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Introduction

Katherine Pond, Stephen Pedley and Chris Edwards

INTRODUCTION

The recognition of links between access to safe drinking-water and socio-economic development is not new. For the majority of the world's population, lack of access to safe drinking-water continues to be a concern in their daily existence. Early in the *International Decade for Action: Water for Life* (2005–2015), we are reminded 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. The following passage from the 1850 Shattuck report is included to illustrate the economic consequences of inadequate water and sanitation has been long recognised.

'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 imposed 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 the provision of improved water and sanitation to communities lacking basic sanitation and using vulnerable and contaminated water can lead to a significant reduction in mortality and morbidity from water-related infectious disease. But there are other important benefits, sometimes forgotten, that are more difficult to quantify physically, such as security, privacy, dignity and time saved accessing water. For the purposes of this book, it is assumed that appropriate technologies exist to achieve these benefits anywhere in the world, and our central concern here is to develop a framework for assessing the socio-economic value of interventions improving access to safe drinking-water, especially through small systems serving people who would otherwise be difficult to reach through large scale schemes.

Access to safe water is one of the Millennium Development Goals (MDGs) agreed by the world's leaders at the UN Millennium Summit in the year 2000 (see Box 1.1).

Box 1.1 The Millennium Development Goals

How did they arise? The World Summit for Social Development (Copenhagen, 1995) proposed a set of International Development Targets (IDTs). These were formally adopted in May 1996 by the Organisation for Economic Cooperation and Development (OECD). Subsequently, the UK Department for International Development (DFID) also adopted these IDTs, but more modest targets were set by the US Agency for International Development (USAID). 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 IDTs. In 2001 these were set out in a *Road Map towards the Implementation of the United Nations Millennium Declaration* (Black and White 2004).

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 (in 2008) 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*’ (UNDP 2006). The baseline for the water and sanitation target is 1990.

As Box 1.1 states, the MDG 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*. At the start of the 1990s, the same goal was restated. However, in 2004, as can seen in Table 1.1 below, the same number of people remained unconnected to improved water supply as in 1990 – 1.1 billion (including 13 million in developed regions; WHO/Unicef, 2006).

Table 1.1 The Millennium Development Goals applicable to water (figures are for developing countries only)

	Reference	1990	2004	2015
		Actual	Actual	Target
Population with access to an improved water source (%)	UN, 2006	71	80	86
Population with access to an improved water source (billions)	UNDP, 2006	2.8	4.3	5.0
Population without access to clean water (billions)	As implied by the figures ion the previous two rows.	1.1	1.1	0.8
Annual average number (millions)				
Gaining access between 1990 and 2004	UNDP, 2006	80		
Needing to gain access (2004-2015) to meet 2015 target	UNDP, 2006	78		

As can be seen from Table 1.1, if progress in achieving access to drinking-water between 2004 and 2015 continues at the same rate as between 1990 and 2004, the global target of halving the proportion without access will be achieved for the developing countries as a whole. However two points needs to be noted. First, this will still leave 800 million people without access and second, the rate of improvement needs to be increased for *some* developing regions to achieve *their* 2015 target. Otherwise these regions (including, most notably, Sub-Saharan Africa) will fail to reach the 2015 targets.

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 2004); (for a summary of the report see http://www.who.int/water_sanitation_health/wsh0404summary/en/ accessed 15th June 2007) 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 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 and Bartram, 2008). The cost of maintaining existing services is estimated to total an additional US$ billion for water supply (Hutton and Bartram, 2008).

A significant challenge to water analysts, including public health engineers, medical doctors, 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 (SCBA), building upon cost-effectiveness analysis (CEA), is a tool to aid this decision-making process, which is applicable to even small scale water supplies.

SAFE DRINKING-WATER AS A HUMAN RIGHT?

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

As the UNDP's 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, 42). Article 12 of the International Covenant on Economic, Social and Cultural Rights recognizes "the right to everyone to the enjoyment of the highest attainable standard of physical and mental health". Article 24 of the Convention on the Rights of the Child (1989) 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, included within the framework of primary health care (which includes the provision of safe drinking-water) (UNHCHR, 1989). In 2002, the United Nations Committee on Economic, Social and Cultural Rights, adopted a General Comment on the right to health. This includes access to safe drinking-water. Regardless of available resources, all States Parties are obliged to ensure that the minimum essential level of right is achieved and there is a constant and continuing duty for States to move towards the full realization of a right. This includes ensuring people have access to enough water to prevent dehydration and disease. More than 90 countries have the right to water in their constitutions, although constitutional provision has not been backed by a coherent strategy for extending access to water[1] (UNDP 2006)).

