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Evaluation of the Costs and Benefits of Water and Sanitation Improvements at the Global Level

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Summary

The aim of this study was to estimate the economic costs and benefits of a range of selected interventions to improve water and sanitation services, with results presented for 17 WHO sub-regions and at the global level. Interventions evaluated include (1) improvements required to meet the millennium development goals (MDG) for water supply (by halving by 2015 the proportion of those without access to safe drinking water), (2) meet the water MDG plus halving by 2015 the proportion of those without access to adequate sanitation, (3)increasing access to improved water and sanitation for everyone, (4) providing disinfection at point-of-use over and above increasing access to improved water supply and sanitation (5) providing regulated piped water supply in house and sewage connection with partial sewerage for everyone. Predicted reductions in the incidence of diarrhoeal disease were calculated for each intervention based on the expected population receiving these interventions. The costs of the interventions included the full investment and annual running costs. The benefits of the interventions included time savings associated with better access to water and sanitation facilities, the gain in productive time due to less time spent ill, health sector and patients costs saved due to less treatment of diarrhoeal diseases, and the value of prevented deaths. The results show that all water and sanitation improvements were found to be cost-beneficial, and this applied to all world regions. In developing regions, the return on a US$1 investment was in the range US$5 to US$28 for intervention 1, remaining at similar levels for interventions 2, 3 and 4. The main contributor to benefits was the saving of time associated with better access to water supply and sanitation services. When different cost and benefit assumptions were used, the cost-benefit ratios changed considerably, but even under pessimistic scenarios the potential economic benefits generally outweighed the costs. Due to uncertainties in many of the data inputs, it is recommended to conduct detailed country case studies as a follow-up to this global analysis.

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Introduction

In the developing world, diseases associated with poor water and sanitation still have considerable public health significance. In 2003, it was estimated that 4% (60.7 million DALYs) of the global burden of disease and 1.6 million deaths per year were attributable to unsafe water supply and sanitation, including lack of hygiene [*1*]. During the 1980s and 1990s there was considerable investment in the provision of water supply and sanitation in developing countries. By 2000, however, still a significant proportion of the world's population remained without access to improved water and sanitation (see Table 1). In Africa, roughly 40% of the population do not have access to improved water supply and sanitation, and in Asia 19% are without access to an improved water supply and 52% are without access to an improved sanitation [*2*]. Other regions of the world have higher rates of access, but even in Latin America and the Caribbean many millions remain without.

Table 1: Water and sanitation coverage by region

Region	**Coverage (%)**	
	Water supply	**Sanitation**
Africa	62	60
Asia	81	48
LA&C	85	78
Oceania	88	93
Europe	96	92
N America	100	100

Source: WHO/UNICEF/WSSCC 2000 [*2*]

In order to increase the rate at which access to improved water and sanitation is extended, further advocacy is needed at international and national levels to increase resource allocations to this process. In the current climate where poverty reduction strategies dominate the development agenda, the potential productivity and income effects of improved access is a significant argument to support further resource allocations to water and sanitation. Cost-effectiveness analysis is proving an increasingly important tool in the allocation of funds within the health sector, although cost-benefit analysis remains the form of economic evaluation most useful for resource allocation to different government-financed activities. While there are many criteria for allocating resources to different ministries and government programmes, the relative economic costs and effects of different programmes and interventions remain critically important.

The issue of perspective continues to be a challenge for those working in the field of economic evaluation of development projects. This was recognised in the case of environmental health interventions by a WHO discussion document [*3*], and later for the case of water supply [*4*]. Presentation from a certain perspective is important not

only from the point of view of financing, but knowing who benefits also helps in advocating interventions that target certain groups or entities, such as the poor, or perhaps private industry. In the case of improving access to water and sanitation, there are several considerations if the analysis is undertaken from the societal perspective:

- In terms of financing interventions, it is important to make a clear distinction between the public and private sectors or spheres. Should water and sanitation be provided at zero or subsidised cost by the government, or should the beneficiary pay the full cost? Are there other agencies that are able to bear some of the cost, such as non-governmental organisations or the private sector?

- In terms of who receives the benefit, a similar public-private distinction should be made with a further desegregation by benefiting government ministry on the one hand (health, agriculture, trade, infrastructure, finance, etc.) and private sector beneficiary on the other (industry, agriculture, household).

Therefore, economic evaluation including cost-benefit analysis should not only aim to provide information on economic efficiency, but also provide other policy-relevant information on who benefits and, therefore, who may be willing to contribute to the financing of interventions.

Methods

Interventions

The range of options available for improving access to water and sanitation is wide, especially in low-income settings where large proportions of the population have access to only the most basic facilities. For developing countries, WHO favours intervention options that are low cost, that are feasible that do not require heavy maintenance.

The entire analysis presented in this paper is based on changes in water and sanitation service levels. Table 2 categorises which types of service are 'improved' and which are considered to be 'unimproved'. Note that services can be defined as unimproved not only if they are unsafe, but also if they are unnecessarily costly, such as bottled water or water provided by tanker truck.

Within the broad categorizations presented in Table 2, two further distinctions can be made:

Table 2: Definition of 'improved' water supply and sanitation

Intervention	Improved	Unimproved *
Water supply	• House connection • Standpost/pipe • Borehole • Protected spring or well • Collected rain water • Water disinfected at the point-of-use	• Unprotected well • Unprotected spring • Vendor-provided water • Bottled water • Water provided by tanker truck
Sanitation	• Sewer connection • Septic tank • Pour-flush • Simple pit latrine • Ventilated Improved Pit-latrine	• Service or bucket latrines • Public latrines • Latrines with an open pit

* Due to being either unsafe or costly

Source: Global Water Supply and Sanitation 2000 Report [2]

First, there are **basic**, low technology improvements to water and sanitation services:

- 'Improved' water supply, generally involving better access and protected water sources (e.g., stand post, borehole, protected spring or well, or collected rain water). Improvement does not mean that the water is safe, but is it more accessible and some measures are taken to protect the water source from contamination.
- 'Improved' sanitation, generally involving better access and safer disposal of excreta (septic tank, pour-flush, simple pit latrine, small bore sewer, or ventilated improved pit-latrine).

Second, there are **further** improvements that make the water or sanitation services safer, or more convenient:

- Water disinfection at the point of use. In the present analysis, the use of chlorine is examined.
- Personal hygiene education.

Finally, there are high technology improvements such as
- Regulated water supply through a household connection, providing water that is safe for drinking.
- Household connection to the sewerage system, and at least partial treatment of the sewage.

Based on these different improvements, five different interventions are modelled in this study, by assuming a shift between exposure scenarios (levels I to VI) shown in Table 3 [*5*]. These are:

Intervention 1.
Millennium targets: halving the proportion of people who do not have access to improved water sources by 2015, with priority given to those already with improved sanitation. This means: Scenario VI to Vb, or Scenario Va to IV (applied to half the population without improved water supply).

Intervention 2.
Millennium targets with sanitation targets: halving the proportion of people who do not have access to improved water sources **and** improved sanitation facilities, by 2015. This means: Scenario VI to IV, or Scenario Va or Vb to IV (applied to half the population without improved water supply and half the population without improved sanitation).

Intervention 3.
Access for all to improved water and improved sanitation. This means: Scenario VI, Va and Vb to IV (applied to the entire population without improved water and the entire population without improved sanitation).

Intervention 4.
A minimum of water disinfected at the point of use for all, on top of improved water and sanitation services. This means: Scenarios VI, Va, Vb and IV go to Scenario III.

Intervention 5.
Access for all to a regulated piped water supply and sewage connection into their houses. This means: Scenarios VI, Va, Vb, IV and III go to Scenario II.

All the interventions were compared to the situation in 2000, which was defined as the baseline year. Therefore, in the analysis, account is taken of the proportion of populations in each country who did not have access to ‘improved’ water and sanitation in 2000.

Table 3: Selected exposure scenarios

Level	Description	Environmental faecal-oral pathogen load
VI	No improved water supply and no basic sanitation in a country which is not extensively covered by those services, and where water supply is not routinely controlled	Very high
Vb	Improved water supply and no basic sanitation in a country which is not extensively covered by those services, and where water supply is not routinely controlled	Very high
Va	Improved sanitation but no improved water supply in a country which is not extensively covered by those services, and where water supply is not routinely controlled	High
IV	Improved water supply and improved sanitation in a country which is not extensively covered by those services, and where water supply is not routinely controlled	High
III	Improved water supply and improved sanitation in a country which is not extensively covered by those services, and where water supply is not routinely controlled, plus household water treatment	High
II	Regulated water supply and full sanitation coverage, with partial treatment for sewage, corresponding to a situation typically occurring in developed countries	Medium to low
I	Ideal situation, corresponding to the absence of transmission of diarrhoeal disease through water, sanitation and hygiene	Low

Based on Prüss *et al*. 2002 [5]

Geographical focus

The analysis was conducted at the country level, and the results were aggregated (weighted by country population size) to give the regional averages (17 WHO sub-regions categorised according to epidemiological indicators) (see Appendix Table A 1.1). For presentation of results, a sample of five sub-regions was chosen to reflect a range of results as well as a range of geographical areas: sub-Saharan Africa epidemiological pattern E (AFRO-E), Americas epidemiological pattern D (AMRO-D), European epidemiological pattern C (EURO-C), South-east Asia epidemiological pattern D (SEARO-D) and Western Pacific Region epidemiological pattern B (WPRO-B1). Together, these five sub-regions account for 55.4% of the world's population in the year 2000, and contain the world's most populous two countries: India (SEARO-D) and China (WPRO-B1). The complete data for all regions are presented in Appendix Tables A 2 (taking account of projected population growth until year 2015) and Appendix Tables A 3 (assuming constant population until year 2015).

Cost measurement

An incremental cost analysis was carried out, with an estimate of the costs of extending access to water supply and sanitation for those currently not having access. Incremental costs consist of all resources required to put in place and maintain the interventions, as well as other costs that result from an intervention. These are separated by investment and recurrent costs. Investment costs include: planning and supervision, hardware, construction and house alteration, protection of water sources and education that accompanies an investment in hardware. Recurrent costs include:

operating materials to provide a service, maintenance of hardware and replacement of parts, emptying of septic tanks, and latrines, regulation and control of water supply, ongoing protection and monitoring of water sources, water treatment and distribution, and continuous education activities.

The main source of data inputs into the estimate of the initial investment costs of water and sanitation interventions was the Global Water Supply and Sanitation Assessment 2000 Report [*2*], which gave the investment cost per person covered in three major world regions (Africa, Latin America and the Caribbean, and Asia/Oceania), presented in Table 4.

Table 4: Initial investment cost per capita

IMPROVEMENT	INITIAL INVESTMENT COST PER CAPITA (US$ YEAR 2000)		
	AFRICA	ASIA	LA&C
Water improvement			
House connection	102	92	144
Standpost	31	64	41
Borehole	23	17	55
Dug well	21	22	48
Rainwater	49	34	36
Disinfection at point of use	0.13	0.094	0.273
Sanitation improvement			
Sewer connection	120	154	160
Small bore sewer	52	60	112
Septic tank	115	104	160
Pour-flush	91	50	60
VIP	57	50	52
Simple pit latrine	39	26	60

Source: Global Water Supply and Sanitation 2000 Report [2]

The estimation of recurrent costs was more problematic due to the lack of easily available data sources. Values from the literature were combined with assumptions for the various components of recurrent costs which are presented in Table 5. Cost assumptions were based on the likely recurrent cost as a percentage to the annual investment cost, using values from the literature (World Bank and other international projects).

Table 5. Assumptions used in estimating annualized and recurrent costs

IMPROVEMENT	Length of life In years (+ range)	Operation, Maintenance, Surveillance as % annual cost (+ range)	Education as % annual cost (+ range)	Water source protection as % annual cost (+ range)
Water improvement				
Household connection	40 (30-50)	30 (30-30)	-	10 (5-15)
Standpost	20 (10-30)	5 (0-10)	-	10 (5-15)
Borehole	20 (10-30)	5 (0-10)	-	5 (0-10)
Dug well	20 (10-30)	5 (0-10)	-	5 (0-10)
Rainwater	20 (10-30)	10 (5-15)	-	0
Sanitation improvement				
Sewer connection	40 (30-50)	30 (15-45)	5 (0-10)	-
Septic tank	30 (20-40)	10 (0-10) ***	5 (0-10)	-
VIP	20 (10-30)	5 (0-10)	5 (0-10)	-
Simple pit latrine	20 (10-30)	5 (0-10)	5 (0-10)	-

Table key: * For regulated water supply add to this: Water treatment costs (60 litres/person/day, at US$0.30/$m^3$ (Africa and Latin America) and US$0.20/$m^3$ (Asia) treated and distributed).

** To calculate sewerage costs, partial sewerage is taken to cost US$0.15/$m^3$ (based on water usage per person) (range US$0.10 to US$0.20), using WHO data treatment costs.

*** To calculate sewerage costs, sewage disposal is assumed to cost US$2/person/year For VIP and simple pit latrine and US$3/person/year for septic tanks.

Table 6 presents the annual costs of each improvement per person reached, based on the intervention costs and assumptions in Tables 4 and 5. It can be seen that the costs vary considerably between different types of improvement. For example, water improvement varies from US$0.33 per person per year in Africa for disinfection at the point of use, to US$12.75 for household water connection including both hardware and software components. Other simple water supply improvements, such as borehole, dug well or standpost at under US$2.50 in Africa are considerably cheaper than piped water options. For sanitation the cost differences between the cheapest (small pit latrine at US$4.88) and the most expensive options (household connection with partial treatment at US$10.03) are not so great, but still important.

Table 6. Annual costs for improvements on a per-person-reached basis

INTERVENTION	Annual cost per person reached (US$ year 2000)		
	Africa	Asia	LA&C
Improved water supply			
Standpost	2.40	4.95	3.17
Borehole	1.70	1.26	4.07
Dug well	1.55	1.63	3.55
Rain water	3.62	2.51	2.66
Disinfected	0.33	0.26	0.58
Regulated piped water in-house (hardware and software)	12.75	9.95	15.29
Regulated piped water in-house (software only)	8.34	5.97	9.06
Improved sanitation			
Septic tank	9.75	9.10	12.39
VIP	6.21	5.70	5.84
Small pit latrine	4.88	3.92	6.44
Household sewer connection plus partial treatment of sewage (hardware and software)	10.03	11.95	13.38
Household sewer connection plus partial treatment of sewage (software only)	4.84	5.28	6.46

Based on annual investment costs (Table 4) and recurrent cost assumptions (Tables 5 and 6)

Health benefits

Knowledge of the health benefits of the five interventions is important not only for a cost-effectiveness analysis, but also for a cost-benefit analysis as some important economic benefits depend on estimates of health effects. Over recent decades, compelling evidence has been gathered that significant and beneficial health impacts are associated with improving water and sanitation facilities. 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: water-borne 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 passed via all these routes, the present study focuses on water-borne and water-washed diseases. This is partly because, at the household level, it is the transmission of these diseases that is most closely associated with poor water supply, poor sanitation and poor hygiene. Moreover, water-borne and water-washed diseases are responsible for the greatest proportion of the direct-effect water and sanitation-related disease burden.

In terms of burden of disease, water-borne 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 food-

borne, droplet and aerosol routes. As infectious diarrhoea causes the main burden resulting from poor access to water and sanitation, and as there are data for all regions on its incidence rates and deaths, in this analysis the impact of interventions is exclusively measured by the following two indicators:

- Reduction in incidence rates (number of cases reduced per year).
- Reduction in mortality rates (number of deaths avoided per year)

These were calculated by applying relative risks taken from a literature review [*5*] which were converted to risk reduction when moving between different exposure scenarios (based on the current water and sanitation situation). Risk reductions are presented in Table 7 below.

Table 7: Relative risks with lower/upper uncertainty estimates for different scenarios

Scenario	I	II	III	IV	Va	Vb	VI
Lower estimate	1	2.5	4.5	3.8	3.8	4.9	6.1
Best estimate	1	2.5	4.5	6.9	6.9	8.7	11.0
Upper estimate	1	2.5	4.5	10.0	10.0	12.6	16.0

Based on Prüss-Üstün *et al*. 2004 [*6*]

The number of people in each exposure scenario were taken from coverage data collected for the Global Water Supply and Sanitation Assessment 2000 Report [*2*], presented below in Table 8.

Table 8: Distribution of the population in exposure scenarios, 2000

Subregion	II [%]	IV [%]	Va [%]	Vb [%]	VI [%]
AFR-D	0	54	5	6	35
AFR-E	0	42	10	9	38
AMR-A	99.8	0	0	0	0.2
AMR-B	0	76	1	9	14
AMR-D	0	68	0	7	25
EMR-B	0	83	5	8	4
EMR-D	0	66	0	16	18
EUR-A	100	0	0	0	0
EUR-B	0	79	8	1	12
EUR-C	0	94	5	0	1
SEAR-B	0	70	3	7	19
SEAR-D	0	35	0	53	12
WPR-A	100	0	0	0	0
WPR-B	0	42	1	33	24

Based on WHO/UNICEF/WSSCC 2000 [6]

Non-health benefits

There are many and diverse potential benefits associated with improved water and sanitation, ranging from the easily identifiable and quantifiable to the intangible and difficult to measure [*4*]. Benefits include both (a) reductions in costs and (b) additional benefits resulting from the interventions, over and above those that occur under current conditions [*7*]. Some of these benefits – the direct benefits related to the health intervention - are used for calculating the cost-effectiveness ratio (CER) in terms of cost per DALY avoided [*8*]. All these benefits, on the other hand, can be used in calculating the cost-benefit ratio (CBR), which is a broader measure of economic efficiency [*9, 10*].

