Beyond Domestic

Case studies on poverty and productive uses of water at the household level

IRC Technical Paper Series 41

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Moriarty, Patrick; Butterworth, John; van Koppen, Barbara (2004). Beyond Domestic: Case studies on poverty and productive uses of water at the household level. Delft, the Netherlands, IRC International Water and Sanitation Centre. (Technical Paper Series; no. 41). 243 p.

Published jointly by IRC International Water and Sanitation Centre, the Natural Resources Institute (NRI) and the International Water Management Institute (IWMI).

ISBN 90-6687-044-3

Design & Printing: Meester en de Jonge, Lochem, the Netherlands

Photographs: Charles Batchelor, John Butterworth, Eric Demildt and Umgeni Water

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Patrick Moriarty, John Butterworth,

Barbara van Koppen (eds.)

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IRC International Water and Sanitation Centre

Delft, the Netherlands

2004

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Foreword

This book deals with a matter very close to my heart and to the heart of the Government of South Africa. Across the world, millions of people live without access to clean drinking water, without adequate sanitation, without sufficient food, and without decent housing. Throughout the world, governments have committed themselves to sustainable development and the eradication of poverty. The South African Government is equally committed to the building of a society based on justice and human rights.

In the decade since 1994, the Government has placed considerable emphasis on the delivery of clean water to the people of South Africa. My Department alone has delivered clean water to almost ten million rural people. The lives of these people, and of the women in particular, have been enhanced by this access to water. Yet many challenges still remain. For instance, we are only beginning to deal with the enormous sanitation backlog. Moreover, the provision of drinking water only deals with one aspect of the water needs of poor households.

Food security is a major issue that we also have to address. People who are hungry cannot live the life of dignity to which they are entitled. Our Constitution guarantees access to sufficient food as a human right. It is self evident that water also plays a key role in food security. Poor people in particular also require water for food gardening, for small businesses, and other productive purposes. The poor, and poor women in particular, draw multiple benefits from having access to water. The combination of the domestic and productive benefits can add up to an appreciable impact on livelihoods and poverty eradication. Therefore, poor households need to be enabled ‘to climb the water ladder’.

Once services for basic health and hygiene are provided, we will facilitate higher levels of services, which support sustainable livelihoods and economic development. This, however, poses significant challenges in terms of the delivery of water for both domestic and productive purposes to the poor. In South Africa we find ourselves facing such challenges and are grappling with the many questions as to how to meet the challenge.

This book helps us to find answers. It reports on research presented at the symposium Water, Poverty and Productive Uses of Water at the Household Level,


ADLE PUMPS

that my Department co-organised with IRC, NRI, and IWMI in January 2003. The book includes positive examples from all continents of how small-scale integrated and multiple-use water management can impact on livelihoods and poverty eradication and lessons learned. Thus, an important step is made towards identifying technical, institutional, and financing models and tools to effectively address the wider needs of people for multi-purpose water access. This will help to contribute to the eradication of poverty and to the building of a world based on equality, dignity and recognition of the value of each and every human life.

Mr Ronnie Kasrils, MP, Minister of Water Affairs and Forestry, South Africa

Acknowledgements

This book is an output of a cross-institution thematic group on ‘productive uses of water at the household level’ (www.irc.nl/prodwat) funded and co-ordinated by the IRC International Water and Sanitation Centre.

The symposium on ‘Water, poverty and the productive uses of water at the household level’ where these papers (except one) were originally presented was organised by John Butterworth, Minnie Venter Hildebrand, Patrick Moriarty, Barbara van Koppen, Barbara Schreiner and Dirk Versfeld. Minnie’s many colleagues, family and friends made a successful event possible, particularly Louise Hildebrand. Financial support from IRC, the Natural Resources Institute (NRI), the International Water Management Institute (IWMI), and hosting of the symposium by the South African Department of Water Affairs and Forestry, is gratefully acknowledged. The organisers were all thankful for a stimulating opening address at the symposium by Mr Ronnie Kasrils, MP, Minister of Water Affairs and Forestry, South Africa.

Inputs by John Butterworth, and support for several papers presented at the symposium, were made possible by the Water, Households and Rural Livelihoods (WHiRL) Project co-ordinated by the Natural Resources Institute (www.nri.org). This project is supported by the UK Department for International Development (Project R7804 ‘Integrating drinking water needs in watershed projects’).

Publication of this book was supported financially by IRC, NRI, IWMI and the Comprehensive Assessment: Water Management in Agriculture.

Juan Carlos Pérez de Mendiguren Castresana (Chapter 2) would like to thank people in the Bushbuckridge communities of Utha, Dixie, MP Stream, Xanthia, Mabharule, Kildare, Ngoromane, Dinglydale, Chris Hani, Mamelodi, Shortline, and Township: the real actors and owners of the lives behind the numbers and analysis presented. Also: AWARD staff members for their support and dedication; Mpatametse Mabelane, a friend and colleague through the fieldwork process; Sharon Pollard and John Butterworth who provided useful input and comments on earlier versions of the paper; and the Leon Foundation Trust who supported the research.

The authors of Chapter 3 (Perez et al.) wish to thank the inhabitants of the Ambichinte area for cooperation in the research, the Corporación Autónoma Regional del Valle del Cauca (CVC) for financial support, Adela Parra for assistance in the development of the willingness to pay survey, and finally, the help of Jhon Jairo Cortez in carrying out the field work.

The authors of Chapter 4 (Raschid-Sally et al.) would like to thank in India the Hubli-Dharwad communities in Budarsingi, Gabbur, Gongadikoppa, Katnur, Madihal and Maradagi for their active participation in the research. The UK Economic and Social Research Council (ESRC) supported the attendance of Andrew Bradford at the symposium (ESRC grant no. R42200134386).

Eline Boelee and Hammou Laamrani (Chapter 5) thank the Office de Mise en Valeur Agricole du Moulouya (ORMVAM) in Morocco, and in particular Mr. O. Laaydi of the irrigation department in Zaio and his colleagues in Berkane, for assisting in field arrangements and providing us freely with all information; the farmers and Jboub users in the Zaio region for their patience and confidence; Wim van der Hoek and Felix Amerasinghe for their comments on earlier versions of this manuscript. This study was funded by the International Water Management Institute.

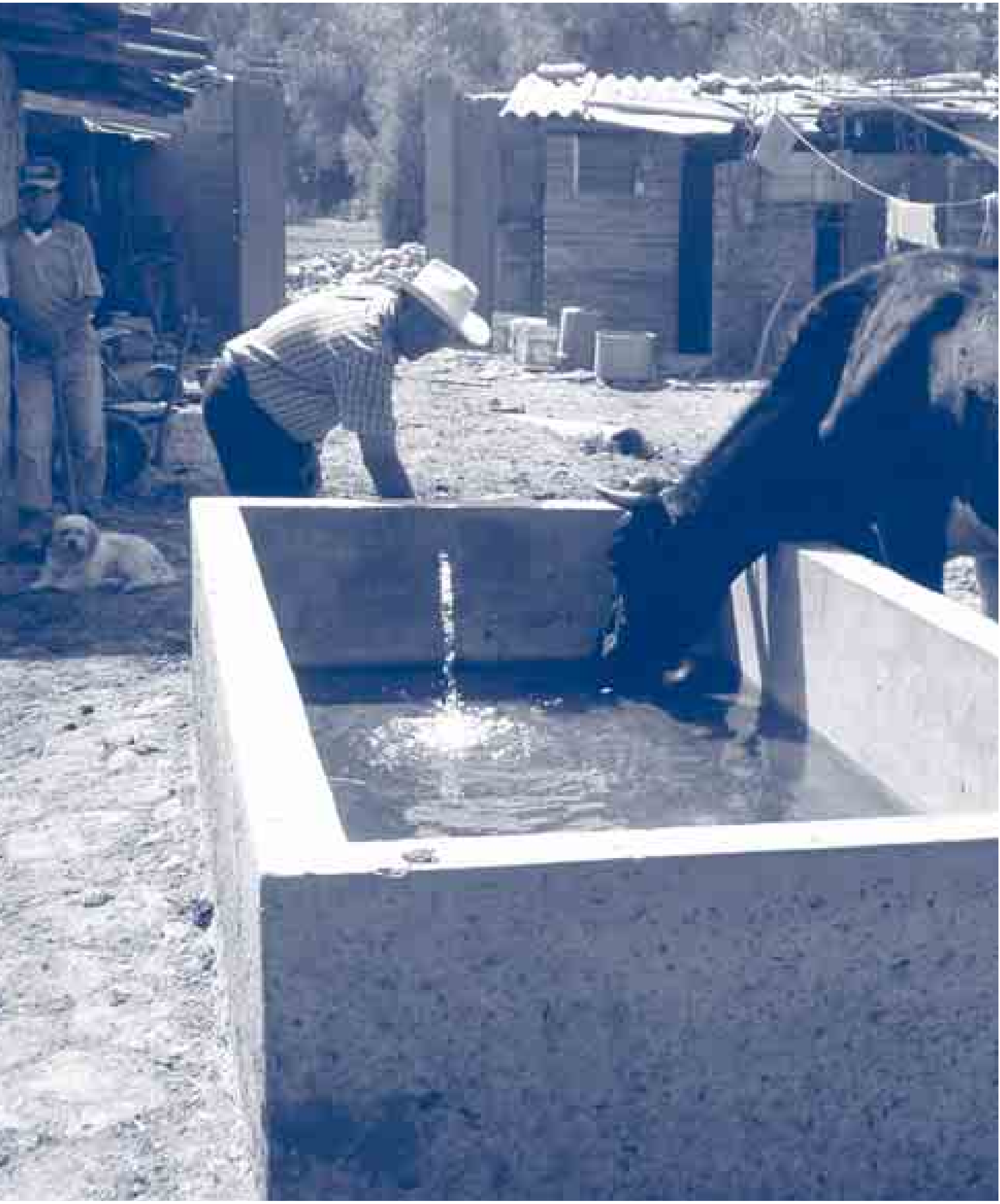
The study from Bolivia reported in Chapter 6 (Bustamante et al.) was made possible through the support of the North-South Programme (a partnership between Wageningen University in the Netherlands and the Universidad Mayor de San Simon in Cochabamba, Bolivia), and the IRC-coordinated thematic group on 'productive uses of water at the household level'. The authors would like to thank all the people from Tarata and Arbieto who provided information and support, and Jeroen Warner at Wageningen University who supervised the original research upon which this paper is based. An earlier version of this chapter was presented as a paper at 'AGUA 2003: International conference on multiple uses of water for life and sustainable development' held from 29-30 September 2003 in Cartagena de Indias, Colombia.

The authors of Chapter 7 (Polak et al.) would like to thank Jack Keller for his review and improvements of the technical sections of the chapter, and for the description of experience with multiple use systems in Guatemala.

The research reported in Chapter 8 (Robinson et al.) undertaken in Bikita District of Zimbabwe owes much to Handy Mulambo of the Agricultural Extension Department, and Robert Mukuwe then district health education officer with Bikita Rural District Council. DFID Harare and Bikita RDC are also thanked for their logistical assistance.

The research reported from Gujarat in Chapter 9 (James) is from a joint project by the IRC International Water and Sanitation Centre, Delft, Netherlands, the Foundation of Public Interest (FPI), and the Self-Employed Women's Association (SEWA), both from Ahmedabad, Gujarat, India, for the Swedish International Development Agency in New Delhi. The research reported from Andhra Pradesh is from the Water Households and Rural Livelihoods (WHiRL) Project, co-ordinated by the Natural Resources Institute, UK and supported by the UK Department for International Development. The author would like to thank John Butterworth for detailed comments on previous drafts of the paper, and the WHiRL project for support to write and present the paper at the symposium.

Photographs were provided by Charles Batchelor, John Butterworth, Eric Demildt and Umgeni Water. Production of this book was coordinated at IRC by Sascha de Graaf. The beautiful maps were drawn by Simon White. Finally thanks to Brian Appleton who ironed out the final kinks.



Preface

These edited papers were originally presented at the international symposium on *Water, poverty, and productive uses of water at the household level* in Johannesburg, South Africa, from 21 to 23 January 2003. The symposium was convened by the IRC International Water and Sanitation Centre, the International Water Management Institute (IWMI), the Natural Resources Institute (NRI), and the South African Department of Water Affairs and Forestry (DWAF) to discuss practical experiences, new research, and policy implications related to innovative approaches to the provision and use of household water supplies. It brought together a multi-disciplinary group of practitioners, researchers, and policy-makers from 14 countries across Africa, Asia, South and North America, and Europe.

Taken together, the ten papers illustrate the great diversity in the ways that people and communities make use of water available to them. They demonstrate too how providing for small-scale productive use of water in addition to basic domestic needs can make a big impression on poverty reduction, while at the same time enhancing the sustainability of improved water supplies. The examples range from the remarkable success of the rope pump in Nicaragua – clearly related to the income boost it brings to users from small-scale irrigation and livestock watering – to productive use of reclaimed wastewater for irrigation in Africa and Asia. There is mounting evidence that linking productive use with domestic supply improvements is cost-effective and brings multiple benefits. Regrettably, sectoral divisions have often meant that the synergies are not recognised in water planning. The Johannesburg symposium sought to bring the livelihood-enhancing aspects of integrated planning to the fore.

Participants undertook to advocate recognition and support for small-scale productive uses of water at the household level, and to work in partnership with others to spread this important message. In this endeavour, they pledged to: change minds; develop tools, methods, and training; build partnerships for effective implementation; and undertake research to fill key gaps in understanding. The symposium participants adopted the advocacy statement that follows this preface.

Through this edited collection of the symposium papers, this book provides the evidence supporting the statement's bold calls for radical changes in the way we go about planning, providing and managing water supplies in response to the urgent need to make water work better in tackling poverty in the developing world.

For further information on initiatives arising from the symposium, see www.irc.nl/prodwat

Statement adopted by the Symposium on Water, poverty, and productive uses of water at the household level, Johannesburg, 21-23 January 2003

1 Productive use of water at the household level by poor people reduces poverty.

1.1 Sustainable livelihoods can be built on access to water that goes beyond current approaches to meeting both domestic needs (drinking, cooking, and washing) and irrigation needs. The water needs of the poor always extend beyond the domestic.

1.2 Productive uses of water at the household level include a range of small-scale activities that enable people to grow food, earn income and save expenditure: fruit and vegetable production, keeping livestock, brick making and building, and a wide range of informal micro-enterprises.

1.3 Without access to sufficient and reliable water for productive uses in and around the household, people are excluded from a range of options that would allow them to diversify and secure their sources of food and income. At the most basic level, poverty is a lack of opportunity. Access to productive water supplies provides opportunities.

1.4 We believe that productive uses of water in and around the household are the most socially and economically effective uses of water after 'traditional' domestic uses, and that providing water for these uses offers one of the most effective ways to use water to tackle poverty in its multiple-dimensions.

1.5 The provision of water services, that include water for productive uses, needs to be planned to ensure that benefits are inclusive or pro-poor. In planning, implementation and research it is important to hear and act upon the voices of the poor, women, and children, recognising that otherwise benefits may be captured by elites.

2 People require more than their domestic water needs to be productive.

2.1 It is universally accepted that people should have access to a basic domestic water supply (often ranging between 25-50 litres per capita per day (lpcd)). We believe that poor people should also have access to water for productive uses. Total household water requirements for poor people including water for productive uses are likely to be in the range 50-200 lpcd.

2.2 These quantities can be realised by helping households secure access to water through a range of alternative approaches (such as roofwater and run-off harvesting, family wells, communal water points, piped water systems, municipal and household level wastewater reuse) and by investment in systems that are equitable and reach the maximum number of poor beneficiaries.

2.3 The better off living in cities around the world typically consume around 200 lpcd. We believe that finding ways to provide and manage the use of similar amounts of water in support of poor people's livelihoods is vital.

3 Productive use enhances the sustainability of water supply systems and services.

3.1 In most cases the sustainability of domestic water supply systems can be increased by explicitly including productive water uses that provide the means and motivation for people to engage in the management of systems. These uses generate income that can be invested in system improvement and maintenance. Sustainability has been hard to achieve in water and sanitation: we believe that the lack of opportunities for productive water uses is central to this problem.

3.2 When people have demands for productive water that are not met, problems arise and ownership and participation are reduced. 'Illegal' connections to domestic piped water systems cause serious problems that could be anticipated and avoided by satisfying the demand for productive water, possibly from different sources. We believe the benefits will normally greatly exceed the incremental financial costs.

3.3 Many irrigation schemes provide multiple benefits. Meeting the needs for other uses of water (including domestic) through an integrated approach enhances the impact as well as performance of irrigation schemes and systems.

3.4 Productive use of wastewater provides opportunities for many urban and peri-urban farmers, but simultaneously places them, the consumers of their products, and the environment at risk. In accordance with the Hyderabad Declaration on Wastewater Use in Agriculture (2002), we believe that appropriate policies, strategies and interventions can mitigate the human health and environmental risks while contributing to poverty reduction. The safer use of wastewater in agriculture should be encouraged and supported, and addressed within an integrated policy framework.

4 People need local solutions and multiple sources for multiple uses.

4.1 Peoples' water needs are typically met through multiple sources - from rainwater to wastewater to piped systems. Rarely do people rely on single sources. And single sources tend to be used for multiple purposes. A holistic approach that builds on this reality is required in planning and service delivery to meet peoples' needs for household water supplies.

4.2 Wherever possible and taking into consideration downstream users, household water needs should be provided from locally available water resources, drawing on local knowledge, and at the lowest possible cost to provide a reasonable level of service.