However, even after a service or capability is defined as a Human Right, two problems remain, namely the scope of the Human Right has to be defined, and the Human Right has to be enforced.

First consider the scope. 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; In the house or within 200 metres from the house? Within one kilometre from the house?

WHO (2003) defines no access when it is necessary to travel more than 1 kilometre or more than 30 minutes round trip to collect less than 5 litres of water per capita per day. Basic access is achieved where up to 20 litres per capita per day is available within 1 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[2]. However, monitoring this is 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).

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[1] This includes South Africa – see box 1.6 on page 64 of UNDP 2006

[2] This per capita daily consumption of 20 litres compares with an average consumption in 1998-2002 in the UK of about 150 litres, in the USA of about 570 litres and in Ghana and Nigeria of about 40 litres (UNDP 2006, 34)

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 there is agreement that in 2004 more than one in six of the world's population was denied this basic need. Can the situation be improved by the Human Right being enforced? The answer is no. It is unlikely that is can be enforced. An attempt in South Africa in the year 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[3].

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 will be asked: 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 drinking-water supply improvements.

The wellbeing problems associated with lack of access to safe drinking-water

In 2003, it was estimated that 4% (expressed as 64 million disability-adjusted life years; DALYs – explained in Chapter 9 of this book) of the global burden of disease and 1.6 million deaths per year were attributable to unsafe water and sanitation, including lack of hygiene (WHO 2003). Children under the age of five are particularly susceptible to waterborne disease and suffer the most severe consequences. Other 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, cholera, salmonellosis, shigellosis, amoebiasis, and other protozoan and viral intestinal infections. Some pathogens causing these diseases are transmitted by water, but other forms of transmission do occur such as person-to-person contact, animal-to-human contact,

[3] This was a case brought by Irene Grootboom against the Government of the Republic of South Africa. The case concerned the right of Grootboom and others to adequate housing under section 26 of the Constitution. The Cape of Good Hope High Court decided that the Constitution does not oblige the state to go beyond its available resources nor to realise immediately the rights set out in the Constitution.

food and aerosols, and by contact with fomites (Hunter 1998). In addition to pathogenic micro-organisms, chemicals such as nitrates, fluoride or arsenic in water can have toxic effects. Although groups of people that consume water contaminated with these chemicals may not immediately display symptoms of disease, the long-term effects on their health can be extremely severe, as shown by the example of arsenic poisoning in Bangladesh (Smith et al. 2000)

In addition, Santaniello-Newton and Hunter (2000) propose there is 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 due to 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 resulting increases in the quantity of water or time used for improving hygiene, rather than water quality improvements, are the determining factors of health benefits (Curtis and 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 for reducing 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, also referred to as opportunity costs. In fact, it has been demonstrated that the biggest benefits in terms of both water and sanitation are time-saving through better access (Hutton et al. 2007).

In addition to the health benefits and time/energy, provision of safe water can also have an influence on school enrolment and attendance savings (in many cultures, particularly affecting young school-age girls). For many poor families the economic value of girls work at home exceeds the perceived returns to schooling. However, education of girls is widely attested to lead to a fall in fertility rates and the next generation's mortality and morbidity rates (World Bank, 2006). How to assess whether water supply improvements are a good investment is the core of this publication. There are two forms of economic assessment that can be used to do this – cost-effectiveness analysis (CEA) and social cost-benefit analysis (SCBA).

What are social cost-benefit and cost-effectiveness analysis?

When WHO identified the issue of analyzing costs and benefits of drinking-water interventions as an MDG priority it was clear that there was little work already published. Earlier work on cost effectiveness (e.g. Walsh and Warren 1979) suggested water and sanitation interventions were not cost effective options for health protection and promotion. This idea persisted for around 20 years until Hutton (2004) showed that by applying a generalised economic analysis it could be demonstrated that water and sanitation interventions can be evaluated as cost-effective. The analysis was applied globally in the Human Development Report (UNDP 2005). Although this was successful, it was clear that there was a need to provide tools on SCBA and CEA at a national level to guide policy development. The generalised methods do not translate well to the national level. The present publication is intended to adjust and describe the methodology that can be applied at and below the national level, with the intention that it can be used by people with little or no expertise in economics. It is worth pointing out, however, some of the major principles/challenges associated with CEA and SCBA (Chapters 2, 9–11).

