Chapter 4

Effective water governance: water's value and cost effectiveness

Water's real value should guide water governance and management to the most economically, socially and environmentally efficient options.

Despite water's necessity for human life, it is among the world's most undervalued resources. What is water's true economic value? The water sector typically focuses on the financial costs of ensuring water quantity and quality. Economic value reflects preferences that depend on services and benefits affected by scarcity. Water's economic value is usually higher in arid areas because water resources are scarcer and thus trigger more competition between users.[1] A more difficult question: Who is using the water and for what purpose? The difficulty of this question is that water's value is closely associated with water value-added or productivity.[2]

Water's economic value

The economic value of consumer goods or assets—that is, the satisfaction they provide or their ability to generate income—is indicated by price. Price signals guide resource allocation and use.

Understanding and capturing water's value is necessary to compare the costs and benefits of policies, programmes and projects. But this is not an easy task.

Establishing water's economic value is one of the most discussed and debated issues in water use and allocation efficiency.[3] Young (2005) stated that "water valuation presents the economic analyst with a wide range of challenging issues and problems. Because water values tend to be quite site-specific, spatial and temporal, each case confronts its own unique issues and typically requires its own original valuations. Effective measurement of water values demands skill and rigueur in application of all the tools of the applied economist's trade. These tools include data collection, statistical analysis, optimization models and research reporting."

As measured by price, water's value is what users are willing to pay for it.[4] Consumers will use water as long as the benefits exceed the costs. Municipal and industrial water provide direct benefits to users and indirect benefits to society. Direct benefits are easy to identify but may be difficult to measure accurately. Indirect benefits, such as impacts on public health and well-being, are very difficult to identify and measure. One approach to estimating the benefits of municipal and industrial water is the contingent valuation method, which uses surveys assessing willingness to pay for improved water. Another is the conjoint analysis, which asks users to select among alternatives. To date, willingness to pay is the most successful application of economic

Box 4.1 **Costs of low-quality drinking water: a case from Amman, Jordan**

In the summer of 1998 a major drinking water pollution outbreak occurred in Amman due to a malfunction of the capital's water treatment plant. So the government advised people "to take more precautionary measures and boil water for at least one minute before drinking it."

In November 2007 thousands of Jordanians were sickened by water contamination. Experts fear the worst is yet to come unless a lasting solution is found to the kingdom's water shortages. The latest incident involved a refugee camp near Irbid, 120 kilometres north of Amman. People reported that their taps had turned yellow and feared their health was at risk. The government immediately shut down the water supply after experts realized the water had been contaminated by sewage. In July 2009 nearly 1,000 people from a village near the northern city of Mafraq developed diarrhoea and high fever from Cryptosporidium, a parasite that had made its way into the local water system. Investigations revealed that the disease had spread because of the town's worn-out water network.

Because of these and similar water crises, small and medium reverse osmosis units have spread in the market. Vendors currently sell and/or distribute treated water on demand. In Amman City alone, more than 120 small businesses are in operation. Many households have installed small reverse osmosis units to ensure adequate drinking water quality. These units' capacities are in the range of 1–5 m^3/d. The annual average value of machinery and apparatus for filtering or purifying water, most of them 1.5 m^3/d, jumped from $2.08 million between 1995 and 1998 to $10.5 million between 2007 and 2011. People are losing trust in drinking water provided by the public network.

Source: IRIN 2007.

valuation techniques for water and sanitation in developing countries.[5]

Resource allocation and use rely on market mechanisms, centralized or decentralized planning systems, or both. Market mechanisms cannot function properly alone for managing and allocating water. In the market, water's price should reflect its economic value. Because public agencies price water at its average delivery cost rather than its value to producers, water is rarely priced at its economic value.[6] Water can be valued by supply (cost of provision) or demand (value-added from productive use). When water is an intermediate good, such as in irrigated agriculture or industry, water demand is derived from the demand for the final output and from water's role in producing this output. In this case, water demand is a function of water's price and the price of the final product. Estimating water's economic value is equivalent to isolating water's marginal contribution from the total output value.[7] The market system thus fails to reach efficient levels; better situations exist where a market participant (producer or consumer) may be made better off without making someone else worse off, as Pareto optimality conditions in allocation.[8] Water rates set by the market and/or planning systems are also not usually at their optimum level, leading to misuse.[9] Market failure to achieve optimal water allocation and price can be attributed to several factors, including ignoring environmental or social benefits or costs.[10] Surface water and groundwater, for example, are often used without paying their "real economic value" in quality and quantity. Rather, policy- and decision-makers focus on covering at least part of the financial costs of provision, leading to misuse, abuse and pollution.[11]

Vague property rights can also contribute to market failure. Absence of specific rules governing groundwater exploitation, for example, can lead to overuse. The water sector is also a natural monopoly; accordingly, governments have usually created public authorities to monitor and control water.

Water and sanitation

Investment in water and sanitation typically generates many financial, economic, environmental and social benefits. Access to clean drinking water and sanitation reduces health risks and frees up time for education and other productive activities in rural areas, improving social capital as well as increasing labour productivity. Proper disposal of wastewater helps improve quality of life, reduce the child mortality rate and protect surface water bodies, benefiting the environment and other economic sectors. But these benefits, usually considered intangible, are not well presented in technical and feasibility studies, so they remain invisible to key decision-makers.[12] Because the benefits of water and sanitation in Arab countries remain insufficiently documented, water and sanitation receive lower priority than other public expenditure sectors.

Health, environmental and political costs

Water and sanitation deficiencies carry high health, environmental and political costs. Waterborne disease outbreaks and the time and cost of treatment reveal the negative health impact. The problem lies not only in absence of water but in lack of access to it, a problem compounded by mismanagement and unfair distribution. Water governance policies and structures must address these issues together.

Affordable, safe and sustainable sanitation can provide:

- Better health from safe disposal of pathogenic domestic waste.
- Better crops from applying decomposed, nutrient-rich domestic waste on fields.
- Better nutritional status of family members from better harvests.
- More income from excess harvest used for food and well-being.
- Better harvest because of fewer sick days.
- Less expenditure on hospital/doctor visits and medicine.
- Better education and career prospects because of fewer sick days at school.

Poor water and sanitation pose considerable public health risks. In 2003 waterborne diseases, notably diarrhoea, accounted for about 4 per cent (60.7 million disability—adjusted life years, or DALYs) of the global disease burden; 1.6 million deaths a year were attributable to unsafe water and sanitation, including lack of hygiene.[13] In 2008 the WHO and the United Nations Environment Programme reported that about 94 per cent of the 1.8 million annual deaths from diarrhoeal disease are attributable to environmental causes—particularly, unsafe drinking water and inadequate sanitation.[14]

Policy interventions can reduce mortality and morbidity-related health costs of water-related diseases. But the health benefits of water and sanitation policy interventions are sometimes underestimated when prioritizing, planning and budgeting. Economic valuation studies demonstrate that the health benefits of drinking water and sanitation interventions can be significant. Cost-benefit analyses have also shown that the benefits of drinking water quality and sewage treatment improvements are frequently greater than the corresponding investment and operating costs. Economic studies of water and sanitation interventions reviewed in Organisation for Economic Co-operation and Development countries have found benefit-cost ratios varying from 1 to 2.3, suggesting significant cost savings in health care.[15]

The health impacts of water-related diseases such as diarrhoea have a significant economic cost. Ample evidence accumulated over years confirms the link between improved health and water and sanitation quality. This link derives from the many waterborne organisms that can infect humans, causing diseases such as cholera, typhoid, trachoma, schistosomiasis, malaria, filariasis and dengue fever.[16] In the Eastern Mediterranean region diarrhoeal diseases cause 16 per cent of deaths in children under five. Providing safe water could reduce diarrhoeal disease incidence by about 21 per cent; improving sanitation, could reduce incidence by 37.5 per cent.[17] The economic value of these health benefits must be assessed to determine whether interventions are economically efficient.[18]

Table 4.1 displays the economic benefits of water and sanitation improvements. Providing water and sanitation infrastructure can improve livelihoods and life conditions. Direct support refers to sanitation infrastructure that will produce an income, such as treated wastewater in agriculture. Indirect support can consist of training to help poor people choose the sanitation infrastructure they need, eventually bringing higher health and hygiene levels.