5 An integrated approach is essential to achieve significant impacts on poverty.

5.1 Demand for water for multiple purposes at the household level has, until recently, been insufficiently recognised in the planning and allocation of water resources in river basins. We recommend a process in which planners, and in particular local-level and catchment planners, acknowledge and take into account these needs as a priority consideration. This will need to be based upon appropriate assessments of the resource base, possible trade-offs, and environmental sustainability, and within an appropriate framework for demand management.

5.2 People who use water productively at the household level are numerous, but a diffuse and poorly represented group. Special attention is required to ensure that the voices of household level users, especially women, are heard at the Integrated Water Resources Management (IWRM) table. We believe that the use and management of multiple sources at the community level lies at the heart of IWRM, and that water should be managed from bucket to basin.

5.2 Improving access to water will not, on its own, eradicate poverty. People need better access to markets and credit, and to overcome many other constraints to make best use of more water. Collaborative partnerships with education, health and enterprise-based programmes can overcome some of these multiple constraints. This calls for better coordination, communication, and cooperation between different government departments, civil society, NGOs and the private sector.

Water, poverty and productive uses of water at the household level

Patrick Moriarty, John Butterworth, Barbara van Koppen and John Soussan

Introduction

Around the world, hundreds of millions of men, women and children live in extreme poverty. Their poverty is multi-faceted: besides lacking money, they have limited access to education, suffer from poor health, have little political weight, and are vulnerable to all manner of external shocks (droughts, wars, economic crises). The poor often have limited or restricted access to resources: natural, physical or financial. Key amongst these is water – in terms of both quality and quantity. A great many of the poor men and women in urban, rural and peri-urban settings base their livelihoods on ‘informal activities’ – small-scale cropping, livestock rearing, agro-processing and other micro-enterprises. In many of these activities, an adequate water supply is a crucial enabling resource: used in, or necessary for, the activity itself; freeing time (by reducing time spent collecting water); or as a key element in improved health that in turn enables people to do work. Water supplies provided to households therefore have a huge potential to impact on poverty. This is particularly true for the poorest (and for women, who are in a majority amongst the poorest). This book, which gathers together a range of experiences from around the world, is about such household water supplies, about how to provide them and how to ensure that their potential to impact on poverty can be fully realised.

Throughout history, people have used water for many different purposes in their livelihoods: drinking, washing, cooking, irrigating, manufacturing, worshipping. Sometimes, they allocate specific sources to specific purposes; more often, they use the same source or sources for multiple uses. Over the course of many years, the modern water ‘sector’ has been created, with its range of sub-sectors[1], each with its own approaches, doctrines, and more or less rigid sectoral boundaries. The success of the sectoral approach has been to provide billions of people with safe water supplies: for domestic use, for agriculture, for industry. The failure is that 20 to 30% of the world’s population, the poorest and disproportionately women, have not shared in these benefits. In the year 2000, some 1.2 billion people remained without an adequate domestic water supply (and another 2.4 billion without access to sanitation). In addition, the environment has suffered as piecemeal, uncoordinated development has led to pollution and inefficient and unsustainable water resource use – culminating in the global 'water crisis'.

1 Throughout the book we use the term 'sub-sectors' to refer to the principal groupings of water-based activities: notably irrigation, industry and domestic water supply/sanitation.

Until now, the different water sub-sectors have not paid sufficient attention to the fact that their paradigms, norms, and models do not cater to the needs of a large number of their 'clients' and thus fail to achieve the impact on poverty that they could. This is as much institutional blindness as disregard by individuals: line departments have been created to be line departments with well defined remits and no mandate to look beyond the boundaries set by these remits; water supply programmes rarely elicit the view of the users as to whether or not the domestic water supply system is providing adequate water from the users' point of view. In recent work in part of India, 51% of water points in an area were, according to users, failing in one or more key functions. Yet government statistics showed that there was 100% sustainable coverage according to government norms (Rama Mohan Rao et al., 2003). The irrigation sector, on the other hand, still largely fails to reach the majority of rural poor directly and tends to prioritise irrigation over other uses, even where domestic water needs have not, as yet, been met. The result of this fragmented approach is water-sector interventions that fail either to be sustainable or to address the real needs of their target audiences, a failing that is most pronounced for the poorest.

In the last decade or so, and in reaction to these failures, new approaches have been tried, based on a more holistic approach to working with water and a more context-sensitive approach to providing water services. These efforts come under a number of headings including sustainable development, participatory and livelihoods-based approaches, demand-responsive approaches and integrated water resource management. The cases and experiences reported in the symposium papers provide a number of examples of these new, holistic and people-centred approaches in the water sector. They demonstrate again and again that the starting point for development and change must come from an understanding of people (men and women, rich and poor, at all levels of society) and what they do (or would like to do) with water. They demonstrate the huge potential that can be realised when small-scale productive uses of water: food production, small businesses, and other productive enterprises are specifically catered for in the design of systems. However, they also indicate that innovative ideas alone are not enough to achieve this potential. The necessary institutional structures, policy environments, and legislation must be in place to support bottom-up development. Only then can organisations take responsibility for issues that are outside, or fall between, the interests and capabilities of individuals and groups, and become empowered to support the real needs of water users.

What this book is about – water supplies and their productive use at the household level

What is meant by 'productive use of water at the household level'? The reason for this rather cumbersome phrase is the need to encapsulate a set of activities that typically fall between a number of sectors or sub-sectors. Household water supplies are most often thought of as coming under the remit of the domestic water supply and sanitation (WATSAN) sub-sector, with its exclusive focus on water supplies for drinking, washing, cooking, and sanitation (so-called basic needs). Water for agricultural production is assumed to be provided by the irrigation sector, but this in turn seldom focuses on smaller scale or domestic uses at the household scale. We use the concept of 'productive use' to refer to water used for small-scale, often informal activities whose primary purpose is improved nutrition and/or income generation. And we use the term 'household level' to indicate both the relatively small scale of the activities (and quantities of water) involved, and the primary social unit at which the use of this water takes place. Enabling productive use means providing a quantity of water over and above that needed for purely basic needs. A major outcome of the Johannesburg symposium in January 2003 "Poverty and Water: Productive Uses of Water at the Household Level" (Butterworth et al., 2003) was agreement among a wide range of professionals that a quantity of water sufficient for both domestic and (at least some) productive use will typically be between 50 and 150 litres per capita per day (lpcd) – not far from what is typically supplied by northern and urban water supply utilities.

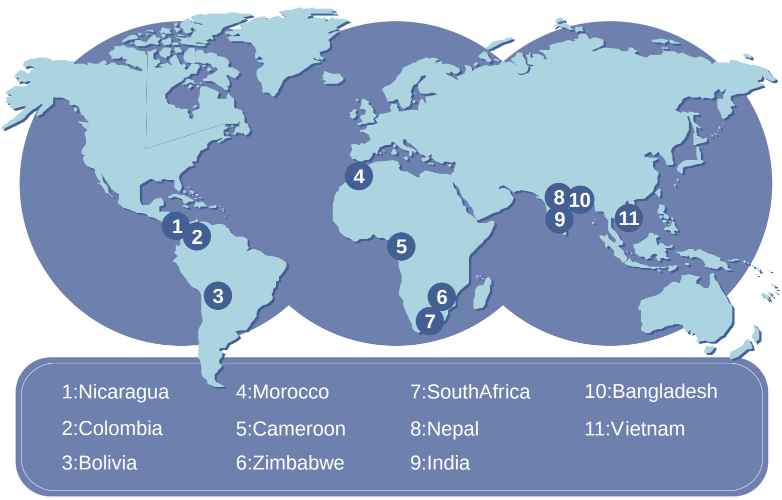


Figure 1. Experiences in household-level productive use of water from around the world

This book brings together experiences in household-level productive use of water from practitioners and researchers around the world and across water's sub-sectors (see map 1). The feature common to all the chapters is that water plays a range of critical roles in the lives of poor people. Some of the experiences report on new technologies that enable poor people to benefit from sub-surface water, others identify and quantify existing use of water for ‘non-planned’ activities – productive use of domestic water, domestic use of agricultural water, and productive use of wastewater. All draw the central lesson that an approach that takes into account, and supports, these multiple and often un-planned uses is a stronger and more sustainable one.

The focus of the papers is on small-scale activities that exist at the intersection of water sub-sectors (especially domestic and irrigation). Because these activities are small-scale and often informal they risk dropping through the gaps between sub-sectors – forever destined to be ‘somebody else’s problem’ – although they are frequently picked up by NGOs whose approach is less sector specific. Yet these informal, diverse, and fragmented activities are absolutely critical to the health and wellbeing of the people who engage in them.

The papers in this book carry two key recommendations for policy makers and planners from both the WATSAN and irrigation sub-sectors, and for the wider population involved in providing water for development:

a) Recognising the importance of productive water.

Productive water is defined (primarily with regard to the domestic water supply sector)[2] as a quantity of water over and above domestic 'basic needs' that is used for small-scale productive uses. The bulk of experiences reported relate to what would generally be regarded as domestic water supplies and for the vast majority of people it is a domestic (utility) supply that is their first and often only source of water. This is particularly so for the poor, who often lack access to land and hence are excluded from much irrigation development. For the WATSAN sub-sector, the key message is that it must shift from domestic water supply to provision of a household supply for a range of purposes. This implies ensuring that, in addition to basic needs, productive uses of water are planned for when designing systems and services, with the important caveats that: enough water is available to make this extra allocation sustainable without damaging the environment; and any service provided is financially sustainable. However, the message does not stop with the WATSAN sector. The irrigation sector is also responsible for bringing water to people, and also needs to take account of the importance of both small-scale productive uses for households and other non-agricultural water uses, which can even have higher priority for the users, such as domestic uses.

2 This is in comparison to the use of the term productive by the irrigation sector – who typically see their role as providing water for 'productive' (i.e. agricultural) activities.

b) Adopting a holistic approach to development projects that involve water.
More generally, the core message from the experiences presented in this book is that narrow (sub-)sectoral approaches do not, in the long run, work either in terms of leading to sustainable services, or in generating the benefits required to impact significantly on poverty. Whether it is in dealing with the use of wastewater from a city in India for small-scale irrigation (Raschid-Sally et al., Chapter 4); managing domestic use of water from irrigation canals in Morocco (Boelee & Laamrani, Chapter 5) or designing domestic water supply systems to take account of people's use of these supplies for backyard vegetable production in South Africa (Pérez de Mendiguren Castresana, Chapter 3); it is essential that development of water resources and services is based on a clear understanding of the full range of uses to which people put (or might put) the water provided.

In essence, both of these key messages are about nothing more complicated than listening to people and putting their needs first. There should not be anything particularly complicated about moving across sectoral boundaries. It isn't hard to see that if an irrigation canal flows past your house and you want to water your vegetables (or wash your clothes) you are likely to 'steal' some water from it. Equally, there should be nothing surprising in people with access to a stand-pipe just down the street deciding to use some extra water to make bricks or brew beer. Yet neither use would be considered 'acceptable' to many designers of systems that are in theory supposed to serve the poor. This needs to change.

Addressing the use of water for small-scale productive activities can reduce poverty by developing and managing water resources sustainably and in ways that maximise the economic and social value added per unit volume supplied. In many of the chapters in the book, these aims are addressed through the productive use of water at the household level – by effectively channelling relatively small quantities of water to poor households where it is used directly to reduce poverty in the widest sense.

Most of the papers concentrate on the benefits of productive use of water. This is not because the already well documented health or other benefits of water supplies to people's livelihoods are not also critical: they are. Safe and secure water is essential to poor people's health and survival, and rightly there is a millennium development goal dedicated to it. But meeting basic needs should not just be about health and hygiene, nor do people always see clean water as their most pressing need. Productive uses have typically been overlooked, ignored, or worse still actively discouraged. This book aims to provide a solid basis of experience to say why this should now change.

It is clear from the chapters that follow, that while there is a growing realisation of the potential of productive uses there is, as yet, only a limited amount of documented practical experience. The example of rope pumps in Nicaragua (Alberts & van der Zee, Chapter 10) is the only truly 'scaled up' experience. It would seem that while there is undoubtedly a growing awareness of the importance and potential of a more holistic approach to water supply, there is as yet only the start of a body of concrete experience of how to go about this.

The following sections briefly summarise some of the main findings reported in more detail in the chapters that follow, as well as the discussions during the Johannesburg symposium.

Unpacking the benefits of (and some problems related to) providing water for productive use

Improved household water supplies, and the institutions surrounding them, have the potential to tackle many different dimensions of poverty: they can reduce sickness, save time, generate income, enhance food security, strengthen local organizations and build cooperation between people. These benefits are summarised in Box 1. Until recently, these multiple benefits of household water supplies had received little attention in the mainstream WATSAN (or indeed the irrigation) world. This has started to change and the recent evaluation by WaterAid – an NGO specialising in domestic water supply and sanitation – of some of its older water supply projects, is a good example, finding (perhaps unsurprisingly) that a much wider range of benefits were reported by beneficiaries than had been

Box 1. Benefits of household water supplies (after Moriarty & Butterworth, 2003)

Better health – it has been widely established and accepted that more and better quality water, and improved hygiene, reduces disease. Healthy people are able to work and live more productive lives.

Time savings – time and effort spent collecting water can be reduced by improved water supplies. Especially for women and children who shoulder the burden of water collection. Given suitable opportunities this saved time can be turned into money by poor people.

Expenditure savings – improved water supplies lead to reduced expenditure on the generally expensive water provided by water vendors, and less money is spent on drugs to cure sickness.

Well-being – better water supplies reduce pressure on people, especially women. As well as time saved, there is less stress, anxiety, and improved safety when water supplies are available close to home.

Education – with more time and improved health, children are able to attend and perform better at school. Adult learning can also be facilitated through water projects.

Environmental sanitation – good drainage at water-points can improve the local environment, and reduce the risks of diseases transmitted by water-based vectors like malaria.

Community capacity – the ability of local institutions to manage resources and systems

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can be enhanced through projects that build capacity e.g. through organisational and financial skills, O&M etc.

Productivity and income – more opportunities for home-based activities lead to improved employment, productivity and incomes. Non-water-based livelihood activities are possible because of time savings, better health and opportunities to invest expenditure savings. Opportunities for water-based livelihood activities are increased because people can access improved (more reliable, greater quantity) supplies. Improved incomes lead to improved status: for example, of women when their economic contribution to the household is visibly improved.

Investment - expenditure savings and improved incomes associated with water supplies have a multiplier effect. Money can be invested in other activities leading to greater returns. This leads to improved markets for goods and services.

Food security / nutrition – is enhanced when improved water supplies make backyard irrigation or keeping livestock easier. Home-based production may be small in amount, but is often nutritious e.g. vegetables, milk, eggs and meat.

Box 2. Looking back – lessons learned by WaterAid from 10 years of WATSAN work

In 2001, WaterAid published the results of an in-depth analysis of the impacts of a number of projects ten years after completion. Although the study confirmed the general trend that the initial justification for the investments in supply was usually based on health objectives (the many health benefits included reduced medical costs, and the main target of reduced diarrhoea and dysentery) the assessment identified a wide range of positive impacts that affected many dimensions of life. The most important benefit was often the time saved and reduction in fatigue from not having to travel to collect water from, on average, six kilometres away. This was often translated into an increased number of working days, with direct income benefits, and inevitably benefited women for whom the burden of work is often far more in terms of time than that of men.

Many new skills were learnt: masonry and mechanics (including poor women in traditionally male preserves), management skills, negotiation skills and leadership skills amongst women. This enhanced human capital again created new livelihood opportunities for many. The local organisations set up for the water supply programmes often formed a basis for wider local mobilisation, provided greater community coherence and developed far greater levels of confidence amongst women and poorer, marginalised households. Savings and credit groups established for the water project provided a basis for the development of accessible credit facilities amongst the communities and assisted with the development of financial management skills. The new skills and confidence, better local organisations and increased economic momentum all had impacts on the wider political and governance systems, including on government policies.

expected or targeted at inception (Box 2; WaterAid, 2001). In a similar vein, the recent Drawers of Water II (Thompson et al., 2001) identified a range of productive uses that were never envisaged when the systems investigated were first constructed 30 years previously.

In the irrigation world too it is also increasingly recognised that irrigation schemes are invariably used for multiple purposes (Bakker et al. 1999). Designers are starting to include devices such as washing steps, livestock watering points, or diversions to facilitate water use for laundry. The importance of leakage from canals to fill adjacent domestic water wells is also better understood. However, these alternative uses remain "add-ons" to the primary design of irrigation schemes. People's, especially women's, own priorities and livelihood needs are still far from being the starting point of irrigation design. More importantly, any ambition to really reach all people, including the poorest, is noticeable by its absence in the irrigation sector. Only in the more recent development to disseminate small-scale appropriate technologies such as treadle pumps, have targets become much more inclusive (Polak et al. Chapter 7).

Gender and reaching the poor

Domestic water supply is now more or less universally acknowledged as not only a right but a key development indicator with an attached Millenium Development Goal. Along with electricity and telephones, domestic water is a utility, a sine-qua-non for existing in the modern world. One interpretation of a utility is something you don't notice until it goes wrong. While for much of the developing world this remains a distant dream, that it should be so one day is accepted by all. Because it is universally accepted that a domestic water supply should be there for everyone, it is an excellent entry point for reaching the poorest. And because it is women who almost universally have responsibility for domestic water supplies, it is also an excellent place to start working with them. This is why we believe that productive water uses should in many cases be bolted onto efforts to provide domestic water. Because the amounts used are typically small they can usually be provided within the domestic framework, though, as we argue later, to do so will mean moving away from low 'survival norms' of the kind used in many countries.

