Introduction

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In a document published in 2000 the World Health Organisation (WHO) and the United Nations Children's Fund (UNICEF) reported that 82% of the population of the world, or 4.9 billion people, had access to basic safe-water supplies, while basic sanitation facilities were available to 60%, or 3.7 billion people (WHO/UNICEF 2000: 8). Efforts by local and international authorities during the 1990s, which followed the UN International Drinking Water Supply and Sanitation Decade, 1981–90, enabled the extension of water supply services to an additional 816 million people, with sanitation services for an extra 747 million. However, owing to global population growth, from 5.3 billion to 6.1 billion, over the same period, the proportion of the world's population served increased only slightly, by just 3% and 5% respectively (WHO/UNICEF 2000: 7).

The definition of 'reasonable access' to basic safe-water supplies used in the WHO/UNICEF study was the availability of at least 20 l of clean water per capita from a source located within 1 km of the person's dwelling (WHO/UNICEF 2000: 77). A range of technologies for water supply was accepted as meeting this criterion, including not only centralised piped supply systems but also public standpipes, protected dug wells and rainwater collection. Sources such as unprotected wells, vendor-provided water and water provided via tanker trucks were excluded on the grounds of quality, cost or reliability (WHO/UNICEF 2000: 77). Allowance was also made for the use of local technologies in assessing access to basic sanitation, considered adequate if it included private or shared facilities that separated excreta from human contact, but inadequate where only public facilities were available. Clearly, although considerable progress has been made, many of those deemed to have adequate access to water and sanitation under the standards adopted by the WHO and UNICEF study still have services much below those regarded as satisfactory in most developed nations.

In the Millennium Declaration of the UN General Assembly in 2000 a commitment was made to halve the proportion of people in the world without access to safe drinking water (United Nations 2000). This commitment was confirmed and extended by the international community in the 2002 Johannesburg Declaration on Sustainable Development (UNCSD 2002a). Although many of the statements in the

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Declaration were vaguely worded, making it hard to measure progress or success, the Plan of Implementation of the Summit, agreed by the delegates to the conference, clearly stated that 'we agree to halve, by the year 2015, the proportion of people who are unable to reach or to afford safe drinking water . . . and the proportion of people who do not have access to basic sanitation' (UNCSD 2002b: paragraph 7).

Given the predicted growth in global population from 6.1 billion in 2000 to 7.2 billion by 2015, using the medium variant projection of the United Nations (UNPD 2002), this commitment will pose formidable challenges. To meet it, by the end of just a decade and half, approximately 6.6 billion people will need to have access to supplies of safe drinking water. This is more than the current population of the world and involves not only maintaining existing levels of supply but also providing new or upgraded services to 1.7 billion people. The challenge for sanitation is equally daunting: 5.8 billion people will need to be serviced, including new access provision for 2.1 billion.

Put in a different way, over the 14-year period from 2001 to 2015 these targets equate to more than 300,000 extra people every day gaining access to safe drinking water and more than 400,000 people per day gaining sanitation services. It is difficult to imagine, therefore, that these targets are achievable even if they are the result of the best of intentions which themselves are backed up by real and effective action. Even if these ambitious targets are somehow met, which would represent a major achievement for the global community, there would still be approximately 650 million people in the world without access to safe drinking water and 1.4 billion without sanitation.

What is clear from the above overview of the challenge facing the international community in terms of water supply and sanitation is the magnitude of the problem and the fact that there is a political will at least to try to tackle the problem even if success is far from certain. Continuation of the status quo and the type of progress made during the 1990s will not permit the Johannesburg targets to be met. Instead, it will be necessary to promote a combination of many different and innovative approaches, each of which will contribute towards to the overall targets. These approaches must include: technological advances that identify new sources and improve the quality of those already in use; managerial techniques that increase the efficiency and effectiveness of service delivery at both the micro and the macro scale; and fiscal approaches that tap into additional financial resources to make improvements affordable. Economic development in some parts of the world may facilitate achieving the goals but if previous trends are any indication of the future then in some regions economic pressures and the resulting population movements will greatly hamper improved access to water and sanitation.