To improve domestic water and sanitation on a large scale, investment must increase. With poverty reduction strategies dominating the international development agenda and infrastructure development improving productivity and raising income level, there is ample justification to allocate more investment in safe drinking water and sanitation. Costs of low-quality drinking water are high (Box 4.1), and cost-benefit analyses have predicted high returns on investments in domestic water and sanitation.[19] Safe sanitation enables poor people to undertake initiatives and mobilize their working assets. Without minimal safe sanitation, and the resulting health and environmental improvements, poor people might lack sufficient energy and productivity to initiate and sustain relevant action.

Water and sanitation projects provide important environmental benefits. The negative impact of untreated water on surrounding ecosystems is evident. The unregulated dumping of effluent waters has polluted many Arab shores and rivers. Untreated wastewater is also a major cause of underground water pollution. Because several Arab countries depend heavily on underground water, the negative health and environmental impact of this pollution is enormous. Treated wastewater is also becoming an important water source for agriculture and industry (see Chapter 2). The environmental benefits of a tightly built and managed sewer network that reduces or even eliminates soil and underground water pollution are clear. The positive environmental impacts of adequate sanitation on the environment also include reduced air pollution.

Allocating water among sectors has been seen as a macroeconomic decision and policy choice. But the implications of such contested decisions go far beyond economics, especially where strong advocacy groups represent sectors.[20] The political costs of water mismanagement can be very high: mass migration, economic recession, collapse of social order, and civil unrest and complaints.

Costs of lack of water and sanitation: an estimate for 2010

The cost-effectiveness approach can help identify the economic, social, environmental and political costs associated with lack of domestic water.[21] The cost-effectiveness ratio is used to cross-check and categorize water and sanitation projects based on the required costs to achieve the established objectives. Cost-effectiveness analysis is used instead of cost-benefit analysis particularly where output can be quantified but not monetized. The ex-ante appraisal assesses expected impacts, while the ex-post evaluation measures achieved impacts. Stakeholder consultations, focus groups and expert panels could provide a wider understanding of the key socio-economic issues for economic value. But cost-effectiveness analysis can only compare options that are simple to implement and have the same type of impact, a situation that rarely exists, so a combination of approaches should be used to reach the best "value for money" assessment. A quick and easy execution depends on the measures considered and the information available to quantify costs and effects. Calculating the cost-effectiveness analysis is fairly straightforward with reliable data.[22]

The costs of inadequate water and sanitation include health care costs, mortality and morbidity, and consumer willingness or ability to pay other sources, such as vendors.[23] Questionable water quality may also lead people to buy bottled water to avoid illness. Including externalities not typically caught in micro-economic cost-benefit studies may help capture projects' social rate of return.

We estimate each of the above-mentioned costs for 2010 to demonstrate the magnitude of economic damage caused by inadequate water and sanitation in Arab countries. The values of these costs are then extrapolated for 2010–2020, giving the cost of inaction.[24] We then estimate the required investment over the same period. This analysis can provide some insight into the magnitude of return on such investment and show how beneficial improving water and sanitation would be.

Costs of buying water from vendors in 2010

In 2010 approximately 63 million people in the Arab region did not have access to safe drinking water.[25] Because most of these people are poor and/or live in lower income countries, their willingness to pay is expected to be higher than that of people connected to the water network.[26] They would therefore rely on private vendors, springs, water harvesting and so forth to secure their water needs. A

Table 4.1 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	Fewer health workers falling sick	More efficiently managed water resources and effects on vector bionomics
Patients	Less expenditure on treatment and less related costs Less expenditure on transport in seeking treatment Less time lost due to treatment seeking	Fewer days lost at work or at school Less time lost for parent/caretaker of sick children Loss to death avoided	More efficiently managed water resources and effects on vector bionomics
Consumers	Better socio-economic conditions and better job opportunities		Time savings related to water collection or accessing sanitary facilities Labour-saving devices in household Move 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	Less impact on productivity of ill- health of workers	Benefits to agriculture and industry of improved water supply, more efficient management of water resources—timesaving or income-generating technologies and land use changes and more labour productivity.

Source: Hutton and Haller 2004.

basic need of 50 litres per capita per day may be met from water vendors at about $1.5 per cubic metre.[27] We estimate the cost of buying water from vendors in selected Arab countries for 2010 at $1,285.56 million (Figure 4.1).

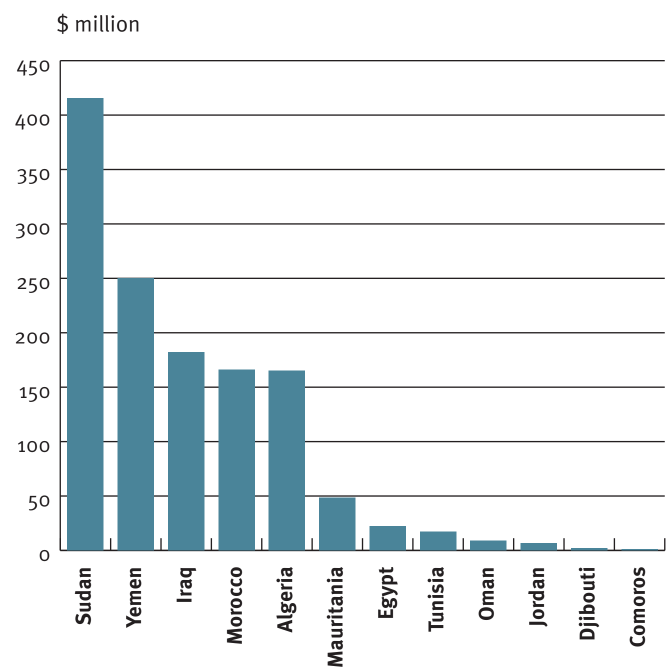
We found that Sudan and Yemen had the highest water shortage costs, at $415.42 and $250.21 million, respectively. This can be attributed to the high proportion of people lacking improved water and sanitation services.

Avertive costs on bottled water in 2010

Individuals or households offset some health risks through avertive expenditure. Consumption of bottled water is rising due to lifestyle and taste preferences as well as low municipal water quality.

According to the Lebanese Ministry of Environment Report (2001), about 0.5 per cent of per capita expenditures in Lebanon are on bottled water, implying a per capita bottled water consumption of 115 litres a year.[28] The report estimated bottled water consumption associated with perceptions of low municipal

Figure 4.1 Estimated cost of water purchase from vendors in selected Arab countries, 2010



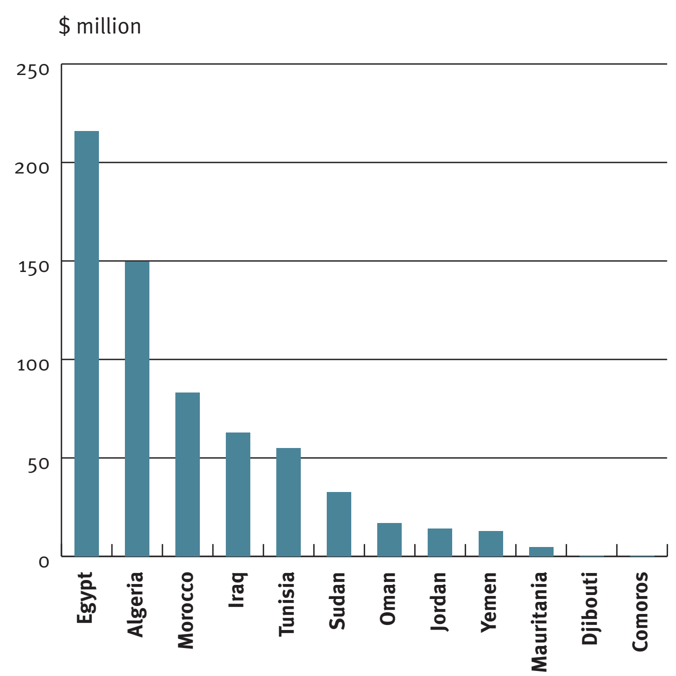
Source: Authors' estimates.