The case studies in this book show what is possible once better water supplies that facilitate productive uses do reach women and the poor. Many of the small-scale activities, like vegetable gardening and brewing beer, are uniquely or primarily the preserve of women. Money that they raise goes directly to women, who in turn tend to spend it on family wellbeing – items such as education, health-care and essential nutrition. For example, in work in Zimbabwe, Moriarty (2003) found that 40% of people involved in community gardening activities spent some of the money earned on education.

Demand-responsive approaches, cost recovery, and sustainability

System sustainability is perhaps the most pressing preoccupation of the WATSAN sub-sector. Demand-responsive approaches (DRA) are all about matching systems to people, with the primary goal of achieving system sustainability (Deverill et al, 2002). Providing a range of options is usually linked with an element of cost recovery from beneficiaries, based on the principle that people are more willing to pay for the type of system and service that they have chosen. The approach aims to avoid the many failures found in water supplies that can be attributed to a poor fit between the supply system (hard and software) and the community in which it is installed: management systems that are ill-matched to existing social structures; technology that demands skills that don't exist in the locality; and services where the water provided is not sufficient or appropriate for the requirements of the people to whom it is provided.

Productive uses of water have crucial roles in system sustainability. Foremost they provide opportunities to turn water into the cash needed to buy spare parts and to pay for routine maintenance. In addition, clearly establishing the link between water supply and economic benefits also seems to increase people's willingness to pay for their water in the first place (Lovell, 2000) and makes cost recovery more realistic. But, equally important, systems that are designed to provide minimal domestic norms and that do not take account of productive use can be expected to fail if people actually want to use water for productive activities (often through illegal connections). Schouten and Moriarty (2003) identify failure to take into account the likely productive uses of community water supplies as an important factor in their subsequent failure.

The successful cases reported in this book reflect the benefits to both system and user of tailoring water supplies to people's existing livelihood strategies, whether by providing cheap family wells for both productive and domestic purposes in Nicaragua or Zimbabwe (Alberts & van der Zee, Chapter 10; Robinson et al., Chapter 8), or adding a productive element to highly reliable community boreholes, again in Zimbabwe in Bikita (Chapter 8). In this they support earlier work that found increased sustainability in systems when productive use is made of water (Lovell, 2000; Waughray et al., 1998, WaterAid, 2001).

Later in this chapter, we suggest a livelihoods-based approach as one means of practically addressing the need to tailor household water supplies better to people's needs. The livelihoods approach finds echoes in sub-sector specific concepts such as demand responsiveness. However, what is different is that by focussing on livelihoods, stepping outside sectoral boundaries becomes both essential and inevitable.

Costs and benefits

At the heart of any discussion of service provision lies cost – or more precisely achieving a sustainable balance between costs and benefits. Most rural domestic water supply services are based on cost minimisation: how to provide a minimum norm for the least amount of money possible (both capital and operation). In this they differ from agricultural sector supplies which are targeted at maximising production. While the cases reported in the book are clear on the benefits of providing mixed use water supplies, they are less clear on the costs of doing so. The rope pump (Alberts & van der Zee, Chapter 10) is the one example of a genuinely win-win technology that exists, being both cheaper and higher yielding than more conventional hand-pumps. Otherwise, the implication of providing a higher level of service and including water for productive uses in supply is greater costs.

These costs can only be justified if they bring even greater benefits, and the extra benefits can be converted into increased willingness to pay. As Pérez de Mendiguren Castresana explains in Chapter 2, no automatic link can be assumed between increased income from water and increased ability or willingness to pay for services, a point that is echoed in Colombia by Pérez et al. (Chapter 3). Nevertheless, there is also evidence that in the right settings – particularly where individuals or communities have genuine ownership of systems – the extra income provided by productive uses does result in greater contributions and hence sustainability. This is particularly – and perhaps obviously – the case with family systems of the sort reported by Alberts & van der Zee in Nicaragua (Chapter 10), but it is also the case with community systems as reported in this book by Robinson et al. from Bikita in Zimbabwe (Chapter 8) and also elsewhere (Moriarty, 2003; Lovell, 2000). The willingness to pay operation and maintenance costs is generally more obvious in the irrigation sector. In the massive private-market led uptake of treadle pumps, users also pay full capital costs (Polak et al. Chapter 7). Productive water uses are more desirable when water is used for higher-value activities, and when there are strong social benefits that reach the poor.

When considering the cost of providing extra water for productive uses, the most important factor is the incremental cost of supplying the additional water. Pérez de Mendiguren Castresana (Chapter 2) presents estimates of capital and operation and maintenance (O&M) costs for water systems in South Africa. These show substantial increases in costs when moving from handpumps to any kind of piped water supply. But after this leap has been made, the additional capital costs involved in moving from communal standposts supplying as little as 15 lpcd to systems supplying 25, 60 or 120 lpcd is much less than the proportional increase in water supplied. The important point is that, given universal commitment to domestic water supplies as a baseline, the costs and benefits of productive water schemes should be judged against the incremental capital and O&M costs of the extra water supplied, not the absolute costs of the entire scheme (which will have to be provided anyway). As can be seen from the example from South Africa, these incremental costs are typically far lower than the value of the water provided for productive activities including vegetable gardens (Pérez de Mendiguren Castresana, Chapter 2).

In the wider context of integrated water resources management and rights-based approaches to water allocations, it is worth clarifying the difference between the largely financial focus of this discussion on costs and benefits, and the underlying economic issues relating to the small-scale productive uses of water. Estimating the value of keeping people healthy, educated, employed, and all the other benefits that have been demonstrated to flow from productive uses of water is a far more complex task than working out the financial costs of providing a water supply, or the returns on activities related to its use. But we believe these benefits are significant, especially when supplies are targeted towards poor people. It is already generally accepted that the provision of domestic water is the most economically important use of water resources. It is therefore not stretching things too far to suggest that water used for small-scale productive purposes, with its potential to make limited but measurable improvements in the lives of billions of people, should be added to this 'domestic' supply when making rights-based allocations of water resources. We propose the term 'household' water to encompass this combination of domestic and small-scale productive supply. This proposal has important implications for water allocation as discussed in the next section.

The critical question of how much water should be included in this expanded definition is dealt with in the final section under the heading 'redefining basic needs'.

Demand management and maintaining system integrity

Using water from domestic systems for productive uses is not always wholly beneficial. Unplanned and unrestricted productive use of domestic water causes problems for users at the tail end of under-designed domestic systems. McKenzie et al. (2003) describe such a situation in South Africa where gardens and small-scale agriculture in one part of a system resulted in users in other parts being dependent on tinkering with extra water supplies. In such a situation of unplanned use, who is to blame: planners for not anticipating correctly the needs of users, and providing water for these uses through additional piped network capacity or alternative sources and systems? or users, for not utilising their water system for the planned purposes? There is no clear answer. However in all cases there will be limits to what is desirable and demand management to control productive uses is essential, especially in piped water systems.

By explicitly recognising that productive uses are valued by people and often inevitable, it is possible to take account of them in planning and to include appropriate demand-management measures, for instance by introducing stepped tariffs. In South Africa, the new framework for water services (DWAF, 2003) proposes that productive activities should utilise water services on a full cost recovery basis, unlike water for basic needs which is free (up to 6000 litres per household per month). However, it is likely to be very difficult in some circumstances to charge for water use for informal home-based activities, especially where metering and billing systems are not already in place for domestic water. By their very nature these activities are irregular, happening seasonally or on an occasional basis which also makes control more problematic. Some subsidies may also make sense on equity and practical grounds – and the South African policy recognises this. Enterprises with their own premises and operating formally and more regularly can be more easily charged for water.

Is productive use a waste of 'drinking quality' water ?

An argument often made against encouraging the use of domestic water for productive purposes is that it is a waste of expensively treated drinking quality water. This argument, while true in some cases, is more often false. It is wrong in part because it makes a number of basically incorrect assumptions about the quality of domestic tap water and the way people use it. The water that flows from developing country taps, stand-posts or handpumps is only rarely of real drinking water quality. This is true of surface water supplies, where problems of quality control at treatment works, lack of chemicals, intermittent pressure, and leaks etc., mean that water coming out of the tap is seldom safe for immediate consumption. It is also true of those cases in which untreated groundwater for systems in rural areas is polluted – although groundwater is generally of better quality than surface sources. Achieving drinking water quality is almost always, in practice, a household level activity, where good hygiene education is more important than technological fixes.

The argument also ignores the fact that the vast majority of domestic water supplied to households in both North and South is used for purposes other than drinking. In fact, if one considers using domestic water for irrigating vegetables to be an expensive luxury, how much more wasteful is it to use it to float faeces down a sewer? Finally, such arguments are rarely based on actual cost benefit analysis. As Pérez de Mendiguren Castresana (Chapter 2) shows in South Africa, the incremental cost of providing a limited extra quantity of productive water (treated if necessary) through a domestic network will often be lower than the benefits derived from productive uses like vegetable gardening, and they will almost invariably be lower than developing a second parallel network.

There are of course exceptions to any rule, and there are cases, particularly where chemical contamination renders some water unfit for human consumption and

expensive to treat, where drinking and productive sources and supplies should be managed separately. This is the case in many parts of India and Bangladesh where chemical contamination (fluoride and arsenic being the best known) means that drinking quality water needs to be carefully managed.
This is of course not to say that other, cheaper alternatives should not be sought. In Tarata in Bolivia (Bustamante et al., Chapter 6), the domestic water utility supplied irrigation water (by canal) for peri-urban gardens at a lower cost than piped domestic water supplies. A flexible approach is necessary, and can be adopted once the starting point of providing a sufficient household water supply for domestic and productive uses is accepted. Then a responsive approach to mixing and matching water supplies can be used, ranging from greater per capita supplies from piped systems, through matching different sources to different uses, to making an allocation for domestic water needs in primarily agricultural systems.

Lessons learned: how to provide appropriate water services to households

The previous section summarised the findings of symposium authors in terms of the benefits of adopting a flexible approach to providing water for productive use. This next section looks, also in broad brush terms, at the lessons learned about how to go about this. Here we broaden our initial focus on domestic supplies, to look at how household supplies for productive uses can be provided by a range of different sub-sectoral activities.

Many of the cases show that people frequently use water in different ways from those envisaged by the planners and developers: be it the productive uses of domestic water (Pérez de Mendiguren Castresana, Chapter 2); productive uses of wastewater (Raschid-Sally et al., Chapter 4); or the domestic uses of irrigation water (Boelee & Laamrani, Chapter 5). While many of these result in beneficial impacts to users, some also bring increased risks to people, for example through exposure to waste water in India (Chapter 4), and systems through over use (see McKenzie et al., 2003). However, there are also several striking examples of how to implement systems that are designed from the outset to support mixed use (Alberts & van der Zee, Chapter 10; Polak et al., Chapter 7). In this section, the insights provided by the papers are dealt with under four headings:

1. flexibility and breaking down sectoral barriers;
2. livelihoods-based approaches;
3. avoiding inappropriate technologies;
4. household-focused planning at community level.

1. Flexibility and breaking down sectoral barriers

The most important and perhaps obvious lesson from the case studies is the need for flexibility and breaking down of sectoral barriers when designing water supply services. It is not surprising (though it is somewhat depressing) that most of the examples of productive uses come from community-level activities initiated by NGOs or donor-funded 'projects'. NGOs large and small have the ability and desire to think outside the box, and cut across boundaries. For example, CARE, ITDG, PLAN and others to some degree employ holistic, livelihoods-based approaches to their development-focused activities – including provision of water. In this book the work of Mvuramanzi Trust and the Bikita integrated water and sanitation project in Zimbabwe (Robinson et al., Chapter 8), of Bombas de Mecate in Nicaragua (Alberts & van der Zee, Chapter 10), and SEWA in India (James, Chapter 9) all demonstrate the benefits to be gained by NGOs from being able to ignore sectoral boundaries at a project implementation scale.

This flexibility is critical in supporting communities and households in gaining the most from water supplies. It is the freedom to mix and match approaches and technologies; to pick and choose recipients; and to be holistic in providing the best mix of water supply interventions and supporting activities, that lies behind the successes reported here. Examples include the freedom to focus on the families with the potential to benefit most as reported by Mvuramanzi Trust; to take a flexible approach in service levels from high yielding boreholes as in Bikita (Chapter 8); to look at access to credit in conjunction with improved water supplies in India (Chapter 9); or to think about training and technologies in minimising risk for wastewater irrigators in India (Chapter 4).

Many cases show the importance of working across traditional boundaries. This could mean working across sub-sectoral boundaries in the way the Mvuramanzi Trust has been experimenting in Zimbabwe: WATSAN people talking to irrigation experts to identify the most appropriate form of small-scale irrigation likely to suit back-yard vegetable production. However, it can also mean working with very different sectors, and trying to find synergies in concerted action. In this vein, a recent study in Nicaragua found that access to drinking water and electricity strongly influences earnings from non-farm self-employment and, along with at least a passable dirt road, appears to be a prerequisite for successful rural business (Corral & Reardon, 2001). This result, which rediscovers the importance of 'the utilities' to people's lives, should not be as surprising as it seems to have been. Similarly, the development of India's smallholder surface irrigation has been driven by a combination of subsidies for developing water, rural electrification, and green revolution technology (Moench et al, 1999).

The downside of NGO and donor success is that it tends to be highly localised, reliant on dedicated individuals, and context specific. Working outside government frameworks often means ignoring them completely, which in turn means that the advantages of government – legitimacy and range – cannot be tapped into when trying to scale up. To scale up, it is essential that the approaches are adopted at a national level – as was the case with rope pumps in Nicaragua (Chapter 10). However, for this to happen, the approaches must either adapt to existing national institutions and frameworks, or seek to change them in a process of partnership with government. The critical issue of taking productive approaches to scale is further developed in the final section of this chapter.

As a final point, it is important to note that supporting small-scale productive uses is not limited to the domestic water supply sector. While, for the majority of the world's population, household water supply is likely to come from a domestic service, there are many people for whom it will sometimes come from an irrigation scheme. In parts of India for example, people rely upon collection of safe quality drinking water from irrigation wells when domestic water supplies contain high fluoride levels. The multiple roles of irrigation systems are now recognised in providing water for domestic purposes, livestock, gardens and other micro-enterprises, with water being diverted from irrigation canals to supply these informal activities. These smaller-scale domestic and productive activities, often under the control of women, have traditionally been overlooked or actively discouraged in the design and management of large irrigation schemes. The International Water Management Institute now has several research projects focused on such multiple uses of 'irrigation' water (see for example Boelee & Laamrani, Chapter 5). And wastewater too can be an important source for productive activities. Cases from India and Cameroon (Rashid-Sally et al., Chapter 4) show how wastewater irrigation usually exists as a totally informal and non-recognised activity, with a range of serious health hazards to both practitioners and users of the produce. People need to make a living, and will often therefore not be dissuaded from using raw sewage to irrigate. A flexible and holistic approach – as recommended by the authors – would seek to work with the irrigators to reduce the risks to both themselves and their clients.

2. Livelihoods-based approaches

Adopting the necessary flexible approach demands a methodology that allows the links between people's needs and the design of a water supply system to be identified and tailored as effectively as possible. One set of methods, arising from the participatory school, are 'livelihoods approaches'. Livelihoods approaches have emerged, along with other participatory and people-centred concepts, as a key element of development practice over the last ten years. DFID's Sustainable Livelihoods, CARE's Household Livelihood Security, or UNDP's sustainable human development are all examples of agencies taking up livelihoods-based approaches as practical tools for implementing pro-poor and poverty-focused development.
In essence, taking a livelihoods approach implies developing interventions based on a thorough analysis and understanding of how people's livelihoods work now, how

they have changed over time and how they could be improved in the future, while identifying and taking into account key opportunities for and obstacles to improvement. From the point of view of water sector practitioners, it means identifying the existing and potential role of water in people's livelihoods – productive, health, consumptive – and identifying sustainable and effective ways of meeting these needs. For an introduction to livelihoods terminology, concepts, and how they can be applied to the water sector see Moriarty and Butterworth (2003). Recent work on adapting a livelihoods approach to designing water supply schemes in South Africa is reported in Monareng et al. (2003).

The examples given later in this book of implementation of projects and programmes to promote productive uses of water, do not explicitly follow a livelihoods approach – this has only really become a practical guide to project design in the last couple of years. Nonetheless all the successful interventions can be understood in terms of having provided a technology or approach that fitted well with people's existing livelihoods. The opposite would be technologies or approaches that require a radical change on the part of people from their existing livelihoods – large irrigation schemes, or complex domestic supply systems for example. Perhaps the greatest value of a livelihoods approach to water supply is that it leads to identification of the many and complex ways in which water supply improvements have the potential to affect people's lives, and so it helps to identify bottlenecks and prioritise activities.

3. Technology – enabler or retarder of productive use

Technology has a critical role to play – both positive and negative - in addressing the need for productive water and this is reflected in the case studies presented in the book. In Chapter 10, Alberts & van der Zee discuss how an inappropriately applied 'small is beautiful' approach means that in many cases expensive boreholes capable of providing sufficient water for a range of activities, are essentially 'plugged' with relatively expensive handpumps that are capable of supplying only a small fraction of the water available. Lovell (2000) identified a similar problem in Zimbabwe, where official support for the bush-pump as the only technology accepted for rural water supply meant that the very low norms (25 lpcd within 500 m) of the rural water supply and sanitation programme were effectively 'hard-wired' into systems that had the potential to supply far more water.