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, Tarvid et al. 1998). This involves a monetary unit divided by a physical unit. The fact that CEA is not measured in monetary terms can be seen as an advantage. Generalised cost-effectiveness analysis (GCEA) is used by the Global Programme on Evidence for Health Policy (GPE) under WHO-CHOICE (**Cho**osing **I**nterventions that are **C**ost-**E**ffective). 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 sub-regions and the results of these CEAs 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 CEA 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 three 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. However it is not straightforward, however, to incorporate livelihood benefits into the WHO generalised CEA without linking very different benefits through a common numeraire, i.e. giving them values/prices. Without such a numeraire only interventions with similar physical outcomes can be compared, virtually ruling out cross-sectoral comparisons.

Social cost-benefit analysis 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. 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). CEA 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 2004) or by calculating the net present value (NPV) 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 (IRR) and this is done by calculating the discount rate which makes the present value of costs the same as the present value of benefits (discounting is discussed again later in this book).

A major issue with SCBA that could give rise to controversy is valuing people's time (e.g. time saved in collecting water), which, as discussed by Hutton (2001) could result in the bias towards services for higher income communities. For example, it is common in SCBA to value a life by 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, CBA is carried out using only financial costs and financial benefits. A more sophisticated approach to building a 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 which will be discussed in Chapters 9–11 of this publication. Implementation of economic assessments is the final step and is discussed in Chapter 12.

The main differences between CEA and CBA are summarised below.

CEA is a method that helps to select the best possible strategy or technique to follow when the available resources are limited.	CBA is used to evaluate public expenditure decisions in order to allocate scarce resources in a more efficient way.
CEA calculates the direct financial cost of reaching specific outcome/output levels and requires one other alternative for comparison	CBA compares all benefits to all costs and can "stand alone." If the benefit/cost ratio exceeds 1, the programme is socially valuable
CEA is typically retrospective	CBA is typically prospective
CEA gives a micro view of programme activities, outputs, or outcomes	CBA gives a macro (societal) view

There are possible livelihood benefits to all economic activities arising from improvements to water access in quantity or quality or both, including funds released for productive investment and human time and energy released from water collection and/or periods of illness. Some of the health and livelihood issues associated with access to safe drinking-water are raised in Chapter 3 of this publication.

Such considerations of drinking-water as a provider of economic benefits is consistent with addressing concerns about giving a higher profile to the water MDG targets in terms of developmental funding. Addressing all the socio-economic uses of domestic drinking-water and its run-off and adopting a livelihoods-based approach to drinking-water interventions can raise the profile of such interventions relative to others directed at achieving other MDG targets claiming an economic justification. Where improved drinking-water has been regarded simply as a stand alone issue of health promotion it becomes sectorally confined to the health sector in terms of competing for funding. A sustainable approach would be one which takes a broad livelihood perspective of the impact of changing drinking-water access and use. Guidance on how to assess the baseline situation with regards health and livelihood impacts associated with water interventions and the ethical challenges posed during communicating rights to knowledge and intellectual property rights are detailed in Chapters 4 and 5.

A broad rather than sector-confined economic analysis may have implications for cost recovery and more effective scheme operation, maintenance and repair. Recognition of non-health, economic gains may mean greater willingness to pay and determination to collect fees for improved drinking-water. A significant improvement in cost recovery would be realised if the water had been provided not only for its health improvements but also for its wider economic benefits (Makoni et al., 2004).

MISSION AND SCOPE

The aim of this publication is to provide guidance on assessing benefits from improving access to safe drinking-water, from decreasing the burden of water-related diseases and improving access to safe drinking-water and comparing the value of these benefits to direct and indirect total costs, with special reference to small systems. The publication:

1. provides a framework for determining and applying burden of disease estimates, cost effectiveness and social cost benefit analysis;
2. describes an evidence base of practical indicators for decision-makers for use in establishing investment priorities; and
3. provides guidance on how to build national and local capacity to collect the indicator information and utilise the framework.