Limited by measurement problems, the aim of this analysis is not to include all the benefits, but to capture the most tangible and measurable ones, and identify who the beneficiaries are. This approach was adopted not only because of the difficulties of measuring some types of economic benefit due to environmental changes [*11-13*], but also because the selected benefits were those most likely to occur in all settings.

For ease of comprehension and interpretation of findings, the benefits of the water and sanitation improvements not captured in the DALY estimates were classified into three main types: (1) direct economic benefits of avoiding diarrhoeal disease; (2) indirect economic benefits related to health improvements; and (3) non-health benefits related to water and sanitation improvements. These benefits are presented in Table 9, grouped by main beneficiary. As a general rule, these benefits were valued in monetary terms using conventional economic methods for valuation [*12-14*]. Details concerning the specific valuation approaches are described for each benefit below.

(1) Direct economic benefits of avoiding diarrhoeal disease

'Direct' in the definition of Gold *et al*. includes "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" [*8*]. In the case of preventive activities – including improvement of water and sanitation facilities – the main benefits (or costs avoided) relate to the health care and non-health care costs avoided due to fewer cases of diarrhoea and other water-associated diseases.

Cost savings in health care related mainly to the reduced number of treatments of diarrhoeal cases [*5, 15*]. As shown in Table 9, costs saved may accrue to the health service (if there is no cost recovery), the patient (if there is cost recovery) and/or the employer of the patient (if the employee covers costs related to sickness). To whom the costs are incurred will depend on the status of the patient as well as on the nature of the payment mechanism in the country where the patient is seeking care. These mechanisms vary from one country to the other. In economic evaluation, what is most important is not who pays, but the overall use of resources, and their value. In the current analysis, therefore, the direct costs of outpatient visits and inpatient days incurred to the health services are assumed to equal the economic value of these services.

For the treatment of diarrhoea, health service unit costs are taken from WHO regional unit cost databases. As shown in Table 10, the total cost avoided is calculated by multiplying the health service unit cost by the number of cases avoided, using assumptions about health service use per case. Due to a lack of studies presenting data on the number of outpatient visits per case, it was assumed that an average case would visit a health facility once, with a range of 0.5 to 1.5 visits. Once hospitalised, the

average length of stay was assumed to equal 5 days (range 3 to 7). In the base case 8.2% of cases were assumed to be hospitalised (data collected by WHO) with a range of 5% to 10% of patients hospitalised. The rest were assumed to be ambulatory. For the sensitivity analysis the base case unit costs were multiplied by 0.75 and 1.25 for the low and high treatment cost savings, respectively. The unit costs included the full health care cost (consultation, medication, overheads, etc.). These data give a mean cost varying between US$10 and US$23 per case of diarrhoea treated, depending on which of the 14 sub-regions is considered.

Table 9: Economic benefits arising from water and sanitation improvements

BENEFICIARY	Direct economic benefits of avoiding diarrhoeal disease	Indirect economic benefits related to health improvement	Non-health benefits related to water and sanitation improvement
Health sector	▪ Less expenditure on treatment of diarrhoeal disease	▪ Value of less health workers falling sick with diarrhoea	▪ More efficiently managed water resources and effects on vector bionomics
Patients	▪ Less expenditure on treatment of diarrhoeal 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	▪ More efficiently managed water resources and effects on vector bionomics
Consumers			▪ Time savings related to water collection or accessing sanitary facilities ▪ Labour-saving devices in household ▪ Switch away from more expensive water sources ▪ Property value rise ▪ Leisure activities and non-use value
Agricultural and industrial sectors	▪ Less expenditure on treatment of employees with diarrhoeal disease	▪ Less impact on productivity of ill-health of workers	▪ Benefits to agriculture and industry of improved water supply, more efficient management of water resources – time-saving or income-generating technologies and land use changes

Direct costs of a non-health care nature are mainly those incurred to the patient, and are usually related to one or more visits to the health facility, such as transport costs, other expenses associated with a visit (e.g. food and drinks) and opportunity costs (e.g. time that could have been spent more productively). The most tangible patient cost included in the analysis refers to transport, although there is a lack of data on

average transport costs. In the base case it was assumed that 50% (range 0%-100%) of patients use some form of transport at US$0.50 per return journey, excluding other direct costs associated with the journey. This gives an average of US$0.25 (range US$0 to US$0.50) per patient visit. Other costs associated with a visit to the health facility were also assumed, such as the costs of food and drinks, and added to transport costs, giving US$0.50 per outpatient visit and US$2 per inpatient admission (range US$1-US$3). Time costs avoided as a result of treatment seeking are assumed to be included in the benefits related to health improvement, and are therefore not included here.

Table 10: Calculation methodology, data sources and values for economic benefits

Benefit by sector	Variable	Data source	Data values (+ range)
1. Health sector			
Direct expenditures avoided, due to less illness from diarrhoeal disease	Unit cost per treatment	WHO regional unit cost data	US$4.3-US$9.7 (cost per visit) US$16.1-US$39.7 (cost per day) *Varying by WHO region*
	Number of cases	WHO BoD data	Variable by region
	Visits or days per case	Expert opinion	1 outpatient visit per case (0.5-1.5) 5 days for hospitalised cases (3-7)
	Hospitalisation rate	WHO data	91.8% of cases ambulatory 8.2% of cases hospitalised
2. Patients			
Direct expenditures avoided, due to less illness from diarrhoeal disease	Transport cost per visit	Assumptions	US$0.50 per visit
	% patients use transport	Assumptions	50% of patients use transport (0-100%)
	Non-health care patient costs	Assumptions	US$0.50 ambulatory (US$0.25-1.00) US$2.00 hospitalisation (US$1.0-3.0)
	Number of cases	WHO BoD data	Variable by region
	Visits or days per case	Expert opinion	1 outpatient visit per case (0.5-1.5) 5 days for hospitalised cases (3-7)
	Hospitalisation rate	WHO data	91.8% of cases ambulatory 8.2% of cases hospitalised
Income gained, due to days lost from work avoided	Days off work/ episode	Expert opinion	2 days (1-4)
	Number of people of working age	WHO population data 2002	Variable by region
	Opportunity cost of time	World Bank data	Minimum wage rate (GNP per capita – value added in manufacturing)
Days of school absenteeism avoided	Absent days / episode	Expert opinion	3 (1-5)
	Number of school age children (5-14)	WHO population data 2002	Variable by region
	Opportunity cost of time	World Bank data	Minimum wage rate (GNP per capita – value added in manufacturing)
Productive parent days lost avoided, due to less child illness	Days sick	Expert opinion	5 (3-7)
	Number of babies (0-4)	WHO population data 2002	Variable by region
	Opportunity cost of time	World Bank data	50% minimum wage rate (50% GNP per capita – 50% value added in manufacturing)
Value of loss-of-life avoided (life expectancy, discounting future years at 3%)	Discounted productive years lost (0 – 4 years)	WASH study [16]	16.2 years (9.5 – 29.1)
	Discounted productive years lost (5 – 14 years)	WASH study [16]	21.9 years (15.2 – 33.8)
	Discounted productive years lost (15+ years)	WASH study [16]	19.0 years (16.3 – 22.7)
	Opportunity cost per year of life lost	World Bank data	Minimum wage rate

Benefit by sector	Variable	Data source	Data values (+ range)
3. Consumers			
'Convenience' – time savings	Water collection time saved per household per day for better external access	Expert opinion	0.5 hours (0.25-1.0)
	Water collection time saved per household per day for piped water	Expert opinion	1.5 hours (1.0-2.0)
	Sanitation access time saved per person	Expert opinion	0.5 hours (0.25-0.75)
	Average household size	WHO population data 2002	6 people (4-8)
	Opportunity cost of time	World Bank data	Minimum wage rate (GNP per capita – value added in manufacturing)

(2) Indirect economic benefits related to health improvement

A second type of benefit stated by Gold *et al*. is the productivity effect of improving health [*8*]. These are traditionally split into two main types: gains related to lower morbidity and gains related to less deaths. In terms of the valuation of changes in time use for cost-benefit analysis, the convention is to value the time that would be spent ill at some rate that reflects its opportunity cost. It is argued that whatever is actually done with the time, whether spent in leisure, household production, or income-earning activities, the true opportunity cost is the amount in monetary units that the person would earn over the same period of time if he/she were working [*14*]. This is a relatively easy estimate to make for those of working age, where the minimum wage can be taken as a minimum value for what their time is worth. Work days gained are valued using the assumed days off work per episode, and multiplying by the number of people of working age and the minimum wage rate. Note, however, that this may overvalue the time gains in countries where a significant proportion of the population works in subsistence agriculture. Per capita Gross National Product (GNP) and value added per worker in manufacturing were used in the sensitivity analysis as low and high values for the opportunity cost of time lost, respectively.

Such a convention is, however, not acceptable for those not of working age, mainly children, or those unable to work. Assuming that children of school age should be at school, then the impact of illness is school absenteeism, which has an impact on their education. For this reason, time not spent at school by children of school age is also valued on the basis of the minimum wage. For the youngest age category, children under five, the assumption is made that a parent or caretaker has to spend more time with sick child than a healthy one, or alternative child care arrangements are needed that impose a cost. Therefore, healthy infant days gained as a result of less diarrhoeal illness are valued at 50% of the minimum wage rate, reflecting the opportunity cost of caring for a sick baby or infant.

A literature search revealed very few studies providing data for the number of days of ill-health attributable to infectious diarrhoea - some studies reported illness rates and changes in illness rates due to changes in risk behaviour, but the actual length of illness is rarely reported. One study in Mexico reported that the average episode for breast-fed infants lasted 3.8 days (standard deviation 2.2) and for formula-fed infants 6.2 days (standard deviation 4.4) [*17*]. For the present analysis, an average of two

working days lost were assumed per case (range: one to four days) for those of working age, while for those of school age three days of school attendance lost were assumed (range: one to five days). The duration of illness for babies and infants was assumed to be five days (range: three to seven days). While it is clear that the impact of a case of diarrhoea will vary from one individual to another (depending on the severity of infection, resistance of the individual and other determinants), in the absence of adequate data a sub-group analysis is not feasible. Therefore, all cases are valued according to a global average cost.

Table 9 also shows other possible economic benefits related to health improvement. An implication for the health system is that there will be less health workers ill from diarrhoea, thus reducing disruption of the health service caused by staff absence. Similarly, the reduction of productive days lost due to less ill-health in the workforce will be an important benefit to agriculture and companies/industry. However, in order to avoid double counting of these benefits (patient benefits of working days lost avoided and companies' benefits of productivity lost avoided) they are excluded from this part of the analysis.

In terms of diarrhoea associated deaths avoided following the introduction of improved water and sanitation, the expected number is predicted from the health impact model (number of cases avoided times case fatality rate, both of which vary by world region). The convention in traditional cost-benefit analysis is to value these deaths avoided at the discounted income stream of the individual whose death is avoided. If the death avoided was that of a child, then the discounted income stream is calculated from the age at which the person becomes productive. To estimate mortality costs the number of productive years ahead of the individual who would have died also needs to be valued, and depends on the age of the person whose life is saved, and therefore the life expectancy. Using assumptions from a previous cost-of-illness study, assumptions about length of productive life were: 40 years for the age group 0-4; 43 years for the age group 5-14; 25 years for the age group 15-59; and no years for the age group over 60 years [*16*]. Future benefits were discounted at 3% per year (range: 1% - 5%) and the minimum wage was used to reflect the opportunity cost. For those not yet in the workforce (those in the 0-4 and 5-15 age brackets) the current value for the future income stream was further discounted to take account of the time period before they become income earners.

(3) Non-health benefits related to water and sanitation improvement

Due to problems in measurement and quantification/valuation, and also because of substantial variability between settings, many non-health benefits of the interventions were not included in the present analysis [*8*]. For completeness sake, however, a brief overview of their nature is presented below.

Beyond any argument, one of the major benefits of water and sanitation improvements is the time saving associated with better access. Time savings occur due to, for example, the relocation of a well or borehole to a site closer to user communities, the installation of piped water supply to households, closer access to latrines and shorter waiting times at public latrines. These time savings translate into either increased production, improved education levels or more leisure time. The value of convenience time savings is estimated by assuming a daily time saving per individual for water and sanitation facilities separately, and multiplying these by the

minimum wage rate for each sub-region. Different time saving assumptions are made based on whether the source is in the house (household connection) or in the community. In this global analysis estimates of time savings per household could not take into account the different methods of delivery of interventions and the mix of rural/urban locations in different countries and regions, due to the dearth of data on time uses in the literature. Even within single settings, considerable variations in access have been found. For example, a study from Kenya showed that journeys to a local well in a small town averaged between 10 and 30 minutes (median around 15 minutes); and journeys to a kiosk between 3 and 13 minutes (median around 10 minutes) [*18*]. In Vietnam, the World Bank reported the average daily household water collection time to be 36 minutes [*19*]. However, to collect enough water for the entire household would require more than one visit, thus requiring closer to one hour or more per household per day. Given the large variation in water availability, it is recognised that savings could vary from a few minutes a day to several hours. For example, a study from Nigeria anecdotally reported that in the dry seasons average journey time to the local springs was 4-7 hours for some rural communities, which does not include waiting time at the spring [*20*].

Given these wide variations quoted in the literature, as well as the expected enormous differences between settings in the developing world in water availability (current and future), this analysis made general assumptions about time savings following water improvements. It was assumed that, on average, a household gaining access to improved water supply will save 30 minutes per day (range: 15 to 60 minutes) and households receiving piped water 90 minutes per day (range: 60 to 120 minutes). These assumptions give 30.4 and 91.25 hours saved per individual per year, for improved access and piped water, respectively, assuming six members per household (range: eight members for low cost assumption and four members for high cost assumption). For improved sanitation, no data were found in the literature for an estimate of time saved per day due to less distant sanitation facilities and less waiting time. Therefore, after consultation with sanitation experts, an assumption was made of 30 minutes saved per person per day, from improvements along the above lines. This assumption gives 182.5 hours per person per year saved. Time savings for all age categories are valued at the minimum wage, with GNP per capita used as the low value, and value added per worker in manufacturing as the high value. Studies by Whittington in Africa showed that households valued their time spent collecting water at around the average wage rate for unskilled labour [*18*].

The other benefits tabulated in the final column of Table 9 were not included in the cost-benefit analysis. These benefits relate mainly to improved water supply and they are described briefly below, with a justification for leaving them out.

- Indirect effects on *vector-borne disease transmission* resulting from water and sanitation improvements depend on many local factors and are therefore globally not predictable.

- Costs avoided due to *reduced reliance on expensive water sources /such as vendors) or on unsafe water purification methods*, due to increased availability of cheaper water and phasing out hazardous methods of water purification such as boiling. These gains are excluded for economic reasons. For example, from the societal point of view, water purchases from vendors are a transfer payment and do not represent an economic loss or gain compared to the use of other sources.

- In areas with improved water and sanitation, *property value* is likely to increase [*11*]. Such an increase is, however, indirect and difficult to evaluate without databases from different regions, and if entire areas receive the improvements the market may not be able to support price increases. Moreover, property value increases represent a transfer of resources and not a gain to society per se.

- There are also *leisure activities (e.g. boating, fishing), aesthetics and non-use values* associated with improvements in water and sanitation. Non-use is divided into option value (the possibility that the person may want to use it in the future), existence value (the person values the fact that the environmental good exists, irrespective of use), and bequest value (the person wants future generations to enjoy it). However, these are difficult to value, and there are very few data available on these benefits [*12, 13, 21*].

- Improved water supply also leads to economic benefits related to options for *labour-saving devices and increased water access*, due to changes in location of water sources and increases in water quantity available. These include benefits within the home (e.g. time savings of buying a washing machine, or the home production and small business possibilities), as well as in agriculture or private industry. Agricultural benefits may mean a change in land use (e.g. due to reclaimed land), loss of land (if a reservoir is created), or the option to chose different crops due to increased water availability. However, there are huge variations as well as uncertainties associated with these benefits and costs, especially in a global analysis, and therefore they are left out in this study.

Results

Presentation of results

This analysis generated a huge quantity of data. Selected results are presented for the five interventions and for the five selected WHO sub-regions discussed above, and include (a) the number of people receiving water and sanitation improvements from each intervention, (b) the number of cases of diarrhoea prevented per year, (c) the intervention costs, (d) the potential benefits resulting from the interventions, and (e) finally the cost-benefit ratios. Cost-benefit ratios are presented for all costs and benefits together, followed by costs and selected benefits. All costs are presented in US$ in the year 2000. Costs and benefits are presented assuming that all the interventions are implemented within a one-year period (the year 2000), hence requiring the annualisation of investment costs using a standard formula (see Table 5 for length of life assumptions) [*7*]. All results are presented under two assumptions about population growth, first at projected population figures for 2015, and second assuming no population growth from 2000 until 2015. The sensitivity analysis presented reflects the high cost assumptions and low benefit assumptions, to give the most conservative cost-benefit ratios. The ranges used are shown in brackets when presenting the mean values in the text above and Table 9.