The issue of system failure due to unplanned productive use is also important. Schouten and Moriarty (2003) identified this as among the major causes of failure in community-managed systems. In South Africa where 'illegal' (unplanned) household connections are a frequent cause of system failure or under-performance (see for example Mckenzie et al., 2003), people using their household connections for productive purposes put their systems under further stress. It is the mismatch between systems and people's needs or livelihoods choices that leads to system failure. Technology choice sits at the heart of a complex network linking needs, water and financial resources, skills and support structures. As such, technology choice can also benefit from a livelihoods-based analysis – looking at the implications of any given technology choice in terms of capital costs, maintenance needs, management structures, potential yield and types of activities possible.

Taking productive uses to scale: breaking down sectoral boundaries and re-defining the role of government

As was noted earlier, many successes related to small-scale productive uses of water come from the NGO or donor-funded sector. In the past they have often had the advantage of working largely outside government frameworks and as a result have been able to take a more flexible and livelihoods-centred approach. However, the down-side of this is that their successes tend to remain limited to the projects and communities where they work – and even these can fail once the agencies 'hand-over' and move on. Alberts & van der Zee highlight this problem in Chapter 2 on the success of rope pumps in Nicaragua and their failure to take off in similar ways elsewhere. In Nicaragua, following initial pilot success, the rope pump was taken up by the local private sector and eventually the national government. Elsewhere, largely due to vested interests of those linked to the importation of expensive handpumps, the rope pump has not gained this stamp of approval and remains a technology developed on the fringes by NGOs (but used increasingly by families who opt for it independently as they see its effectiveness and relevance).

Taking productive use to scale therefore requires all those involved in supplying water, but most importantly governments, to change how they work. Much of that change is already under way as part of a general decentralisation and deconcentration of responsibilities. Policy and legislation from South Africa show the way, with devolved decision-making and legislative encouragement to break down sector barriers, in principle. Probably the single most crucial legislative change is the acknowledgement of productive uses in national domestic water supply legislation, and related domestic water supply norms. Without this, those working in line ministries will continue to find it difficult to take up the challenge of incorporating productive uses into the mainstream. An important issue here is the wider recognition within national policies of the informal sector, where much of the productive activity reported in subsequent chapters takes place.

However, changing policy and legislation is only the start. To take advantage of the opportunities offered by such changes, it is necessary to develop a whole new cadre of professionals trained in providing and supporting small scale productive uses of water. It will also be necessary to change training programmes and curricula to incorporate designing for productive uses of domestic water, and to increase the ability of professionals to work across sectoral boundaries.

For these changes to happen, a wider range of experiences and models will be needed. The remaining chapters identify a number, but there is still a need for larger, more detailed case studies to underpin the redesign of norms, tariff structures and economic models, and for tools to support system design that incorporates productive uses.

Rights, priorities, and implications for investment and water resources management

This section looks briefly at productive uses of water in the wider context provided by the move towards Integrated Water Resource Management (IWRM) and the related issue of rights-based approaches, both of which are strongly linked to productive uses of domestic water. Integrated water resources management is defined as being: "a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP, 2001). IWRM, as reflected in the above definition, and in the four Dublin principles (WMO, 1992) is based on the holistic management of water across disciplines and sectors; decentralised approaches; the importance of women; and water's role as a crucial economic and social good.

The gradual blurring and breaking down of boundaries between water supply projects: providing water for both drinking and productive uses; agricultural departments supporting community gardens; and government departments or parastatals supporting larger scale irrigation schemes are fully in line with the holistic principles of IWRM. Decentralisation is called for in the Dublin principles, and is also an ally of more holistic approaches generally. To function autonomously, decentralised line ministry branches under local control need to establish a much greater reference to the local reality than is the case where they are centralised.

What then are the IWRM implications of promoting more productive use of domestic water supplies? Accepting the household water concept clearly means a need for more water for small-scale users. As well as avoiding wasteful demands on water supply infrastructure and management systems, there is likely to be a need for increased abstractions for beneficial uses from aquifers, rivers or reservoirs and for more storage to overcome dry season shortages. Once options for increased storage are exhausted, more contentiously, a need may arise to reallocate existing abstractions. Allocations need to be reviewed in an IWRM framework that considers issues such as the potential impacts on downstream users and the benefits associated with alternative uses. These issues will be particularly important in water-scarce river basins. As we see later in Bolivia (Bustamante et al., Chapter 6), when water is scarce, promotion of productive uses at the household scale can lead to conflict with other water users.

Because productive uses of domestic water often relate to the less visible informal sector and do not fit neatly into the categories in which most sector professionals have been trained, they are in danger of being left out of the water allocation hierarchy. Productive uses may fall between domestic needs – invariably given highest priority – and the needs of industry or agriculture which come next and are typically represented by powerful, well-organised bodies. Productive users of domestic water on the other hand are scattered, poorly represented, and therefore easy to overlook. We believe that household water supplies should be treated as domestic water already is, and should not normally be subject to the same allocation criteria as water for large-scale 'commercial' uses. In other words, a proportion of water for productive use (as part of a household allocation) should be included in rights-based allocations. This argument is based primarily on principles of equity and poverty alleviation, recognising that meeting basic income needs is as vital for the poor as meeting other basic needs. It is also underpinned by the hypothesis that a proper economic evaluation of water use will show that small-scale productive uses are generally more economically important than others because of the vital role they play in supporting and stabilising the livelihoods of the poor.

Finally, it is essential to address the issue of the absolute quantities of water for household use, and whether these in themselves may become unsustainable. Except for some arid areas, this not really an issue in most countries, with the problem continuing to be one of inadequate supply and storage rather than water resource shortage. However there are also quite a few countries, including South Africa and India, where over-use of water-stressed basins - or over-abstracted aquifers – mean that water may be physically scarce, at least during dry seasons and periods of drought. Even in such cases, small-scale uses are minimal compared with the larger requirements of irrigation farmers and industries (especially mining – a major user and polluter). Here, the issue of continuing development of physically scarce water resources by growing populations is replaced by one of allocation, or reallocation. Demand management for large-scale users should curtail their water use, though that is difficult politically even if the legal tools are in place to take from the haves to reallocate to the have-nots, as in the National Water Act of South Africa. Demand management for small users, who are still deprived of the quantities that their better-off neighbours consider their basic needs, means increasing their effective demand for water.

4. Community-level planning for household-level use

We have suggested the concept of household water supply as a replacement for the overly narrow existing concept of domestic water. However, the reality is that - despite successes such as Zimbabwe's household wells, or Nicaragua's rope pumps - most households' water supplies come through communal water systems of one sort or another. So while we advocate planning on the basis of household use of water, this will need to be done at a community level.

In terms of equity the lesson of decades of developmental effort is stark. Any developmental activity that does not either aim for total coverage within some clearly defined 'service area[3]', or specifically target the poor will end up leaving them out. So, for instance, supplies from individual household water points are unlikely to be spontaneously adopted by the poorest (as noted by Mvuramanzi Trust in Zimbabwe, see Chapter 8). Only by planning at a community level can total coverage be ensured. Only by ensuring total coverage can the poorest be reached.

With regard to the efficient use of resources, planning at the scale of the community allows a balance to be made among a variety of alternative sources. Within a community, average household needs may be assessed at 150 lpcd and that water may be sourced from a mix of private, public, low and high quality sources, with different sources being used for different purposes – e.g. a dam for cattle and laundry, boreholes and rainwater harvesting for drinking water supply, rooftop rainwater harvesting for backyard gardens, and stand-alone boreholes for a community garden.

Moving forward, next steps

Developing a policy environment favourable to mixed-use household water supplies

In the previous section we identified the need for a paradigm shift away from existing sector-based water supply models and towards a new concept of 'household water supply'. In the longer term we believe this should mean a goal of piped water supplies in each household (preferably from sources close to the community). In the shorter term it will imply developing planning tools for matching multiple sources with multiple uses at the community level. Essentially we are advocating a change in the way in which people working with the poor and women develop water supply services. This is needed primarily in agencies whose task it is to provide water, where managers and decision makers in the various water sub-sectors should start to view their primary goal as the tackling of poverty through the supply of sustainable and appropriate household water services.

The ground is shifting. In particular, the widespread advocacy of demand-responsive approaches within the WATSAN sector should lead to the voice of household water needs becoming more generally heard and recognised. An encouraging indication

3 The term service area is used to denote some commonly accepted administrative boundary used for the purpose of demarcating boundaries and responsibilities for service provision. It may be a district, municipality or village. The point is that meeting the needs of everyone within such an area implies the need to cater to rich and poor alike.

that this shift is happening is seen in South Africa's new strategic framework for water services, which explicitly recognises productive uses of domestic water as a key step in providing more than just basic services and climbing the 'water ladder' (Box 3).

The final section of this paper looks at what the next steps are to enable this change, in terms of research for new approaches and advocacy to support the concept of household water supplies, but also at creating the necessary changes in the policy environment to allow the concept to be implemented. First, we try to develop an initial estimate of just what a household water supply might look like in terms of quantity and quality of water supplied.

Box 3. The new strategic framework for water services in South Africa (DWAF, 2003) explicitly recognises the role of economic activities:

- 'Water and sanitation programmes should be designed to support sustainable livelihoods and local economic development. The provision of water supply and sanitation services has significant potential to alleviate poverty through the creation of jobs, use of local resources, improvement of nutrition and health, development of skills, and provision of a long-term livelihood for many households.'
- 'Water services authorities do not, and should not, only provide water services necessary for basic health and hygiene. It is important that municipalities facilitate the provision of higher levels of services for domestic users where viable, undertake gender-sensitive health communication, and provide services which support sustainable livelihoods and economic development.'

Redefining basic needs

One barrier to change is the traditional definition of 'basic needs' (for drinking, sanitation, bathing and cooking – see Box 4). As it stands, it means that design norms are often insufficient to provide for the range of household-based activities described in the chapters in this book. A supply-focused approach based upon norms that do not take account of productive water uses has been dominant in WATSAN over recent decades. When, as is the case everywhere in the North and in many urban areas and cities in the South, these norms are set to very high levels this does not cause a problem. However when extremely low 'survival' norms are set, such as South Africa's benchmark short-term target of 25 lpcd, opportunities to engage in productive activities are severely constrained.

So, given that 25 lpcd is not enough, how much is? First we should be clear that good IWRM practice, and good common sense, make it obvious that such a figure should not be decided on a 'one size fits all' basis. Household water supply norms should be decided on a national (or ideally) catchment basis, and should adopt a building block approach, starting with water needed for drinking and bathing and working up to possible productive activities. Box 5 below sets out the water use associated with a number of productive activities such as livestock watering and growing tomatoes.

Box 4 .Domestic water supply norms

The traditional approach to 'basic needs' excludes water for productive activities within the household. Gleick (1996), for example, proposed 50 lpcd as a recommended minimum based on the following figures: Drinking water 5; Sanitation services 20; Bathing 15; Cooking and kitchen 10.
In different countries there are different 'basic needs' targets. In rural areas, sometimes these are as low as 25 lpcd (e.g. rural South Africa), or as high as 55 lpcd (India's recently revised norm for rural areas). Targets are best reviewed and revised to suit circumstances. For example, South Africa has short, medium and long-term targets to address water supply backlogs pragmatically.

Box 5. Water use associated with different activities

Some examples:

- In India, design norms assume that large stock (cow or buffalo) will need 50l/d, while small stock require 10 l/d.
- Using FAO's Crop Water Requirement guidelines, a conservative estimate of water requirement for irrigating tomatoes is 100l/d for 24m^2 (this could yield 100 kg every 120 days)
- Polak et al. (Chapter 7) in their description of hybrid systems state that a backyard drip irrigation system needs 500l/d.

  Depending on the setting, different elements could be added to the calculation of the norm. So, for example in arid areas with pastoralist inhabitants, livestock-based norms would be used, while in less arid rural areas the importance of being able to grow vegetables around the house might predominate, and in peri-urban areas commercial uses would have the leading role.

Given the need to tailor norms to local realities, we nonetheless feel confident in suggesting, in all but the most extreme cases (such as desert dwellers), a norm in the range 50-200 lpcd, as identified by those present at the Johannesburg symposium, as being both adequate and sustainable from a water resources point of view. This is a huge increase from the survival norms of rural Africa and India, but is comparable with most urban utility supplies. With such a supply, a family of five could comfortably irrigate 100 m^2 of garden (assuming that they have access to the necessary land), or water 5 cattle, or a mix of the two. The benefits to the households concerned and society as a whole of the productive uses of this water are, we believe, amply demonstrated in the chapters that follow.

In terms of quality, treating water supplied through piped networks to full drinking water quality may not be the best use of scarce resources. Rather, a greater quantity of domestic (but non-drinking) quality water, underpinned by good hygiene awareness raising, is more likely to impact on both poverty and health. When household water supplies are being delivered by a mix of sources (rooftop, borehole, piped network, etc.) then clearly the most appropriate quality norm for the planned use should apply.

Finally, we look briefly at what is required to move the discussion of productive uses of household water forward in terms of

1. advocacy for policy change, and

2. research to underpin the development of new models and tools

1. Advocacy

In this chapter, we have advocated the concept of a multi-purpose ‘household supply’ as an alternative to the current drinking, cooking, washing, and sanitation only domestic supply. Whether the concept is taken up under this or another name, there is a need for a concerted effort to ensure that those responsible for providing water to people – be they from the domestic, or agricultural water sectors – take a needs-based and inclusive approach that recognises the potential for water to serve multiple roles within people’s livelihoods. This advocacy should focus on a number of distinct priorities.

- Multi-use water supplies – water as a key element in planning for development
  Water should, in planning arenas at least, escape from its current sectoral straight-jacket and be planned at a local level to satisfy all household needs. In practical terms this means that irrigation schemes need to take account of domestic needs and requirements, and domestic schemes need to take account of the need to provide water for productive use (at least up to the threshold norm for household supplies – see next point). Planners need to be encouraged to seek to match available water from all sources (conventional and non-conventional) with needs in a sustainable manner.
- Quantity – 50-200 lpcd as a threshold norm for household supplies
  The figure of 50-200 lpcd is one that we believe to be both realistic and reasonable, and based on a growing body of experience. Survival norms of 15-25 lpcd should be recognised as appropriate in only the most extreme emergency or drought scenarios.
- Equity – poor people have a right to an equitable share of water resources
  This benchmark household-use norm should form a basis for water resource management and allocation. Using the concept of the pyramid of needs, the apex

of the pyramid should be reserved for survival levels of domestic water, and the next step for the basic level of household supply. Only when sufficient quantities exist to meet these and environmental needs should water be allocated to other sectors and uses.

2. Further research

This book includes 9 further chapters with case studies from countries in Africa, Asia, and Latin America. Far more are needed, from a wider range of countries. A body of strong case-study material will be instrumental in persuading the various water sub-sectors to change their approach. However, in addition to general success stories and 'how to' cases, specific research in a number of areas is particularly important. Three of these are considered:

Hard evidence of costs and benefits of supplying increased quantities of water for mixed use is necessary. One of the most compelling critiques of providing increased quantities of water for domestic use is that 'it is too expensive'. 1.1 billion people lack any safe water supply and, while various figures are floated as to how much it will cost to meet this need, they all agree that requirements are hugely greater than current investment levels. So, to recommend that water supply norms should be doubled or tripled is open to accusations of being grossly unrealistic.

To consider these arguments and make rational decisions, two sorts of evidence are necessary. First, we need better data on the incremental costs of supplying increased quantities of water - and the incremental benefits of an increased water supply. How much does it cost to provide each extra litre of water above the 25 lpcd survival norm? And how does that compare with the extra benefits gained? While these figures, particularly the first, may seem rather basic, they are difficult to find. Evidence reported at the symposium supports a strong hypothesis that, to the order of magnitude being talked about, benefits will considerably outweigh costs.

With these figures it is at least possible to make the financial and economic arguments for increased supply. But this is only half the argument. Second, therefore, there is a need for more studies showing that not only do benefits outweigh costs but this in turn leads to increased willingness to pay and actual cost recovery. At the end of the day, if the huge deficit in water supply is to be met, new forms of financing are going to have to be identified and sustained. Proof that increased water supplies can be turned into increased revenue flows would give very powerful ammunition to the argument that increased supply for productive use is not only economically sensible, but leads to more profitable water supply options.

Required changes to policy, legislation and institutions

While advocacy for change is needed, and evidence on which to base the advocacy essential, on their own they are not enough. Once people have been persuaded to take a new approach, they still need to be shown how to do so. This requires models, tools, and training materials: models for legislation, policy and financing mechanisms; tools to support holistic, livelihoods- and poverty-focused planning for water supply services, and training materials to teach people how to use them.

Conclusions

- People draw multiple benefits from access to small-scale water supplies – it is the combination of these benefits that add up to an appreciable impact on livelihoods and poverty. Artificial distinctions between domestic, irrigation, and other water use should be abandoned in favour of the concept of a 'household water supply' which is sufficient for a range of basic needs (drinking, washing, cooking, sanitation) and household-scale productive activities suitable to the livelihoods of the people concerned.

- Narrow approaches to water supply that neglect the potential of productive uses are an opportunity missed. Worse than that, because in practice people will use water for productive activities anyway, ignoring productive use leads to undersigned systems that fail through unplanned use. It is therefore much better to include small-scale productive use in initial system planning and design.