In the past the provision of water and sanitation was seen primarily as the responsibility of government, which had the task of supporting research into technology, managing supply and disposal systems and providing the funds to pay for those systems. This view has changed: since the 1980s, and increasingly so in the 1990s and 2000s, there has been a growing trend towards privatisation of many aspects of the water sector. Underpinning this has been a shift away from seeing water as a public good that is essential for life, with subsidised supply provided as part of an overall welfare system, to a more market-oriented approach where the

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state, although still responsible for maintaining universal access to water services, uses market forces to meet this aim. Some form of well-regulated privatisation is now seen by many experts as providing the cheapest means of maintaining and extending water and sanitation systems at the least political cost, thus leading to a rapidly growing global market for the private management of water services (Haugton 2002).

Fully privatised water-supply and waste-disposal systems are still rare, supplying less than 6% of the world's urban dwellers. However, partial privatisation and related operations such as concessionary schemes or build–own–operate–transfer (BOOT) schemes are becoming more common, for a variety of reasons. In many developing countries in particular, governments have found it increasingly difficult to fund expanded water-supply and waste-disposal systems through large-scale borrowings, and they have been under pressure from international agencies to pursue options based on private-sector participation (Marvin and Laurie 1999: 346).

Global institutions such as the World Bank and the International Monetary Fund (IMF) can use their funding programmes in individual countries and regions to promote their agenda of developing an international free market (Marvin and Laurie 1999). The World Bank in particular has been active in facilitating the commercialisation of public water utilities and the development of regulatory frameworks (Pitman 2002). As an example, in the case of the concession for the Buenos Aires water and sanitation system that was put in place in 1993, the World Bank and Inter-American Development Bank (IADB) had both been involved in the sector for several years and assisted with the overall implementation of the process (Loftus and McDonald 2001).

In more developed parts of the world privatisation is often seen as a means of improving the existing services provided by a supposedly inefficient government-owned water and sanitation sector. The expectation is that privatisation will bring improvements, partly through the injection of additional capital and partly by facilitating access to the management skills and expertise of local or international private companies.

There remain some concerns about the effects of privatisation of water systems because the supply of water and disposal of waste are effectively natural monopolies, especially for urban communities where delivery and removal are dependent on pipe networks that cannot economically be duplicated. Thus strong government regulation of price and quality of service is regarded as a necessity, especially given that the cost of water tends to bear disproportionately on poorer citizens, with disastrous consequences for human health if the water becomes unaffordable. There is also a risk that services to rural communities may be less attractive to investors, particularly given that the water industry has come to be dominated by a relatively small number of large international companies.

The role of the private sector in the provision of water and sanitation supply is a significant issue relating to the implementation of the goals set at Johannesburg, but it is only one of a number of problems that must be tackled by water and sanitation practitioners and by the international development community more generally. New technologies are urgently needed, together with measures that ensure that they can be effectively utilised in developed and less-developed countries. There is also a

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need for a greater understanding of issues reflecting the specific conditions of individual countries and regions.

The contents of this book

This book is divided into five parts in which the authors address the above concerns. It begins with a group of chapters discussing general theory and goes on to look at aspects of water and sanitation privatisation and new technologies. In the final two parts it presents regionally focused papers, looking first at rural areas and then at urban areas.

Part 1: General theory

In Chapter 1 Renzetti examines the issue of demand-side information in water utility operations and planning. In the past it was assumed that consumers' water needs were not sensitive to policy measures open to water utilities; hence, the provision of domestic water focused on the management of supply rather than demand. Renzetti argues that the available empirical evidence indicates that by making more extensive use of demand-side information, such as information on consumers' sensitivity to pricing or willingness to pay for new infrastructure, major benefits both for utilities and their consumers will result.

In Chapter 2 Terrill further explores one of the key themes of Renzetti's chapter: namely, the pricing of water. He argues that provision of a water supply can be expensive because of the significant investment that is generally required and because scarcity limits supply. Particularly when scarcity is a factor, effective use of pricing can reduce wastage and inefficient use. Terrill argues that in order to harness appropriate levels of innovation and research expertise in water we need to accept that water prices must increase under certain circumstances and that they must vary according to supply conditions.