Table 4.2 **Estimated total costs attributable to none or lack of provision of improved water and sanitation in selected Arab countries, 2010**

Country	Cost of diarrhoeal death	Cost of diarrhoeal illness	Cost of diarrhoeal treatment	Cost of water purchase from vendors	Avertive costs on bottled water	Total cost attributed to none or lack of provision of improved water and sanitation	GDP current	% of GDP
Algeria	837.9	111.8	109.7	165.1	149.6	1374.0	161979.4	0.85
Comoros	7.7	0.7	3.9	1.0	0.3	13.6	541.1	2.52
Djibouti	14.0	1.1	3.6	2.0	0.5	21.1	1049.1	2.01
Egypt	192.2	177.3	286.6	22.2	216.0	894.2	218894.3	0.41
Iraq	655.7	96.5	165.0	182.1	62.7	1162.1	81112.4	1.43
Jordan	24.6	25.0	26.0	6.8	14.1	96.5	26425.4	0.37
Mauritania	57.1	3.9	16.3	48.3	4.7	130.3	3613.9	3.6
Morocco	356.5	61.1	96.1	166.2	83.1	763.0	90802.9	0.84
Oman	45.8	39.7	9.0	9.1	17.0	120.6	57849.2	0.21
Sudan	668.2	73.2	203.3	415.4	32.7	1392.9	66996.5	2.08
Tunisia	56.8	25.9	27.6	17.2	54.9	182.4	44238.2	0.41
Yemen	319.4	36.6	129.1	250.2	12.9	748.2	31042.7	2.41
Arab countries	3235.8	652.8	1076.1	1285.6	648.5	6898.8	784545.1	0.88

Source: Authors' estimates.

Figure 4.2 **Estimated avertive costs on bottled water in selected Arab countries, 2010**



Source: Authors' estimates.

water quality at an average of 86 litres per capita a year. At an average cost of $0.23 a litre, this represents about $86 million a year in avertive expenditures.[29]

Parker (2010) estimated the world outlook for bottled water across more than 200 countries. For each year, he reported estimates for potential demand, or potential industry earnings from bottled water sales. The estimated demand for bottled water for Arab countries rose from $1,429 million in 2001 to $2,229 million in 2011. The estimates of latent demand for bottled water in 2010 are about $2,090 million.

If one assumes that 50 per cent of bottled water consumption comes from efforts to avoid the health risks of low-quality water, this represents about $648.5 million a year in avertive expenditures in selected Arab countries. Other estimates go much higher.

The Arab countries with the largest populations were burdened with the highest avertive bottled water costs. Egypt and Algeria had the highest, at $216.0 and $149.6 million, respectively (Figure 4.2).[30]

Costs of diarrhoeal death in 2010

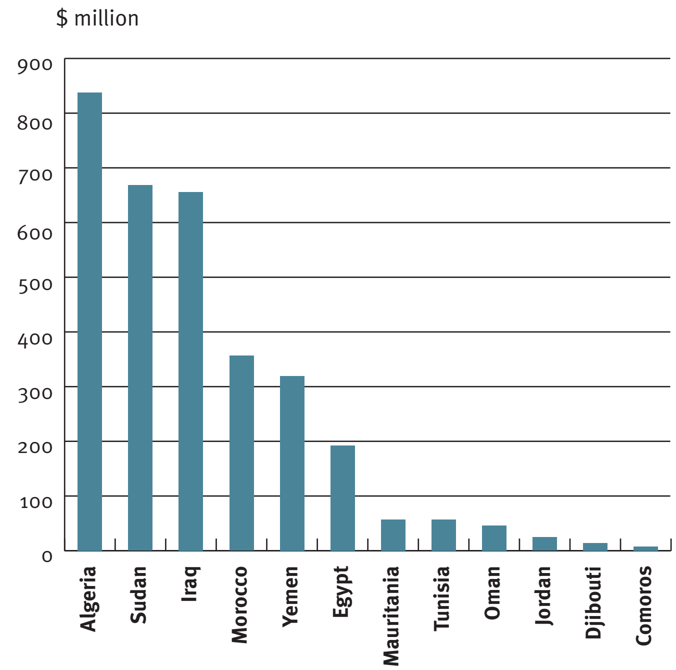
Waterborne disease outbreaks are the most obvious manifestation of the impacts of contaminated water on human health. The Arab region is severely affected. The number of recorded cases of waterborne disease in recent years shows that access to safe drinking water remains a problem. "Diarrhoeal diseases are estimated to be the largest contributor to the burden of water-related disease. Infectious diarrhoea can be caused by bacteria (for example, cholera, E. coli, shigellosis, typhoid fever and so forth); viruses (for example, norovirus, rotavirus and so forth); and protozoan parasites (for example, amoebiasis, cryptosporidiosis, giardiasis)."[31]

WHO and UNEP (2008) estimated that 94 per cent of the 1.8 million annual global deaths from diarrhoeal disease may be attributed to environmental causes—particularly, unsafe drinking water and inadequate sanitation. Not all of these deaths are water-related, but providing adequate drinking water and improved sanitation and hygiene would reduce the frequency of children diarrhoeal deaths by 88 per cent.[32]

Using the most recent data on death/ DALYs and age-standardized death rate per 100,000, and assuming that 80 per cent of diarrhoeal cases were due to inadequate drinking water, sanitation and hygiene, we estimated the number of deaths caused by diarrhoea in 2010 in selected Arab countries at 97,583 (1,386,675 DALYs).[33] Applying the human capital approach, and assuming that the value of 1 DALY corresponds to per capita gross domestic product (GDP) in dollars, the annual cost of diarrhoeal death was about $3,235.84 million in selected Arab countries in 2010 (Figure 4.3).

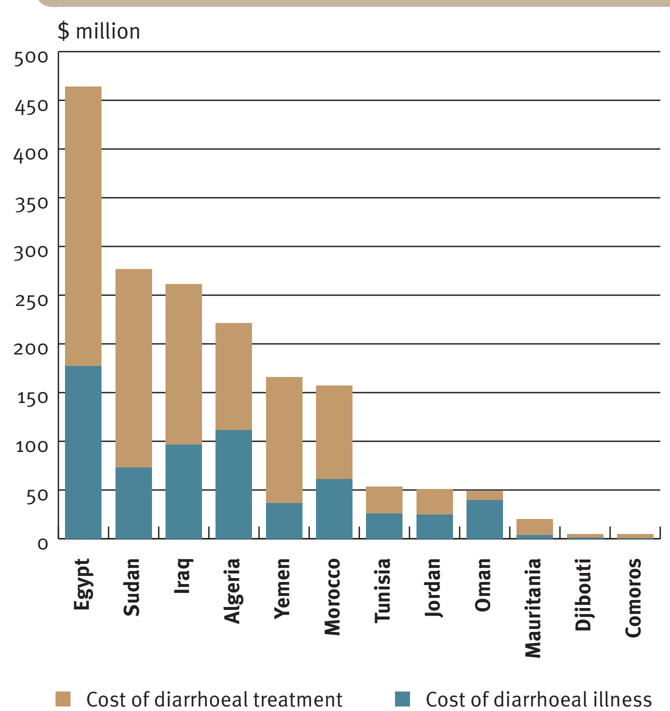
The magnitude of costs due to diarrhoeal deaths in each of these countries may be attributed to the number of diarrhoeal deaths, the number of DALYs per death at country level, as well as prevailing GDP per capita. Costs may thus not always reflect death incidence. Rather, DALYs per death and/or GDP,

