Background

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Socioeconomic development is clearly linked to access to safe drinking-water. Recognition of this link is not new. Yet, for the majority of the world’s population, lack of access to safe drinking-water continues to be a concern in their daily existence. The International Decade for Action: Water for Life (2005–2015) (United Nations General Assembly, 2003) reminds us of the slow progress made over the last century and a half towards what must be the most basic of basic needs in providing a decent quality of life for all globally. As long ago as 1850, the Shattuck report recognized the economic consequences of inadequate water and sanitation:

“We believe that the conditions of perfect health, either public or personal, are seldom or never attained, though attainable; that the average length of human life may be very much extended, and its physical power greatly augmented; that in every year, within this commonwealth, thousands of lives are lost which
might have been saved; that tens of thousands of cases of sickness occur, which might have been prevented; that a vast amount of unnecessarily impaired health, and physical disability exists among those not actually confined by sickness; that these preventable evils require an enormous expenditure and loss of money, and impose upon the people unnumbered and immeasurable calamities, pecuniary, social, physical, mental and moral, which might be avoided; that means exist, within our reach, for their mitigation or removal; and that measures for prevention will effect infinitely more, than remedies for the cure of disease.” (Shattuck, 1850)

Since the publication of the Shattuck report, a wealth of evidence has accumulated to show that, where communities lack basic sanitation and use vulnerable and contaminated water, the provision of improved water and sanitation generally leads to a significant reduction in premature mortality and morbidity from water-related infectious disease. But there are other important benefits, sometimes forgotten, that are more difficult to quantify, such as security, privacy and dignity, as well as time saved accessing water. For the purposes of this book, we assume that appropriate technologies exist to achieve these benefits anywhere in the world. Our central concern here is to develop a framework for assessing the socioeconomic value of interventions improving access to safe drinking-water. We focus especially on small systems serving people who would otherwise be difficult to reach. Such people are often missed by large-scale schemes.

Access to safe drinking-water is one of the Millennium Development Goals (MDGs) agreed upon by the world’s leaders at the United Nations Millennium Summit in 2000 (see Box 1.1).

The MDG drinking-water target is to halve by 2015 the proportion of people without sustainable access to safe drinking-water. But this is not the first time that the international community has set ambitious targets. In the early 1980s governments enthusiastically embraced the goal of Water and Sanitation for All by 1990 (United Nations, 1977). At the start of the 1990s, the same goal was restated. In 2004, however, the same number of people lacked access to an improved drinking-water source as in 1990, and these 1.1 billion people included 13 million in developed regions (WHO/UNICEF, 2006).

The 2008 WHO/UNICEF JMP report gave some good news, however. For the first time since reporting began, the estimated number of people without access to improved drinking-water sources had dropped below one billion (WHO/UNICEF, 2008). More than half of the global population now benefits from piped water reaching their homes, and the numbers using unimproved water supplies are going down. The 2010 WHO/UNICEF JMP report showed this trend for drinking-water to be consolidating.
If progress in achieving access to drinking-water between 2006 and 2015 continues at the same rate as between 1990 and 2008, the global target of halving the proportion without access will be achieved (and actually surpassed) for the developing countries as a whole (Table 1.1). However, two points need to be noted. First, this will still leave some 700 million people without access. Second, the rate of improvement needs to be increased for some developing regions to achieve their 2015 targets. Otherwise these regions (including, most notably, sub-Saharan Africa) will fail to reach the 2015 targets. Over the next decade the population of developing countries is forecast to increase by 830 million, with sub-Saharan Africa accounting for a quarter of the increase and South Asia for another third. Taking into account this population growth, at least an additional 900 million people need access to water by 2015, otherwise these regions will fail to reach the 2015 targets (UNDP, 2006).

Access to safe drinking-water is an essential element of sustainable development, and it is central to the goal of poverty reduction. A recent WHO report (Hutton & Haller, 2004) shows that the total cost of providing safe water varies considerably depending upon the size and location of the target population. In order to achieve the most basic target of halving the proportion of

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**Box 1.1 The Millennium Development Goals**

*How did they arise?* The World Summit for Social Development, held in Copenhagen in 1995, proposed a set of international development targets. These were formally adopted in May 1996 by the Organisation for Economic Cooperation and Development. Subsequently, the United Kingdom Department for International Development also adopted these international development targets, but more modest targets were set by the United States Agency for International Development.

In September 2000, a Millennium Summit held at the United Nations headquarters in New York adopted a set of Millennium Development Goals (MDGs) which were modified versions of the international development targets. In 2001, these MDGs were set out in a road map towards the implementation of the United Nations Millennium Declaration.