In Chapter 3 Bixio, Thoeye and De Gueldre focus on the provision of reliable treatment in water and sanitation projects from a risk management perspective. Cost implications must be balanced with the benefits of compliance by means of probabilistic risk assessment techniques and the imperfect information that is available to decision-makers. Bixio *et al*. argue that the ability to identify, manage and share risks effectively can greatly reduce the costs for projects with certain types of risk profiles. The starting point is a clear understanding of the risk assignments, which is achievable only when an explicit link between the risks and uncertainties that generate those risks is developed.

In Chapter 4 Gminder examines how strategic management, daily operational management and sustainability can be balanced within water utilities that are operating in a commercially oriented environment. He explores how corporate sustainability can be incorporated into the concept of the 'balanced scorecard' in the context of a large water utility and finds that it offers a management tool that is flexible enough to deal with environmental and societal issues. A major benefit

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of the technique is the ability to translate the strategies of corporate sustainability into action and integrate them into general management so that sustainability no longer has to be managed apart from other management tasks and systems.

These first four theoretical chapters collectively point to the need to make maximum use of informational resources in an integrated fashion in the operation of water utilities so that water costs to consumers are kept as low as possible, profit levels are sufficient to ensure that reinvestment in the sector continues and resource sustainability is maintained.

Part 2: Privatisation

Owen begins the part on privatisation by providing in Chapter 5 an overview of the recent global trend towards privatisation and examines the degree to which privatisation now influences the water and sanitation sector globally. He argues that international and locally based private water companies have developed a diverse suite of financial and contractual arrangements that offer flexibility for the future development and management of the sector. Although private-sector participation in developing countries is a relatively recent phenomenon, certain management approaches have benefits that exceed the alternatives. He further emphasises the need for the industrial and academic communities to engage better with each other to promote a more constructive dialogue between the various interest groups involved in the sector.

In Chapter 6 Rothenberger and Truffer examine alternative private-sector participation contracts in the water sector, analysing whether high transaction costs involved in contract setting increase the risk of opportunistic behaviour by the contract parties. They argue that, in order to limit the impact of problems with asymmetric information and of transaction costs, short-term and easy-to-define contracts should be used where possible to improve the performance of inefficient public service providers. Conventional economics, with its focus on production efficiency as indicated by the 'lowest bid for water price' criterion when awarding concession contracts, is too narrow to form a real base for overall welfare improvements.

In Chapter 7 Renzetti and Dupont assess what is known regarding the relationship between the ownership and performance of water utilities. Theoretical arguments predict that privately owned water utilities will outperform public ones, but Renzetti and Dupont show that there is no compelling empirical evidence to support this. However, they argue that the available evidence supports the view that public–private partnerships may facilitate efficient and sustainable operations.

In Chapter 8 Morris and Cabrera examine the effects of private-sector involvement in the water sector by focusing on how water pricing and allocation policy affects specific principles of sustainability, particularly the implications for the urban poor. Although they find that tariff increases following privatisation may result in serious challenges for low-income households, they argue that through more carefully structured water-pricing policies it would be possible to provide water both equitably and in an environmentally sustainable manner.

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In Chapter 9 Bremer and Nebiker ask the question of whether joint-use municipal–industrial infrastructure projects could help promote service coverage expansion while reducing the cost of that expansion. They suggest that corporate investments to meet water and waste-water treatment needs in manufacturing facilities could be structured in a way that also provides water and waste-water services to nearby municipalities.

To those familiar with the field, it is no surprise that the range of perspectives and issues covered in the five chapters in this part on private-sector involvement in the water sector fail to present a clear-cut picture either for or against privatisation. Rather, a very complicated situation is identified with regard to privatisation, the implementation of privatisation and its relative benefits and costs. In part, this may be attributable to the monopoly nature of water and sanitation supply, so that the privatisation of these services is more complicated and problematic than private-sector involvement in other areas that were formerly seen as the responsibility of government. The five chapters presented here suggest, however, that the private sector does have a significant role to play in the water industry in certain situations but that the negative externalities of private-sector involvement must be carefully managed, otherwise any benefits gained may be outweighed by the resulting disadvantages.

Part 3: Technology

In Chapter 10 Nowak examines the potential use of geothermal energy to power a desalination plant on Milos, a small Greek Island where demand for fresh water greatly exceeds natural supply. Despite the expected benefits of the project, the project met with a degree of opposition by the local community and certain interest groups, meaning that there was a need to convince the local community of the benefits of the project. The geothermal desalination plant has been a success, as it is economically, environmentally and socially sustainable and is accepted by stakeholders.