Figure 4.3 Estimated cost of diarrhoeal death in selected Arab countries, 2010



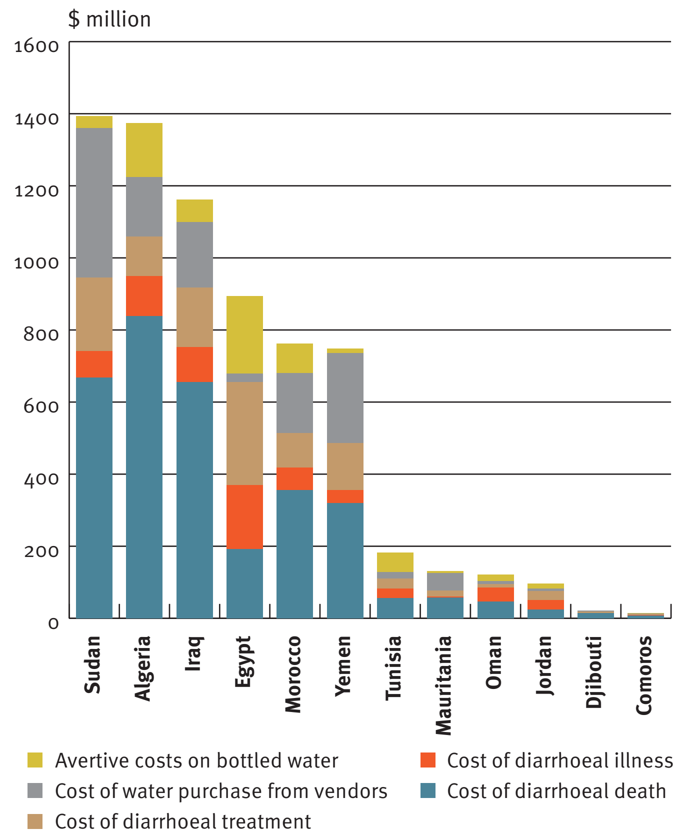
Source: Authors' estimates.

Figure 4.4 Estimated costs of diarrhoeal morbidity (illness and treatment) in selected Arab countries, 2010



Source: Authors' estimates.

Figure 4.5 Estimated costs attributable to lack of provision of improved water and sanitation in selected Arab countries, 2010



Source: Authors' estimates.

even in countries experiencing the same level of diarrhoeal deaths, may also contribute to high death costs.

The highest cost of diarrhoeal death was found in Algeria, Iraq and Sudan, where it exceeded $500 million. Comoros and Djibouti experienced the lowest. This low cost can be attributed to these countries' very low per capita income.

Costs of diarrhoeal morbidity in 2010

Costs of diarrhoeal illness in 2010

To estimate the costs of morbidity (cost of illness and cost of treatment), we calculated the prevalence of diarrhoea in children under five using 2008 WHO data, the most recent available, and 2010 UNDESA population estimates.[34] We assumed that 80 per cent of diarrhoeal cases were due to lack of improved water and sanitation.[35] The cost of illness is represented by the total days lost due to diarrhoea, which were estimated assuming that the average episode of diarrhoea would last five days.[36] The welfare losses due to parents' days lost from work were estimated as the opportunity cost of time equivalent to 15 per cent of daily monetary income, using GDP per capita proxy time value. The number of diarrhoeal morbidity cases among children under five attributed to lack of improved water and sanitation involved DALYs of 239,864 for the selected Arab countries.[37] We estimate the annual cost of diarrhoeal illness at $652.83 million in selected Arab countries in 2010.

Costs of diarrhoeal treatment in 2010

Diarrhoea's complexity and the rising cost of treatment put additional burden on the health sector. To estimate the cost of diarrhoeal treatment in Arab countries, we calculated the annual number of episodes (all children under five) using WHO statistics.[38]

We used per capita public and private health expenditures to estimate the treatment cost of diarrhoeal diseases attributed to unsafe water and sanitation. We assumed the cost of a doctor visit ($8), medicines ($8.5), oral rehydration therapy and caregiver time ($7). As above, the treatment cost for diarrhoea attributed to lack of improved water and sanitation services is 80 per cent of diarrhoeal treatment cost for children under five. The estimated annual cost of diarrhoeal treatment was $1,076.08 million in selected Arab countries in 2010 (Table 4.2). Accordingly, the cost of diarrhoeal morbidity (illness and treatment) was $1,728.91 million in the selected Arab countries in 2010 (Figure 4.4).

The cost of lack of domestic water and sanitation in selected Arab countries is thus about $6,898.81 million for 2010, representing 0.88 per cent of GDP (Table 4.2).

The absolute figures indicate that Algeria, Iraq and Sudan experience the highest cost of inadequate water and sanitation, exceeding $1,000 million (Figure 4.5). The cost in these countries together accounted for $3,928.93 million, about 57 per cent of the cost in Arab countries studied.

Relatively, Comoros, Djibouti, Iraq, Mauritania, Sudan and Yemen experience the highest cost as a proportion of GDP due to inadequate water and sanitation, exceeding 2 per cent.

Projection of water-associated costs for 2010–2020: cost of action versus cost of inaction

To demonstrate the benefit of improving water and sanitation, we extrapolated the costs of lack of these services for 2010–2020 and estimated the required investment for universal provision over the same period. These estimates should show the magnitude of investment return. All calculations are undiscounted and estimated using 2010 prices.

Cost-effectiveness analysis can help assess and select the most economically efficient measure to meet escalating water demand. Several measures can be taken to achieve the goal of universal water and sanitation provision involving different technologies, approaches and funding mechanisms. By considering the costs of inaction, one can evaluate the costs of various actions to select the optimal one.

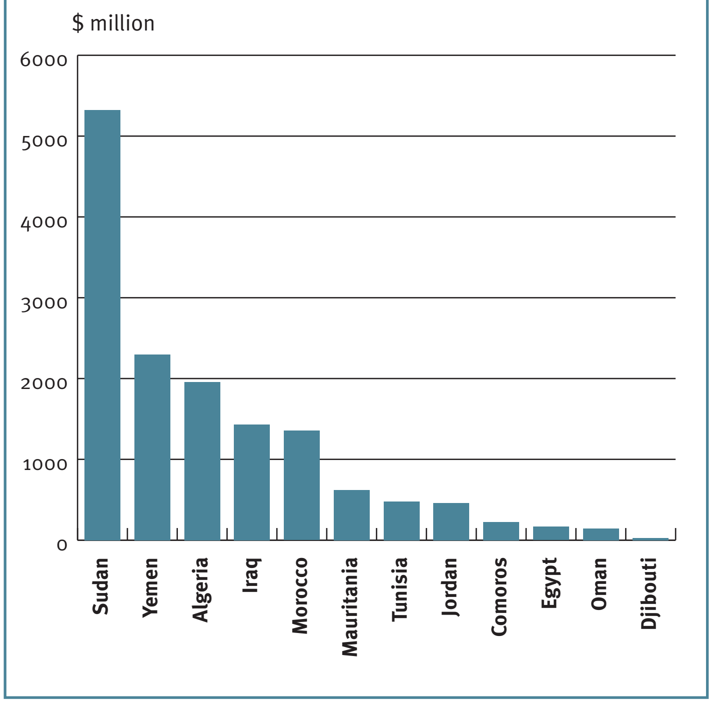
If no action is taken to improve domestic water and sanitation, the number of people lacking these services in the Arab region is expected to reach at least 76 million and 103 million, respectively, by 2020.[39] This lack of improved water and/or sanitation, typically associated with waterborne illnesses and mortality, will incur social costs.[40]

The values in tables 4.3 and 4.4, calculated using the same methods as for Table 4.2, relate to the cost of inaction. All these costs can be converted to benefits if and when drinking water and sanitation are improved and extended. This conversion will require effective water governance.