- One of the major reasons that projects fail to address these needs is that such small-scale productive uses slip between sub-sectoral remits. A sub-sectoral approach, where irrigation, industrial, drinking and wastewater services are treated separately, typically fails to identify productive needs (or potentials). Projects implemented under these rigid sub-sectoral approaches usually don't recognise multiple benefits, and therefore don't impact on poverty as effectively as they could. A bottom-up, people-centred, and multi-sectoral planning process is needed if productive uses are to be effectively supported.

- Low and inflexible norms-based 'basic needs' or rights-based approaches can also be a handicap – by setting targets too low they fail to provide for the productive activities that could help people grow food, make money, and escape poverty. These uses should be considered basic or standard. Norms are required for proper planning, but they should be based on at least some productive use, and should in any case act as benchmarks and not upper limits. A norm of 50-200 lpcd depending on setting should be adequate to provide sufficient water for productive uses while not placing an unbearable strain on water resources or the environment in any but the most extreme emergency or drought situations.

- There are many positive examples now emerging of how better water supplies do impact on livelihoods and poverty. They need to be supplemented and reported more widely. While research findings are promising, there continue to be few (if any) models, or toolkits that address the wider needs of people for multi-purpose water supplies. In addition, examples reported tend to be project and location-specific and have not yet been taken to scale.

- There is a genuine increase in recognition, across the water sub-sectors, of the need for a holistic approach to meeting people's water needs at household level, and there is some convergence between sectors. In particular, the domestic and irrigation sector are both starting to recognise the importance of household water supplies (albeit from different starting points). These trends are encouraging evidence of a more integrated approach to water resource development and management.

- Livelihoods-based approaches to developing water resources offer a potential justification of, and incentive to, genuinely bottom-up Integrated Water Resource Management. They also provide a challenge to all those who claim to represent the largely poor and scattered small-scale users of water: to include their demands within rights-based approaches; to ensure that their voice is heard at the catchment management table; and to ensure that they get a fair share of available water resources.

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Productive uses of water at the household level: evidence from Bushbuckridge, South Africa

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Summary

Demand Responsive Approach (DRA) was the 'new phrase' in the South African Water Supply and Sanitation sector at the turn of the century. The fundamental basis of this new approach was that sustainable water systems at community level can only be achieved if people are provided with the level of service they want and are able to pay for. In other words, sustainability requires understanding and being responsive to people's effective demand for water. Consequently, the obvious question to ask was how well do we understand that demand?

The answer is: not very well. Our current understanding of water demands is biased towards formal sector users of water (Agriculture, Forestry, Mining, Industry and Tourism). Very little is known about water use and demand in rural communities and most of the research has focused on water for human consumption. Systems have been designed solely to provide small quantities of drinking quality water and, in many cases, the unit cost of the water is high.

But, do these systems meet demand for water in rural areas? Are there any 'productive uses' for domestic water? How much water is demanded for these other uses? Is there an effective demand for this type of water (can people afford to pay for that water)? Are there any economic benefits to the use of this water? What happens when the system does not cater for this demand? This paper discusses some of these questions, based upon evidence from research undertaken in 13 'rural' communities in the Bushbuckridge District of South Africa.

Introduction

The beginning of the 1990s saw a shift to a new approach in the Water Supply and Sanitation sector. It stressed the consideration of water as an economic good and the importance of demand as a driving force. It was accordingly named the Demand-Driven or Demand Responsive Approach (DRA) (Sara, 1998; Garn, 1998; Dreyer, 1998) and is based mainly on two of the principles that were endorsed at the 1992 International Conference on Water and the Environment in Dublin:

1 With contributions from Sharon Pollard, John Soussan and John Butterworth

- Water is an economic, as well as a social good and should be managed as such; and
- Water should be managed at the lowest appropriate level, with users involved in the planning and implementation of projects.

The implications of this new approach for the water supply sector are far reaching. It focuses attention on consumer demand, that is the quantity and quality that consumers want at a given price. It requires that managerial decisions about the levels of service, location of facilities, cost recovery and O&M should be responsive to local needs as defined by users.

The international debate and the shift towards a DRA has coincided in South Africa with a changing policy environment arising from the effort of the new democratic government to address inequalities brought about by the apartheid regime. These two trends have had profound repercussions in the water supply sector and together provide the general context for this research.

The South African policy and institutional context

Any discussion of water issues in contemporary South Africa must be set within the context of the existing dynamic changes to water laws, policies and institutional responsibilities. The process of change derives from the provisions of the Water Services Act (1997) and the National Water Act (1998). The Water Services Act gives substance to constitutional requirements with respect to rights of access to water supplies, establishes national norms and standards and defines the institutional framework for the provision of water and sanitation services. The National Water Act establishes the ways that water resources are to be protected, used, developed, managed and controlled, based on principles of equity, sustainability, efficiency and accessibility. Furthermore, in a fundamental departure from the previous legislation, the new National Water Act recognises water allocations to two water 'users' prior to provision to any other sector. This is embodied in the concept of 'the Reserve', which comprises both water for the river itself (to maintain ecological integrity) and water for basic human needs, which has been interpreted as 25 lpcd at the tap, the so-called RDP minimum standard (Pollard et al. 2002).

In the domestic sphere, this low initial target (there are higher medium and long-term targets) reflects a definition of basic needs that assumes domestic water supply is only about health and hygiene: water for drinking, cooking, sanitation and washing. Productive activities that take place in the household have yet to be recognised in planning and allocation processes (Soussan et al. 2002; Pollard et al. 2002). As we shall see, these are a key element of the livelihoods of rural people in the Bushbuckridge area.

The rural water supply and sanitation sector in South Africa

Past inequalities in access to water are also reflected in the amount of information available about each sector's water demand and use. During apartheid in South Africa, government policies not only followed the logic of a supply-driven approach but also incorporated a paternalistic and racist component to the provision of water to South African people. The assumptions of the traditional approach were reinforced by: urban bias; a preference for white farmers; socio-political divisions based on race; and the notion that black South Africans were unable to make decisions about their own lives. The result is that current knowledge is flawed in its focus on formal water users such as irrigated agriculture, forestry, industry, mining, recreation and ecotourism and does not take into account many small-scale and informal activities.

Furthermore, most of the research at the rural domestic level has focused on water for human consumption. However, in rural areas, water sources are used for a combination of basic human consumption (basic needs) and productive purposes[2]. The former refers to water used for drinking, cooking, personal hygiene, and household cleaning. The latter highlights the fact that in rural areas people engage in economic activities that are highly dependent on the availability of secure and reliable water supplies. Vegetable gardens, cattle farming, traditional beer making, hair salons and brick making are some examples of the uses of water for income generation.

Therefore, under current circumstances, the need to fill the information gap regarding domestic water use becomes a priority issue for at least three important reasons:

- Understanding domestic water-use patterns and demand from a broad perspective (for both basic needs and economic activities) will improve the ability to respond to demand, the essence of DRA, and one of the important steps towards sustainability.
- As domestic and municipal users, previously disadvantaged communities will have to compete with the other key sectors in their quest to gain access to water over and above the basic needs level. If the allocation mechanism brought about by the National Water Act is to be based on fair competition among the different sectors, a better understanding is needed of the productive uses of water in rural areas, and the role that water plays in supporting rural livelihoods.
- In the context of DRA, the need to recover the cost of water service provision is

2 There are also other religious, ritual and recreational uses for water that are neither basic nor productive, but more or less border on a health and hygiene-focused basic category (Mokgope and Butterworth, 2001)

now accepted as a priority for the sector (DWAF 1994; DWAF 1997a, b; Jackson 1997; Jackson 1998). The argument is that establishing effective cost-recovery mechanisms is necessary to ensure the sustainability of the water supply systems. It generates a feeling of ownership of the water systems by the community[3] and, most importantly, it is the only way of ensuring the financial sustainability[4] of service providers, and therefore their ability to continue the service provision into the future. The ability of the rural poor to access increasing quantities of water will not only be determined by the availability of the water (supply side), but mainly by their ability to bear the costs of the water and its delivery (effective demand / ability to pay). In turn, the ability to pay can only be enhanced by promoting income-generating activities and increasing the economic opportunities of the rural poor. Accessing water over and above basic needs may be a necessary condition for this.

Research questions

The Association for Water and Rural Development (AWARD) - a rurally-based South African NGO, has been working directly with rural communities in the Bushbuckridge area since 1993. The main focus for AWARD has been to support formerly disadvantaged communities in their efforts to secure access to sustainable water supply systems. As a result, the AWARD team has developed an understanding of the context in which domestic water is used in these communities. After identifying key gaps in current knowledge about domestic water use in Bushbuckridge, a research process was designed to answer the following questions:

- Given the current minimum national standards for domestic supply (RDP minimum standards: 25 lpcd within 200 m of the household), and current use patterns, does this minimum standard meet basic needs in rural Bushbuckridge?
- What are the productive uses for domestic water? How much water is used for these productive activities?
- What are the economic benefits generated from these activities?

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3 Boydell (1999), referring to evidence from the UNDP-World Bank funded schemes, indicated that, for schemes to be sustainable, communities should pay for O&M and should make a ‘substantial’ contribution to capital costs (this contribution will vary from project to project, but should be substantial enough to generate a feeling of ownership). He also noted that principles of cost-sharing should aim at negotiated cost-sharing arrangements in which the local community chooses the levels of service for which it is willing to pay, based on a full understanding of the implications of that choice (i.e. capital and operational costs are likely to increase for higher levels of service).

4 Sustainability is defined here as: the benefits of the water-supply project continuing indefinitely in a reliable manner at a level genuinely acceptable to the community it serves and close to the design parameters, without an unacceptable level of external managerial, technical or financial support (DWAF1997b).

- Do people pay for water in Bushbuckridge? (Is there an effective demand for water?)
- Are people willing to pay for the water? What factors affect 'willingness to pay' for water?

A detailed research report is available (Perez de Mendiguren & Mabalane, 2001).

The study area

The study area[5] for the research was the Bushbuckridge (BBR) district located in the South African lowveld on the border between the Mpumalanga and Northern Limpopo provinces[6] and covering an area of 240 km^2 between the Drakensberg mountains in the west and conservation areas and the Kruger National Park in the east (see Figure 1). The Sand and the Sabie are the major rivers flowing through the area. Mean annual precipitation is 600 mm, concentrated during the summer months (October to March), but rainfall is significantly lower towards the eastern part of the district and cyclical droughts are a common occurrence.

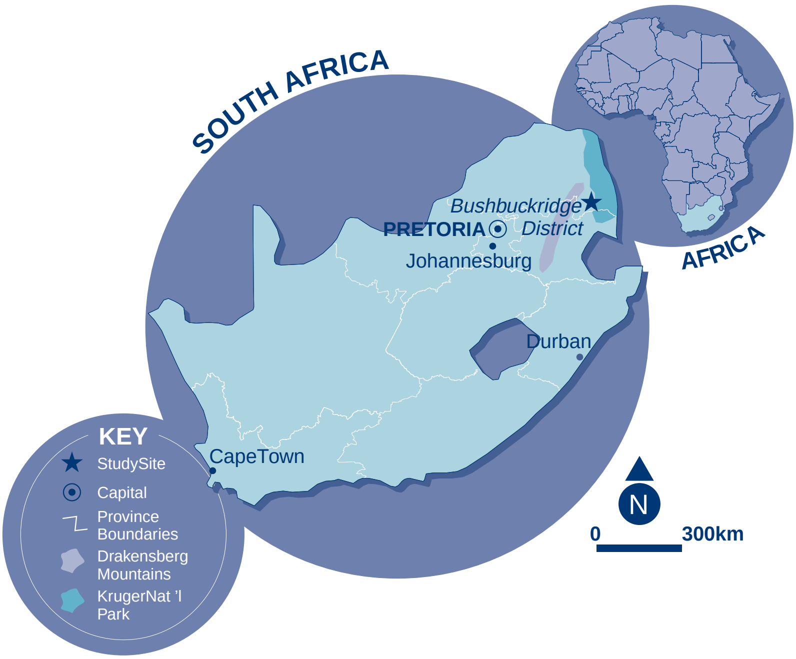


Figure 1. The study area

Typical of many densely populated former homeland areas of the country, high unemployment is one of the main socio-economic characteristics in Bushbuckridge.

5 Extensive details for the entire district are provided by Shackleton et al (1999). Detailed information on the northern and midland areas of BBR, falling within the Sand River Sub-catchment, is also given in Pollard et al (1998).

6 Known as Northern Province prior to July 2002.

The unemployment rate is 40% of the active population. Livelihood options include (limited) irrigated agriculture, dry-land farming, animal husbandry, harvesting of wild plant and animal resources and a variety of small businesses. Also, with formal sources of income becoming limited and saturated, increasing numbers of people are turning to the informal economy for income generation. Informal sector activities range from food processing and beer brewing, to small-scale retailing of fruit and vegetables, low-cost household goods, wood carving, reed mats, other craft work, and selling wild herbs. For most households it is not unusual to be involved in more than one of these activities at the same time in an effort to diversify sources of income. Some of the activities depend on domestic water as an important input in the production process.

Reliable access to safe water of a sufficient quantity continues to be one of the major problems for many people in Bushbuckridge, particularly in rural settlements. This is due to a combination of socio-economic, historical and natural factors (source constraints), which result in poor infrastructure and management of water resources. Both groundwater and surface water are important sources for villages in the area. Communal standpipes (public taps) are the standard level of service in the rural settings (see Table 1), while piped water in houses is more frequent in the declared townships of the area (Thulamahashe, Dwarsloop, Shatale and Mhkuklu). However, even at the village level, there are spatial variations in water service provision regarding quality, quantity, reliability and distance to the source[7]. Situations in which some people in the village are irrigating their lawns while, a short distance away, others are queuing to fill up buckets of water are everyday scenes in Bushbuckridge. In some areas, people still have to consume water from rivers, unprotected springs, or wells dug in the riverbeds.

Table 1. Level of domestic supply for households in Bushbuckridge

Level of domestic supply	% of households
Piped water in dwelling	14
Piped water on site	16
Public tap	50
Water-carrier/tanker	1
Borehole/rainwater tank/well	11
Dam/river/stream/spring	6
Other	2

Note: Data derived from the 1996 Census

7 For descriptions of water infrastructure in the area see AFRICON Consortium, 1998; Pollard et al 1998; Chunnett, Fourie & Partners, 1990.

Methodology

General approach

A comparative village case-study approach was followed. Based on institutional and climatic differences, Bushbuckridge was subdivided into 6 areas: north-west, north-east, mid-west, mid-east, south-west, and south-east. In each area, two villages were chosen with similar socio-economic and physical attributes but diametrically opposed domestic water supply situations[8]. For the purpose of this study, villages in each pair were termed as either 'worst case' or 'best case'. The criteria for selection are shown in Table 2. The survey covered a total of 13 villages (or sections of larger settlements) that had a combined population of over 15,000 people. Table 3 summarises the main population statistics for the case study villages.

Table 2. Research categories and main characteristic for each category

Category	Characteristics
'Best case scenario' villages/sections	• Functional reticulated supply. Minimum RDP standards met for all households. • Most households have one or more yard taps. • Very few households have in-house connections. • Water supply is very reliable. • Yard tap is the highest level of service.
'Worst case scenario' villages/sections	• No reticulated supply in the village (or non-functional). • Minimum RDP standards are not met for all households. • Large differences in the level of service between households. • People walk long distances and queue to fetch water. • Supply is very unreliable and people face long periods without water. • Most households suffer severe shortages of water. • Private vendors are common. • Community tensions arise due to differences in access to water.

The research was part of a learning process both for AWARD and for the communities involved. It included the collection of data from a combination of

8 Although selection of case study communities tried to control for factors other than the differences in access to domestic water supply, this was not always possible. Some of the differences in the analysis presented in the research are conditioned by factors other than access to domestic water supply. When possible these factors were identified and their importance assessed using qualitative data and/or anecdotal evidence.

primary and secondary sources. Most data were obtained through intensive fieldwork using participatory methodologies. Six to seven days were spent in each of the villages over the study period. Emphasis was placed on allowing community members enough time to discuss research issues, and in reporting back on the research findings to the communities.

Table 3. Population statistics in case study villages

'Best case scenario' villages				'Worst case scenario' villages			
Village	Population	No. of house holds	Avg. house hold size	Avg. house hold size	No. of house holds	Population	Village
Shortline	165	35	4.7	4.9	360	1800	Violetbank F
Dingleydale	1759	268	5.5	5.6	314	1765	Township
Boshoek & Matafeni	1225	175	7.1	5.9	20	119	Itereleng
Utha	1250	221	9.8	5.2	76	430	Dixie
Xanthia A	1023	165	6.3	7.5	207	1594	MP Stream C
Kildare B	1729	290	6	7.4	378	2007	Mabharule
				5.8	29	165	Tsakane
	Class Average		6.2	6.1	Class Average		

Methods for data gathering included: group discussions with specialist and non-specialist groups, semi-structured household interviews and in-depth interviews with individuals. Semi-structured household interviews were conducted in all villages to complement and validate the information gathered in very informative mass meetings and group discussions. In communities where data collected in the mass meetings were insufficient, a random sample of households was interviewed. Sampling frames were constructed for each village. Existing village maps were ground-tested, modified and used when possible. ESKOM (South Africa's electricity utility) maps were used in one community. Maps from the Agincourt Demographic and Health Information Project (CCP) were also used in another area. Participatory mapping exercises were carried out in villages in which maps were not available or were inaccurate.