In Chapter 11 Simpson-Hebert, Rosemarin and Winblad examine the possibility of using dry sanitation options to make the task of expanding the proportion of the world serviced with adequate sanitation more attainable. The ecological sanitation systems they describe operate on natural processes of desiccation and decomposition, are cost-effective and environmentally sound and do not depend on elaborate technology or the significant quantities of water that are required for flush systems. Particularly in water-stressed regions they make sanitation much more affordable, but even in more humid regions they have a potential role to play preventing the pollution of fresh water resources that results from the inadequate treatment of sewage.

In Chapter 12 Johnson explores the potential for water metering in rural areas to improve water services in those areas. Although metering is generally accepted as necessary in urban settings, in rural areas it is often regarded with hostility by engineers, development workers and project beneficiaries alike, and it may be rejected both on philosophical and on technical grounds. Johnson argues that a pragmatic and appropriate use of meters in rural water supply systems can promote

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fair and equal distribution in a manner acceptable to the community and can also make the water delivery process more efficient, businesslike and profitable.

In Chapter 13 Mann examines how water can be supplied sustainably to isolated rural populations. Broken hand-pumps can be found across much of southern Africa, their users unable to maintain them once those who designed and built the systems have left. Mann argues that the sustainability of any technology is dependent on the knowledge, capacity and confidence of community members who use the technology to maintain and repair the equipment. Systems need to be put in place at the time a water project is implemented to ensure that the community can maintain the project once the international aid funding has come to an end and external resources cease to be available. As in the chapters by Simpson-Hebert *et al.* (Chapter 11) and by Johnson (Chapter 12), Mann finds that high technology is not required to solve some rural water supply problems but rather that it is the careful use of appropriate low technology that is needed.

These four chapters on the use of technology to support the extension of water and sanitation services show that low-technology solutions are just as important as more high-tech solutions. In either case, though, it is dealing with the associated social issues that is most critical as this is the only way to ensure that the proposed technology is accepted and effectively used to facilitate water and sanitation coverage extension.

Part 4: Regionally focused case studies: rural environments

Social issues are further highlighted by Akiwumi, in Chapter 14, in which she analyses the effects of contrasting concepts of water in Sierra Leone, where the national government and global interests promote water as a marketable good, in contrast to the more holistic view of water in traditional society. Conflict between these two viewpoints arises when community water sources are taken over for commercial use without adequate consultation, Often, the resulting indigenous protests have limited project success and caused loss of capital investment. Akiwumi concludes that water scientists must broaden their knowledge base to encompass a variety of relevant disciplines such as history, sociology and anthropology, enabling them to work with greater sensitivity in indigenous systems.

In Chapter 15 Howlett explores the potential for a professional association to create a water aid charity in conjunction with a non-governmental organisation (NGO), in this case the American Red Cross. The Water Relief Network established in 1996 by the US-based Chlorine Chemistry Council seeks to promote access to clean water and sanitation through a range of sustainable initiatives. Howlett argues that such partnerships between the public and private sector, as demonstrated by the Network's work in Guatemala, allow the leveraging of resources to support improvements in the water sector. It is only through global co-operation and partnerships such as these that sufficient resources will be made available to meet the water and sanitation challenge. Howlett acknowledges that at the same time such partnerships are, in the long term, commercial interests of industry bodies as, in the long run, they will promote the development of new markets.

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In Chapter 16 Sarantakos, Kontogianni, Skourtos and Dimitriou examine the distortions arising from the inappropriate water management that can lead to unnecessary inefficiencies. Using as a case study the Axios River Basin in northern Greece, an important agricultural area that faces severe seasonal water scarcity and pollution problems, they show that water pricing policy is strongly linked to agricultural policy and that there is an urgent need for radical reform and immediate action to address water-related problems. They conclude that reform of the agricultural policy at national and EU level needs to include a consideration of the viability of crop species under the specific geographical and environmental (climatic) conditions present and the intoduction of measures that promote the most efficient crop species for each climatic area. Effective use of water pricing can promote reduced usage of water and greater economic returns for the community.