In brief, the calculation of the total societal economic benefit is the sum of:

(1) Health sector benefit due to avoided illness
(2) Patient expenses avoided due to avoided illness
(3) Value of deaths avoided
(4) Value of time savings due to access to water and sanitation
(5) Value of productive days gained of those with avoided illness
(6) Value of days of school attendance gained of those with avoided illness
(7) Value of child days gained of those with avoided illness

Numbers of people reached

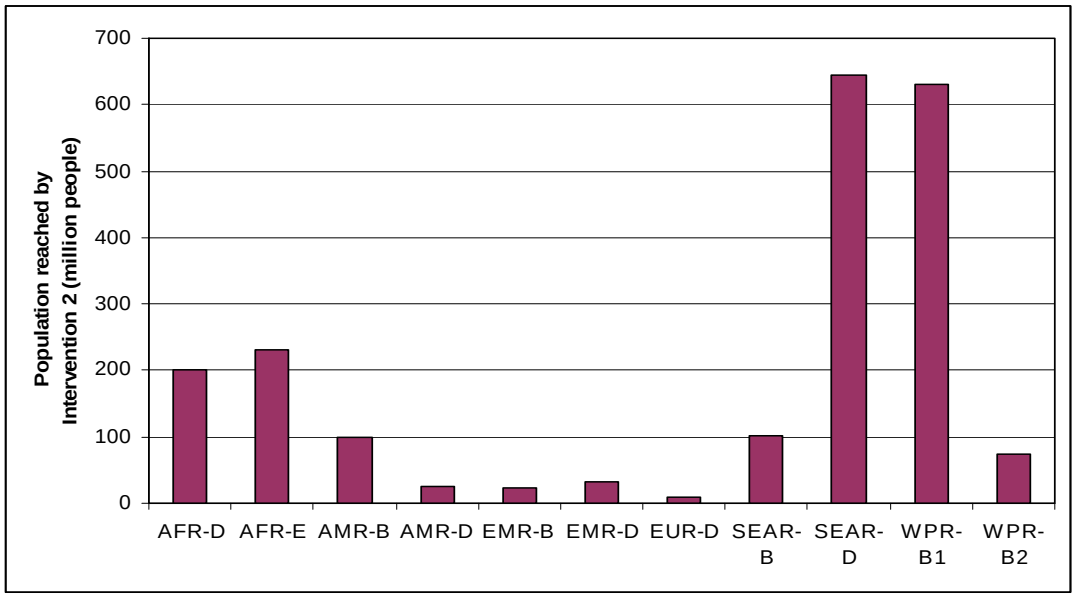
Table 11 presents the number of people receiving improvements by selected WHO sub-regions (AFRO-E, AMRO-D, EURO-D, SEARO-D and WPRO-B1). Appendix Table A2.1 shows the results for all WHO sub-regions. Overall, 693 million people would receive improvements in water supply if the MDG target for water was reached. This corresponds to 9.6% of the world's population by the year 2015. If the sanitation targets were also met (intervention 2), an additional 20.6% - about 1.5 billion people - of the world's population would receive an improvement. Figure 1 shows that the majority of this population is from SEAR-D, WPR-B1, AFR-D and AFR-E.

In bringing improved water and sanitation to all those currently without improved water or sanitation, 42.6% of the world's population would be reached. For many of the least developed sub-regions, at least half of the population is reached by Intervention 3. At a global level, 3 billion people could benefit from improving water supply and sanitation that are currently without improved services. About two thirds of this population are in two sub-regions: SEAR-D and WPR-B1.

Table 11: Number of people receiving improvements

WHO sub-region	Region/ Country	Population (million)	Population (m) receiving interventions				
			1	2	3	4	5
2	AFR-E	481	116	232	279	481	481
5	AMR-D	93	11	26	29	93	93
11	EUR-D	223	2	10	17	223	223
13	SEAR-D	1689	109	645	1'073	1'689	1'689
15	WPR-B1	1488	180	631	903	1'488	1'488
WORLD		7183	693	2'161	3'060	6'326	6'326

Figure 1: Population reached by achieving the combined water and sanitation Millennium Development Goals, by world sub-region



By improving the quality of drinking water (Intervention 4), a further 3.3 billion people could be reached, summing to a total of 88% of the world's population who could benefit from this intervention by 2015. The same number of people would benefit from intervention 5 (regulated water supply and partial sewerage) as from Intervention 4.

Predicted health impact

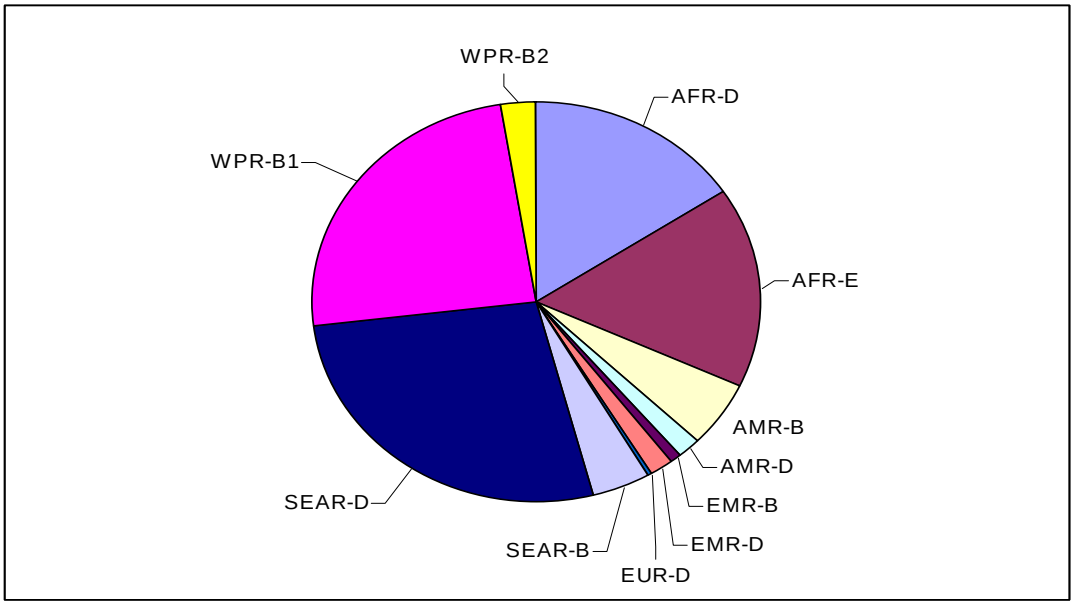
Table 12 presents the total number of cases (in millions) avoided under each of the five interventions. Out of an estimated annual number of cases of diarrhoea of 5.4 billion globally, Intervention 1 potentially prevents 155 million, increasing to 546 million cases prevented for Intervention 2, and 903 million for intervention 3. Clean drinking water and improved sanitation for the entire world (Intervention 4) would hypothetically avoid 2.9 billion cases annually, which is 53% of the number of cases. Intervention 5 would add a further 850 million prevented cases, due to better sewerage. Appendix Table A2.2 and Figure 2 below show that four sub-regions account for the majority of avoided diarrhoeal cases: AFR-D, AFR-E, SEAR-D and

WPR-B1. In terms of cases avoided per capita, if the whole population disinfected their water at the point of use on top of improved water supply and sanitation, the gains would be as high as 1.05 cases avoided per person in Africa, and around 0.40 – 0.60 in most other developing country regions (see Appendix Table A 2.3). Of these cases, globally around 50% are gained by the 0-4 age group. However, the gains by age group vary by world sub-region, depending on the proportion of population in this age group. For example, in China only 20% of diarrhoeal cases avoided are in the 0-4 age group.

Table 12: Annual number of diarrhoeal cases avoided

WHO sub-region	Region/ Country	Pop. (m)	Cases of diarrhoea (million)	Number of cases avoided per year ('000s), by intervention				
				1	2	3	4	5
2	AFR-E	481	619	28'548	87'405	127'049	345'132	439'980
5	AMR-D	93	93	3'250	9'307	13'208	48'679	64'106
11	EUR-D	223	43	112	568	1'056	19'816	27'983
13	SEAR-D	1689	1491	26'895	146'829	272'361	807'596	1'043'922
15	WPR-B1	1488	1193	39'454	131'171	239'104	659'687	844'381
WORLD		7183	5388	154'854	545'950	903'004	2'860'951	3'717'971

Figure 2: Distribution of diarrhoeal cases avoided if the combined water and sanitation Millennium Development Goals are achieved, by world sub-region



Intervention costs

Table 13 (and Appendix Table A 2.4) show the estimated costs of achieving the targets defined by the five interventions, by world sub-regions. Intervention 1 has total annual costs of US$1.78 billion. At US$11.3 billion annually, Intervention 2 represents quite a significant cost increase from Intervention 1, as the sanitation

improvements are considerably more expensive than water improvements (4 times more expensive, on average). Two sub-regions dominate the global costs of reaching the combined water and sanitation MDGs – SEAR-D (US$3.6 billion annually) and WPR-B1 (US$3.3 billion annually).

Figure 3: Share of global costs of reaching combined water and sanitation Millennium Development Goals, by world sub-region

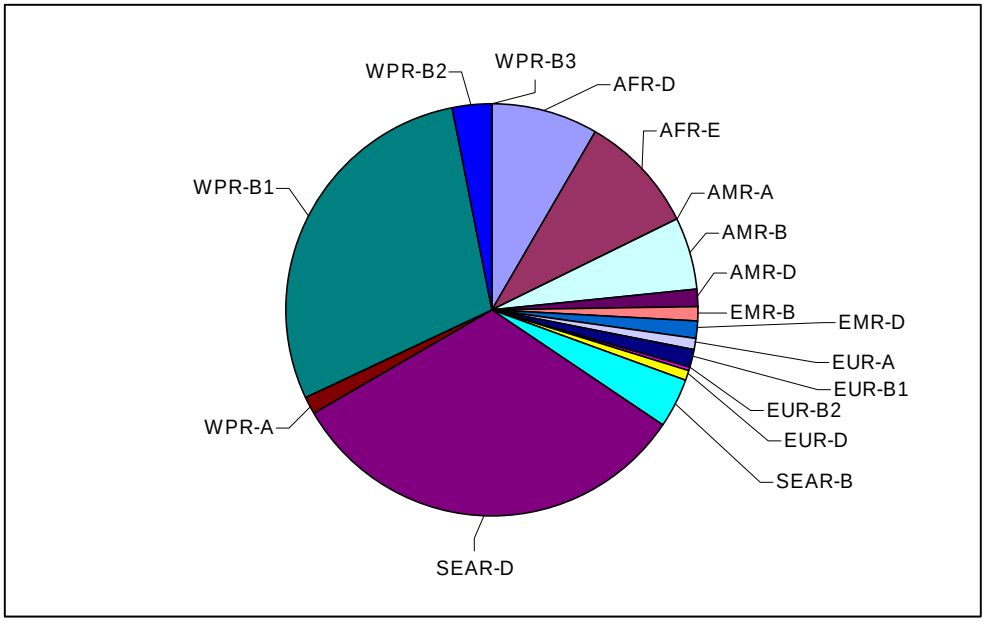


Table 13: Total annual cost of interventions

WHO sub-region	Region/ Country	Population (million)	Total cost of interventions (US$m Year 2000), by intervention				
			1	2	3	4	5
2	AFR-E	481	268	1'074	2'149	2'306	12'201
5	AMR-D	93	38	157	315	368	2'320
11	EUR-D	223	8	71	143	266	4'206
13	SEAR-D	1689	282	3'628	7'257	7'704	35'074
15	WPR-B1	1488	465	3'282	6'563	6'957	28'129
WORLD		7183	1'784	11'305	22'609	24'649	136'515

Table 13 shows that to reach the entire unserved population with water supply and sanitation services would cost US$22.6 billion (Intervention 3), which is twice the cost of Intervention 2. Intervention 4 involves only a small cost increase over intervention 3, of US$2 billion (under 10% increase) as only the cost of chlorination is added.

Finally, at US$136 billion annually, Intervention 5 involves a massive investment in hardware as well as running costs, representing an almost five-fold cost increase from intervention 4. It is likely that this calculation underestimates the true costs due to lack of reliable data on the costs of regulated water and partial sewerage in developing countries.

The annual cost per person reached with the five interventions is shown in Table 14 and Appendix Table A 2.5. The annual per capita cost is under US$3.5 in developing sub-regions for Intervention 1, rising to under US$7.0 for Intervention 2, and up to US$10.7 for Intervention 3. The cost per person reached for Intervention 4 is lower at under US$5 per capita in developing regions, due to the massively increased coverage of this intervention at relatively little additional cost. The services provided in Intervention 5 bring the cost per person covered to over US$20. When the costs are spread over the entire population (see Appendix Table A 2.6), the costs reduce to well under US$1 per capita for Intervention 1 and under US$2.5 for Intervention 2.

Table 14: Annual cost per person receiving interventions

WHO sub-region	Region/ Country	Population (million)	Cost per capita per year (US$ Year 2000), by intervention				
			1	2	3	4	5
2	AFR-E	481	2.3	4.6	7.7	4.8	25.4
5	AMR-D	93	3.4	6.1	10.7	4.0	25.0
11	EUR-D	223	3.1	7.0	8.5	1.2	18.9
13	SEAR-D	1689	2.6	5.6	6.8	4.6	20.8
15	WPR-B1	1488	2.6	5.2	7.3	4.7	18.9

Treatment costs saved due to less cases of infectious diarrhoea

The potential annual health sector costs saved are presented in Table 15 and Appendix Table A 2.7, showing considerable variation between regions and interventions. For Intervention 1, the global costs savings could be US$2 billion per year, rising to as much as US$7 billion per year for Intervention 2. In some of the least developed sub-regions (e.g. AFRO-D, AMRO-D, WPRO-B1) the per capita savings are at least US$0.40 for Intervention 1, rising to at least US$1.40 for intervention 2, and around US$2.00 for Intervention 3. These results are closely linked to the avoided cases per capita in Appendix Table A 2.3, but also to the cost saving assumptions used, such as the estimated costs of ambulatory care and hospitalisation and the proportion of cases admitted to hospital. If, for example, it is assumed instead that only a small proportion of current diarrhoeal cases reach formal health services, then the cost savings to the health sectors around the world would correspondingly be significantly lower.

Table 15: Annual health sector treatment costs saved

WHO sub-region	Region/ Country	Population (million)	Annual health sector treatment costs saved per capita (US$m year 2000), by intervention				
			1	2	3	4	5
2	AFR-E	481	288	883	1'284	3'487	4'445
5	AMR-D	93	45	128	181	668	879
11	EUR-D	223	2	12	22	419	591
13	SEAR-D	1689	262	1'431	2'654	7'869	10'172
15	WPR-B1	1488	636	2'115	3'855	10'636	13'614
WORLD		7183	2'020	6'975	11'624	38'337	50'022

Table 16 shows the patient treatment and travel costs saved, which are much lower than the health sector costs saved. The global patient cost savings are under US$100 million per annum for Intervention 1, rising to US$340 million for Intervention 2. The patient cost savings per capita is negligible for most countries for basic improvements in water and sanitation, at under US$0.20, but these gains rise to over US$0.35 per capita for interventions 4 and 5. Given that these savings will accrue to specific groups and not the whole population, especially households with children, these benefits could be important for those households. This is especially true where patients have to travel long distances to the health facility, and where public health facilities charge for their services or private health care is used. Appendix Table A 2.9 gives details for all sub-regions.

Table 16: Annual patient treatment costs saved

WHO sub-region	Region/ Country	Population (million)	Annual patient treatment costs saved per capita (US$m year 2000), by intervention				
			1	2	3	4	5
2	AFR-E	481	18	54	79	215	274
5	AMR-D	93	2	6	8	30	40
11	EUR-D	223	0	0	1	12	17
13	SEAR-D	1689	17	91	170	503	650
15	WPR-B1	1488	25	82	149	411	526
WORLD		7183	97	341	565	1'787	2'322

Days gained from less illness

Tables 17, 18 and 19 show the number of days gained due to lower incidence of diarrhoea in selected sub-regions, for adults, children and babies, respectively. Under the assumption that 2 work days are lost per case of adult diarrhoea, the global gain is 919 million working days for the total working population aged 15-59 for Intervention 1. When sanitation is added in Intervention 2, the global gain rises to 3.2 billion working days gained. In developing sub-regions, Intervention 1 gives a gain of under 0.10 working days per capita per year for some developing regions (AMR-B, EMR-B, SEAR-B), 0.15 for others (AFR-D, AFR-E), to over 0.30 for WPR-B1. The savings per capita per person for Intervention 2 are about three times those for Intervention 1.

Table 17: Productive days gained due to less diarrhoeal illness

WHO sub-region	Region/ Country	Population (million)	Productive days gained due to less diarrhoeal illness (million days), by intervention				
			1	2	3	4	5
2	AFR-E	481	75	229	333	905	1'153
5	AMR-D	93	12	35	49	182	239
11	EUR-D	223	1	4	8	148	210
15	WPR-B1	1488	516	1'714	3'125	8'622	11'036
WORLD		7183	919	3'225	5'600	17'043	22'059

The potential days of school attendance gained are presented in Table 18, assuming an average of three days off school per case of diarrhoea. The global gain is almost 80 million days per year for Intervention 1, most of which accrue to sub-Saharan Africa, Latin America, South-East Asia and the developing regions of the Western Pacific.

Table 18: School attendance days gained due to less diarrhoeal illness

WHO sub-region	Region/ Country	Population (million)	Days of school attendance gained due to less diarrhoeal illness (‘000 days), by intervention				
			1	2	3	4	5
2	AFR-E	481	16'473	50'437	73'313	199'158	253'890
5	AMR-D	93	2'808	8'042	11'413	42'062	55'392
11	EUR-D	223	21	109	203	3'817	5'390
13	SEAR-D	1689	12'422	67'813	125'790	372'988	482'135
15	WPR-B1	1488	15'101	50'204	91'513	252'485	323'174
WORLD		7183	78'708	272'482	443'219	1'431'223	1'863'335

Table 19 shows the healthy baby/infant days gained – at a gain per average episode of five days of diarrhoea avoided. A global total of 413 million healthy baby/infant days gained for Intervention 1 rises to 1500 million for Intervention 2, and 2400 million for Intervention 3. With disinfected water, the global gains are three times higher than for Intervention 3, at over 7.5 billion baby/infant ill days avoided.