Method for data aggregation

As a general procedure, to obtain both inter-village and inter-category comparisons, average water consumption patterns and gross margins for each productive activity were calculated and aggregated for each village and also for the combined categories of villages (‘best case villages’ and ‘worst case villages’). Statistical tests were then conducted to determine whether the observed differences between ‘best case’ and ’worst case’ were significant.

Some caution is required when translating household consumption into average per capita consumption, the underlying assumption being that, irrespective of their age and gender, all individuals within a household have equal access to equal amounts of domestic water and the health and economic benefits it can generate and also equal rights to prioritise its use. Household dynamics in Bushbuckridge are complex due to a combination of issues related to kinship relations (extended families), the existence of polygamy, and the high prevalence of migrant workers. Age and gender differences in access to resources are very acute and decisions over the allocation of resources happen in the context of the different set of objectives that exist for individuals within the household (as opposed to one unique set of objectives for the household).

Discussion of results

Water for basic needs

All households, of course, use water for their basic needs: for drinking, cooking, bathing and washing clothes and utensils. The amounts used varied somewhat according to the quality and proximity of the water supply and the size and wealth of households, but in almost all villages the average use for these purposes was close to or below the minimum ‘basic needs’ figure of 25 lpcd. There was no statistical difference in the quantities of water used for these purposes between villages with good water supplies and villages where supplies were poor. Recorded averages for the two categories of villages show that water consumption was only 1.2 litres higher in villages with better water supply (22.4 lpcd compared with 21.2 lpcd). In other words, with the available data it can be concluded that consumption for basic needs is generally similar among villages regardless of the water supply systems (at least within the range studied in the area).

The general absence of in-house water connections in surveyed households is one explanation for this fairly low water use for basic activities. For households with access to yard taps, it was still observed that women found it more convenient to store water for daily use in the kitchen or inside the premises, so use was similar to that found when only communal taps were available. Significant differences in consumption (at least for drinking, cooking and household cleaning) are not expected unless the household has access to in-house connections and probably water-based sanitation systems - flush toilets, but also showers/baths[9]. Evidence from research elsewhere in Africa also shows that if water must be carried, the quantity brought home varies little for sources between 30 m and 100 m from the household (White, Bradley, and White, 1972).

In many cases, accessing 25 lpcd of water meant women spending a long time fetching water from distant sources, queuing for water at communal water points or buying water from vendors. There were also concerns about water quality in some cases. The main benefits of improved water supplies for basic needs was seen to be the time saved in fetching water rather than the increased amount that could be consumed. These time savings were very significant for women and children in particular, freeing up time for other livelihood-supporting activities or for leisure or study time.

Productive uses of domestic water

The research found a wide range of water-dependent productive activities in the study area. While some of these activities are about lifestyle improvements (as opposed to profit-orientated activities), they provide goods and services to poor households and constitute an important part of the livelihoods of participating families. The main water-dependent productive activities were vegetable gardens, fruit trees, beer brewing, brick making, hairdressing, livestock (cattle and goats) and ice-block making. A similar list of activities was found in most villages, though the importance of different ones varied from village to village. Other activities were cited in just one or two villages. These included grassmat weaving, smearing and plastering of walls and floors, medication and religious uses, baking, poultry, duckponds and car washing.

Vegetable gardens

Where adequate water is available the most common productive water use is vegetable gardens (also referred to as ‘private gardens’ to differentiate them from community gardens). They are small portions of land used to grow vegetables such as tomatoes, cabbage, lettuce, and pepper in the winter; and rainfed field-crops such as maize, groundnuts, and cassava in the summer. As opposed to other agricultural land and communal gardens they are normally located within the individual homestead and irrigated with domestic water. Most of the produce is for household consumption, but some is sold in local and regional markets. Private gardens are generally small (30 to 600 m^2) and the amount of time and effort dedicated to them varies from household to household.

9 In a ‘before/after’ case study carried out in Utha after their domestic supply was improved to RDP minimum levels, households indicated that the quantity collected for their daily used had not increased, although the time invested in fetching water had clearly decreased.

The existence of private vegetable gardens (particularly during winter) is an indicator of the status of the domestic water supply in a village. In the study area, 45% of all sample households in ‘best case’ villages were growing vegetables compared with only 14% of households in ‘worst case’ villages. Average water consumption for irrigation of vegetable gardens was also much higher in ‘best case’ villages (32.2 lpcd) than in ‘worst case’ villages (8.3 lpcd). Both differences were statistically significant. In ‘worst case’ villages, the inability to engage in gardening activities was often raised as a concern in meetings and, together with fruit production, it was identified as one of the activities that people would undertake if there were more favourable conditions such as an improved water supply.

Fruit trees

Many homestead plots also contain a number of fruit trees, which provide shade and have aesthetic value as well as giving fruits. The most common types of fruit trees are mango, litchi, banana, paw-paw, avocado, guava and peach. The existence of fruit trees as a crop can also be a good indicator of the water supply situation in a particular village. However, trees will survive long periods without water, particularly if they are adult, so a less reliable supply is needed than for vegetables. Also, since trees provide other services such as shade they are common even in villages with poor domestic supply, although they are less likely to be productive. Households in ‘best case’ villages tend to have a significantly higher number of fruit trees in their homesteads. The average number of trees increases from 8.6 per household in ‘worst case’ villages to 13.6 per household in best case villages. Furthermore, villagers in ‘best case’ villages use a significantly greater amount of water for their trees than those in ‘worst case’ villages (12.7 lpcd and 4.4 lpcd respectively), where irrigating trees with recycled or grey water is a common practice.

Building

Building was another productive use of water that showed important differences between villages with good and bad water supply. Families in Bushbuckridge normally build their own houses. Households extend their living space when need arises and some building activity happens nearly every year in any given household, mainly during the rainy season when more water is available. Even if the building activity does not translate into a monetary income for the household members, it provides housing services that would otherwise have to be hired or bought. In addition, some individuals make cement bricks for sale. The study showed that households in both ‘best’ and ‘worst’ case scenarios are equally as likely to undertake some building activity. However, among households that decide to build, those in ‘best case’ scenario villages use more cement (49 versus 29 bags of cement per year per house), and hence use a significantly higher amount of water.

Brewing

Brewing traditional beer is a common practice among most rural households in Bushbuckridge. It is usually associated with functions, festivities, rituals and ceremonials. Normally, the beer produced for such events is not sold but given away to friends and family and/or consumed in the household. The research concentrated on commercial brewers. They brewed at least once a month through the year, although it was often on a weekly basis. Beer brewers were normally old women living in poor households. In many areas brewing and selling traditional beer was stigmatised, as it normally involved hosting a 'shebeen' (unauthorised bar). Brewing beer was also perceived as an indication of poverty and often respondents indicated that they would only brew beer to sell if they had no other income option. There are differences in the amount of water used between brewers in 'best case' and 'worst case' villages. The total amount of beer brewed per day is 72% higher in 'best case' villages (625.8 litres versus 364.2 litres). Also brewers in villages with a good water supply brew an average of 28.4 litres per day, whereas those villages with poor supplies brew only 17.3 litres.

Livestock

The source of water for cattle is often not from a 'domestic' system, but from outside the village (cattle dams, rivers and springs). Livestock can be moved to more distant water sources. Hence, it is still possible to raise cattle in villages where the water supply system is poor but there are alternative sources of water. This is confirmed by the absence of significant differences between 'best case' and 'worst case' scenario villages in all the variables examined in this section (% ownership, livestock numbers and water consumption) for both cows and goats. However, fieldwork in Utha, Dixie and MP Stream C showed that the relationship between livestock ownership and availability of 'domestic water' was more complex than initially assumed. Livestock was perceived as a competing user for domestic water, particularly in times of water stress, when domestic supplies may keep livestock alive. In some villages, failure to provide appropriate facilities for livestock consumption had resulted in cattle and goats being watered at communal taps, causing damage to facilities and creating health hazards. Also people in Utha and Dixie indicated that in times of stress villagers had at times vandalised reservoirs and storage facilities in order to access water for their livestock.

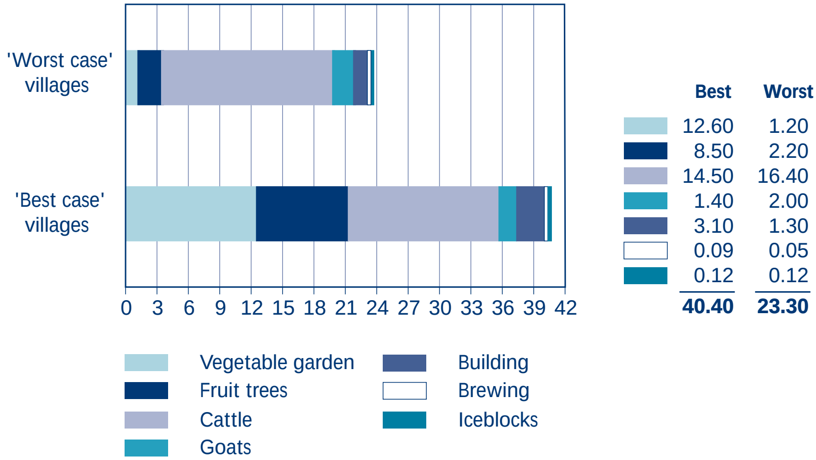


Figure 2. Summary consumption for main water-based livelihood activities in 'best cases' versus 'worst cases' (lpcd)

Overall results

In general, there were major differences in the quantity and pattern of water use for livelihood activities between villages dependent upon the performance of their water supply. Figure 2 summarises the average water consumption for all productive activities averaged across all the households in a village in order to provide suitable estimates for village-level planning (rather than figures averaged across the households engaged in an activity as cited in the previous sections).

The main conclusion from these figures is that an additional water supply of 40 lpcd is able to support a wide range of productive activities (given current proportions of households involved in the activities and their water consumption). The activities using most water are cattle watering, vegetable gardens, beer brewing and watering trees. Comparisons between consumption in 'best case' and 'worst case' villages provide an indication of the likely increase in water consumption with improved water supplies. Water consumption for all activities except livestock and ice-blocks, is much higher in 'best case' villages. The most important increases occur in the irrigation of gardens (950%), irrigation of fruit trees (286%), building activities (138%) and beer brewing (80%). However, as they are averages for all households, the figures do not reflect the real amount of water used by a household involved in a particular activity. The amount required for individuals involved in each activity is much higher than the average. Figure 3 provides average consumption figures for each activity, when only those households engaged in the activity are considered.

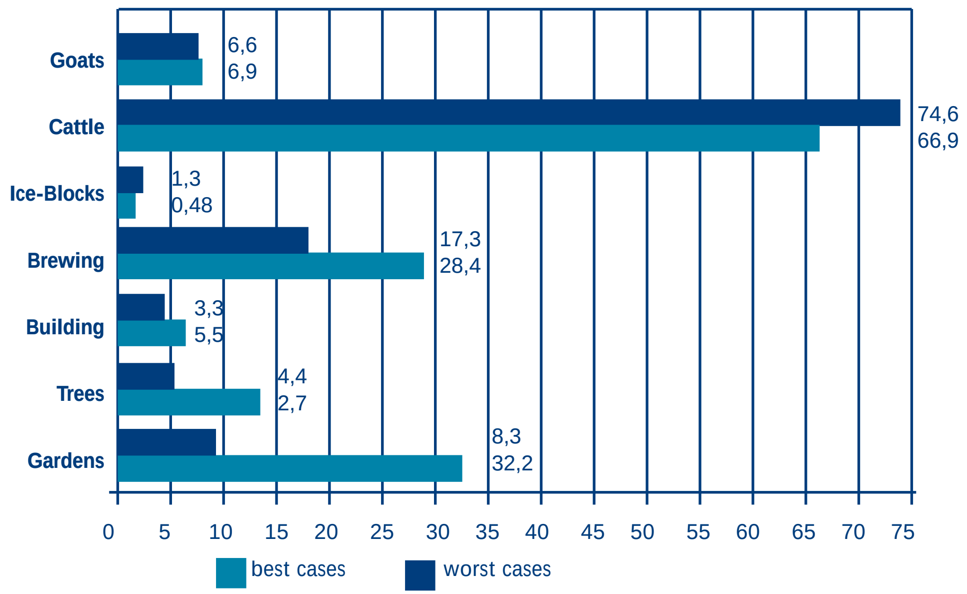


Figure 3. Water consumption per business in households involved in the business (lpcd)

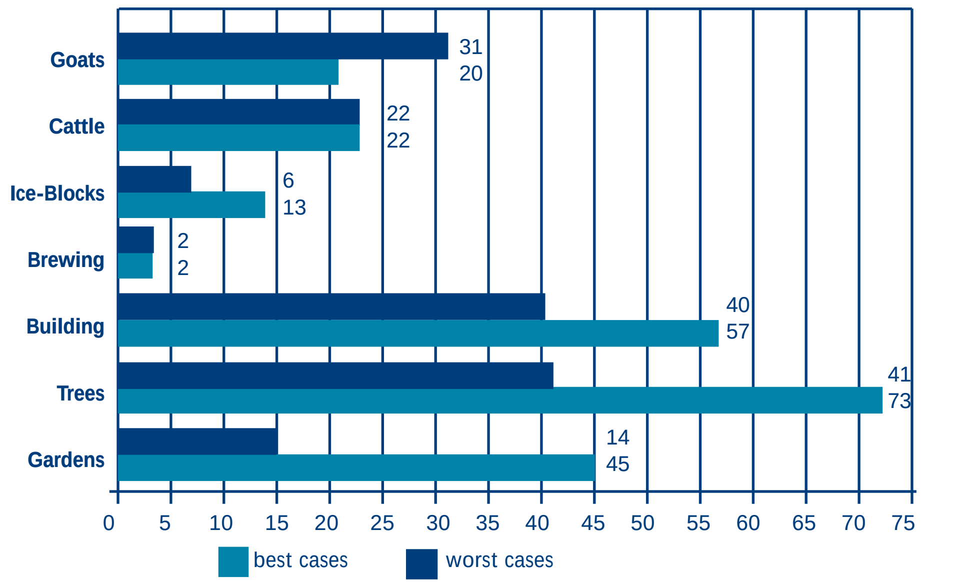


Figure 4 Percentage of households involved in each activity (%)

Figure 4 is an overview of the average level of involvement of households in each of the activities. Not all households engaged in water-dependent productive activities. In 'best case' villages, the proportion of households involved in each activity ranged from 2% of the households for beer brewing to 73% for the irrigation of fruit trees. For most activities, the proportion of households involved was also higher in 'best case' villages than in 'worst case' villages. Also, households in 'best case' villages are more likely to be involved in more than one productive activity (60% of households in 'best case' villages were involved in 2 businesses as opposed to 38% in 'worst cases', while the percentages of households involved in 3 businesses were 11% and 3% respectively). This demonstrates that the ability to participate in these livelihood opportunities is directly related to the location and reliability of the water supply - a conclusion supported by the views of the participants in the research.

We can consequently see that the productive use of domestic water is extremely common throughout the Bushbuckridge area, and in all probability would be even more widespread if all communities had reliable access to a convenient water supply.

Income from productive uses of domestic water

The economic significance of domestic water-based activities was measured by looking at the income generated from each activity. Gross margins[10] per litre of water were calculated for each activity and then multiplied by average consumption. The limitations of the results presented below relate to the fact that neither the cost of the labour input to each activity nor the price of water were included in the calculations of gross margins. Further research is needed to include these factors (direct and/or indirect cost of engaging in the activities, including the time spent in fetching water) and to refine the gross margin figures presented here.

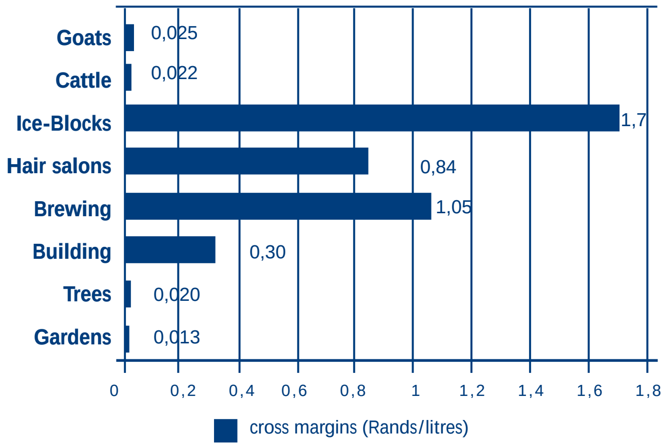


Figure 5. Gross margins for 'water-dependent low-level economic activities' (Rands/litre) (10.5 Rand = US$1)

Figure 5 presents an overview of the 'gross margins' for all activities. They show a wide variation across businesses. Ice-block making provided the highest return (1.7 Rands/l) followed by beer brewing (1.05 Rands/l) and hair salons (0.84 Rands/l). Building was next (0.3 Rands/l), followed by livestock rearing (0.025 Rands/l) and fruit trees (0.02 Rands/l). Vegetable gardens (0.013 Rands/l) provided the lowest return. Returns for the last three activities are partly much smaller than the rest because the activities are relatively more intensive in water use.