*What are they?* There are eight MDGs with 18 targets or indicators attached to them. All but one of the targets are set for 2015, so we are now well over half-way through the target period. All of these MDGs are aimed at reducing poverty but there are multiple goals because there are multiple dimensions of poverty. Goal 7 aims to “ensure environmental sustainability” and target 10 under this goal aims to “halve by 2015 the proportion of people without sustainable access to safe drinking-water and sanitation.” The baseline for the water and sanitation targets is 1990.

people without sustainable access to an improved water supply by 2015, it has been estimated that developing countries need to spend US$ 42 billion on new coverage (Hutton & Bartram, 2008). The cost of maintaining existing services is estimated to total an additional one billion US dollars for water supply (Hutton & Bartram, 2008).

### Table 1.1 The Millennium Development Goals applicable to water (global figures)

<table>
<thead>
<tr>
<th>Reference</th>
<th>1990 Actual</th>
<th>2008 Actual</th>
<th>2015 Target</th>
</tr>
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<tbody>
<tr>
<td>Population with access to an improved water source (%)</td>
<td>WHO/UNICEF (2008)</td>
<td>77</td>
<td>87</td>
</tr>
<tr>
<td>Population with access to an improved water source (billions)</td>
<td>WHO/UNICEF (2008)</td>
<td>4.1</td>
<td>5.9</td>
</tr>
<tr>
<td>Population without access to safe water (billions)</td>
<td>As implied by the figures in the previous two rows.</td>
<td>1.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Number of people who gained access between 1990 and 2008 (millions)</td>
<td>WHO/UNICEF (2010)</td>
<td>1 774</td>
<td></td>
</tr>
</tbody>
</table>

A significant challenge to water analysts, including public health engineers, physicians, technicians and economists, is to advise policy-makers on interventions to improve access to safe drinking-water that also produce total benefits greater than total costs. Social cost-benefit analysis, which builds on cost-effectiveness analysis, is a tool to aid this decision-making process. Social cost-benefit analysis is applicable even to small-scale water supplies.

### SAFE DRINKING-WATER AS A HUMAN RIGHT

An objection often raised to using economic assessment in decision-making on whether or not to invest in expanding access to safe drinking-water is that a given minimum quantity and quality of drinking-water should be provided as a human right. If this is the case, then surely we do not need to show that drinking-water improvements up to that standard are economically justified by giving a positive rate of return.

As the UNDP Human Development Report of 2006 puts it: “ultimately, the case for public action in water and sanitation is rooted in human rights and moral imperatives” (UNDP, 2006, page 42). Article 12 of the International Covenant on Economic, Social and Cultural Rights recognizes “the right of everyone to
the enjoyment of the highest attainable standard of physical and mental health” (The Office of the United Nations High Commissioner for Human Rights, 1976). Article 24 of the Convention on the Rights of the Child (Office of the United Nations High Commissioner for Human Rights, 1976) ensures that children are entitled to the enjoyment of the highest attainable standards of health, which requires State Parties to take appropriate measures to combat disease and malnutrition, including within the framework of primary health care (which includes the provision of safe drinking-water).

In 2002, the United Nations Committee on Economic, Social and Cultural Rights, adopted a General Comment on the right to health (United Nations Economic and Social Council, 2002). This includes access to safe drinking-water. Regardless of available resources, all States Parties are obliged to ensure that the minimum essential level of rights is achieved, and there is a constant and continuing duty for States to move towards the full realization of a right. This includes ensuring that people have access to enough water to prevent dehydration and disease. The constitutions of more than 90 countries include a reference to the right to water, although such constitutional provision has not been backed by a coherent strategy for extending access to water (UNDP, 2006).

Recently, the United Nations General Assembly adopted Resolution 64/292 confirming that safe and clean drinking-water and sanitation is a human right essential to the full enjoyment of life and all other human rights. Subsequently, the United Nations Human Rights Council affirmed, in its Resolution A/HRC/RES/15/9, that the right to water and sanitation is derived from the right to an adequate standard of living and inextricably related to the right to the highest attainable standard of physical and mental health, as well as the right to life and human dignity (Office of the United Nations High Commissioner for Human Rights, 2010).

When a service or capability is defined as a human right, two problems remain: first, the scope of the human right has to be defined; and second, the human right has to be enforced.

Consider the scope of the right to water. How do we define a minimum standard for water access? Should it be defined in terms of the daily quantity (say, number of litres) to which a household has access? If so, what is that daily amount? What quality standards should this water meet? And what do we mean by acceptable access? Does it mean in the house? Or does it mean within 200 metres from the house? Or within one kilometre from the house?