Table 19: Healthy baby/infant days gained due to less diarrhoeal illness

WHO sub-region	Region/ Country	Population (million)	Healthy baby/infant days gained due to less diarrhoeal illness (million days) , by intervention				
			1	2	3	4	5
2	AFR-E	481	96	295	429	1'166	1'486
5	AMR-D	93	9	24	35	128	168
11	EUR-D	223	0	2	3	56	78
13	SEAR-D	1689	84	460	854	2'531	3'272
15	WPR-B1	1488	43	143	261	720	922
WORLD		7183	413	1'467	2'372	7'646	9'953

Figure 4 shows the distribution of days of illness avoided, by sub-region and by age group. The greatest benefits accrue to the adult population, especially in WPR-B1 and SEAR-D. This is largely because this age group has the largest number of adults in it compared to children and infants, especially in WPR-B1. The second greatest benefit is to babies and infants, mainly in AFR-D, AFR-E and SEAR-D, and this mainly because of the fact that diarrhoeal incidence in these age groups is considerably higher than for children and adults. WPR-B1 has a lower proportion of benefits in the 0-4 age group due to the relatively small proportion of the population in this age group compared to other developing sub-regions.

In the cost-benefit analysis, benefits were converted into monetary amounts using assumptions about the value of identified benefits such as productive days gained. Table 20 shows the value of productive days gained (15-49 age group) due to less diarrhoeal illness, using the minimum wage as the measure of value. The annual global value of adult days gained is US$210 million for Intervention 1, rising to almost US$750 million for intervention 2 and US$1.23 billion for Intervention 3. Due to the huge marginal health impact of disinfecting water at the point of use, the value of productive days gained is over US$4 billion for Intervention 4.

Figure 4: Days of illness avoided due to meeting water and sanitation MDGs

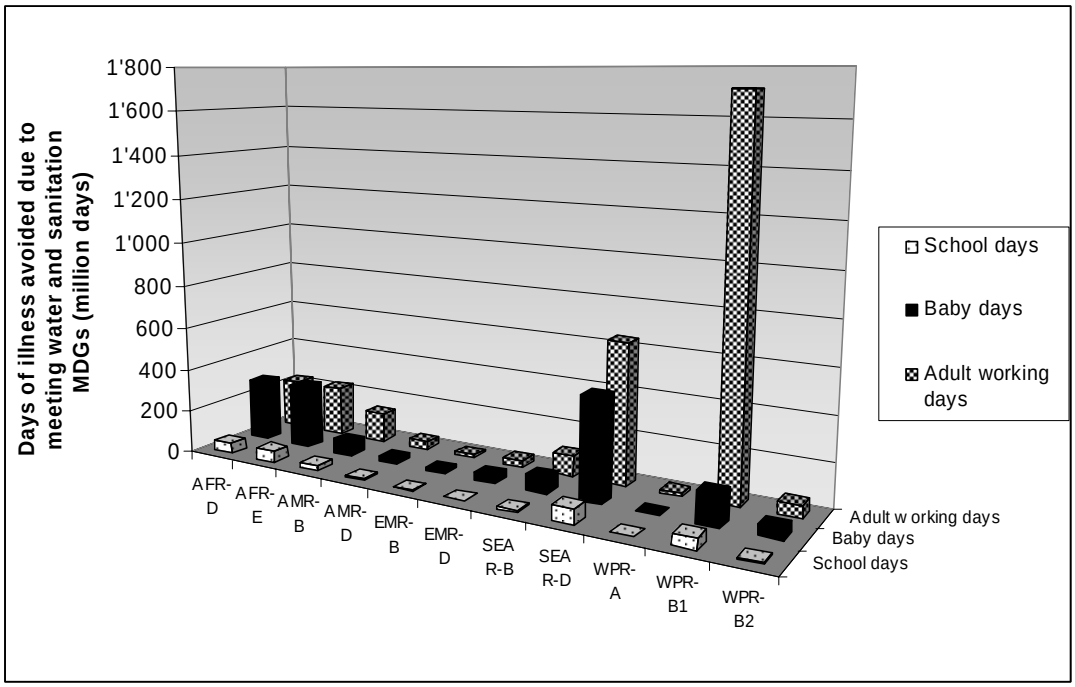


Table 20: Value of (adult) productive days gained due to less diarrhoeal illness

WHO sub-region	Region/ Country	Population (million)	Value of productive days gained due to less diarrhoeal illness (US$ M), by intervention				
			1	2	3	4	5
2	AFR-E	481	21	65	95	256	327
5	AMR-D	93	4	11	16	56	73
11	EUR-D	223	0	1	2	33	46
13	SEAR-D	1689	26	124	223	648	835
15	WPR-B1	1488	74	263	482	1'472	1'906
WORLD		7183	210	737	1'252	4'212	5'508

Convenience time savings

Table 21 shows the annual time gain associated with the improved access to water and sanitation following from the five interventions.

Table 21: Annual time gain due to more convenient water supply and sanitation

WHO sub-region	Region/ Country	Population (million)	Annual time gain (million hours saved), by intervention				
			1	2	3	4	5
2	AFR-E	481	4'925	26'034	52'202	52'202	106'603
5	AMR-D	93	483	2'553	6'261	6'261	14'042
11	EUR-D	223	104	550	3'040	3'040	12'916
13	SEAR-D	1689	4'640	24'525	205'016	205'016	292'445
15	WPR-B1	1488	7'661	40'491	180'047	180'047	160'003
WORLD		7183	29'522	156'045	594'695	594'695	992'634

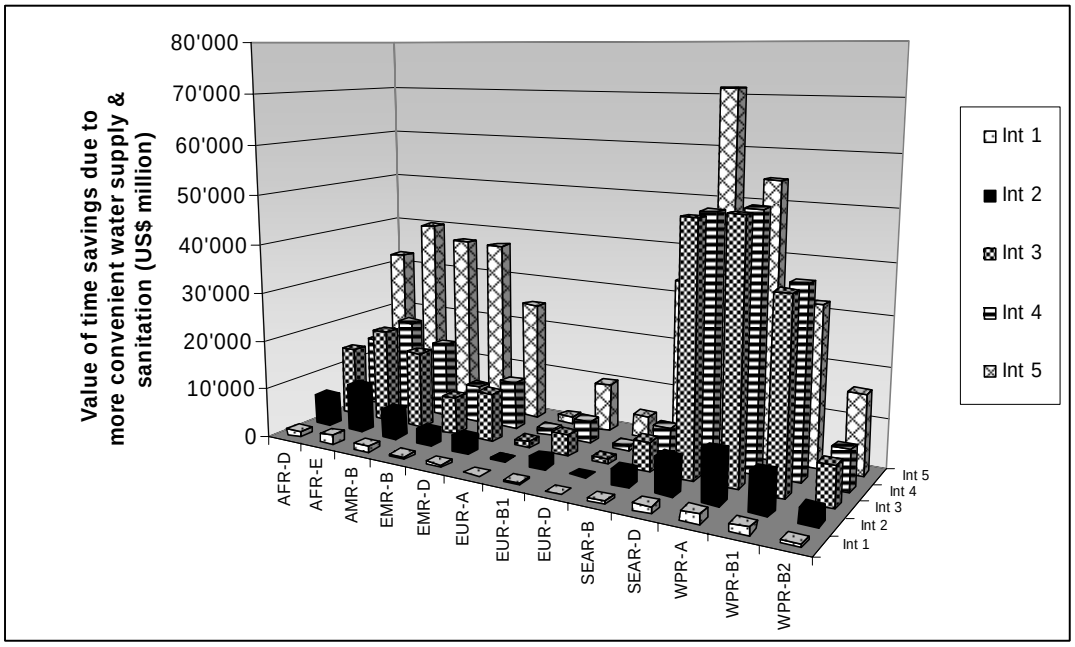
The annual number of hours gained from Intervention 1 is estimated at just under 30 billion hours (or about 4 billion working days), increasing to 156 billion for Intervention 2 (or about 20 billion working days). This shows that the greatest proportion of time gain is from sanitation interventions – i.e. the closer proximity of toilets or less waiting time for public facilities. For the developing regions that benefit the most, around 10 hours for the entire population are gained per capita per year from Intervention 1, and 50 hours per capita from intervention 2. Interventions 3 and 4 save around 100 hours per capita per year, spread over the entire population. There is another big gain for all developing regions when moving from Interventions 3 or 4 to Intervention 5, giving about 200 hours saved per capita per year.

Table 22 presents the annual value of these time savings, spread over the entire population, and using the minimum wage rate to measure the value of time. Intervention 1 gives a global annual value of US$12 billion, spread relatively equally between six sub-regions – AFR-D, AFR-E, AMR-B, SEAR-D, WPR-A, and WPR-B1 (full data shown in Appendix Table A 2.16). Figure 5 illustrates where the gains are distributed in selected world sub-regions, for the five interventions.

Table 22: Annual value of time savings

WHO sub-region	Region/ Country	Population (million)	Annual value of time savings (US$ M 2000) , by intervention				
			1	2	3	4	5
2	AFR-E	481	1'820	9'619	19'558	19'558	39'798
5	AMR-D	93	212	1'122	2'649	2'649	5'825
11	EUR-D	223	42	224	901	901	4'418
13	SEAR-D	1689	1'330	7'028	49'128	49'128	71'531
15	WPR-B1	1488	1'448	7'656	37'357	37'357	31'894
WORLD		7183	12'022	63'547	229'158	229'158	405'457

Figure 5: Value of time savings due to more convenient water supply and sanitation for the five interventions, in selected world sub-regions



Value of avoided deaths

Based on the number of deaths avoided in each age group the value of avoiding these deaths was calculated using the discounted future earnings of people whose lives are saved from each intervention. The value of these avoided deaths is presented in Table 23.

Table 23: Value of avoided deaths per capita (based on predicted future earnings)

WHO sub-region	Region/ Country	Population (million)	Value of avoided deaths per capita (US$m 2000), by intervention				
			1	2	3	4	5
2	AFR-E	481	326	990	1'433	3'818	4'855
5	AMR-D	93	12	35	52	176	231
11	EUR-D	223	0	0	0	40	58
13	SEAR-D	1689	205	1'023	1'826	5'149	6'615
15	WPR-B1	1488	5	17	30	85	108
WORLD		7183	1'035	3'560	5'585	17'566	22'803

Globally, the present value of these avoided deaths is US$1 billion annually for Intervention 1. Intervention 2, due to the increased sanitation coverage, increases this gain to US$3.5 billion, and full coverage of improved water supply and sanitation services gives a global economic benefit of US$5.5 billion. A large proportion of these benefits (80%) accrue in AFR-D, AFR-E and SEAR-D. The sub-region WPR-B1 has much lower benefits due to the older average age of those whose lives are saved from the interventions, and the much lower annual minimum wage in China (US$325) than in most other sub-regions where it was at least US$700.

Economic value of all benefits combined

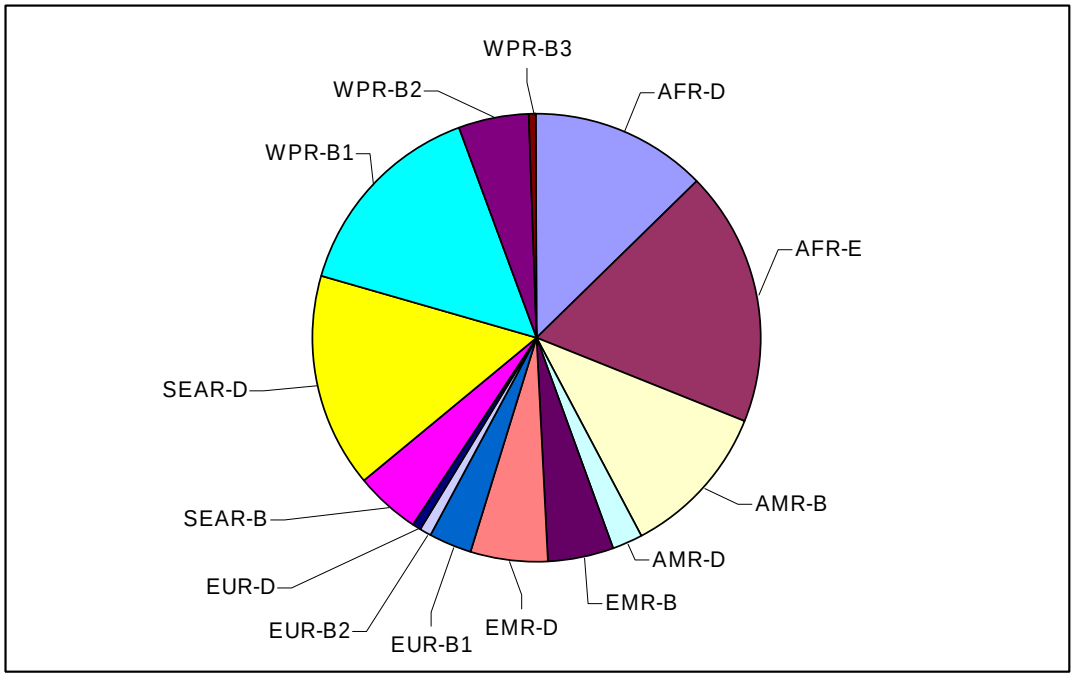
All the economic benefits presented above were summated to arrive at an overall value, which was then used for calculating the cost-benefit ratio. Table 24 presents the total annual economic value for selected sub-regions. The global value ranges from US$18 billion for Intervention 1, to US$84 billion for Intervention 2, and upwards of US$250 billion for the other interventions.

Table 24: Total economic benefits of interventions

WHO sub-region	Region/ Country	Population (million)	Total economic benefits of interventions (US$m year 2000)				
			1	2	3	4	5
2	AFR-E	481	3'084	13'475	25'153	34'631	58'993
5	AMR-D	93	382	1'607	3'334	5'074	9'007
11	EUR-D	223	46	242	934	1'551	5'337
13	SEAR-D	1689	2'201	11'457	57'155	72'478	101'643
15	WPR-B1	1488	2'436	11'013	43'487	54'885	54'426
WORLD		7183	18'143	84'400	262'879	344'106	555'901

Figure 6 shows the distribution of global economic benefits from meeting combined water and sanitation MDGs, by world sub-region but excluding the three most developed sub-regions (AMR-A, EUR-A, and WPR-A). Over 72% of the benefits accrue to five world regions: WPR-B1, SEAR-D, AFR-D, AFR-E, and AMR-B. This is in line with expectations, as these five sub-regions account for 75% of the population from the developing regions.

Figure 6: Distribution (%) of global economic benefits from improved water and sanitation (Intervention 2), by developing world sub-region



Cost-benefit ratios

Table 25 shows the cost-benefit ratios for selected WHO regions, taking into account all the costs and benefits quantified in the analysis. Appendix Table A 2.20 shows the details for all world sub-regions.

Table 25: Cost-benefit ratios – all costs and all benefits included

WHO sub-region	Region/ Country	Population (million)	Cost-benefit ratio, by intervention				
			1	2	3	4	5
2	AFR-E	481	11.50	12.54	11.71	15.02	4.84
5	AMR-D	93	10.01	10.21	10.59	13.77	3.88
11	EUR-D	223	6.03	3.40	6.55	5.82	1.27
13	SEAR-D	1689	7.81	3.16	7.88	9.41	2.90
15	WPR-B1	1488	5.24	3.36	6.63	7.89	1.93

The most important finding is that in all regions and for all five interventions, the cost-benefit ratio (CBR) is significantly greater than 1, recording values in developing regions of between 5 and 28 for Intervention 1, between 3 and 34 for Intervention 2, between 6 and 42 for Intervention 3, and between 5 and 60 for Intervention 4. In AFR-D and AFR-E the cost-benefit ratio for Interventions 1-4 ranges between 9.8 and 14.8, while in WPR-B1 and SEAR-D the cost-benefit ratios are lower at between 3.1 and 9.3. The cost-benefit ratio tends to be higher in the more developed regions, and

this is mainly because the cost estimates may be underestimated for these regions, thus overestimating the true cost-benefit ratio.
The distribution of benefits between different types of benefit is presented in Figures 7 and 8 for two world sub-regions – AFR-D and WPR-B1.

