OECD	$3,813	$14,507

From Hutton *et al.*, 2006

Table B2. Total annual benefit estimates for achieving MDG target and universal access to sanitation, $US millions

World Region	MDG	Universal
Sub-Saharan Africa	$14,359	$21,293
Arab States	$1,005	$6,230
East Asia and Pacific	$5,003	$63,093
South Asia	$5,507	$34,305
Latin America and Caribbean	$8,287	$28,787
Eastern Europe and CIS	$542	$8,711
Total Non-OECD	$34,703	163,088

From Hutton *et al.*, 2006

Table B3: Full Benefit/Cost Ratios for Sanitation and Water

World Region	MDG			Universal		
	Water	Sanitation	W&S	Water	Sanitation	W&S
Sub-Saharan Africa	2.8	6.6	5.7	3.9	6.5	5.7
Arab States	6.1	5.3	5.4	5.9	12.7	11.3
East Asia and Pacific	6.9	12.5	10.1	6.6	13.8	12.2
South Asia	3.5	6.9	6.6	3.9	6.8	6.6
Latin America and Caribbean	8.1	37.8	35.9	17.2	39.2	36.3
Eastern Europe and CIS	8.3	27.8	18.9	8.9	29.9	27.4
Total Non-OECD	4.4	9.1	8.1	5.8	11.2	10.3

From Hutton *et al.*, 2006

Appendix C – Coverage Estimates

Country	Remaining % population to be served to reach MDG target compared to the 2015 forecast	
	Water MDG target	Sanitation MDG target
World Region 1: Sub-Saharan Africa		
Angola	1	33
Benin	11	5
Botswana	0	26
Burkina Faso	0	36
Burundi	0	41
Cameroon	0	22
Central African Republic	0	29
Chad	0	43
Comoros	16	35
Cote d'Ivoire	0	12
Dem. Rep. Of the Congo	22	18
Eritrea	0	44
Ethiopia	39	29
Ghana	0	36
Guinea	16	35
Kenya	5	26
Liberia***	14	50
Madagascar	18	10
Malawi	0	3
Mali	2	15
Mauritania	0	26
Mozambique	23	20
Namibia	0	38
Niger	16	35
Nigeria	30	22
Rwanda	0	20
South Africa	0	23
Togo	21	33
Uganda	0	28
United Republic of Tanzania	1	26
Zambia	7	9
Zimbabwe	4	21
World Region 2: Arab States		
Algeria	20	0
Djibouti	12	6
Jordan	0	5
Morocco	4	0
Sudan	11	32
Yemen	23	14
World Region 3: East Asia & Pacific		
China	4	3
Cook Islands	0	0
Dem. People's Republic of Korea	0	0

Fiji	0	10
Indonesia	7	9
Kiribati	0	5
Marshall Islands	18	0
Micronesia, (Fed. States of)	0	35
Palau	4	0
Philippines	12	0
Samoa	11	0
Vanuatu	20	0
World Region 4: South Asia		
Bangladesh	10	8
India	0	9
Maldives	23	0
Nepal	0	2
World Region 5: Latin America & Caribbean		
Bolivia	0	10
Brazil	0	7
Colombia	2	0
El Salvador	0	7
Haiti	16	21
Jamaica	1	3
Nicaragua	1	26
Peru	0	5
Trinidad and Tobago	6	0
World Region 6: Eastern Europe & CIS		
Azerbaijan	1	0
Georgia	6	4
Russian Federation	0	6
Slovakia	0	0
Uzbekistan	21	0

From Hutton et al. (2006)

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WaterAid America

WaterAid's mission is to overcome poverty by enabling the world's poorest people to gain access to safe water, sanitation and hygiene education.

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