WHO (2003) defines “no access” as circumstances when it is necessary to travel more than one kilometre or for more than 30 minutes to make a round trip to collect less than 5 litres of water per capita per day. Basic access is considered to be achieved where up to 20 litres per capita per day is available within one kilometre or 30 minutes round trip. Intermediate access is where water is
provided on-plot through at least one tap (yard level) and it is possible to collect approximately 50 litres of water per capita per day. Optimal access is a supply of water through multiple taps within the house allowing an average of 100–200 litres per capita per day. Monitoring the supply of water is, however, a problem: “what emerges from research across a large group of countries is that patterns of water use are far more complex and dynamic than the static picture presented in global reporting systems” (UNDP, 2006).

To recapitulate: General Comment 15 on the right to water, adopted in November 2002 by the Committee on Economic, Social and Cultural Rights, sets the criteria for the full enjoyment of the right to water. Yet in 2008 about one in seven of the world’s population was denied this basic need. Could the situation be improved by enforcing the human right? The answer is probably no because enforcement of the right to water would not appear to be a feasible option. For example, an attempt in South Africa in 2000 to enforce a right to adequate housing failed, with the Constitutional Court stating that the enforcement of any rights specified in the Constitution depends on the availability of resources. Yet, the right to water and sanitation as now adopted by UN Member States will be a powerful legal instrument to enhance the drive towards the goal of universal coverage, applying the principle of progressive realization.

This means that even if we can agree on a definition of adequacy for access to safe drinking-water, a case needs to be made for expanding sustainable access as compared with competing claims for other poverty reduction measures. That is, the question that will be asked is: does the expansion of access to safe drinking-water have a higher claim on resources than investments in other areas of development? There is, in short, a need for economic assessment of improvements in drinking-water supply.

HOW LACK OF ACCESS TO SAFE DRINKING-WATER AFFECTS WELL-BEING

Unsafe water and sanitation, including lack of hygiene, account for almost one tenth of the global burden of disease (Fewtrell et al., 2007). The use of disability-adjusted life years (DALYs) to measure burden of disease is explained in Chapter 10 of this book. Children under the age of 5 years are particularly susceptible to waterborne disease and suffer the most severe consequences. Other most vulnerable groups include the elderly and pregnant women.

Many life-threatening diarrhoeal diseases are waterborne, so that improving water quality in terms of microbiological contamination is one of the most important contributions of improved water supply to public health. Waterborne
and other water-related diseases consist mainly of infectious diarrhoea, typhoid, cholera, salmonellosis, shigellosis, amoebiasis, and other protozoan and viral intestinal infections. Some pathogens causing these diseases are transmitted by water, although other forms of transmission do occur such as person-to-person contact, animal-to-human contact, transmission through food and aerosols, and by contact with fomites (Hunter, 1998). In addition to the dangers posed by pathogenic microorganisms, chemicals such as nitrates, fluoride or arsenic in water can have toxic effects. People who consume water contaminated with these chemicals may not immediately display symptoms of disease, but the long-term effects on their health can be extremely severe, as shown by the example of arsenic poisoning in Bangladesh (Smith, Lingas & Rahman, 2000). In addition, Santaniello-Newton & Hunter (2000) propose a category of diseases that are spread by the daily migration of people to collect water, such as meningococcal disease (“water-carrying disease”). Various non-infectious disorders of the musculoskeletal system resulting from the prolonged carrying of heavy weights, especially during childhood, should also be considered.

A number of studies from low-income countries have indicated that improved access to water – and the resulting increases in the quantity of water or time used for hygiene – are the determining factors of health benefits, rather than improvements in water quality (Curtis & Cairncross, 2003). Providing water security can play a wider role in poverty reduction and improving livelihoods, by reducing uncertainty and releasing resources that can be used to decrease vulnerability. It has been noted that improved domestic water supplies and improved local institutions can enhance food security, strengthen local organizations and build cooperation between people (Soussan, 2003). A water source may be very close to a village but may be of poor quality or only seasonally accessible. In order to reach a source of good quality it may be necessary to travel a considerable distance, thus resulting in less time for other activities (in other words, opportunity costs). In fact, it has been demonstrated that the biggest benefit, in terms of both water and sanitation, is time-saving through better access (Hutton et al., 2007).

In addition to the health benefits and the saving of time and energy, providing safe water can also have an influence on school enrolment and attendance. In many cultures, this particularly affects young school-age girls because, for many poor families, the economic value of a girl’s work at home exceeds the perceived returns from schooling. On a wider scale, however, the education of girls is widely attested to lead to a fall in fertility rates and in the next generation’s mortality and morbidity rates (World Bank, 2006). Clearly, improvements in water supply increase well-being. But are they a good investment?