Figure 7: Distribution of economic benefits by type of benefit in AFR-D

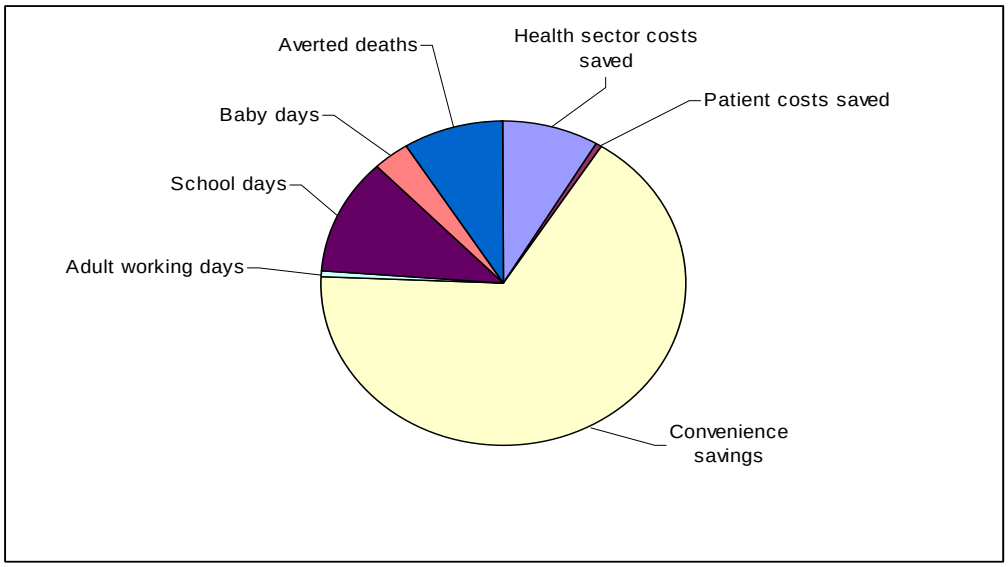
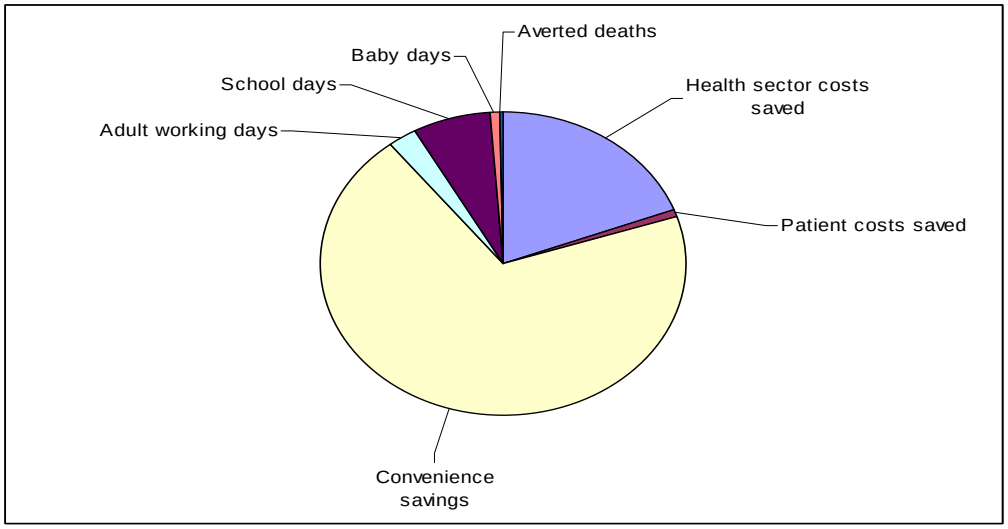


Figure 8: Distribution of economic benefits by type of benefit in WPR-B1



In both regions, the value of time savings due to more convenient services clearly dominates the other benefits, contributing to at least 65% of the economic benefits. The remaining share is, however, distributed differently between the two sub-regions

shown, with a proportionally higher value for avoided deaths and days of school absenteeism in AFR-D, and proportionally higher value for health sector costs saved and adult working days saved in WPR-B1.

The cost-benefit ratios were also recalculated including only the value of time savings. The details are presented in Appendix Table A 2.20. The results show that time savings alone will give cost-benefit ratios of at least 1 for all interventions and all world regions.

Sensitivity analysis

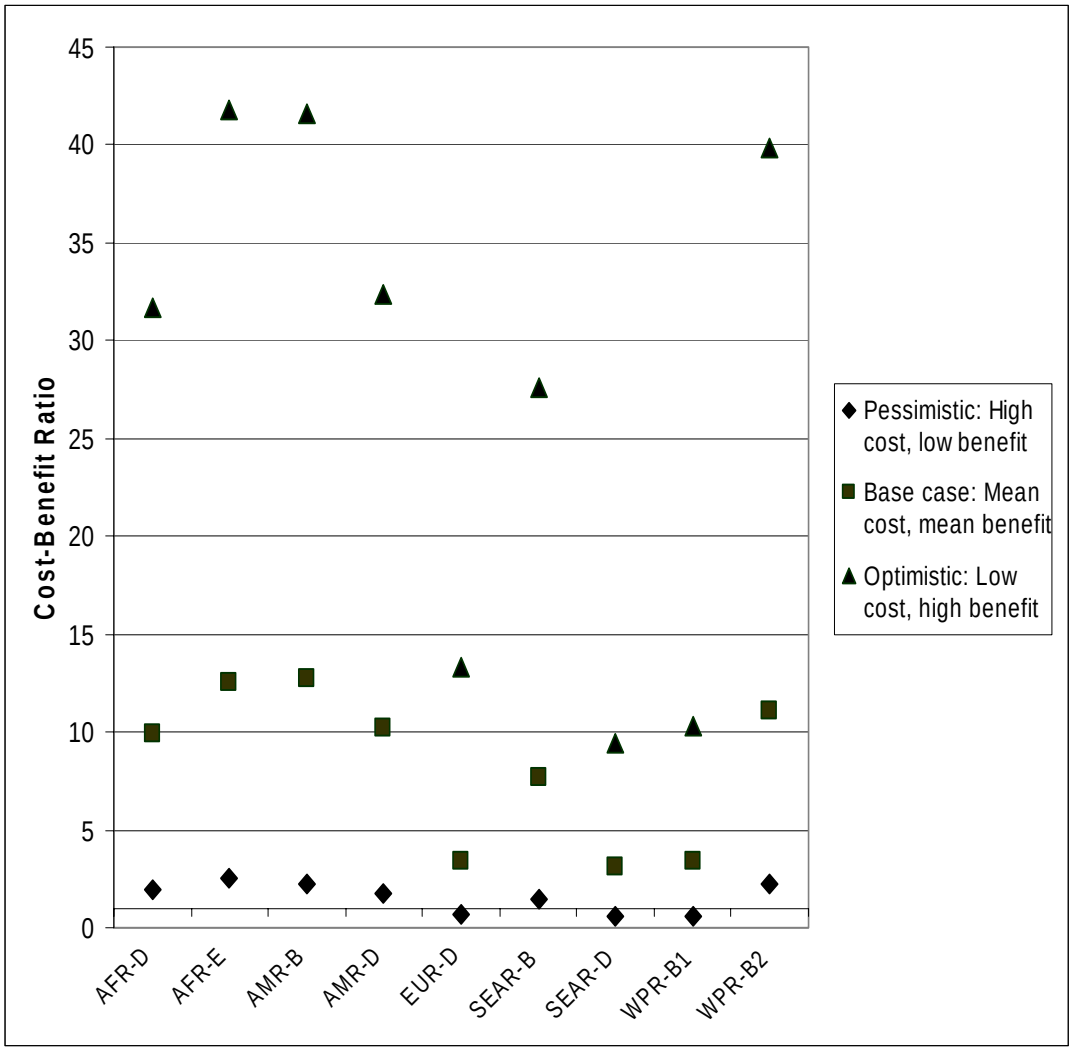
As the results reveal such a high benefit per cost investment, it is important to test the conclusions of the base case analysis by recalculating the cost-benefit ratios under different assumptions. For example, does the cost-benefit ratio remain above unity (1.0) when all the cost input data are given their upper bound and combining these with the lowest input values for all the benefit variables. The results of this analysis are presented in Table 26, which reveals that this operation reduces the ratios considerably compared to the base case results presented in Table 25. The impact is particularly significant for Interventions 1, 2 and 5 in EUR-D, SEAR-B, SEAR-D and WPR-B1, where the ratios in some cases fall below 1.0. Interventions 3 and 4 remain, however, cost-beneficial under the most pessimistic scenario in all sub-regions. In conclusion, the results are highly sensitive to changes in assumptions, but in the greater proportion of scenarios the interventions are still cost-beneficial. Appendix Table A 2.21 shows details for all sub-regions under pessimistic scenarios.

Table 26: Cost-benefit ratios under high cost and low benefit assumptions

WHO sub-region	Region/ Country	Population (million)	Cost-benefit ratio, by intervention				
			1	2	3	4	5
2	AFR-E	481	1.75	2.50	2.39	2.93	1.13
5	AMR-D	93	1.17	1.75	1.97	2.15	0.76
11	EUR-D	223	0.93	0.71	1.43	1.18	0.29
13	SEAR-D	1689	1.16	0.63	1.75	1.97	0.66
15	WPR-B1	1488	0.57	0.56	1.34	1.35	0.33

Figure 9 shows the cost-benefit results for Intervention 2 under most optimistic assumptions *(triangle)* as well as most pessimistic assumptions *(square)*, around the base case cost-benefit ratios *(diamond)*. The line drawn at a CBR of 1 shows that in EUR-D, SEAR-D and WPR-B1 the cost-benefit ratio falls below 1.

Figure 9: Range on mean cost-benefit ratio for Intervention 2 under different assumptions for selected sub-regions (line drawn at CBR = 1)



Discussion

Interpretation of main findings

The cost-benefit ratio of water and sanitation interventions is high when all benefits are included, standing at around between US$5 and US$11 economic benefit per US$1 invested for most developing world sub-regions and for most interventions. In some cases the ratio is significantly higher than this, and in some cases it is lower. It may even fall below 1 for some regions when pessimistic assumptions are used for data inputs (i.e. high cost and low benefit assumptions). The main contributor to the cost of the interventions was found to be the investment cost for the low technology interventions. The main contributor to the overall economic benefits was the time saving associated with more convenient access to water supply and sanitation.

In interpreting the impressive cost-benefit ratios presented in this study, an important caveat needs to be taken into account. On the cost side, the costs are very tangible, requiring financial and time input upfront for the interventions to be put in place. On the benefit side, however, many of the benefits are not highly tangible, in that the benefits do not bring immediate money 'in the hand'. The benefits involve possible money savings from less health service use, accruing to both the health sector and the patient. The reduced number of days spent ill can lead to direct economic benefits, such as more time spent on income earning activities, or to other benefits such as more leisure time or more time spent at school, which do not have immediate economic implications. On the other hand, the benefits related to time savings due to less time spent collecting water or accessing sanitation services can also be argued to be valuable to household members, as it increases their time spent in productive activities.

Therefore, while this analysis attempted to make realistic assumptions about the economic value of these potential savings, it is recognised that the real economic benefits accruing to the population may not be financial in nature, nor will they be immediate. Also, the real benefits depend on a number of factors related to the individual or household, such as what activities are done instead when time is saved or illness avoided, and what health seeking behaviour does he/she engage in. Furthermore, the assumptions about the value of time may overestimate the actual economic value, due to the presence of unemployment, underemployment or seasonal labour, which all determine the income earned when more time is available for work. In some cases the changes in time uses will lead to income gains, but data from micro-economic studies to support the assumptions used in this study are limited.

Omission of variables

The omission of health impacts other than diarrhoeal disease will underestimate the cost-benefit ratios presented in this study. Also, some potential economic and non-economic benefits were left out of the analysis, as presented in Table 9. These benefits were left out for various reasons: (a) lack of research studies presenting the likely range of benefits per project or per person, (b) lack of valuation methods for estimating the monetary equivalent value of some benefits, such as, for example, the aesthetic value of a reservoir, and (c) some benefits were likely to be small in relation to others. On the other hand, some potential negative impacts of changes to water and sanitation technologies were also omitted, thus leading to the underestimate of cost. For example, a partial improvement such as a household sewer connection may mean

discharge of sewage into an open sewer, providing a habitat for vectors to breed, and the possibility of re-infection. Clearly all these omitted benefits and costs should be included for a comprehensive analysis, and a more accurate cost-benefit ratio, and future cost-benefit analyses should try and quantify their effects.

Financing considerations

While cost-benefit analysis can be carried out to identify clearly all the beneficiaries and the (potential) financers of development projects, the analysis does not provide answers to the question of who should pay. This represents a particular challenge to economic evaluation when health care interventions have non-health sector costs and benefits, as the objective of the health ministry – "to maximise health with a given budget" – may come into conflict with other societal objectives, including the maximisation of non-health related welfare. For this reason, the societal perspective is very rarely represented in a comprehensive way in the economic evaluation of health care programmes.

If all costs and benefits are included in a cost-benefit analysis, then a full analysis can be made of financing options. While this study did not include all the benefits, the most widespread benefits were included, which were generally the benefits where country and regional averages could be estimated. For example, benefits accruing to agriculture and industry are very setting-specific, and even estimating economic gains by country would be a challenging task. One of the problems associated with identifying beneficiaries in order to identify those willing to pay for the costs is that the main beneficiaries (patients and consumers) do not always understand the full benefits until well after the investment. Also, most costs are incurred in the first year of the intervention, while benefits accrue over time. These factors together lead to a type of market failure, and implies that many private consumers cannot be expected to finance the initial investment costs up-front. On the other hand, water supply improvements may in fact involve a lower annual cost than the current options, if water trucks, water vendors or bottled water are used. This means that certain groups could be convinced that a household water connection could be cheaper in the long-term, and therefore persuade them to finance water supply improvements privately.

With respect to the question whether the health sector would be interested in financing the interventions, it is clear from this analysis that in most regions and for most interventions there is little incentive for the health sector to make significant contributions to the costs, as the real savings to the sector are small in comparison to the annual intervention costs. Compared to the potential cost savings reported in this study, it is unlikely that the health sector will ever be able to recover these costs, as only a small proportion are marginal costs directly related to the treatment cost of the diarrhoeal episode. Most costs, such as personnel and infrastructure, are fixed costs that do not change with patient throughput in the short-term. On the other hand, the reduced burden to the health system due to less patients presenting with diarrhoea will free up capacity in the health system to treat other patients.

The implication of these arguments is that there should exist a variety of financing mechanisms for meeting the costs of water and sanitation improvements, depending on the income and asset base of the target populations, the availability of credit, the economic benefits perceived by the various stakeholders, the budget freedom of government ministries, and the presence of NGOs to promote and finance water and

sanitation improvements. One finding is clear though: the health sector, with the meagre budget it has at its disposal in most developing countries, cannot and should not be expected to fund water and sanitation improvements. On the other hand, it can play a key role in providing the 'software' (education for behaviour change) alongside 'hardware' interventions, involving both technical and limited financial contributions, and it can provide a strengthened knowledge base to repeat at the national level the type of analysis presented in this publication from a global perspective.

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Appendix A 1: WHO world sub-regions

Table A 1.1: Countries included in World Health Organization epidemiological sub-regions

Region*	Mortality stratum**	Countries
AFR	**D**	Algeria, Angola, Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Comoros, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Madagascar, Mali, Mauritania, Mauritius, Niger, Nigeria, Sao Tome And Principe, Senegal, Seychelles, Sierra Leone, Togo
AFR	**E**	Botswana, Burundi, Central African Republic, Congo, Côte d'Ivoire, Democratic Republic Of The Congo, Eritrea, Ethiopia, Kenya, Lesotho, Malawi, Mozambique, Namibia, Rwanda, South Africa, Swaziland, Uganda, United Republic of Tanzania, Zambia, Zimbabwe
AMR	**B**	Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela
AMR	**D**	Bolivia, Ecuador, Guatemala, Haiti, Nicaragua, Peru
EMR	**B**	Bahrain, Cyprus, Iran (Islamic Republic Of), Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates
EMR	**D**	Afghanistan, Djibouti, Egypt, Iraq, Morocco, Pakistan, Somalia, Sudan, Yemen
EUR	**B**	Albania, Armenia, Azerbaijan, Bosnia And Herzegovina, Bulgaria, Georgia, Kyrgyzstan, Poland, Romania, Slovakia, Tajikistan, The Former Yugoslav Republic Of Macedonia, Turkey, Turkmenistan, Uzbekistan, Yugoslavia
EUR	**C**	Belarus, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Republic of Moldova, Russian Federation, Ukraine
SEAR	**B**	Indonesia, Sri Lanka, Thailand
SEAR	**D**	Bangladesh, Bhutan, Democratic People's Republic Of Korea, India, Maldives, Myanmar, Nepal
WPR	**B**	Cambodia, China, Lao People's Democratic Republic, Malaysia, Mongolia, Philippines, Republic Of Korea, Viet Nam
		Cook Islands, Fiji, Kiribati, Marshall Islands, Micronesia (Federated States Of), Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu

* AFR = Africa Region; AMR = Region of the Americas; EMR = Eastern Mediterranean Region; EUR = European Region; SEAR = South East Asian Region; WPR = Western Pacific Region

** B = low adult, low child mortality; C = high adult, low child mortality;
D = high adult, high child mortality; E = very high adult, high child mortality

Appendix A 2: Detailed cost-benefit results under projected population growth until 2015

Table A 2.1: Number of people receiving improvements (using predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Population (m) receiving interventions				
			1	2	3	4	5
1	AFR-D	487	96	200	227	487	487
2	AFR-E	481	116	232	279	481	481
3	AMR-A	356	0	0	0	0	0
4	AMR-B	531	40	100	127	531	531
5	AMR-D	93	11	26	29	93	93
6	EMR-B	184	10	22	32	184	184
7	EMR-D	189	13	33	40	189	189
8	EUR-A	413	5	17	23	23	23
9	EUR-B1	176	13	26	32	176	176
10	EUR-B2	62	5	11	18	62	62
11	EUR-D	223	2	10	17	223	223
12	SEAR-B	473	47	102	123	473	473
13	SEAR-D	1689	109	645	1'073	1'689	1'689
14	WPR-A	154	7	28	41	41	41
15	WPR-B1	1488	180	631	903	1'488	1'488
16	WPR-B2	176	37	74	90	176	176
17	WPR-B3	9	2	4	5	9	9
WORLD		7183	693	2'161	3'060	6'326	6'326

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.2: Annual number of diarrhoeal cases averted

(predicted population growth until 2015)

Region Number	Region/ Country	Pop. (m)	Cases diarrhoea (m)	Number of cases averted per year ('000s), by intervention				
				1	2	3	4	5
1	AFR-D	487	620	28'946	85'032	117'936	340'955	437'876
2	AFR-E	481	619	28'548	87'405	127'049	345'132	439'980
3	AMR-A	356	24	3	7	9	15	18
4	AMR-B	531	459	9'371	28'373	45'030	228'457	308'336
5	AMR-D	93	93	3'250	9'307	13'208	48'679	64'106
6	EMR-B	184	133	1'032	4'173	7'111	63'169	87'581
7	EMR-D	189	153	3'312	9'622	14'499	75'925	102'659
8	EUR-A	413	28	282	904	1'611	3'271	4'004
9	EUR-B1	176	46	641	2'157	3'281	22'155	30'361
10	EUR-B2	62	41	447	1'594	2'926	19'768	27'114
11	EUR-D	223	43	112	568	1'056	19'816	27'983
12	SEAR-B	473	304	7'707	22'559	32'854	153'143	205'467
13	SEAR-D	1689	1491	26'895	146'829	272'361	807'596	1'043'922
14	WPR-A	154	17	413	1'497	2'747	5'761	7'096
15	WPR-B1	1488	1193	39'454	131'171	239'104	659'687	844'381
16	WPR-B2	176	117	4'346	14'226	21'318	63'658	82'079
17	WPR-B3	9	7	95	526	904	3'765	5'008
WORLD		7183	5388	154'854	545'950	903'004	2'860'951	3'717'971