10 Gross margins = Income minus operating cost. Capital cost for the activities was not included.

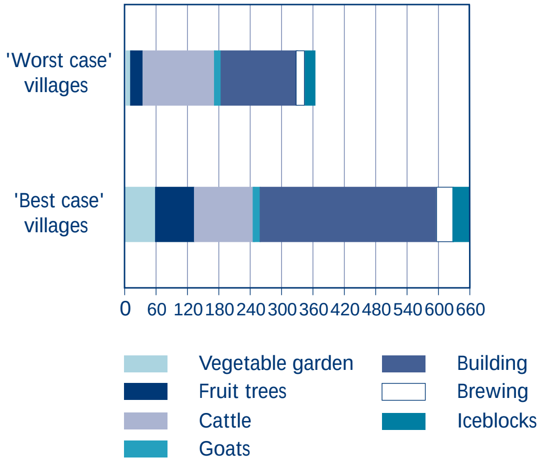
Paradoxically, the highest rates of involvement in the productive use of domestic water are for those activities with the lowest returns per litre of water. This is the case for fruit trees and vegetable gardens. In contrast, beer brewing and ice-block making provide the highest returns per litre but have the lowest rate of household involvement. This may be due to the fact that the activities with highest returns (beer brewing, hair salons, ice-block making) are mainly undertaken for commercial purposes with most of the product being sold in local markets in order to generate cash income. As markets for these activities tend to be very local (one village), there is only a limited amount of such business in any given village.

On the other hand, activities with comparatively lower returns such as fruit and vegetable production, normally have a dual purpose, namely, for income and consumption. In the case of private gardens, estimations of self-consumption varied from 50% to 80% of the product for the biggest backyard gardens and 100% for the smallest ones. Therefore, as they are not that dependent on the size of the market, these activities are the most likely to happen when access to water improves.

Gross margins from irrigation of gardens and trees[11] may be low but the welfare impact and the economic benefits for those who engage in this activity can be much higher. Health benefits derived from a more diverse diet and the regular consumption of fresh fruit and vegetables are widely acknowledged. Also, having access to small but reliable sources of income from gardens and fruit trees can contribute to lower income insecurity and enable the benefits to be reinvested in other activities. A pilot project using productive water points to irrigate gardens in southern Zimbabwe found that: *'For women with little access to cash, materials or productive resources, obtaining a steady seasonal income from the scheme has greatly lowered elements of risk and income insecurity in the households' decision making and planning processes.'* Also, reliable income flows have allowed the 'revival and blossoming of 'revolving funds' at productive water points'. (Lovell, 2000).

Figure 6 summarises the returns from all household-based economic activities in both types of villages. The income shown is for all activities averaged across all households, regardless of whether each household engages in the activity or not (under current proportion of household involvement and water consumption). Total income generated from these economic activities averages from R361 to R653 per person/year although the actual amount earned varies from household to household and community to community.

11 Gross margins for vegetables were done on the total value of production – inputs, not only on the value of the part that was sold.



	Best	Worst
	58	7
	66	11
	113	131
	11	18
	339	142
	33	18
	33	33
	653	**361**

Figure 6. Total gross margins from water-dependent livelihood activities in the two types of villages (Rands/capita/year)

Given current income levels in the Bushbuckridge area (R2,106 per year), the income from productive uses of domestic water represents around 17% of average household income in 'worst case scenario' villages and 31% in 'best case' villages. In fact, from the figures presented above, it can be concluded that the extra water (17.1 l/c/d) available to individuals in 'best case scenario' villages translates into an extra income of R292 per person per year (or 46,7 R/m3).

The income levels in Figure 6 show the average benefits of an additional water allocation, but they do not reflect the real income generated by a household involved in a particular activity. Figure 7 provides average 'gross margin' figures for each activity, when only those households that engage in the activity are considered. The figures are, of course, higher, showing that for those households engaged in these activities they are a major source of livelihood. This is particularly true for the poorer households involved, many of them women-headed, as their income is often far below the average figure for the region.

Overall, the data presented here demonstrate the importance of the use of domestic water for productive activities in the livelihood systems and the general economy of Bushbuckridge. It can be concluded that the inability to access domestic water for productive purposes can reduce considerably the livelihood options in an area, particularly for poor and vulnerable households, who have limited access to livelihood access assets and few alternative income opportunities. For these people, growing fruit and vegetables, running a hair dressing salon or brewing beer can be key to avoiding, or at least reducing, poverty.

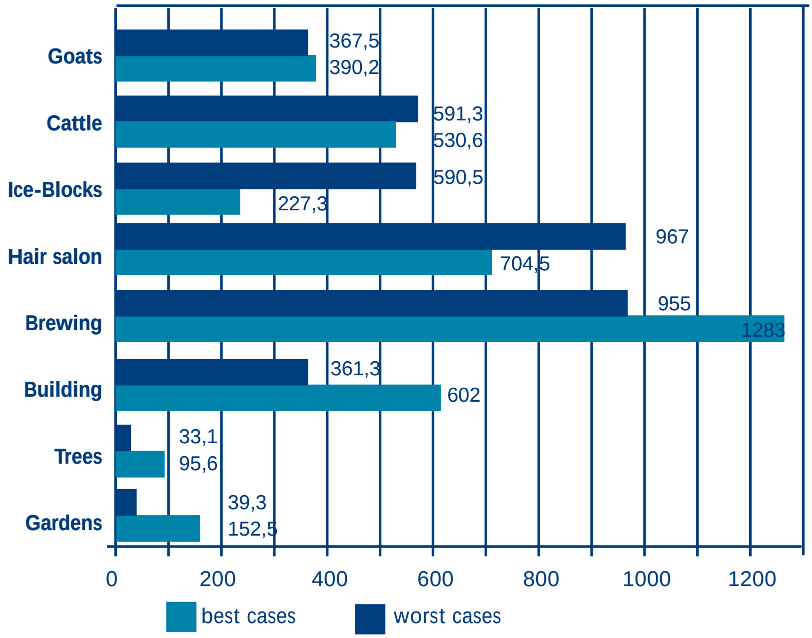


Figure 7. Annual gross margins per capita for those involved in each activity (Rands/capita/year)

These results offer a first assessment of the role of productive water use in rural livelihood systems in Bushbuckridge. However, the insight into rural livelihoods provided by this research is somewhat limited. How these water-based livelihoods feature in the overall livelihood strategies for rural households remains largely unanswered and should be the focus of further research. The evidence from Zimbabwe (Lovell, 2000) shows that the livelihood impact of increased access to water for productive uses can be very important. Income from productive water points (mainly used for vegetable production) has created opportunities for those with limited access to cash or productive resources to start their own income-generating activities. As Lovell reports, it has shown how obtaining a steady seasonal income from a productive water point lowers elements of risk and insecurity in the household budget and decision-making process. Comparisons with surveys carried out at standard (non-productive) domestic water points draw attention to the difference that a secure source of income from a productive water point can make in enhancing broader production systems.

The cost of providing extra water

When considering the cost of meeting the needs to use water productively, the most important factor is the incremental cost of supplying more water. Capital and operation and maintenance costs for water systems in South Africa are shown in Table 4. These figures can help to put into context the gross margin figures presented in the previous section.

There are huge increases in costs when moving from handpumps supplied by groundwater to any kind of piped water supply. But, after this leap has been made, the additional capital costs involved in moving from communal standposts supplying as little as 15 lpcd to systems supplying 25, 60 or 120 lpcd are much less then the proportional increase in water supplied. Interestingly, operation and maintenance costs are shown to increase much more when improving supplies to a high standard urban system (e.g. by 50% from 60 to 120 lpcd). The benefits of productive uses of domestic water supplies need to be set against these incremental capital and O&M costs in supplying water.

The extra capital cost implied in designing a system to supply 60 lpcd from roof tanks compared with 25 lpcd from yard tanks is R800 per household. The extra O&M costs over 20 years would be R960. For this extra cost, an additional 35 lpcd is available, equivalent to over 1,500 m^3 over twenty years. The combined additional cost per m^3 is only R1.1. On the other hand, gross margins presented in Figure 5 ranged from R13 - R20 per m^3 for vegetable gardens and fruit trees (the most common use of extra water) to R1,050 - R1,700 m^3 for beer brewing and ice-block making.

Table 4. Costs of providing different types and levels of water supply, South Africa (Rands)

Service level	Rural – handpump	Rural/ peri-urban – communal standpost	Urban – yard tank (low pressure)	Urban – roof tank (medium pressure)	Urban –piped water and house connection (full pressure)
Typical consumption (lpcd)	15-25	15-25	25	60	120
Capital cost (per household)	250	3,050	3,900	4,700	5,300
O&M costs (per household / month)	4	14	20	24	38

Note: Figures compiled from 2 studies carried out for DWAF. O&M costs exclude capital repayment

Payments for water and willingness to pay

Although the debate around payment for water is high on the water policy agenda, implementation is a controversial issue in Bushbuckridge, as in much of the rest of South Africa[12]. Moreover, as controversial as it is, the debate around cost recovery and payment for water is also confused by a series of assumptions about the rural domestic water sector that are too often incorrect and contribute to an incomplete analysis of reality. Some of these are:

- People in rural areas do not pay for water, and
- Ability to pay for water is the main problem.

It cannot be assumed that in general rural inhabitants do not pay for water. Evidence from this research indicates that the opposite may well be the case. Most villages in Bushbuckridge have no formal arrangements for payment for water. However, prices paid by rural households to water vendors can be much higher than prices paid in areas where proper cost-recovery mechanisms are in place.

Direct water-vending activities were recorded in five 'worst case' villages. Prices paid are well in excess of those paid in areas with regularised household connections and unlimited access to water. They also show a large variation from village to village and from vendor to vendor within the same village. The range of prices encountered varied from R0.25 for 25 litres (R10 per m^3) in MP Stream C to R2.50 for 25 litres (R100 per m^3) in Mabharule, with prices around R0.20 to R0.50 per 25 litres (R8 to R20 per m^3) being the norm in most villages where vending activities were recorded.

In 'best-case' villages most households obtain water free of charge, which often involves making unauthorised connections to the pipes running through the village. Although in some areas households request permission to connect to the network, in most places connections are not regulated and are performed when the need arises. Households buy the materials and contract local plumbers or make the connections themselves. In Xanthia and M&B some households indicated that the cost of making a connection varies from R180 to R400, including material and labour costs.

The second assumption that needs to be revisited is that poor people cannot pay for water. Whereas low affordability is a reality for many rural households, evidence shows that it is likely that the poorest people in Bushbuckridge area are facing the highest prices for water. The R8 to R20 per m^3 paid to water vendors in the area are one order of magnitude higher than the prices per m^3 in declared townships and neighbouring towns. Moreover, some vendors do not deliver the water on site (Violetbank and Township), and people have to walk long distances to the source. Furthermore, prices for domestic water in some of the Bushbuckridge villages are well in excess of prices paid in some of the richest fully serviced households in the country. For instance, in areas such as Greater Hermanus, tariffs consist of a monthly connection fee of R40 per month and a water usage tariff (excluding VAT) starting

12 A new groundbreaking policy of free basic water and sanitation services has been recently introduced in South Africa. This means that everybody in South Africa has a right to a basic amount of water and a basic sanitation service that is affordable. With this right comes a responsibility – not to abuse the right to free basic services and to pay for services where these are provided over and above a basic amount. (see DWAF, 2002)

at the very low level of R0.30 per m^3 for the first 5 m^3 and gradually increasing in 10 steps to R10 per m^3.

Nevertheless, the issue of affordability needs to be separated from the question of whether people are willing to pay. They are two different issues and the evidence showing that poor people can, and do, pay for water should not imply that the priority for the sector should be to make poor people pay for water. The fact that rural people are paying the highest prices for water indicates that there is room for manoeuvre. In some cases, where the need for payment for water is justified, implementing a formal payment system, with tariffs reflecting local conditions and choice of level of supply, can improve the situation of the poorest (some degree of cross-subsidisation is also possible).

Conclusions, lessons and policy implications

This research has tried to contribute to bridging the information gap on productive uses for water at the household level in rural areas and to show the impacts of these activities on poverty reduction and livelihoods. It demonstrates that a full understanding of the relationship between water management and poverty reduction cannot be captured by conventional approaches to water supply systems. Domestic supply provision is premised on the assumption that the main issue is health and hygiene within the household. Conversely, discussion of productive uses of water by poor people tends to focus almost exclusively, in rural areas, on agriculture. Yet the key role of water in poverty reduction and livelihoods development for many poor people (and especially those with limited access to agricultural land) lies in opportunities for water-dependent production within the household.

The study shows the high potential benefits linked to the relatively small quantities of water that allow these productive uses to happen. An additional 17 lpcd can result in an increase of approximately 14% in current personal income in the area. This demands a basic re-think of how we view basic needs and domestic water, as well as the types of poverty-focused water programmes that are developed. A number of specific policy conclusions can be drawn from the case study.

These are:

- Rural water sector policy should not only be driven by the supply of ‘basic needs’ but also by the economic opportunities that the access to additional water can generate in rural areas. The allocation of water for these livelihood activities should be a key element of the on-going development of water service development plans and catchment management approaches, and in the development of water supply infrastructure.

- For organisations involved in the rural water sector, there is a need to shift the focus and approach in project design and implementation to include productive uses of domestic water from an early stage of the intervention. This effort to better understand demand for domestic water from a broader perspective can be the key to the achievement of sustainable projects.

- Recovering the cost of water services is necessary to ensure the financial sustainability of service providers, and therefore, their ability to continue the service provision into the future. The ability to pay, in turn, can only be enhanced by promoting income-generating activities and increasing the economic opportunities of the rural poor. Accessing water over and above the basic needs may contribute to this aim.

- Ensuring allocation of water for these water-dependent productive activities will not ensure that most households will automatically start this type of activity. Access to water is a key factor but not the only one. Difficulties in getting finance (credit) or failure to access markets can substantially reduce the options to engage in these activities or the income-stream and livelihood benefits derived from them.

- Paying attention to productive uses for domestic water may result in the need to re-assess the structure of organisations involved in the water supply and sanitation sector. The complex relationship between domestic water systems and poverty reduction will need collaborative effort between specialised agencies and sector-based organisations (for example, micro-credit institutions and traditional water supply and sanitation organisations) in order to approach projects in a more holistic manner and maximise the rate of success.

- Alternative ways of providing water for productive uses need to be explored. In some circumstances, providing this water through current domestic water systems may not be the most effective way (see experience with homestead gardens in Zimbabwe, in Lovell 2000). Some creative thinking will be needed from engineers and technical experts to provide solutions that are appropriate to the South African context.

- Finally, the provision of water for productive uses needs to be done without compromising the provision of basic needs.

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Multiple use of water, livelihoods and poverty in Colombia: a case study from the Ambichinte micro-catchment

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Summary

In Colombia, the sustainability of water supply systems is increasingly being put at risk by the ways in which water resources are managed. Although the country is rich in water resources, there is a growing scarcity of water of adequate quality, which affects drinking water supply systems. Water supply organisations are becoming more and more aware of conflicts about the use and management of the water for different purposes (domestic, productive and recreational).

The environmental authority of the Department of the Valle del Cauca (CVC) contracted Cinara to help in resolving water-use problems in a specific micro-catchment and at the same time to develop methodologies that would allow the replication of the solutions in other areas under CVC's jurisdiction. The area selected is the Ambichinte micro-catchment located on the western slopes of the Andes, in the Municipality of Dagua. This paper presents some results from the first phase – a participative appraisal of the water situation in the micro-catchment. It focuses on how water supply affects poverty and livelihood options and how these are linked to water management.

The micro-catchment is an area of in-migration and colonisation from other parts of the country and as a weekend retreat for rich people from Cali. These migration patterns have resulted in fractured and individualistic communities with little social cohesion and a wide range of wealth strata. The individualism is reflected in the high demand for private water supplies, a challenge taken up by the institutions in charge of issuing water use concessions and investing in water supply infrastructure. The result is a patchwork of overlapping systems, individual and communal, made possible by the easy availability of water. However, none of the systems delivers water of adequate quality, due to lack of treatment facilities. The economies of scale necessary to make treatment affordable are not achievable with the fragmented small-scale systems. As a reaction to the poor water quality, most of the inhabitants use alternative water sources, such as springs, bottled water and other water supply systems. This implies extra costs and especially affects the poorest. People express a strong demand to improve water supplies and generally seem willing to pay an increased tariff to cover operation and maintenance costs of better water services.

In addition to domestic household use, water is also used for productive purposes such as irrigation, poultry and pig rearing, fishing ponds and recreational activities (watering of gardens and swimming pools). These uses amount to about a fifth of all water consumption in the area and contribute directly to the economic wellbeing of more than 25% of the population. The vast majority of those that now use water for such purpose are willing to pay to maintain their access to this water, women even more than men. Improvements in water supply should therefore provide water both of adequate quality and of sufficient quantity for productive use. Various technological options exist for achieving that, but they require a more in-depth cost-benefit analysis.

Multiple-use water supply systems can contribute to the fighting of poverty by addressing both health improvement and increased production and income. The Ambichinte case is thought to be typical of the Andean environment and some of the issues involved in multiple-use systems, notably balancing water quality and quantity and the relationship with water resources management. Although multiple use is not new, little work has been done on these kinds of systems in terms of policies, design and management. Hence, the authors recommend:

- advocating the recognition of multiple use systems;
- further investigating the social and economic importance of productive water use;
- identifying and testing possible technological solutions for multiple use systems;
- strengthening community organisations responsible for the administration of multiple use water supply systems; and
- developing forms of water resources management that are more responsive to peoples' livelihood needs.