Thus the specific focus of this publication is on the socio-economic appraisal and evaluation of drinking-water interventions. Of course, interventions that combine drinking-water and sanitation improvements will reinforce the benefits from improved drinking-water alone. But while the framework offered here could be applied to sanitation improvements, there are some specific issues that would be better addressed in a separate publication.

This publication is especially concerned with small drinking-water systems – which are predominantly relevant to rural areas (although the tool described in this publication can be applied in principal to large-scale, formal drinking-water systems in urban areas). These have been identified by low, medium and high-income countries as critical to both development and health. In any of these countries, communities depending on small systems are the hardest to reach for achieving the water and sanitation MDG (WHO 2005). The basic distinction is, however, not so much between urban and rural areas (although rural communities are most likely to be served by a small system), as it is one based on differences in the level of technology and the institutional arrangements for management, maintenance, and protection.

Small drinking-water systems are also of concern as they are more liable to contamination and breakdown and therefore pose a permanent potential health risk. 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 (UK) 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. A further issue with rural communities 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 as considerable value to an integrated approach to improving access to safe drinking-water (Sobsey, 2002).

The technologies that supply water in small-scale schemes can be generally technically simple, for example handpump supplies and gravity piped supplies (see Chapter 6). As discussed by Mara (2003) improvements in secure water availability of good quality are required to minimize water-washed transmission of faecal-oral diseases and improve livelihoods. As discussed in Chapter 6 of this publication 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 (Chapters 7 and 8). Directing CEA- (Chapter 9) or SCBA- (Chapters 10 and 11) justified funding towards the small scale drinking-water sector is desirable in order not only to meet the MDG targets, but also to meet the wider development goals of technological and economic sustainability under decentralised, good governance.

This publication covers the process involved in conducting a socio-economic evaluation of water interventions in small rural communities. It essentially takes the reader through five steps:

1. Establish a base-line. This is used to collect information on the current situation regarding availability of and access to drinking-water in terms of quantity and quality, as well as benefits from possible improvements, and use it to identify the patterns of benefits and costs of different interventions options (Chapters 4, 5).

2. Identify the physically feasible water improvement interventions. These could include intra-household point of use interventions, or interventions designed to bring safe water closer to groups of households; or interventions such as hygiene education or capacity building to improve management of existing water systems (Chapter 6).
3. Establish the costs of physically feasible improvements. These should include capital investment and recurrent costs for public and private agencies and households (Chapter 7). A detailed cost analysis is the minimum requirement as a basis for an economic assessment.
4. Estimate the benefits of the improvements. These should include all direct and indirect changes in broadly defined economic activities. These benefits can then be compared with costs using cost-effectiveness analysis or market or synthetic (shadow) monetary values can then be attached to the benefits in a full SCBA (Chapter 8, 9, 10, 11).
5. Select the best improvement by comparing social rates of return (Chapter 12).

These steps are used to give a structure to this publication as shown in Figure 1.1.

Steps to follow	Relevant chapters	Chapter description
Background	Chapter 2: An introduction to the economic assessment of drinking-water improvements.	Background to: Least cost analysis Cost-effectiveness analysis Social Cost benefit analysis
	Chapter 3: Scoping the current situation regarding access to drinking-water	Provides information to date on the global situation regarding access to drinking-water.
Define your current situation	Chapter 4: Defining the current situation - epidemiology	Chapter 4 provides guidance on how to assess: the burden of disease in the target group; and the proportion of disease due to deficiencies in water supply to be remedied by the intervention.
	Chapter 5: Defining the current situation - livelihoods	Are there any livelihood responses that would result from the outcomes of the intervention? Chapter 5 provides guidance on how to gather livelihood data and the potential challenges associated with this.
Identify the feasible interventions	Chapter 6: Possible interventions for water provisions in rural communities	A summary of the interventions that are available to improve water provision for communities in rural areas. The chapter is divided into three sections describing water interventions, education and community training, and policy and planning interventions.