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.3: Annual number of diarrhoeal cases averted per capita (predicted population growth until 2015)

Region Number	Region/ Country	Pop. (m)	Number of cases averted per capita per year, by intervention				
			1	2	3	4	5
1	AFR-D	487	0.09	0.26	0.36	1.05	1.35
2	AFR-E	481	0.08	0.24	0.34	0.94	1.19
3	AMR-A	356	0.00	0.00	0.00	0.00	0.00
4	AMR-B	531	0.02	0.06	0.10	0.52	0.70
5	AMR-D	93	0.04	0.13	0.18	0.66	0.87
6	EMR-B	184	0.01	0.03	0.05	0.41	0.57
7	EMR-D	189	0.02	0.06	0.10	0.50	0.68
8	EUR-A	413	0.00	0.00	0.00	0.01	0.01
9	EUR-B1	176	0.00	0.01	0.02	0.12	0.17
10	EUR-B2	62	0.01	0.03	0.06	0.38	0.52
11	EUR-D	223	0.00	0.00	0.00	0.08	0.12
12	SEAR-B	473	0.02	0.06	0.08	0.37	0.50
13	SEAR-D	1689	0.02	0.12	0.22	0.67	0.86
14	WPR-A	154	0.00	0.01	0.02	0.04	0.05
15	WPR-B1	1488	0.03	0.10	0.18	0.49	0.62
16	WPR-B2	176	0.03	0.10	0.15	0.44	0.56
17	WPR-B3	9	0.01	0.08	0.14	0.56	0.75

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.4: Total annual cost of interventions

(predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Total annual cost of interventions (US$m Year 2000), by intervention				
			1	2	3	4	5
1	AFR-D	487	222	947	1'894	2'054	12'528
2	AFR-E	481	268	1'074	2'149	2'306	12'201
3	AMR-A	356	0	0	1	1	2
4	AMR-B	531	133	631	1'262	1'569	11'765
5	AMR-D	93	38	157	315	368	2'320
6	EMR-B	184	24	100	201	250	3'275
7	EMR-D	189	33	163	325	383	4'054
8	EUR-A	413	17	111	222	235	656
9	EUR-B1	176	39	136	271	346	3'338
10	EUR-B2	62	13	51	102	118	1'264
11	EUR-D	223	8	71	143	266	4'206
12	SEAR-B	473	121	466	933	1'058	12'164
13	SEAR-D	1689	282	3'628	7'257	7'704	35'074
14	WPR-A	154	19	147	294	304	900
15	WPR-B1	1488	465	3'282	6'563	6'957	28'129
16	WPR-B2	176	94	326	653	700	4'420
17	WPR-B3	9	6	13	27	29	218
WORLD		7183	1'784	11'305	22'609	24'649	136'515

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.5: Annual cost per person receiving interventions (predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Cost per capita per year (US$ Year 2000), by intervention				
			1	2	3	4	5
1	AFR-D	487	2.3	4.7	8.4	4.2	25.7
2	AFR-E	481	2.3	4.6	7.7	4.8	25.4
3	AMR-A	356	3.4	5.8	11.6	12.2	28.7
4	AMR-B	531	3.4	6.3	10.0	3.0	22.2
5	AMR-D	93	3.4	6.1	10.7	4.0	25.0
6	EMR-B	184	2.6	4.6	6.2	1.4	17.8
7	EMR-D	189	2.5	4.9	8.1	2.0	21.5
8	EUR-A	413	3.3	6.6	9.5	10.0	28.1
9	EUR-B1	176	2.9	5.2	8.4	2.0	19.0
10	EUR-B2	62	2.6	4.5	5.6	1.9	20.4
11	EUR-D	223	3.1	7.0	8.5	1.2	18.9
12	SEAR-B	473	2.6	4.6	7.6	2.2	25.7
13	SEAR-D	1689	2.6	5.6	6.8	4.6	20.8
14	WPR-A	154	2.6	5.3	7.1	7.4	21.9
15	WPR-B1	1488	2.6	5.2	7.3	4.7	18.9
16	WPR-B2	176	2.6	4.4	7.2	4.0	25.2
17	WPR-B3	9	2.6	3.8	5.3	3.2	23.6

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.6: Annual cost per capita (entire population) of interventions (predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Annual cost per capita (entire population) (US$ 2000), by intervention				
			1	2	3	4	5
1	AFR-D	487	0.5	1.9	3.9	4.2	25.7
2	AFR-E	481	0.6	2.2	4.5	4.8	25.4
3	AMR-A	356	0.0	0.0	0.0	0.0	0.0
4	AMR-B	531	0.3	1.2	2.4	3.0	22.2
5	AMR-D	93	0.4	1.7	3.4	4.0	25.0
6	EMR-B	184	0.1	0.5	1.1	1.4	17.8
7	EMR-D	189	0.2	0.9	1.7	2.0	21.5
8	EUR-A	413	0.0	0.3	0.5	0.6	1.6
9	EUR-B1	176	0.2	0.8	1.5	2.0	19.0
10	EUR-B2	62	0.2	0.8	1.6	1.9	20.4
11	EUR-D	223	0.0	0.3	0.6	1.2	18.9
12	SEAR-B	473	0.3	1.0	2.0	2.2	25.7
13	SEAR-D	1689	0.2	2.1	4.3	4.6	20.8
14	WPR-A	154	0.1	1.0	1.9	2.0	5.9
15	WPR-B1	1488	0.3	2.2	4.4	4.7	18.9
16	WPR-B2	176	0.5	1.9	3.7	4.0	25.2
17	WPR-B3	9	0.7	1.4	2.9	3.2	23.6

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.7: Annual health sector treatment costs saved (predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Annual health sector treatment costs saved (US$m 2000), by intervention				
			1	2	3	4	5
1	AFR-D	487	276	812	1'126	3'255	4'180
2	AFR-E	481	288	883	1'284	3'487	4'445
3	AMR-A	356	0	0	0	1	1
4	AMR-B	531	212	643	1'020	5'177	6'987
5	AMR-D	93	45	128	181	668	879
6	EMR-B	184	23	95	161	1'434	1'988
7	EMR-D	189	40	117	177	927	1'254
8	EUR-A	413	12	40	71	145	177
9	EUR-B1	176	12	41	62	421	577
10	EUR-B2	62	9	30	56	376	516
11	EUR-D	223	2	12	22	419	591
12	SEAR-B	473	109	318	463	2'156	2'893
13	SEAR-D	1689	262	1'431	2'654	7'869	10'172
14	WPR-A	154	20	72	133	278	343
15	WPR-B1	1488	636	2'115	3'855	10'636	13'614
16	WPR-B2	176	70	229	344	1'026	1'323
17	WPR-B3	9	2	8	15	61	81
WORLD		7183	2'020	6'975	11'624	38'337	50'022

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.8: Annual health sector treatment costs saved per capita (predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Annual health sector treatment costs saved per capita (US$m 2000), by intervention				
			1	2	3	4	5
1	AFR-D	487	0.57	1.67	2.31	6.68	8.58
2	AFR-E	481	0.60	1.84	2.67	7.25	9.24
3	AMR-A	356	0.00	0.00	0.00	0.00	0.00
4	AMR-B	531	0.40	1.21	1.92	9.75	13.16
5	AMR-D	93	0.48	1.38	1.95	7.19	9.47
6	EMR-B	184	0.13	0.51	0.88	7.78	10.79
7	EMR-D	189	0.21	0.62	0.94	4.91	6.64
8	EUR-A	413	0.03	0.10	0.17	0.35	0.43
9	EUR-B1	176	0.07	0.23	0.36	2.40	3.29
10	EUR-B2	62	0.14	0.49	0.90	6.05	8.30
11	EUR-D	223	0.01	0.05	0.10	1.88	2.66
12	SEAR-B	473	0.23	0.67	0.98	4.56	6.12
13	SEAR-D	1689	0.16	0.85	1.57	4.66	6.02
14	WPR-A	154	0.13	0.47	0.86	1.81	2.23
15	WPR-B1	1488	0.43	1.42	2.59	7.15	9.15
16	WPR-B2	176	0.40	1.31	1.96	5.85	7.54
17	WPR-B3	9	0.17	0.92	1.58	6.57	8.74

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.9: Annual patient treatment costs saved

(predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Annual patient treatment costs saved (US$m 2000), by intervention				
			1	2	3	4	5
1	AFR-D	487	18	53	73	212	273
2	AFR-E	481	18	54	79	215	274
3	AMR-A	356	0	0	0	0	0
4	AMR-B	531	6	18	28	142	192
5	AMR-D	93	2	6	8	30	40
6	EMR-B	184	1	3	4	39	55
7	EMR-D	189	2	6	9	47	64
8	EUR-A	413	0	1	2	4	4
9	EUR-B1	176	0	1	2	14	19
10	EUR-B2	62	0	1	2	12	17
11	EUR-D	223	0	0	1	12	17
12	SEAR-B	473	5	14	20	95	128
13	SEAR-D	1689	17	91	170	503	650
14	WPR-A	154	0	2	3	6	8
15	WPR-B1	1488	25	82	149	411	526
16	WPR-B2	176	3	9	13	40	51
17	WPR-B3	9	0	0	1	2	3
WORLD		7183	97	341	565	1'787	2'322

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.10: Annual patient treatment costs saved per capita (predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Annual patient treatment costs saved per capita (US$ 2000), by intervention				
			1	2	3	4	5
1	AFR-D	487	0.04	0.11	0.15	0.44	0.56
2	AFR-E	481	0.04	0.11	0.16	0.45	0.57
3	AMR-A	356	0.00	0.00	0.00	0.00	0.00
4	AMR-B	531	0.01	0.03	0.05	0.27	0.36
5	AMR-D	93	0.02	0.06	0.09	0.33	0.43
6	EMR-B	184	0.00	0.01	0.02	0.21	0.30
7	EMR-D	189	0.01	0.03	0.05	0.25	0.34
8	EUR-A	413	0.00	0.00	0.00	0.01	0.01
9	EUR-B1	176	0.00	0.01	0.01	0.08	0.11
10	EUR-B2	62	0.00	0.02	0.03	0.20	0.27
11	EUR-D	223	0.00	0.00	0.00	0.06	0.08
12	SEAR-B	473	0.01	0.03	0.04	0.20	0.27
13	SEAR-D	1689	0.01	0.05	0.10	0.30	0.39
14	WPR-A	154	0.00	0.01	0.02	0.04	0.05
15	WPR-B1	1488	0.02	0.05	0.10	0.28	0.35
16	WPR-B2	176	0.02	0.05	0.08	0.23	0.29
17	WPR-B3	9	0.01	0.04	0.06	0.25	0.34

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.11: Productive days gained due to less diarrhoeal illness (predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Productive days gained due to less diarrhoeal illness (million days), by intervention				
			1	2	3	4	5
1	AFR-D	487	77	227	314	908	1'167
2	AFR-E	481	75	229	333	905	1'153
3	AMR-A	356	0	0	0	0	0
4	AMR-B	531	45	136	216	1'098	1'482
5	AMR-D	93	12	35	49	182	239
6	EMR-B	184	4	14	24	217	301
7	EMR-D	189	10	30	45	233	315
8	EUR-A	413	2	8	14	29	35
9	EUR-B1	176	4	13	19	129	177
10	EUR-B2	62	2	6	12	78	107
11	EUR-D	223	1	4	8	148	210
12	SEAR-B	473	33	96	140	654	878
13	SEAR-D	1689	117	641	1'189	3'525	4'557
14	WPR-A	154	4	13	25	52	64
15	WPR-B1	1488	516	1'714	3'125	8'622	11'036
16	WPR-B2	176	17	56	84	251	323
17	WPR-B3	9	0	2	3	11	15
WORLD		7183	919	3'225	5'600	17'043	22'059

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.12: Value of productive days gained due to less diarrhoeal illness

(predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Value of productive days gained due to less diarrhoeal illness (US$m), by intervention				
			1	2	3	4	5
1	AFR-D	487	17	51	73	216	278
2	AFR-E	481	21	65	95	256	327
3	AMR-A	356	0	0	0	0	0
4	AMR-B	531	22	66	103	536	725
5	AMR-D	93	4	11	16	56	73
6	EMR-B	184	4	15	27	245	340
7	EMR-D	189	9	25	39	153	202
8	EUR-A	413	0	2	3	6	7
9	EUR-B1	176	2	7	11	67	92
10	EUR-B2	62	1	2	4	27	37
11	EUR-D	223	0	1	2	33	46
12	SEAR-B	473	6	17	26	169	231
13	SEAR-D	1689	26	124	223	648	835
14	WPR-A	154	17	63	116	244	301
15	WPR-B1	1488	74	263	482	1'472	1'906
16	WPR-B2	176	7	20	30	78	99
17	WPR-B3	9	0	1	2	6	8
WORLD		7183	210	737	1'252	4'212	5'508

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.13: School days gained due to less diarrhoeal illness (predicted population growth until 2015)

WHO Region Number	Region/ Country	Pop. (m)	School days gained due to less diarrhoeal illness ('000 days), by intervention				
			1	2	3	4	5
1	AFR-D	487	16'541	48'591	67'394	194'837	250'223
2	AFR-E	481	16'473	50'437	73'313	199'158	253'890
3	AMR-A	356	1	1	2	3	4
4	AMR-B	531	7'951	24'074	38'208	193'843	261'619
5	AMR-D	93	2'808	8'042	11'413	42'062	55'392
6	EMR-B	184	547	2'214	3'773	33'514	46'465
7	EMR-D	189	1'511	4'389	6'614	34'636	46'831
8	EUR-A	413	52	166	297	602	737
9	EUR-B1	176	118	398	605	4'087	5'600
10	EUR-B2	62	244	869	1'594	10'772	14'775
11	EUR-D	223	21	109	203	3'817	5'390
12	SEAR-B	473	2'975	8'708	12'682	59'116	79'314
13	SEAR-D	1689	12'422	67'813	125'790	372'988	482'135
14	WPR-A	154	70	252	463	970	1'195
15	WPR-B1	1488	15'101	50'204	91'513	252'485	323'174
16	WPR-B2	176	1'838	6'015	9'014	26'916	34'705
17	WPR-B3	9	36	198	340	1'418	1'886
WORLD		7183	78'708	272'482	443'219	1'431'223	1'863'335

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.14: Baby days gained due to less diarrhoeal illness (predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Baby days gained due to less diarrhoeal illness (million days) , by intervention				
			1	2	3	4	5
1	AFR-D	487	98	287	398	1'151	1'478
2	AFR-E	481	96	295	429	1'166	1'486
3	AMR-A	356	0	0	0	0	0
4	AMR-B	531	22	68	107	544	734
5	AMR-D	93	9	24	35	128	168
6	EMR-B	184	3	14	23	205	285
7	EMR-D	189	11	33	50	263	356
8	EUR-A	413	1	2	4	8	10
9	EUR-B1	176	2	7	11	71	98
10	EUR-B2	62	1	5	9	61	84
11	EUR-D	223	0	2	3	56	78
12	SEAR-B	473	25	74	108	503	675
13	SEAR-D	1689	84	460	854	2'531	3'272
14	WPR-A	154	1	4	7	14	18
15	WPR-B1	1488	43	143	261	720	922
16	WPR-B2	176	14	47	70	210	271
17	WPR-B3	9	0	2	3	14	18
WORLD		7183	413	1'467	2'372	7'646	9'953

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.15: Annual time gain due to more convenient water supply and sanitation facilities

(predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Annual time gain (million hours saved) , by intervention				
			1	2	3	4	5
1	AFR-D	487	4'085	21'593	46'242	46'242	107'853
2	AFR-E	481	4'925	26'034	52'202	52'202	106'603
3	AMR-A	356	2	9	18	18	22
4	AMR-B	531	1'688	8'924	25'470	25'470	57'345
5	AMR-D	93	483	2'553	6'261	6'261	14'042
6	EMR-B	184	405	2'140	5'248	5'248	25'061
7	EMR-D	189	565	2'986	8'423	8'423	30'593
8	EUR-A	413	216	1'142	4'697	4'697	5'191
9	EUR-B1	176	567	2'995	5'811	5'811	14'661
10	EUR-B2	62	220	1'164	2'628	2'628	9'883
11	EUR-D	223	104	550	3'040	3'040	12'916
12	SEAR-B	473	1'997	10'558	24'177	24'177	105'983
13	SEAR-D	1689	4'640	24'525	205'016	205'016	292'445
14	WPR-A	154	308	1'627	8'107	8'107	8'810
15	WPR-B1	1488	7'661	40'491	180'047	180'047	160'003
16	WPR-B2	176	1'556	8'223	16'682	16'682	39'496
17	WPR-B3	9	100	531	626	626	1'728
WORLD		7183	29'522	156'045	594'695	594'695	992'634

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.16: Annual value of time savings

(predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Annual value of time savings per capita (US$m 2000) , by intervention				
			1	2	3	4	5
1	AFR-D	487	1'184	6'258	14'414	14'414	32'495
2	AFR-E	481	1'820	9'619	19'558	19'558	39'798
3	AMR-A	356	7	35	71	71	86
4	AMR-B	531	1'117	5'902	15'859	15'859	36'987
5	AMR-D	93	212	1'122	2'649	2'649	5'825
6	EMR-B	184	571	3'017	7'677	7'677	36'807
7	EMR-D	189	632	3'343	9'899	9'899	24'783
8	EUR-A	413	51	268	1'328	1'328	1'444
9	EUR-B1	176	419	2'213	4'367	4'367	9'831
10	EUR-B2	62	95	500	1'260	1'260	4'430
11	EUR-D	223	42	224	901	901	4'418
12	SEAR-B	473	563	2'977	5'966	5'966	33'338
13	SEAR-D	1689	1'330	7'028	49'128	49'128	71'531
14	WPR-A	154	1'903	10'058	50'256	50'256	54'606
15	WPR-B1	1488	1'448	7'656	37'357	37'357	31'894
16	WPR-B2	176	555	2'936	8'007	8'007	15'914
17	WPR-B3	9	74	391	461	461	1'272
WORLD		7183	12'022	63'547	229'158	229'158	405'457

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.17: Value of averted deaths per capita (predicted future earnings)

(predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Value of averted deaths per capita (US$m 2000) , by intervention				
			1	2	3	4	5
1	AFR-D	487	279	830	1'174	3'496	4'505
2	AFR-E	481	326	990	1'433	3'818	4'855
3	AMR-A	356	5	15	26	109	146
4	AMR-B	531	22	67	105	549	743
5	AMR-D	93	12	35	52	176	231
6	EMR-B	184	19	72	119	1'009	1'396
7	EMR-D	189	39	113	165	882	1'193
8	EUR-A	413	41	123	200	546	698
9	EUR-B1	176	7	22	32	192	262
10	EUR-B2	62	2	7	13	49	64
11	EUR-D	223	0	0	0	40	58
12	SEAR-B	473	10	28	40	224	304
13	SEAR-D	1689	205	1'023	1'826	5'149	6'615
14	WPR-A	154	27	108	200	798	1'060
15	WPR-B1	1488	5	17	30	85	108
16	WPR-B2	176	36	108	164	420	532
17	WPR-B3	9	1	3	6	25	33
WORLD		7183	1'035	3'560	5'585	17'566	22'803

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.18: Total economic benefits of interventions

(predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Total economic benefits of interventions (US$m 2000) , by intervention				
			1	2	3	4	5
1	AFR-D	487	2'256	9'433	18'883	27'583	49'448
2	AFR-E	481	3'084	13'475	25'153	34'631	58'993
3	AMR-A	356	12	51	99	183	235
4	AMR-B	531	1'817	8'028	19'198	33'055	60'216
5	AMR-D	93	382	1'607	3'334	5'074	9'007
6	EMR-B	184	688	3'505	8'523	15'355	47'461
7	EMR-D	189	900	4'125	11'093	15'036	31'637
8	EUR-A	413	107	439	1'614	2'050	2'357
9	EUR-B1	176	454	2'329	4'540	5'459	11'323
10	EUR-B2	62	118	582	1'410	2'199	5'714
11	EUR-D	223	46	242	934	1'551	5'337
12	SEAR-B	473	767	3'579	6'846	10'785	39'869
13	SEAR-D	1689	2'201	11'457	57'155	72'478	101'643
14	WPR-A	154	2'024	10'509	51'086	52'375	57'292
15	WPR-B1	1488	2'436	11'013	43'487	54'885	54'426
16	WPR-B2	176	772	3'604	9'012	10'735	19'393
17	WPR-B3	9	79	420	512	672	1'553
WORLD		7183	18'143	84'400	262'879	344'106	555'901

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.19: Cost-benefit ratios – all costs and all benefits (predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Cost-benefit ratio, by intervention				
			1	2	3	4	5
1	AFR-D	487	10.14	9.96	9.97	13.43	3.95
2	AFR-E	481	11.50	12.54	11.71	15.02	4.84
3	AMR-A	356	90.09	112.67	107.99	191.05	104.16
4	AMR-B	531	13.63	12.72	15.21	21.07	5.12
5	AMR-D	93	10.01	10.21	10.59	13.77	3.88
6	EMR-B	184	28.30	34.95	42.50	61.47	14.49
7	EMR-D	189	27.45	25.36	34.10	39.27	7.80
8	EUR-A	413	6.36	3.96	7.28	8.74	3.59
9	EUR-B1	176	11.61	17.18	16.74	15.76	3.39
10	EUR-B2	62	8.79	11.46	13.89	18.64	4.52
11	EUR-D	223	6.03	3.40	6.55	5.82	1.27
12	SEAR-B	473	6.32	7.67	7.34	10.19	3.28
13	SEAR-D	1689	7.81	3.16	7.88	9.41	2.90
14	WPR-A	154	108.29	71.61	174.04	172.05	63.64
15	WPR-B1	1488	5.24	3.36	6.63	7.89	1.93
16	WPR-B2	176	8.17	11.04	13.80	15.35	4.39
17	WPR-B3	9	12.99	31.43	19.13	23.02	7.12

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.20: Cost-benefit ratios – all costs, time saving benefits only (predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Cost-benefit ratio, by intervention				
			1	2	3	4	5
1	AFR-D	487	5.32	6.61	7.61	7.02	2.59
2	AFR-E	481	6.79	8.95	9.10	8.48	3.26
3	AMR-A	356	50.63	77.65	77.65	73.96	38.16
4	AMR-B	531	8.38	9.35	12.57	10.11	3.14
5	AMR-D	93	5.56	7.12	8.41	7.19	2.51
6	EMR-B	184	23.48	30.09	38.28	30.73	11.24
7	EMR-D	189	19.28	20.55	30.44	25.85	6.11
8	EUR-A	413	3.02	2.42	5.99	5.66	2.20
9	EUR-B1	176	10.71	16.32	16.10	12.61	2.95
10	EUR-B2	62	7.07	9.84	12.40	10.68	3.51
11	EUR-D	223	5.54	3.14	6.32	3.38	1.05
12	SEAR-B	473	4.64	6.38	6.40	5.64	2.74
13	SEAR-D	1689	4.72	1.94	6.77	6.38	2.04
14	WPR-A	154	101.80	68.53	171.21	165.09	60.66
15	WPR-B1	1488	3.11	2.33	5.69	5.37	1.13
16	WPR-B2	176	5.88	8.99	12.26	11.45	3.60
17	WPR-B3	9	12.12	29.22	17.23	15.78	5.83

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 2.21: Cost-benefit ratios - high cost and low benefit assumptions

(predicted population growth until 2015)

WHO Region Number	Region/ Country	Population (million)	Cost-benefit ratio, by intervention				
			1	2	3	4	5
1	AFR-D	487	1.52	1.96	2.04	2.63	0.92
2	AFR-E	481	1.75	2.50	2.39	2.93	1.13
3	AMR-A	356	22.47	31.05	29.34	67.84	43.90
4	AMR-B	531	1.60	2.20	2.88	3.05	0.93
5	AMR-D	93	1.17	1.75	1.97	2.15	0.76
6	EMR-B	184	4.39	7.24	9.02	11.23	3.33
7	EMR-D	189	4.10	5.20	7.30	8.13	1.85
8	EUR-A	413	1.45	1.05	1.76	2.40	1.14
9	EUR-B1	176	1.88	3.64	3.56	3.50	0.83
10	EUR-B2	62	1.29	2.30	2.87	3.05	0.98
11	EUR-D	223	0.93	0.71	1.43	1.18	0.29
12	SEAR-B	473	0.85	1.49	1.47	1.64	0.75
13	SEAR-D	1689	1.16	0.63	1.75	1.97	0.66
14	WPR-A	154	17.86	16.21	40.16	40.43	16.61
15	WPR-B1	1488	0.57	0.56	1.34	1.35	0.33
16	WPR-B2	176	1.21	2.21	2.89	3.04	1.03
17	WPR-B3	9	2.08	6.39	3.76	4.19	1.68

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Appendix A 3: Detailed cost-benefit results under constant population size from year 2000 until 2015

Table A 3.1: Number of people receiving improvements (population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Population (m) receiving interventions				
			1	2	3	4	5
1	AFR-D	335	65	135	153	335	335
2	AFR-E	346	80	160	193	346	346
3	AMR-A	314	0	0	0	0	0
4	AMR-B	442	33	83	105	442	442
5	AMR-D	71	9	20	23	71	71
6	EMR-B	139	7	17	25	139	139
7	EMR-D	139	9	22	27	139	139
8	EUR-A	412	5	17	23	23	23
9	EUR-B1	166	12	25	31	166	166
10	EUR-B2	52	4	10	15	52	52
11	EUR-D	243	3	11	18	243	243
12	SEAR-B	396	40	86	103	396	396
13	SEAR-D	1335	84	511	854	1'335	1'335
14	WPR-A	150	7	28	41	41	41
15	WPR-B1	1354	164	574	821	1'354	1'354
16	WPR-B2	144	30	60	74	144	144
17	WPR-B3	7	2	3	4	7	7
WORLD		6045	553	1'761	2'510	5'233	5'233

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.2: Annual number of diarrhoeal cases averted

(population remains stable from year 2000 until 2015)

Region Number	Region/ Country	Pop. (m)	Cases diarrhoea (m)	Number of cases averted per year ('000s), by intervention				
				1	2	3	4	5
1	AFR-D	335	424	19'359	57'033	79'196	232'362	298'931
2	AFR-E	346	440	19'666	60'208	87'369	243'994	312'106
3	AMR-A	314	21	2	6	8	14	16
4	AMR-B	442	382	7'815	23'649	37'503	190'199	256'695
5	AMR-D	71	72	2'544	7'276	10'304	37'533	49'376
6	EMR-B	139	101	832	3'314	5'630	47'934	66'359
7	EMR-D	139	112	2'259	6'539	9'751	55'015	74'710
8	EUR-A	412	28	279	893	1'590	3'226	3'948
9	EUR-B1	166	43	643	2'117	3'204	21'046	28'804
10	EUR-B2	52	35	391	1'394	2'558	16'785	22'991
11	EUR-D	243	47	125	627	1'165	21'657	30'578
12	SEAR-B	396	254	6'468	18'941	27'586	128'308	172'119
13	SEAR-D	1335	1178	20'746	115'610	215'662	638'486	825'233
14	WPR-A	150	16	411	1'491	2'737	5'739	7'069
15	WPR-B1	1354	1085	35'874	119'284	217'446	600'062	768'083
16	WPR-B2	144	96	3'501	11'491	17'276	52'063	67'198
17	WPR-B3	7	5	76	400	675	2'787	3'704
WORLD		6045	4342	120'991	430'275	719'660	2'297'209	2'987'920

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.3: Annual number of diarrhoeal cases averted per capita (population remains stable from year 2000 until 2015)

Region Number	Region/ Country	Pop. (m)	Number of cases averted per capita per year, by intervention				
			1	2	3	4	5
1	AFR-D	335	0.06	0.17	0.24	0.69	0.89
2	AFR-E	346	0.06	0.17	0.25	0.71	0.90
3	AMR-A	314	0.00	0.00	0.00	0.00	0.00
4	AMR-B	442	0.02	0.05	0.08	0.43	0.58
5	AMR-D	71	0.04	0.10	0.14	0.53	0.69
6	EMR-B	139	0.01	0.02	0.04	0.34	0.48
7	EMR-D	139	0.02	0.05	0.07	0.40	0.54
8	EUR-A	412	0.00	0.00	0.00	0.01	0.01
9	EUR-B1	166	0.00	0.01	0.02	0.13	0.17
10	EUR-B2	52	0.01	0.03	0.05	0.32	0.44
11	EUR-D	243	0.00	0.00	0.00	0.09	0.13
12	SEAR-B	396	0.02	0.05	0.07	0.32	0.43
13	SEAR-D	1335	0.02	0.09	0.16	0.48	0.62
14	WPR-A	150	0.00	0.01	0.02	0.04	0.05
15	WPR-B1	1354	0.03	0.09	0.16	0.44	0.57
16	WPR-B2	144	0.02	0.08	0.12	0.36	0.47
17	WPR-B3	7	0.01	0.06	0.10	0.41	0.54

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.4: Total annual cost of interventions

(population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Total annual cost of interventions (US$m Year 2000), by intervention				
			1	2	3	4	5
1	AFR-D	335	150	637	1'275	1'384	8'567
2	AFR-E	346	186	739	1'478	1'591	8'809
3	AMR-A	314	0	0	1	1	2
4	AMR-B	442	111	525	1'050	1'306	9'792
5	AMR-D	71	30	123	245	286	1'774
6	EMR-B	139	18	78	157	194	2'480
7	EMR-D	139	22	109	219	261	2'994
8	EUR-A	412	17	110	220	232	649
9	EUR-B1	166	37	133	265	339	3'195
10	EUR-B2	52	11	44	88	102	1'064
11	EUR-D	243	8	78	157	292	4'594
12	SEAR-B	396	102	392	784	889	10'206
13	SEAR-D	1335	217	2'882	5'765	6'118	27'658
14	WPR-A	150	19	146	292	303	897
15	WPR-B1	1354	423	2'984	5'969	6'327	25'587
16	WPR-B2	144	77	265	530	568	3'640
17	WPR-B3	7	4	10	20	22	160
WORLD		6045	1'432	9'257	18'514	20'217	112'069

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.5: Annual cost per person receiving interventions (population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Cost per capita per year (US$ Year 2000), by intervention				
			1	2	3	4	5
1	AFR-D	335	2.3	4.7	8.3	4.1	25.6
2	AFR-E	346	2.3	4.6	7.7	4.6	25.5
3	AMR-A	314	3.4	5.8	11.6	12.2	28.7
4	AMR-B	442	3.4	6.3	10.0	3.0	22.1
5	AMR-D	71	3.4	6.1	10.8	4.0	24.9
6	EMR-B	139	2.6	4.7	6.3	1.4	17.8
7	EMR-D	139	2.5	4.9	8.2	1.9	21.5
8	EUR-A	412	3.3	6.6	9.5	10.1	28.2
9	EUR-B1	166	3.0	5.3	8.6	2.0	19.2
10	EUR-B2	52	2.6	4.6	5.7	1.9	20.3
11	EUR-D	243	3.1	7.0	8.5	1.2	18.9
12	SEAR-B	396	2.6	4.6	7.6	2.2	25.8
13	SEAR-D	1335	2.6	5.6	6.7	4.6	20.7
14	WPR-A	150	2.6	5.3	7.1	7.4	21.9
15	WPR-B1	1354	2.6	5.2	7.3	4.7	18.9
16	WPR-B2	144	2.6	4.4	7.2	3.9	25.2
17	WPR-B3	7	2.6	3.8	5.4	3.2	23.5

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.6: Annual cost per capita (entire population) of interventions (population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Annual cost per capita (entire population) (US$ 2000), by intervention				
			1	2	3	4	5
1	AFR-D	6.3	0.4	1.9	3.8	4.1	25.6
2	AFR-E	30.7	0.5	2.1	4.3	4.6	25.5
3	AMR-A	30.8	0.0	0.0	0.0	0.0	0.0
4	AMR-B	98.9	0.3	1.2	2.4	3.0	22.1
5	AMR-D	12.6	0.4	1.7	3.4	4.0	24.9
6	EMR-B	3.5	0.1	0.6	1.1	1.4	17.8
7	EMR-D	67.9	0.2	0.8	1.6	1.9	21.5
8	EUR-A	15.9	0.0	0.3	0.5	0.6	1.6
9	EUR-B1	38.6	0.2	0.8	1.6	2.0	19.2
10	EUR-B2	4.9	0.2	0.8	1.7	1.9	20.3
11	EUR-D	145.5	0.0	0.3	0.6	1.2	18.9
12	SEAR-B	62.8	0.3	1.0	2.0	2.2	25.8
13	SEAR-D	23.0	0.2	2.2	4.3	4.6	20.7
14	WPR-A	3.8	0.1	1.0	1.9	2.0	6.0
15	WPR-B1	1'282.4	0.3	2.2	4.4	4.7	18.9
16	WPR-B2	78.1	0.5	1.8	3.7	3.9	25.2
17	WPR-B3	4.8	0.7	1.4	2.9	3.2	23.5

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.7: Annual patient treatment costs saved

(population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Annual patient treatment costs saved per capita (US$m 2000), by intervention				
			1	2	3	4	5
1	AFR-D	335	12	36	49	145	186
2	AFR-E	346	12	38	54	152	194
3	AMR-A	314	0	0	0	0	0
4	AMR-B	442	5	15	23	118	160
5	AMR-D	71	2	5	6	23	31
6	EMR-B	139	1	2	4	30	41
7	EMR-D	139	1	4	6	34	47
8	EUR-A	412	0	1	2	4	4
9	EUR-B1	166	0	1	2	13	18
10	EUR-B2	52	0	1	2	10	14
11	EUR-D	243	0	0	1	13	19
12	SEAR-B	396	4	12	17	80	107
13	SEAR-D	1335	13	72	134	398	514
14	WPR-A	150	0	2	3	6	8
15	WPR-B1	1354	22	74	135	374	479
16	WPR-B2	144	2	7	11	32	42
17	WPR-B3	7	0	0	0	2	2
WORLD		6045	76	269	450	1'436	1'867