Costs of buying water from vendors for 2010–2020

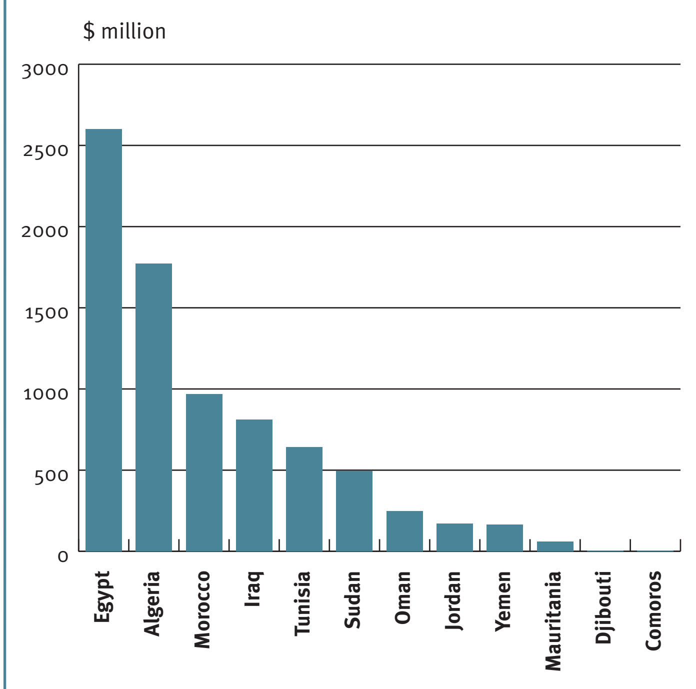
By 2020, 76 million people in the Arab region are expected to lack access to safe drinking water. They will therefore rely on private vendors, springs, water harvesting and so forth to secure

Figure 4.6 Projected costs of water purchase from vendors in selected Arab countries, 2010–2020



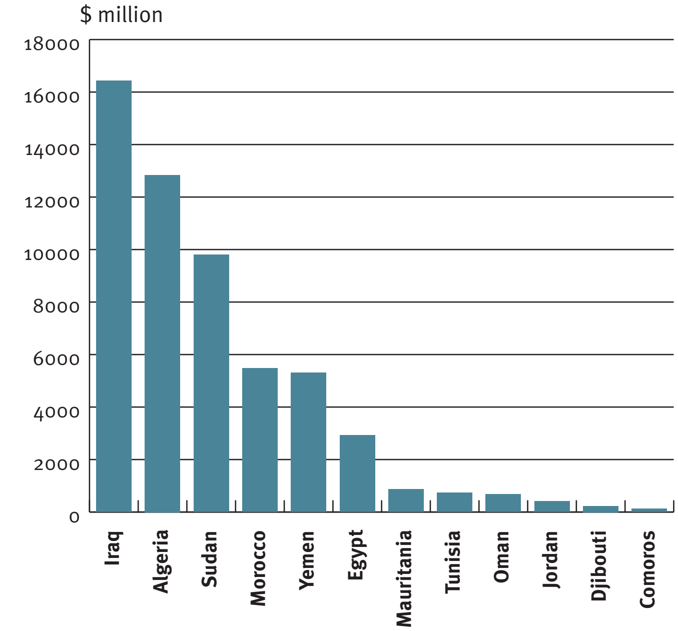
Source: Authors' estimates.

Figure 4.7 Projected avertive costs on bottled water in selected Arab countries, 2010–2020



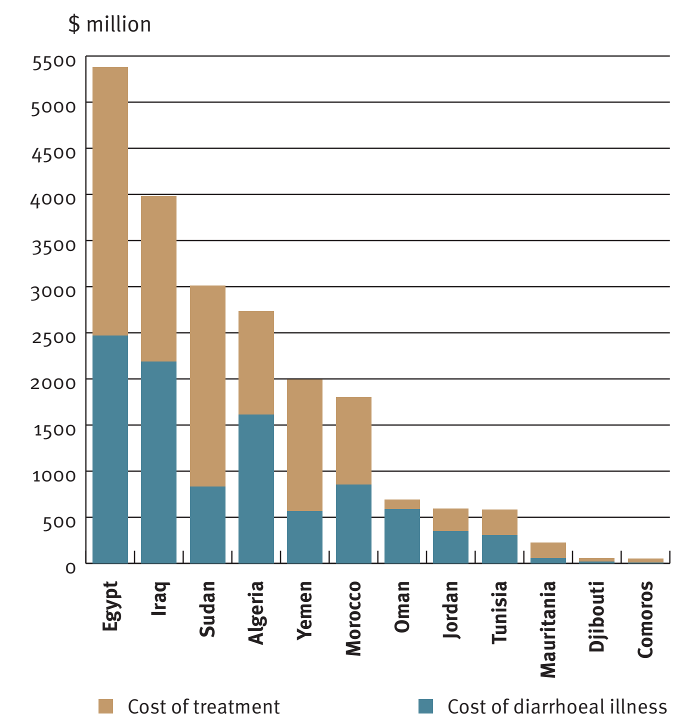
Source: Authors' estimates.

Figure 4.8 Projected costs of diarrhoeal death in selected Arab countries, 2010–2020



Source: Authors' estimates.

Figure 4.9 Projected costs of diarrhoeal morbidity (illness and treatment) in selected Arab countries, 2010–2020



Source: Authors' estimates.

their water needs. The cost of water purchase from vendors for 2010–2020 in selected Arab countries will be about $14,481.11 million (Figure 4.6, Table 4.3).

Arab countries with the highest spending on water vendors from 2010 to 2020 include Algeria, Iraq, Morocco, Sudan and Yemen, with $1,955.6; $1,430.62; $1,353.37; $5,322.10; $2,298.53 million, respectively.

Avertive costs on bottled water for 2010–2020

Assuming that current trends of bottled water consumption prevail, the average latent demand for bottled water from 2010 to 2020 is estimated at $15,882.72 million.[41] Assuming that 50 per cent of bottled water consumption is related to the health risks of low-quality drinking water, this represents a cumulative avertive cost from bottled water of about $7,941.36 million in selected Arab countries (Figure 4.7, Table 4.3).

Costs of diarrhoeal death for 2010–2020

The number of deaths attributed to lack of water and sanitation is about 992,363 for 2010–2020 for the selected Arab countries. This amounts to 18,339,459 DALYs over the same period. Applying the human capital approach, and assuming that the value of 1 DALY corresponds to the per capita GDP in dollars, the estimated annual cost of diarrhoeal death in the selected Arab countries is $55,839.63 million for 2010–2020 (Figure 4.8, Table 4.3).

Costs of diarrhoeal morbidity (illness and treatment) for 2010–2020

Costs of diarrhoeal illness for 2010–2020

The number of diarrhoeal cases among children under five attributed to lack of water and sanitation is expected to lead to a loss of DALYs of 2.734 million for the selected Arab countries for 2010–2020. The cumulative cost of diarrhoeal illness is accordingly about $9,847.82 million in selected Arab countries over the same period (Table 4.3).

Treatment is estimated at $11,254.54 million for 2010–2020.