This book shows how to assess whether improvements in access to safe drinking-water are a good investment. There are two forms of economic
assessments that can be used to do this: cost–effectiveness analysis and social cost–benefit analysis.

**WHAT ARE COST–EFFECTIVENESS ANALYSIS AND SOCIAL COST–BENEFIT ANALYSIS?**

When WHO identified the need to analyse the costs and benefits of drinking-water interventions as an MDG priority it was clear that there was little work already published on the subject. Earlier work on cost–effectiveness (for example, Walsh & Warren, 1979) had suggested that, of the options for health protection and promotion, water and sanitation interventions were the least cost-effective. This idea persisted for around 20 years until Hutton & Haller (2004) demonstrated, by applying a generalized economic analysis, that water and sanitation interventions are indeed cost–effective. The analysis was applied globally in the *Human Development Report* (UNDP, 2005).

Although the generalized methods were successfully applied at the global level, they do not translate well to the national level. It was clear that there was a need to provide tools on cost–effectiveness analysis and social cost–benefit analysis at a national level to guide policy development. This book describes the methods that can be applied at and below the national level, by people with little or no expertise in economics.

Cost–effectiveness analysis refers to the comparison of the relative expenditure (costs) and physical outcomes (effects) associated with two or more courses of action. In the health sector, cost–effectiveness analysis measures the incremental health outcomes attributable to specific health sector investments, using the direct call on health sector resources as the measure of cost. For WHO, the cost–effectiveness of an intervention is estimated using US$ per case averted, US$ per death averted and US$ per disability-adjusted life year (DALY) saved (Varley et al., 1998). This involves a monetary unit divided by a physical unit. The fact that cost–effectiveness analysis is not measured purely in monetary terms can be seen as an advantage. Generalized cost–effectiveness analysis is used by the Global Programme on Evidence for Health Policy under WHO-CHOICE (Choosing Interventions that are Cost-Effective) (http://www.who.int/choice/description/en/). WHO-CHOICE was started in 1998 “with the objective of providing policy-makers with the evidence for deciding on the interventions and programmes which maximise health for the available resources”. To achieve its objectives, WHO-CHOICE reports the costs and effects of a wide range of health interventions in the 14 epidemiological subregions, and the results of these cost–effectiveness analyses are assembled in
regional databases which policy-makers can adapt to their specific country setting. This has undoubtedly been a useful addition to the tool kits of health policy analysts.

A significant problem with cost–effectiveness analysis is the issue of dealing with wider livelihood benefits. For example, assume that piped water is supplied to a rural village whereas previously the nearest source was 3 km away. In addition to a possible reduction in cases of diarrhoea resulting from the improved access to water, there will be benefits to the households in the form of a saving in time spent in collecting water. It is not straightforward, however, to incorporate livelihood benefits into the WHO generalized cost–effectiveness analysis without assigning values or prices in a common currency to very different benefits. Without such a common currency, only interventions with similar physical outcomes can be compared, virtually ruling out cross-sectoral comparisons.

Social cost–benefit analysis (SCBA) is a framework that allows such comparisons of interventions with complex outcomes. It involves, either explicitly or implicitly, weighing the total expected value of costs against the total expected benefits of one or more actions in order to choose the best or most socially valuable option in terms of value for money. A comprehensive SCBA involves choosing values for all costs and benefits regardless of whether or not they have a market price. In the absence of a clear market price or if the market price is influenced by a powerful public or private agency, then the analyst must choose a price (a shadow price) stating clearly the assumptions that were made in arriving at the value of the shadow price.

To cope with differing patterns of costs and benefits across time, SCBA expresses future costs and benefits of interventions in present-day (year zero) monetary terms. To take account of the value of time (“time is money”), costs and benefits accruing in the future are discounted back to the present by applying a rate of discount to give the “present values” of the costs and benefits (a simple inversion of the calculation used to calculate the value of a present sum of money at any time in the future at a given interest rate). Cost–effectiveness analysis may also use discounting when costs are distributed differently across time. A ranking of interventions can be done by producing ratios of benefits to costs (Hutton & Haller, 2004) or by calculating the net present value of the project by simply subtracting the present value of the costs from the present value of benefits. The ranking can also be achieved by calculating the internal rate of return and this is done by calculating the discount rate which makes the present value of costs the same as the present value of benefits.