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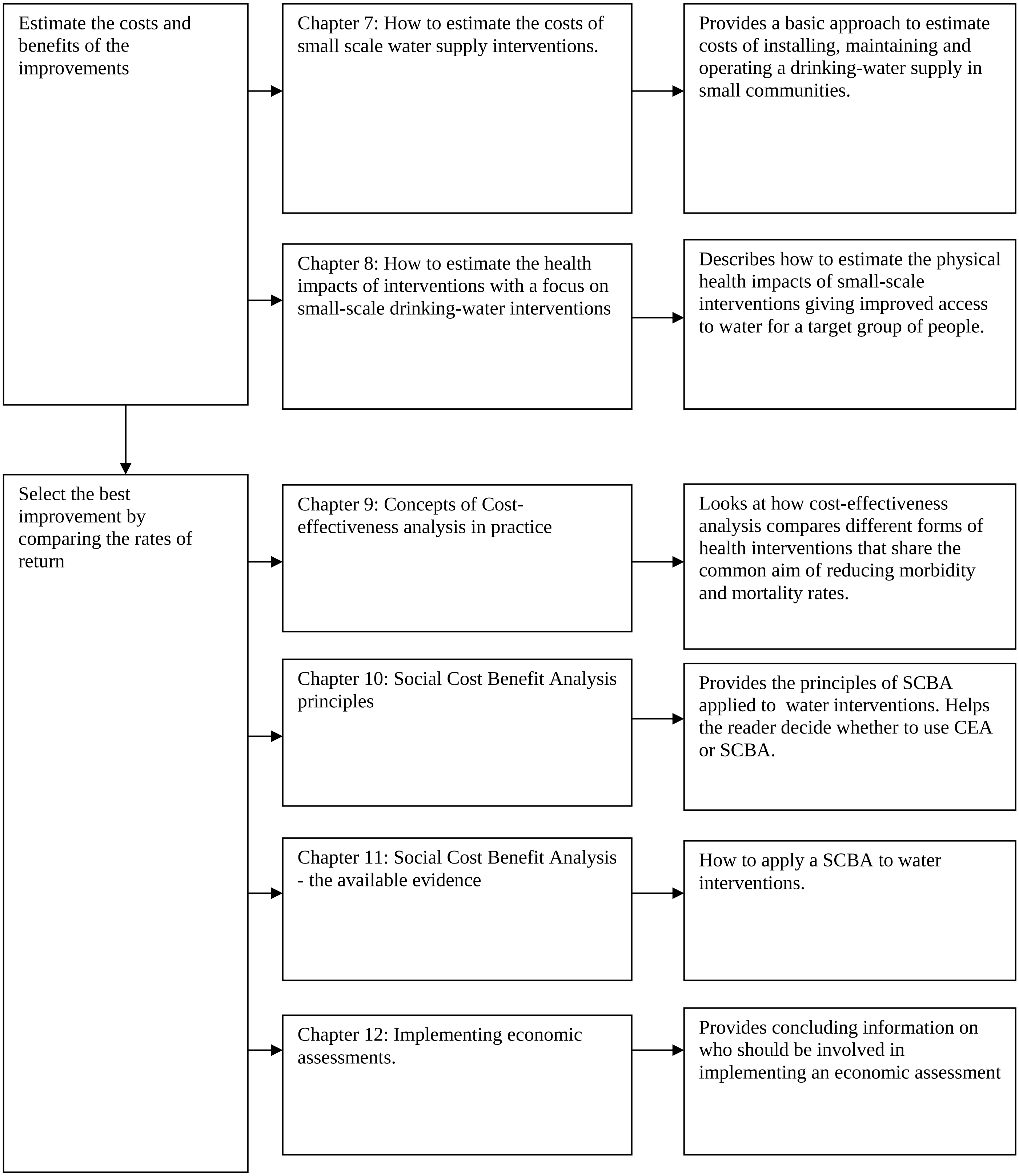

Figure 1.1 Structure of the book.

AUDIENCE

This publication is primarily aimed at experts in all relevant disciplines (including health professionals, engineers and economists) working in the field of drinking-water in low, medium and high-income countries who are involved in advising on the most appropriate drinking-water interventions to install in small-scale settings. Such experts will find at least one chapter close to their field and others less familiar and we have tried to keep a level of presentation that would satisfy an expert in the field and be accessible to a non-expert. To help achieve this goal, this book has been co-authored by a multi-disciplinary team.

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