If one adds illness and treatment costs, the cost of diarrhoeal morbidity cases related to inadequate drinking water and sanitation in

Table 4.3 Estimated costs attributable to none or lack of provision of improved water and sanitation in selected Arab countries, 2010–2020 ($ million)

	Cost of diarrhoeal death	Cost of diarrhoeal illness	Cost of diarrhoeal treatment	Cost of water purchase from vendors	Avertive costs of buying bottled water	Total cost attributed to none or lack of provision of improved water and sanitation
Algeria	12,839.6	1,610.0	1,126.2	1,955.6	1,771.9	19,303.3
Comoros	119.8	10.0	40.8	226.1	4.1	400.9
Djibouti	232.0	17.4	38.3	27.5	5.7	320.9
Egypt	2,926.0	2,468.1	2,914.1	165.7	2,599.8	11,073.6
Iraq	16,433.4	2,189.1	1,789.6	1,430.6	810.6	22,653.3
Jordan	409.3	347.5	246.6	461.0	171.2	1,635.5
Mauritania	867.0	55.0	173.4	619.0	58.5	1,772.9
Morocco	5,484.8	855.4	946.4	1,353.4	968.3	9,608.4
Oman	673.7	589.9	100.6	145.2	246.8	1,756.0
Sudan	9,807.5	830.0	2,179.1	5,322.1	495.6	18,634.3
Tunisia	736.8	307.6	274.0	476.6	643.0	2,438.0
Yemen	5,309.7	567.9	1,425.5	2,298.5	165.9	9,767.5
Total	55,839.6	9,847.8	11,254.5	14,481.1	7,941.4	99,364.5

Source: Authors' estimates.

selected Arab countries is about $21,102.36 million for 2010–2020 (Figure 4.9, Table 4.3).

The cost of lack of domestic water and sanitation in selected Arab countries is thus about $99,364.46 million for 2010–2020 (Table 4.3).

Figure 4.10 presents the cost of inaction—that is, maintaining the current trends and percentages of water and sanitation provision. These costs, no matter who covers them, are social costs. This estimate is extremely conservative: we considered only avertive and direct health costs. Including environmental, social and political costs would make these estimates much higher.

The cost of action: direct investment in water and sanitation for 2010–2020

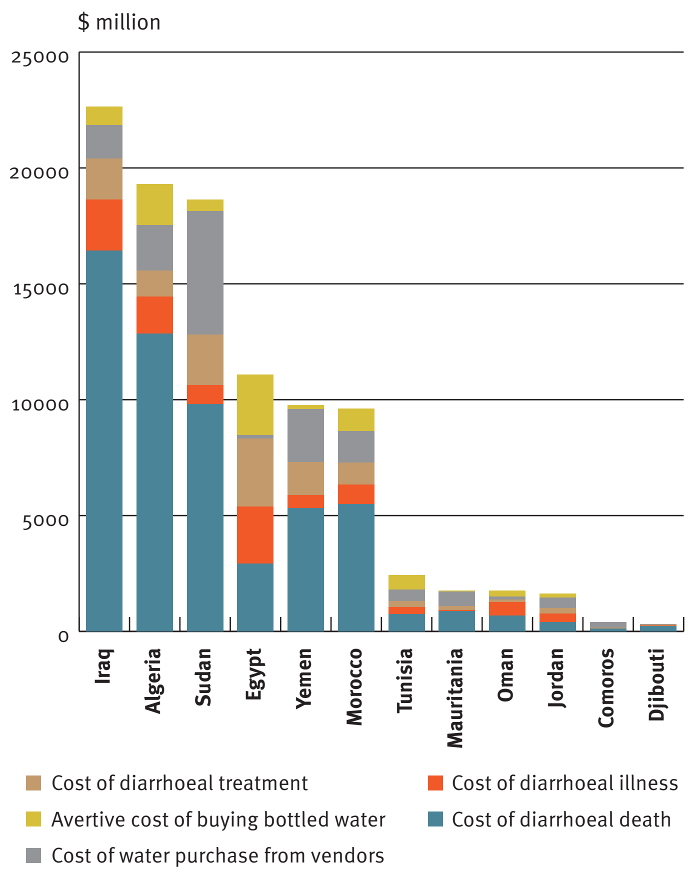
Upgrading water and sanitation, an established international goal, is vital to livelihoods and social well-being in Arab countries. MDG 7, which all Arab countries have committed to, calls for substantive increase in providing water and sanitation.

Many countries have made major progress. UNICEF (2008) indicated that about 84 per cent of the Arab population had access to improved water in 2006. This means about 50 million out of 324 million Arabs, mostly in Algeria, Iraq, Morocco, Somalia, Sudan, Syria and Yemen did not have a secure water supply.[42] Achieving 100 per cent provision of clean water is required. But other issues are also necessary, such as equity; accountability and transparency; efficient distribution; affordability for consumers; and water quality, reliability and sustainability. All these issues relate to efficient water governance.

To estimate the cost of action to achieve universal water and sanitation provision, we calculated the number of people who would lack access to improved water and sanitation for 2010–2020, based on population projections and current provision levels. Using the WHO cost estimate averages for water and sanitation provision per household, we then calculated capital and recurrent costs.[43]

We carried out an incremental cost analysis, estimating the costs of extending access to water

Figure 4.10 Projected costs of low-quality water and sanitation provision in selected Arab countries, 2010–2020



Source: Authors' estimates.

and taking population growth into account. The main data source for initial investment costs of water and sanitation interventions was the WHO global water and sanitation assessment 2012 report.[44] The WHO report provided annual capital and recurrent costs for a typical water and sanitation project, assuming a project lifespan of twenty years. These annual figures provided by the WHO were multiplied by the number of remaining years to 2020. Provision in 2010 and 2011, for instance, would involve annual capital and recurrent costs for 11 and 10 years, respectively.

We estimated that 100,406 million and 209,676 million households in selected Arab countries need improved water and sanitation, respectively, for 2010–2020 (Figures 4.11 and 4.12).[45] The cumulative costs of providing improved water for 2010–2020 were estimated at $19,692.35 million. The cumulative costs of providing sanitation over the same period were found, as expected, to be higher, at $52,531.64 million. This brings the capital and recurrent costs of providing improved water and sanitation in selected Arab countries for 2010–2020 to $72,223.99 million (Table 4.4).

Rate of return on investment in water and sanitation for 2010–2020: action vs. inaction

To assess the economic viability of potential actions to improve domestic water and sanitation provision, we made undiscounted estimates of the required investment for 2010–2020. If these actions are undertaken (Table 4.4), the costs of inaction (Table 4.3) will represent the benefits for each country.

The investment required for universal provision of improved water and sanitation varied considerably among countries. They reached as high as $8,217.06 million, $8,484.21 million, $30,187.13 million and $12,722.43 million in Iraq, Morocco, Sudan and Yemen, respectively (Table 4.5).

The returns on investment in improved water and sanitation are huge (Figure 4.13). And the above estimates do not capture all the social and environmental costs of inaction, such as time wasted by household members to obtain water or get rid of wastewater. Estimating and incorporating such costs would significantly increase these estimates and, accordingly, the rate of return.