One aspect of SCBA that could give rise to controversy is how to value people’s time (for example, time saved in collecting water). As discussed by Hutton (2001), assigning a value to people’s time could result in a bias towards services for higher
income communities. For example, it is common in SCBA to value a life in terms of the future earnings lost. This will mean that, unless a counter-weight is applied to allow for income distribution, the life of a highly-paid person will be valued more than the life of a lowly-paid person of the same age. In its simplest form, SCBA is carried out using only financial costs and financial benefits. A more sophisticated approach to building cost–benefit models is to try to put a financial value on intangible costs and benefits. This involves distributional judgements by the analyst that need to be made explicit and subjected to sensitivity tests, as discussed in this book. Implementation of actions in response to economic assessments is the final step in the procedure.

The main differences between cost–effectiveness analysis and SCBA are summarized in Table 1.2.

<table>
<thead>
<tr>
<th>Cost–effectiveness analysis</th>
<th>Social cost–benefit analysis</th>
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<tbody>
<tr>
<td>• helps to select the best possible strategy or technique to follow when the available resources are limited;</td>
<td>• is used to evaluate public expenditure decisions in order to allocate scarce resources in a more efficient way;</td>
</tr>
<tr>
<td>• calculates the direct financial cost of reaching specific outcome or output levels and requires one other option for comparison;</td>
<td>• compares all benefits to all costs and can stand alone. (if the benefit/cost ratio exceeds 1, an intervention is socially valuable);</td>
</tr>
<tr>
<td>• is typically retrospective;</td>
<td>• is typically prospective;</td>
</tr>
<tr>
<td>• gives a micro (community) view of programme activities, outputs or outcomes.</td>
<td>• gives a macro (societal) view.</td>
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Improvements to water access – in quantity or quality or both – may create livelihood benefits for all economic activities. Benefits include the funds released for productive investment, and the human time and energy released from water collection or periods of illness. Some of the health and livelihood benefits associated with access to safe drinking-water are discussed in Chapter 6 of this book.

Considering drinking-water as a provider of economic benefits is one way of giving a higher profile to the water MDG target, with a view to attracting development funding. Addressing all the socioeconomic uses of domestic
drinking-water and its run-off, and adopting a livelihoods-based approach to drinking-water interventions can provide an economic justification for such interventions relative to others directed at achieving other MDG targets. Where the improvement of drinking-water has been regarded simply as a stand alone matter of health promotion, competing for funding has been confined to the health sector. A more sustainable approach would be to take a broad livelihoods perspective, across all sectors, of the effect of changing drinking-water access and use. Chapters 5 and 6 provide guidance on how to assess the baseline situation as regards the health and livelihood effects associated with water interventions, and the ethical challenges posed in communicating rights to knowledge and intellectual property rights.

A multisectoral economic analysis is more likely to justify cost recovery than the analysis of a single sector. Recognition of economic gains over and above those related to health may mean a greater willingness to pay for improved drinking-water, and a more determined effort to collect fees. This, in turn, may lead to more effective operation, maintenance and repair of the water supply scheme. Cost recovery will be enhanced if improved drinking-water is provided, not only because of its positive effect on health, but also because of its wider economic benefits (Makoni, Manase & Ndamba, 2004).

There are numerous reports of outbreaks associated with small (often rural) water supplies in developed as well as developing countries. Richardson et al. (2007), for example, report on an outbreak of *Campylobacter jejuni* in a South Wales (United Kingdom) rural housing estate which received mains water via a covered holding reservoir. A crack in the wall of the holding reservoir was identified. Contamination with surface water from nearby pasture land was the likely cause of this outbreak. Another problem is that drinking-water can become contaminated following its collection from communal sources such as wells and tap-stands, as well as during its storage in the home. Numerous studies have shown that, taken in isolation, physical improvements to quantity and quality of drinking-water supply have only limited effects on public health, and that household water treatment and safe storage adds considerable value to an integrated approach to improving access to safe drinking-water (Sobsey, 2002).

Generally, the technologies that supply water in small-scale schemes can be technically simple, for example handpump supplies and gravity piped supplies (see Chapter 7). As discussed by Mara (2003), improvements in secure availability of good quality water are required to minimize water-washed transmission of faecal-oral diseases and improve livelihoods. The technologies exist to ensure access to safe drinking-water for all, under local control. In deciding which intervention is most appropriate, values for all costs and benefits associated with the intervention must be estimated.
Justifying funding for small-scale drinking-water interventions is desirable in order not only to reach the Millennium Development Goal targets, but also to achieve the wider development goals of technological and economic sustainability under decentralized, good governance.

The process involved in conducting a socioeconomic evaluation of water interventions in small rural communities consists essentially of five steps:

- Establish a base-line.
- Identify the feasible interventions.
- Estimate the costs of the interventions.
- Estimate the benefits of the interventions.
- Select the best intervention by comparing the social rates of return.

REFERENCES