In Chapter 17 Stephen describes the work in South Africa of Umgeni Water as the implementing agent for water projects in rural areas of KwaZulu-Natal. The projects are being developed in the context of rapid reforms in the water sector and a changing role for local government in the region. He highlights the wide range of different factors that must be considered if available funds are to be used effectively and if water and sanitation backlogs are to be reduced.

WHO figures indicate that access to basic water supplies in rural areas is poorer than in urban areas and that the disparity for sanitation services is even greater, so the extension and improvement of rural water and sanitation coverage is critical to global development efforts. These four rurally focused regional chapters (and the chapters in Part 3 of the book) show how difficult it is to generalise about the range of problems or solutions to rural water supply because of the diversity of environments and social systems that are found around the world. One thing that is common to each of these four chapters is the emphasis on the importance of working with local communities and organisations. Done effectively, this will ensure that the use of existing knowledge can be maximised and systems be put in place that are appropriate to the local social environment and that are therefore more likely to be sustainable in the long term.

Part 5: Regionally focused case studies: urban environments

Constraints on urban supply and sanitation systems are often rather different from those in rural areas. In Chapter 18 Venkatachalam examines the extent to which urban water supply schemes in India fail as a result of financial scarcity: a poor quality of service leads to a low willingness to pay on the part of households, therefore resutling in low revenue for the water supply authority, which in turn leads to a poor quality of service. Drawing on a case study in the State of Tamil Nadu, Venkatachalam argues that it is not necessarily a fundamental lack of finance that causes a scheme to fail; rather it is the overall management approach adopted by supply authorities that may be contradictory to the expectations of the actual users.

In Chapter 19 Goh analyses the water supply options open to Singapore. Despite being located in a climatically wet region, the densely populated and highly industrialised island city-state is considered to be a water-stressed nation. At present much of Singapore's water supply is imported from Malaysia, but this dependence

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on one external source is seen as rendering the country vulnerable to supply issues beyond its control. In trying to overcome this, Singapore has evolved a highly efficient internal water management system that provides a model of how to create an effective water supply for a nation with poor water resources but excellent human and financial capital.

These two urban-focused regional chapters point to the importance of having effective structures for managing the water supply and sanitation systems of urban areas. Indeed, it can be argued that they illustrate that appropriate and effective management is considerably more critical to a good water supply system than plentiful natural water supplies.

Overview

In 2000 there were more than 26 countries with fewer than 1,000 cubic metres per capita of fresh water available as internal renewable water resources, a level described as water-scarce; 16 of these countries had fewer than 500 cubic metres per capita and are thus considered to be facing absolute water scarcity (WRI 2001). As populations grow, and with the that likelihood that water consumption per capita will continue to increase, this situation can only get worse. This collection looks at some of the ways in which those responsible for water management can respond to the problem.

We have sought to illustrate the range of approaches that will be necessary if the percentage of the global population having access to adequate and safe water and sanitation is to be increased in line with the brave assertions from the Johannesburg Summit. The contributors have been selected to illustrate the variety of organisations that must contribute to this task. They include academics, the staff of water-management organisations, industry personnel, consultants and employees of NGOs.

Some of the approaches that are advocated are large-scale 'Western-style' improvements involving the creation of new business models, their effectiveness measured by the traditional approaches of fiscal and social analysis. Such schemes may be instigated and partly funded by governments, but governments are increasingly turning to the private sector for money and expertise. In contrast, in many smaller communities it may be more beneficial to follow a different path to improved water supply and sanitation. Because of their size, location or traditions better results may be obtained through the adoption of local small-scale solutions. NGOs have been very active in this area, but to extend their operations many are seeking to adopt a more business-like model.

All acknowledge that governments and water supply and waste disposal agencies, large or small, need to support and encourage continued research into technological solutions that seek out better, more sustainable, ways to use our increasingly scarce supplies of good-quality fresh water. The research needs to be tempered by a better understanding of the social and cultural environments into which the technology will be introduced, thus ensuring that optimum use is made of new and existing systems.

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The challenge of fulfilling the water and sanitation goals set at Johannesburg is formidable. Nonetheless, the chapters presented in this book collectively portray many issues that must be addressed as part of this process. They also point out some of the technological, social and managerial solutions that can be adopted in attempting to fulfil water and sanitation goals.

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