But the rate of return on such provision varies considerably, with countries such as Algeria, Egypt, Iraq and Oman reaching 39.35 per cent, 13.36 per cent, 15.97 per cent and 52.37 per cent, respectively (Figure 4.14). Such high rates of return are associated with the limited amount of investment needed for universal provision of improved water and sanitation, relative to potential benefits in avoided health costs. On the other hand, rates of return were negative for poorer Arab countries with lower GDPs per capita and much lower water and sanitation coverage, such as Sudan and Yemen, mainly because all

Table 4.4 Estimated required investment in water and sanitation services provision, 2010–2020 ($ million)

Country	Total capital cost for water provision	Total recurrent cost for water provision	Overall total cost of water provision	Total capital cost for sanitation provision	Total recurrent cost for sanitation provision	Overall total cost of sanitation provision	Overall cost of water and sanitation services provision
Algeria	1,485.6	830.5	2,316.1	700.2	606.0	1,306.2	3,622.3
Comoros	12.5	7.0	19.5	146.4	52.8	199.2	218.7
Djibouti	39.9	22.3	62.2	170.3	51.9	222.2	284.4
Egypt	326.8	182.6	509.4	2,130.7	1,844.3	3,975.0	4,484.4
Iraq	1,502.6	839.7	2,342.3	3,149.0	2,725.8	5,874.8	8,217.1
Jordan	36.1	20.2	56.3	42.4	36.7	79.0	135.3
Mauritania	332.7	185.9	518.6	872.5	755.2	1,627.7	2,146.3
Morocco	1,245.0	696.0	1,941.0	3,507.3	3,035.9	6,543.2	8,484.2
Oman	86.8	48.5	135.3	66.7	57.7	124.4	259.7
Sudan	4,564.5	2,551.0	7,115.5	12,367.0	10,704.7	23,071.7	30,187.1
Tunisia	173.4	97.0	270.4	638.7	552.9	1,191.6	1,461.9
Yemen	2,826.4	1,579.4	4,405.7	4,458.0	3,858.8	8,316.7	12,722.4
Total	12,632.4	7,060.0	19,692.4	28,249.0	24,282.6	52,531.6	72,224.0

Source: Authors' estimates.

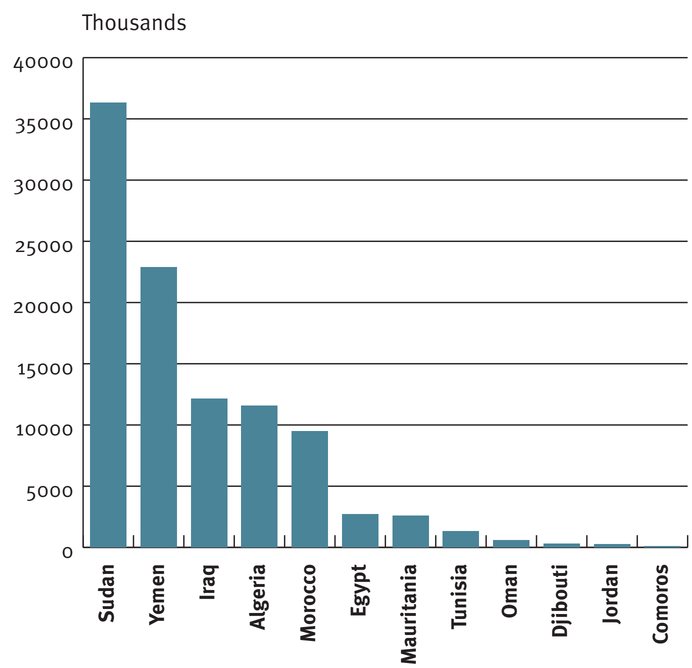
investment figures calculated in this report are based on average house connection costs. Also, when the rate of return is negative, provision options other than house connections must be explored. Options may vary in technologies, approaches and execution modalities. In Yemen, for example, using wells and septic tanks for water and sanitation provision would decrease costs enough to make the rate of return 54.22 per cent.

The goal should be to identify the optimal intervention with the highest rates of return to achieve universal water and sanitation coverage—a goal that cost-effectiveness analysis can help achieve.

Proper valuation of water and cost-effectiveness analysis: tools for establishing effective water governance

Improper valuation of water has marred management and governance approaches, with negative socio-economic and environmental repercussions. Water's value can and should be

Figure 4.11 Projected cumulative number of households without access to improved water in selected Arab countries, 2010–2020



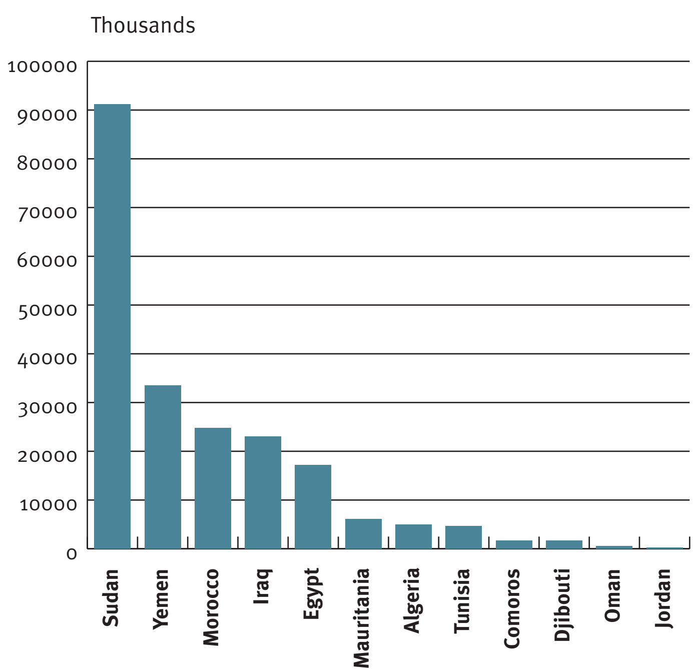
Source: Authors' estimates.

Table 4.5 The expected cost and benefit of action and expected rate of return on investment in improved water and sanitation provision for 2010–2020

Country	Required investments in provision of water and sanitation services ($ million)	Potential benefit (avoided total cost attributed to none or lack of provision of improved water and sanitation; ($ million)	Rate of return (%)	Average annual rate of return (%)
Algeria	3,622.3	19,303.3	432.9	39.4
Comoros	218.7	400.9	83.3	7.6
Djibouti	284.4	320.9	12.8	1.2
Egypt	4,484.4	11,073.6	146.9	13.4
Iraq	8,217.1	22,653.3	175.7	16.0
Jordan	135.3	1,635.5	1108.7	100.8
Mauritania	2,146.3	1,772.9	−17.4	−1.6
Morocco	8,484.2	9,608.4	13.3	1.2
Oman	259.7	1,756.0	576.1	52.4
Sudan	30,187.1	18,634.3	−38.3	−3.5
Tunisia	1,461.9	2,438.0	66.8	6.1
Yemen	12,722.4	9,767.5	−23.2	−2.1
Total	72,224.0	99,364.5	37.6	3.4

Source: Authors' estimates.

Figure 4.12 Projected cumulative number of households without access to sanitation services in selected Arab countries, 2010–2020



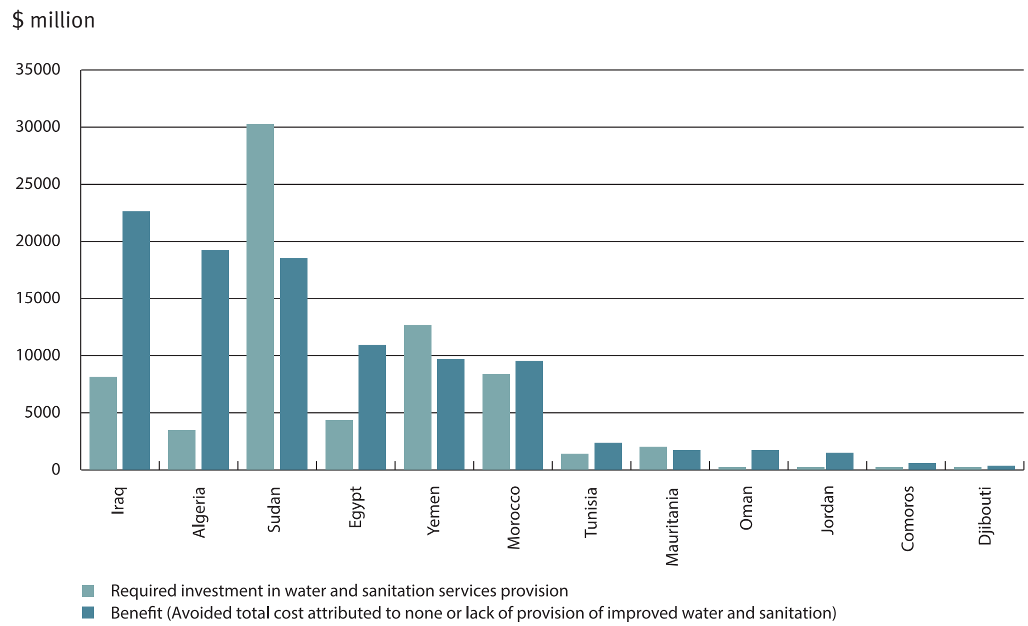
Source: Authors' estimates.

calculated with attention to social, economic and environmental dimensions.