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.8: Annual health sector treatment costs saved (population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Annual health sector treatment costs saved (US$m Year 2000), by intervention				
			1	2	3	4	5
1	AFR-D	335	185	544	756	2'218	2'854
2	AFR-E	346	199	608	883	2'465	3'153
3	AMR-A	314	0	0	0	1	1
4	AMR-B	442	177	536	850	4'310	5'817
5	AMR-D	71	35	100	141	515	677
6	EMR-B	139	19	75	128	1'088	1'506
7	EMR-D	139	28	80	119	672	912
8	EUR-A	412	12	39	70	143	175
9	EUR-B1	166	12	40	61	400	548
10	EUR-B2	52	7	27	49	319	437
11	EUR-D	243	3	13	25	458	646
12	SEAR-B	396	91	267	388	1'807	2'424
13	SEAR-D	1335	202	1'127	2'101	6'221	8'041
14	WPR-A	150	20	72	132	277	342
15	WPR-B1	1354	578	1'923	3'506	9'675	12'384
16	WPR-B2	144	56	185	279	839	1'083
17	WPR-B3	7	1	6	11	45	60
WORLD		6045	1'626	5'644	9'499	31'453	41'060

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.9: Annual health sector treatment costs saved per capita (population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Annual health sector treatment costs saved per capita (US$ 2000), by intervention				
			1	2	3	4	5
1	AFR-D	335	0.55	1.63	2.26	6.63	8.53
2	AFR-E	346	0.58	1.76	2.55	7.14	9.13
3	AMR-A	314	0.00	0.00	0.00	0.00	0.00
4	AMR-B	442	0.40	1.21	1.92	9.75	13.16
5	AMR-D	71	0.49	1.40	1.98	7.23	9.51
6	EMR-B	139	0.14	0.54	0.92	7.82	10.83
7	EMR-D	139	0.20	0.57	0.86	4.83	6.56
8	EUR-A	412	0.03	0.10	0.17	0.35	0.42
9	EUR-B1	166	0.07	0.24	0.37	2.41	3.30
10	EUR-B2	52	0.14	0.51	0.93	6.08	8.33
11	EUR-D	243	0.01	0.05	0.10	1.88	2.66
12	SEAR-B	396	0.23	0.67	0.98	4.56	6.12
13	SEAR-D	1335	0.15	0.84	1.57	4.66	6.02
14	WPR-A	150	0.13	0.48	0.88	1.85	2.28
15	WPR-B1	1354	0.43	1.42	2.59	7.15	9.15
16	WPR-B2	144	0.39	1.28	1.93	5.82	7.51
17	WPR-B3	7	0.18	0.95	1.60	6.59	8.76

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.10: Annual patient treatment costs saved

(population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Annual patient treatment costs saved (US$ 2000), by intervention				
			1	2	3	4	5
1	AFR-D	335	12	36	49	145	186
2	AFR-E	346	12	38	54	152	194
3	AMR-A	314	0	0	0	0	0
4	AMR-B	442	5	15	23	118	160
5	AMR-D	71	2	5	6	23	31
6	EMR-B	139	1	2	4	30	41
7	EMR-D	139	1	4	6	34	47
8	EUR-A	412	0	1	2	4	4
9	EUR-B1	166	0	1	2	13	18
10	EUR-B2	52	0	1	2	10	14
11	EUR-D	243	0	0	1	13	19
12	SEAR-B	396	4	12	17	80	107
13	SEAR-D	1335	13	72	134	398	514
14	WPR-A	150	0	2	3	6	8
15	WPR-B1	1354	22	74	135	374	479
16	WPR-B2	144	2	7	11	32	42
17	WPR-B3	7	0	0	0	2	2

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.11: Productive days gained due to less diarrhoeal illness (population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Productive days gained due to less diarrhoeal illness (million days), by intervention				
			1	2	3	4	5
1	AFR-D	335	52	152	211	619	796
2	AFR-E	346	52	158	229	640	818
3	AMR-A	314	0	0	0	0	0
4	AMR-B	442	38	114	180	914	1'234
5	AMR-D	71	9	27	38	140	184
6	EMR-B	139	3	11	19	165	228
7	EMR-D	139	7	20	30	169	230
8	EUR-A	412	2	8	14	28	35
9	EUR-B1	166	4	12	19	123	168
10	EUR-B2	52	2	6	10	66	91
11	EUR-D	243	1	5	9	162	229
12	SEAR-B	396	28	81	118	548	735
13	SEAR-D	1335	91	505	941	2'787	3'602
14	WPR-A	150	4	13	25	52	64
15	WPR-B1	1354	469	1'559	2'842	7'843	10'038
16	WPR-B2	144	14	45	68	205	265
17	WPR-B3	7	0	1	2	8	11
WORLD		6045	773	2'717	4'755	14'469	18'729

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.12: Value of productive days gained due to less diarrhoeal illness

(population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Value of productive days gained due to less diarrhoeal illness (US$m), by intervention				
			1	2	3	4	5
1	AFR-D	335	12	34	49	148	192
2	AFR-E	346	15	45	65	181	231
3	AMR-A	314	0	0	0	0	0
4	AMR-B	442	18	55	86	448	605
5	AMR-D	71	3	9	13	44	57
6	EMR-B	139	3	12	21	185	256
7	EMR-D	139	6	16	25	102	135
8	EUR-A	412	0	1	2	5	6
9	EUR-B1	166	2	7	11	64	87
10	EUR-B2	52	1	2	4	23	31
11	EUR-D	243	0	1	2	36	51
12	SEAR-B	396	5	14	21	139	190
13	SEAR-D	1335	19	95	172	501	647
14	WPR-A	150	17	63	116	243	299
15	WPR-B1	1354	67	240	439	1'343	1'739
16	WPR-B2	144	5	16	24	63	80
17	WPR-B3	7	0	1	1	5	6
WORLD		6045	173	613	1'052	3'529	4'614

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.13: School days gained due to less diarrhoeal illness (population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	School days gained due to less diarrhoeal illness ('000 days), by intervention				
			1	2	3	4	5
1	AFR-D	335	11'063	32'591	45'256	132'783	170'823
2	AFR-E	346	11'348	34'743	50'416	140'796	180'100
3	AMR-A	314	0	1	2	3	3
4	AMR-B	442	6'631	20'066	31'821	161'381	217'801
5	AMR-D	71	2'198	6'287	8'904	32'431	42'664
6	EMR-B	139	441	1'758	2'987	25'431	35'206
7	EMR-D	139	1'030	2'983	4'448	25'097	34'082
8	EUR-A	412	51	164	293	594	727
9	EUR-B1	166	119	390	591	3'882	5'313
10	EUR-B2	52	213	760	1'394	9'146	12'528
11	EUR-D	243	24	121	224	4'171	5'890
12	SEAR-B	396	2'497	7'312	10'649	49'529	66'441
13	SEAR-D	1335	9'582	53'394	99'603	294'885	381'133
14	WPR-A	150	69	251	461	967	1'191
15	WPR-B1	1354	13'730	45'654	83'224	229'664	293'972
16	WPR-B2	144	1'480	4'859	7'305	22'013	28'413
17	WPR-B3	7	29	151	254	1'050	1'395
WORLD		6045	60'506	211'487	347'832	1'133'823	1'477'683

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.14: Baby days gained due to less diarrhoeal illness (population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Baby days gained due to less diarrhoeal illness (million days) , by intervention				
			1	2	3	4	5
1	AFR-D	335	65	193	267	785	1'009
2	AFR-E	346	66	203	295	824	1'054
3	AMR-A	314	0	0	0	0	0
4	AMR-B	442	19	56	89	453	611
5	AMR-D	71	7	19	27	98	129
6	EMR-B	139	3	11	18	156	216
7	EMR-D	139	8	23	34	191	259
8	EUR-A	412	1	2	4	8	10
9	EUR-B1	166	2	7	10	68	93
10	EUR-B2	52	1	4	8	52	71
11	EUR-D	243	0	2	3	61	86
12	SEAR-B	396	21	62	91	421	565
13	SEAR-D	1335	65	362	676	2'001	2'586
14	WPR-A	150	1	4	7	14	17
15	WPR-B1	1354	39	130	237	655	839
16	WPR-B2	144	12	38	57	172	222
17	WPR-B3	7	0	1	2	10	13
WORLD		6045	310	1'118	1'827	5'969	7'782

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.15: Annual time gain due to more convenient water supply and sanitation facilities

(population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Annual time gain (million hours saved) , by intervention				
			1	2	3	4	5
1	AFR-D	335	2'749	14'529	31'116	31'116	73'293
2	AFR-E	346	3'412	18'037	35'885	35'885	76'213
3	AMR-A	314	1	8	16	16	19
4	AMR-B	442	1'405	7'425	21'199	21'199	47'818
5	AMR-D	71	377	1'994	4'877	4'877	10'729
6	EMR-B	139	299	1'579	4'128	4'128	19'316
7	EMR-D	139	385	2'036	5'624	5'624	22'223
8	EUR-A	412	214	1'131	4'630	4'630	5'119
9	EUR-B1	166	531	2'806	5'659	5'659	14'033
10	EUR-B2	52	186	981	2'284	2'284	8'331
11	EUR-D	243	113	598	3'341	3'341	14'024
12	SEAR-B	396	1'685	8'905	20'309	20'309	89'044
13	SEAR-D	1335	3'578	18'914	163'043	163'043	230'530
14	WPR-A	150	306	1'619	8'076	8'076	8'776
15	WPR-B1	1354	6'965	36'817	163'748	163'748	145'501
16	WPR-B2	144	1'266	6'689	13'539	13'539	32'445
17	WPR-B3	7	74	391	463	463	1'273
WORLD		6045	23'546	124'460	487'937	487'937	798'689

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.16: Annual value of time savings

(population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Annual value of time savings per capita (US$m 2000) , by intervention				
			1	2	3	4	5
1	AFR-D	335	795	4'200	9'740	9'740	22'184
2	AFR-E	346	1'259	6'652	13'441	13'441	28'438
3	AMR-A	314	6	32	63	63	77
4	AMR-B	442	932	4'927	13'226	13'226	30'932
5	AMR-D	71	166	879	2'077	2'077	4'490
6	EMR-B	139	416	2'197	5'978	5'978	28'185
7	EMR-D	139	406	2'147	6'252	6'252	16'399
8	EUR-A	412	41	219	1'075	1'075	1'170
9	EUR-B1	166	399	2'108	4'301	4'301	9'437
10	EUR-B2	52	80	421	1'096	1'096	3'734
11	EUR-D	243	46	244	994	994	4'786
12	SEAR-B	396	468	2'475	4'899	4'899	27'513
13	SEAR-D	1335	977	5'163	38'229	38'229	55'176
14	WPR-A	150	1'895	10'015	50'073	50'073	54'404
15	WPR-B1	1354	1'318	6'966	34'044	34'044	29'045
16	WPR-B2	144	444	2'344	6'430	6'430	12'992
17	WPR-B3	7	54	288	341	341	937
WORLD		6045	9'701	51'276	192'259	192'259	329'901

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.17: Value of averted deaths per capita (predicted future earnings)

(population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Value of averted deaths per capita (US$m 2000) , by intervention				
			1	2	3	4	5
1	AFR-D	335	186	556	789	2'405	3'108
2	AFR-E	346	224	681	983	2'689	3'431
3	AMR-A	314	4	11	20	84	112
4	AMR-B	442	19	56	88	461	623
5	AMR-D	71	9	27	40	135	176
6	EMR-B	139	15	56	93	764	1'056
7	EMR-D	139	29	84	122	653	884
8	EUR-A	412	23	68	111	303	386
9	EUR-B1	166	7	22	32	183	249
10	EUR-B2	52	2	6	11	44	58
11	EUR-D	243	0	0	0	35	49
12	SEAR-B	396	8	23	33	183	248
13	SEAR-D	1335	152	787	1'424	4'055	5'217
14	WPR-A	150	18	75	138	552	733
15	WPR-B1	1354	5	15	28	77	98
16	WPR-B2	144	29	86	132	343	435
17	WPR-B3	7	0	3	4	18	24
WORLD		6045	729	2'556	4'049	12'982	16'889

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.18: Total economic benefits of interventions

(population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Value of averted deaths per capita (US$m 2000) , by intervention				
			1	2	3	4	5
1	AFR-D	335	1'510	6'328	12'744	18'777	33'846
2	AFR-E	346	2'130	9'308	17'286	24'083	42'037
3	AMR-A	314	10	44	85	150	192
4	AMR-B	442	1'517	6'702	16'011	27'569	50'307
5	AMR-D	71	299	1'260	2'612	3'954	6'952
6	EMR-B	139	509	2'581	6'642	11'777	36'221
7	EMR-D	139	584	2'663	7'034	9'800	21'151
8	EUR-A	412	79	334	1'269	1'546	1'763
9	EUR-B1	166	434	2'222	4'472	5'341	10'856
10	EUR-B2	52	100	493	1'228	1'896	4'827
11	EUR-D	243	50	264	1'031	1'695	5'776
12	SEAR-B	396	637	2'975	5'629	8'895	32'930
13	SEAR-D	1335	1'628	8'584	44'492	56'510	78'763
14	WPR-A	150	2'007	10'431	50'839	51'941	56'758
15	WPR-B1	1354	2'216	10'020	39'623	50'005	49'564
16	WPR-B2	144	616	2'880	7'239	8'651	15'829
17	WPR-B3	7	59	310	379	497	1'145
WORLD		6045	14'386	67'398	218'614	283'090	448'916

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.29: Cost-benefit ratios – all costs and all benefits (population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Cost-benefit ratio, by intervention				
			1	2	3	4	5
1	AFR-D	335	10.09	9.93	10.00	13.56	3.95
2	AFR-E	346	11.47	12.60	11.70	15.14	4.77
3	AMR-A	314	85.16	108.25	104.08	175.44	95.34
4	AMR-B	442	13.68	12.76	15.24	21.11	5.14
5	AMR-D	71	10.05	10.27	10.65	13.80	3.92
6	EMR-B	139	28.38	32.94	42.38	60.75	14.60
7	EMR-D	139	26.30	24.37	32.18	37.48	7.06
8	EUR-A	412	4.71	3.04	5.78	6.65	2.71
9	EUR-B1	166	11.71	16.75	16.85	15.77	3.40
10	EUR-B2	52	8.86	11.21	13.96	18.62	4.54
11	EUR-D	243	6.01	3.36	6.58	5.80	1.26
12	SEAR-B	396	6.23	7.59	7.18	10.01	3.23
13	SEAR-D	1335	7.49	2.98	7.72	9.24	2.85
14	WPR-A	150	107.90	71.35	173.86	171.27	63.29
15	WPR-B1	1354	5.24	3.36	6.64	7.90	1.94
16	WPR-B2	144	8.02	10.86	13.66	15.22	4.35
17	WPR-B3	7	13.06	31.39	19.16	23.05	7.14

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.20: Cost-benefit ratios – all costs, time saving benefits only (population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Cost-benefit ratio, by intervention				
			1	2	3	4	5
1	AFR-D	335	5.31	6.59	7.64	7.04	2.59
2	AFR-E	346	6.77	9.00	9.09	8.45	3.23
3	AMR-A	314	50.63	77.65	77.65	73.96	38.16
4	AMR-B	442	8.41	9.38	12.59	10.13	3.16
5	AMR-D	71	5.59	7.17	8.47	7.25	2.53
6	EMR-B	139	23.17	28.04	38.14	30.83	11.36
7	EMR-D	139	18.30	19.65	28.61	23.91	5.48
8	EUR-A	412	2.49	2.00	4.90	4.63	1.80
9	EUR-B1	166	10.75	15.89	16.21	12.70	2.95
10	EUR-B2	52	7.07	9.58	12.45	10.76	3.51
11	EUR-D	243	5.51	3.11	6.34	3.40	1.04
12	SEAR-B	396	4.58	6.32	6.25	5.51	2.70
13	SEAR-D	1335	4.49	1.79	6.63	6.25	1.99
14	WPR-A	150	101.84	68.50	171.24	165.11	60.67
15	WPR-B1	1354	3.12	2.33	5.70	5.38	1.14
16	WPR-B2	144	5.77	8.84	12.13	11.31	3.57
17	WPR-B3	7	12.12	29.12	17.24	15.80	5.84

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses

Table A 3.21: Cost-benefit ratios - high cost and low benefit assumptions (population remains stable from year 2000 until 2015)

WHO Region Number	Region/ Country	Population (million)	Cost-benefit ratio, by intervention				
			1	2	3	4	5
1	AFR-D	335	1.51	1.96	2.04	2.65	0.92
2	AFR-E	346	1.75	2.51	2.38	2.95	1.11
3	AMR-A	314	20.57	29.11	27.62	60.82	39.28
4	AMR-B	442	1.61	2.21	2.89	3.05	0.94
5	AMR-D	71	1.18	1.76	1.98	2.16	0.77
6	EMR-B	139	4.38	6.81	9.03	11.17	3.36
7	EMR-D	139	3.96	5.00	6.88	7.77	1.67
8	EUR-A	412	0.95	0.73	1.33	1.68	0.79
9	EUR-B1	166	1.90	3.55	3.59	3.52	0.84
10	EUR-B2	52	1.29	2.24	2.89	3.08	0.98
11	EUR-D	243	0.93	0.70	1.44	1.17	0.28
12	SEAR-B	396	0.84	1.47	1.43	1.60	0.74
13	SEAR-D	1335	1.11	0.59	1.72	1.94	0.65
14	WPR-A	150	17.69	16.09	40.07	40.05	16.43
15	WPR-B1	1354	0.57	0.56	1.34	1.36	0.33
16	WPR-B2	144	1.19	2.17	2.85	3.01	1.02
17	WPR-B3	7	2.09	6.38	3.77	4.20	1.68

Interventions: by the year 2015 -

Intervention 1: Halving the proportion of people without access to improved water sources

Intervention 2: Halving the proportion of people without access to improved water sources and sanitation

Intervention 3: Everyone has access to improved water and improved sanitation services

Intervention 4: Intervention 3 + everyone has a minimum of water disinfected at the point of use

Intervention 5: Everyone has access to a regulated piped water supply & sewage connection in their houses