Action (achieving universal water and sanitation coverage) is clearly feasible and has a higher rate of return than inaction (continuing prevailing water governance structures and practices). Several potential approaches to this goal can be identified, all with different costs. Cost-effectiveness analysis thus comes in handy. The approach presented above for calculating the costs of action and inaction can be replicated for each option; the expected return and benefit of each option will help identify the most cost-effective option.

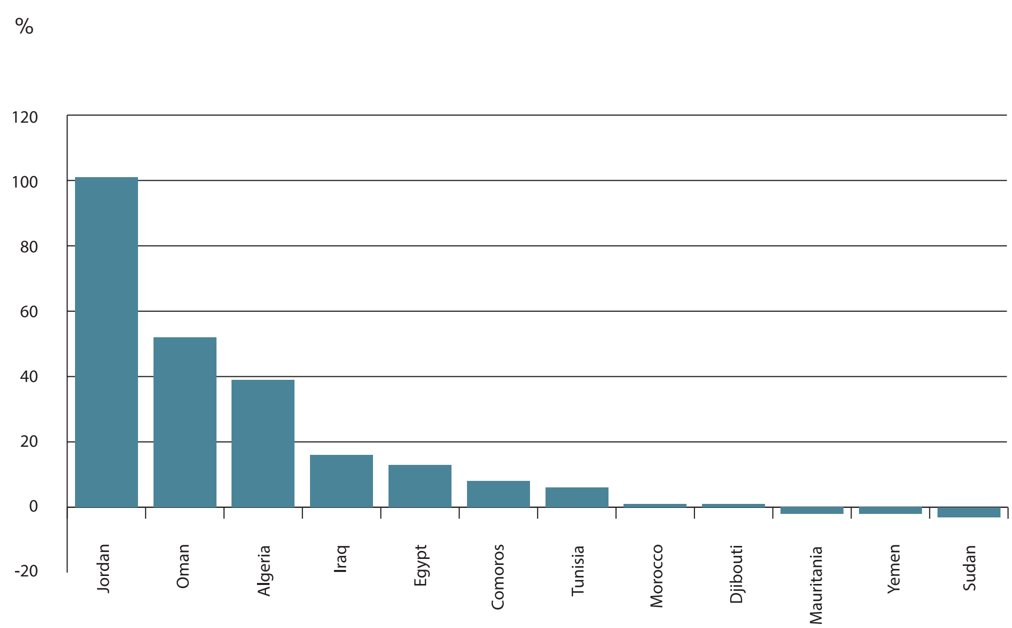
Cost-effectiveness analysis can help decision-makers limit the gap between demand and supply as they work to achieve effective water governance. By assessing policy options with attention to all the economic, social and environmental variables, cost-effectiveness analysis helps establish consensus among stakeholders. It reveals the health, political and environmental benefits of improved water and sanitation. The proper valuation of water, through cost-effectiveness analysis, guides decision-makers in assessing the efficiency and costs of alternative water management strategies.

Figure 4.13 **Water and sanitation in selected Arab countries: projected cost of action versus cost of inaction**



Source: Authors' estimates.

Figure 4.14 **Estimated average annual rate of return on investments in water and sanitation provision in selected Arab countries, 2010–2020**



Source: Authors' estimates.

Endnotes

[1] NWRI 2003.

[2] For example, hydroelectric power generation companies estimate water's value by the quantity of electricity it can produce. Fishermen assess the value of water and water quality by the number and size of the fish they can catch (Ramachandra, Rajanikanth, and Ranjini 2005).

[3] Gibbons 1986.

[4] Willingness to pay is the price ($/amount) that a buyer is willing to give up (opportunity cost) to acquire a good or service.

[5] Mitchell and Carson 1989.

[6] Young 2005.

[7] Young 2005; Turner and others 2004.

[8] Market failure, in economic theory, is the market's inability to allocate goods and services optimally among sectors and/or uses within sectors.

[9] Abdrabo 2003.

[10] Taylor 2003; Young 2005. In economics, external costs or benefits, or negative and positive externalities, are borne/obtained by a third party not directly involved in market transactions—that is, not a producer or consumer. Third parties are thus not taken into account by the market system.

[11] Koundouri 2000.

[12] OECD 2011.

[13] Hutton, Haller, and Bartram 2006. DALYs (disability-adjusted life years) for a disease or health condition are calculated as the sum of the years of life lost (YLL) and years lost due to disability (YLD).

[14] WHO and UNEP 2008.

[15] OECD 2007.

[16] Hutton and Haller 2004.

[17] WHO 2011.

[18] OECD 2007.

[19] Hutton and Haller 2004.

[20] Molle and Berkhoff 2005.

[21] Assumptions and calculations presented in this section are based on the work of two core Arab Water Report team members, Dr. Mohamed Abdrabo and Dr. Emad Karablieh.

[22] EC 2009.

[23] Willingness to pay represents the maximum amount of money a person or a household would be willing to pay for water, taking benefits into account. Such willingness to pay would depend on household income, water use efficiency and frequency (toilets, appliances, among others) and the relative prices of other goods and services purchased by the household.

[24] The estimated costs represent only part of the economic costs associated with lack of water and sanitation in Arab countries. Most of the environmental, social and political costs are not included due to inadequate data and information. Costs, and consequently benefits, will rise once all costs are included.

[25] WHO and UNICEF 2010.

[26] Whittington, Lauria, and Mu 1991.

[27] Gleick 1996. Willingness to pay augments water supply by private vendors in Jordan in rural areas and during network supply failure and interrupt pumping in urban areas at about $6 per cubic metre; in Yemen this figure is about $3–$4. An average of $1.5 per cubic metre is used here as a very conservative estimate to take variations in living standards into account.

[28] Sarraf, Larsen, and Owaygen 2004.

[29] Sarraf, Larsen, and Owaygen 2004.

[30] Due to lack of data and information on municipal water quality, these estimates are based mainly on population size.

[31] OECD 2007.

[32] WHO 2011.

[33] WHO 2004, 2008a.

[34] WHO 2008a; UNDESA 2011.

[35] This age group is considered to be the most vulnerable to diarrhoeal disease.

[36] WHO 2012.

[37] Many more cases of nonfatal diarrhoeal diseases occur each year, not only causing illness but also incurring treatment costs, caregiver time and earning losses of parents. The cost-of-illness approach estimates these cost components. DALYs lost to morbidity have also been valued to account for the cost of pain and suffering not included in the cost-of-illness approach (World Bank 2003).

[38] WHO 2008b.

[39] These estimates are conservative; other estimates are higher (WHO and UNICEF 2010).

[40] World Bank 2004b.

[41] Parker 2010.

[42] UNICEF 2008.

[43] WHO 2011.

[44] WHO 2012.

[45] We used the national average household size prevailing in 2010 to estimate the number of households up to 2020.