Introduction

Characteristics and challenges of the water sector in Colombia

Colombia is located in the north-west of South America and has an area of 1,138,914 km^2 and a population of 44 million. It is a middle-income country, having a GDP per capita of US$ 1,840 (DNP, 2003) and its Human Development Index is 0.772, occupying the 68th position in the world (UNDP, 2002). Despite this relatively high position, nearly 40% of the population still have an income of less than US$ 2 per day (UNDP, 2002). Another important characteristic of the country is its high degree of urbanisation, with 71% of its population living in urban areas. On the other hand, more than 80% of the 1,072 municipalities in the country have less than 12,500 inhabitants.

Colombia is well endowed with fresh water resources. On average some 57,000 m^3 per capita per year are available (FAO, 2001), which is one of the highest availabilities in the world. However, a large part of this is needed to maintain ecological functions and the areas with highest water availability are the least populated. The valleys of the Cauca and Magdalena rivers, in which 80% of the population is located, have a water availability which ranges from just sufficient to slightly below current demands (Ministerio del Medio Ambiente, 1998). About 20-25% of available sources are groundwater. In terms of water quality, surface water resources are characterised by high sediment contents and bacteriological contamination. To a certain extent this is due to natural causes, but it is increasingly aggravated by processes such as deforestation and disposal of untreated wastewater. For example, only about 7% of the wastewater that is generated is treated to some degree before being discharged to water bodies (FAO, 2001). This situation is recognised in the national water resources study, which indicates that contamination is leading to a problem of "scarcity of water of adequate quality", while the number of Municipalities experiencing absolute water scarcity in quantity terms is still small, though on the rise (IDEAM, 2000).

'Improved' drinking water supply is generally understood as reticulation systems with household connections. As such it is also defined in the so-called *Reglamento Técnico del Sector de Agua Potable y Saneamiento* (the Technical Regulation for the Water and Sanitation Sector; RAS, see also Box 1). Table 1 summarizes the coverage of different types of water supply.

Table 1. Water supply coverage in Colombia

Type of water supply	% of households
Public reticulation system	75.1
Community reticulation system	9.9
Wells	5.2
Rainwater harvesting	0.5
Water vendors	0.6
Direct abstraction from streams	7.4
Other	1.3

Source: DANE (1997)

Other statistics indicate that the average national coverage of improved water supply (i.e. reticulation systems with household connections) is about 76% (Mindesarrollo/Findeter-Univalle-Cinara, 1998). However, there is a large difference between urban and rural areas, with coverage rates of 89% and 45% respectively. Although these figures are quite high, the number of systems that deliver water that meets quality criteria is low: only 10% in the rural areas and 62% in urban areas

(Visscher, 1997). This is because most reticulation systems are fed by surface water which would need water treatment. However, only 33% of small towns and communities have water treatment facilities and they are often in a poor state. So, scarcity of water of adequate quality is directly affecting water supply and the way that water resources are managed will have an increasing impact on the sustainability of water services.

It is not only overall water resources management that affects sustainability, but also the way in which water is used and managed within the water supply systems. Conflicts over the use of drinking water for different purposes are receiving increasing attention. It is common in rural areas that people use their drinking water supply systems for different kinds of productive use, such as vegetable gardening, livestock watering or recreational and tourism development. Although the RAS (see Box 1) stipulates that economic activities of the population should be considered when designing water supply systems, this is often not the case. This neglect can lead to conflicts between communities and institutions. An example of such a situation is the La Castilla community, located half way between Cali and Ambichinte, where some the inhabitants are opposing a drinking water treatment plant the Municipal Health Secretary is building (see Sánchez Torres and Smits, forthcoming). They fear the chlorine that will be applied will damage the vegetables and herbs they grow. The Municipal Health Secretary also forbids irrigation, as it is considered a waste to use treated water for irrigation. On the other hand, there are conflicts between community members that use water for irrigation and those that don't, the latter saying the former are using too much, whilst paying the same tariff. Similar cases are common in Colombia and other Andean countries such as Bolivia (Camacho, 2002).

Box 1. Norms for improved water supply services

The Technical Regulations for the Water and Sanitation Sector (RAS) are guidelines for project planning and implementation in the sector as determined by the former Ministry of Economic Development (Ministerio de Desarrollo Económico, 2000). They set, for example, guideline water supply design norms based on the level of complexity of the systems. In general, for the rural areas, a standard of net supply of 130 lpcd with household connections is used. In the urban areas (with higher degree of complexity) the norms are slightly higher. They also stipulate that the design should consider the economic activities of the population in relation to possible water use. In general, such design norms can easily be achieved given the relatively high water resources availability. Actual gross supplies are often much higher, due to general low efficiencies. Water quality criteria are set by the former Ministry of Health (Ministerio de Salud, 1998) and are in line with those set by the World Health Organisation (WHO).

Roles and responsibilities in the water sector are well defined. Utility provision has been decentralised since the beginning of the nineties. This means that the Municipalities are responsible for guaranteeing water supply and sanitation, which may be provided directly by the Municipality, by ‘mixed’ companies (i.e. public and private), by private companies or by community-based organisations. National institutions are responsible for regulation and control functions (García Vargas, 2001). Responsibility for water resources management lies with so-called Regional Autonomous Corporations. There are 34 Corporations in the country and their administrative boundaries largely coincide with Departmental boundaries, although some of them have jurisdiction over watersheds.

Project background and approach

In the Department of the Valle del Cauca, most of the water resources problems mentioned above are increasingly affecting water supply and sanitation services. These services are in turn having an impact on the water resources of downstream users. In many cases, the low water quality supplied, leads to water-related illnesses, like diarrhoea and skin infections[1]. Dealing with this situation of water-quality induced scarcity needs new management approaches. CVC’s project is in a micro-catchment with ‘typical’ problems, such as reduced water availability in the dry season, deforestation, increasing demand, pollution from domestic wastewater disposal and little interest from the community in the environmental situation. The project is required not only to contribute to resolving the water-related problems in this area, but also to generate methodologies for intervention in other areas under CVC’s jurisdiction with similar conditions. It has contracted the Institute Cinara (Instituto de Investigación y Desarrollo en Agua Potable, Saneamiento Básico y Conservación del Recurso Hídrico) at the Universidad del Valle, to lead this process and design and develop the methodologies.

The first phase of the project was a participative appraisal of the water situation in the micro-catchment. It was realised that the appraisal should specifically address the relation between water supply and water resources management and water use within the systems. Hence, it began by trying to get to grips with water and its management in all its different forms and uses (broader water resources management, drinking water supply, water for productive and recreational uses and wastewater). Secondly, the appraisal was to learn about the people in the catchment, their livelihoods and the role of water in those livelihoods. Users’ demand for different water services and their perception of the current situation was also assessed. Integrating these elements gives a framework for planning future water resources management and water services provision with a poverty/livelihoods perspective.

1 In 1999 diarrhoeal diseases were the second death cause among children under 5 years in Colombia and diseases like cholera and typhus are still endemic in some areas (Ministerio de Salud-OPS, 2000).

Different key stakeholders in the catchment participated: male and female community members and leaders; members of the community water supply organisations; operators of the community water supply systems; local youth; and institutions (the CVC, the Municipality and a community ecological corporation). A gender and poverty-focused approach was applied, addressing men and women and different wealth categories specifically in the various activities. Data collected have been disaggregated according to gender and wealth status and also by locality. Activities included workshops and technical visits to the micro-catchment and the water and sanitation infrastructure with the stakeholders. A range of participatory techniques including social mapping, Venn diagrams, daily routine diagrams, transect walks, and key-informant interviews with a range of community and institutional stakeholders were used to characterise the water supply situation and general features of the area. In addition, a thorough review was carried out of secondary data sources, especially hydro-meteorological data for the area, and relevant literature. A survey among 101 households found out about the water supply and use at household level. A willingness to pay (WTP) survey focussed on inhabitants' willingness to pay for: i) the implementation of measures to improve water resources management; ii) improved water supply; and iii) access to water for productive and recreational uses. The same survey collected data on peoples' actual spending on water resources management, water services and other public services to cross-check and complement the WTP results. More details on the WTP study can be found in Pérez et al. (2003) and Parra (2002).

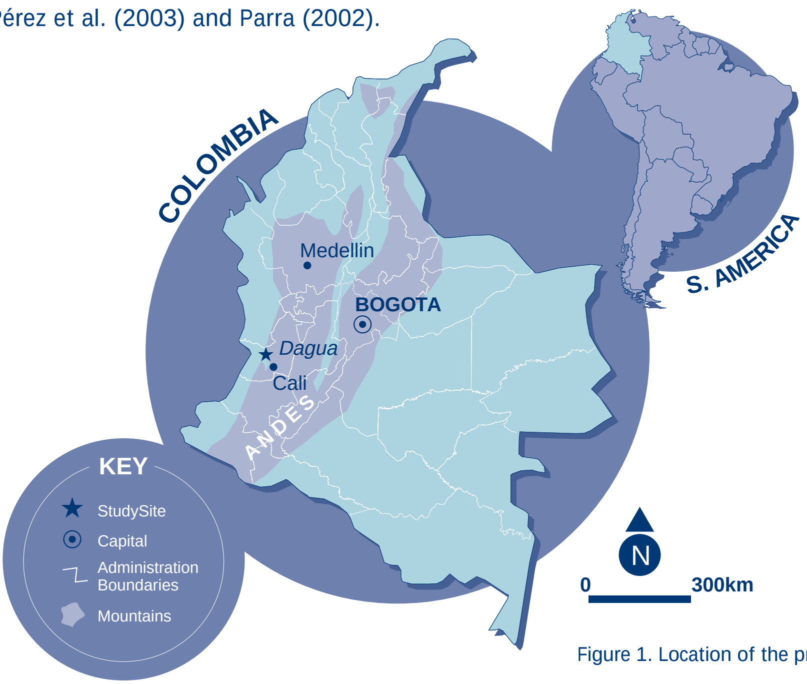

Figure 1. Location of the project area

2 For more details on other aspects of water resources management and water services in the area see Pérez et al., 2003.

This chapter discusses the outcomes of the participative appraisal, focusing mainly on the livelihood aspects of water[2]. It shows how water supply can influence poverty and livelihoods in different ways. Additionally, it discusses how water resources management is linked to that, and how that can (or cannot) enhance forms of water supply that have a livelihoods objective. The results are structured around the three major forms in which water is used and managed: water resources management; drinking water supply; and water for productive and recreational uses.
The latter two issues are focused on poverty and livelihoods.

Area description

The project area is called the Ambichinte micro-catchment, located entirely within the Municipality of Dagua, some 30 km from the city of Cali, which is the capital of the department (see Figure 1). The micro-catchment has an area of 13km^2 and is located on the western slopes of the Andes between 1,300 and 2,000 metres above sea level. In this area we find 5 communities that all belong to the same *corregimiento*[3], called Borrero Ayerbe. These communities are called Km 26, Chipre (Km 27), Km 28, Km 30 and El Vergel. These are merely localities spread out along a road and boundaries between them are sometimes difficult to establish (see Figure 2). The village of Km 30 is the main locality of the *corregimiento*. In addition, there are three *parcelaciones* (kind of rural compounds).

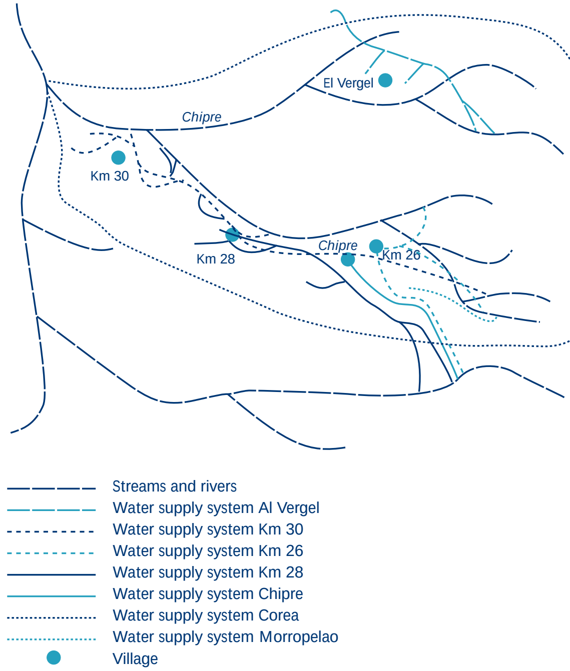

Figure 2. Map of the area with the water supply infrastructure. (Adapted from: Univalle/Cinara-CVC)

3 A *corregimiento*, best translated as bailiwick, is an administrative unit, one level below the Municipality. One *corregimiento* usually comprises various *veredas*, or neighbourhoods.

The number of houses in the area is 1,368. There are 5,600 permanent inhabitants. Km 30 is the largest community having 3,656 inhabitants. The others all have around 500, except for Chipre which only has 12 families. During weekends and holidays many people from Cali come here for recreation. Also, many inhabitants work and stay in Cali during weekdays, and come back to the area at the weekend. This leads to an estimated extra 6,000 temporary inhabitants.

Socio-economic situation

In Colombia, all households, by law, have to be stratified into socio-economic classes, ranging from 1 (poorest) to 6 (richest). Also by law, tariffs for public services and taxes are based on these strata. Utility companies, including community-managed service providers, are supposed to apply the stratification in their tariffs. Each household's stratum is determined on the basis of the conditions of the homestead and its surroundings. Determining these is difficult and hence many community-based service providers do not apply stratification in their tariffs. Another common criterion for defining poverty is by income. There is a legally established minimum salary, which at the moment of carrying out the appraisal (July 2002) amounted to the equivalent of US$ 124. Most people express their wealth status in terms of their stratum (if they know it) or in terms of a number of minimum salaries.

The area in general can be characterized as poor: 25% of the households receive less than half the minimum salary, and 50% between half and one minimum salary. Only 8% of the households earn more than 2 minimum salaries. Most houses belong to stratum 1 or 2. However, there are also many weekend houses belonging to rich people from Cali[4], all belonging to stratum 6.

The variety of wealth classes is the result of historical migration patterns. Until the 1970s, it was an area of colonisation by smallholder farmers. Social cohesion was limited, as people came from different parts of the country. From then on, the area became popular with wealthy people from Cali, including drug barons. They built individual homesteads and did not integrate in community life. This process has led to further individualisation of the communities. Community organisations are weak and do not have much legitimacy among the inhabitants. Among others, this situation has resulted in many people trying to resolve their water supply in an individual way and not via community organisations or collective solutions. This issue will be dealt with later more in detail.

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4 Due to guerrilla activities many of these houses are not visited any more and it has been difficult to contact these people in the survey and the WTP study, so this stratum is not so well represented in the socio-economic data.

Although stratum and income situation give a good idea of the poverty situation, the appraisal showed that it is important to consider whether a family has an urban or a rural livelihood strategy. The inhabitants of Km 30, the main village, have an urban orientation. Only a small percentage of its inhabitants get their main income from agriculture-related activities, and they show strong migration patterns towards Cali. The other communities are more dispersed and agriculture has a more important role. In these more rural settings, some people gain their main income from working as caretakers at the weekend houses, where they also have small vegetable gardens, animals or fish ponds. Although the entire zone is considered a rural area, in reality it is a hybrid society, with both urban and rural livelihood strategies (for some indicators see Table 2). This is an important point as it has an effect on water use and the value people give to water.

Table 2. Socio-economic characteristics of the communities

Indicator	El Vergel	Km 26	Chipre[5]	Km 28	Km 30	Average total
Number of persons per household	3.4	4.8	3.8	4.3	3.7	4.0
Average family income (US$/month)	161	84	116	125	135	131
Average area of homesteads (m^2)	1,222	155	501	959	424	585
% of persons that own their house	48.8	73.5	31.3	46.3	70.0	63.3
% of population in agriculture	10.3	24.2		10.0	4.2	3.1
% of population working as caretakers of holiday houses	28.2	15.2		32.0	6.2	14

Source: Univalle/Cinara-CVC, 2002

With respect to the gender situation, 25% of the households are headed by women. Households are generally small (average of four persons) and normally consist of husband, wife and their children. Sometimes other relatives like brothers or sisters also live in the house. Especially in Km 30, a large percentage of the men work in Cali during weekdays and come to the community only at weekends. Most women work as housewives, only a few doing remunerated work. Participation of men and women is not equal in the boards of the community water supply organisations. Of

5 As the population of Chipre is very small, data on the economic activities of its inhabitants are included in the statistics of Km 28.

the seven water supply systems, only five have a steering committee. In Km 30, the largest community, four men and three women form this committee, and women occupy the positions of president and administrator. In the other committees women occupy only a quarter of the available positions, but often have the leading positions of president or vice-president.

Results

Water resources and their management

The effective annual rainfall in the catchment is estimated[6] to be 1078 mm and the reference evaporation 882 mm (Sarmiento, 2001). There are two 'dry' and two 'wet' periods, but even the dry periods have at least an average rainfall of about 60 mm/month. In the dry months, potential evapotranspiration from the main crops such as coffee and plantain is higher than rainfall but, as these are deep rooting crops, stored soil moisture can provide part of the deficit. However, crops like vegetables and beans do experience water stress when it does not rain for some two weeks in the dry period.

Water is available in the form of small streams and springs (La Clorinda, La Clorindita, La Mina, Peña Alegría and Ambichinte) that together form the Ambichinte river. No discharge measurements exist for this river. Based on land-use types and typical run-off rates, average total surface run-off in the catchment has been estimated to be the equivalent of 260 l/s (Sarmiento, 2001). During the summer, flows reduce by about half. No data exist on groundwater and at the moment the only groundwater that is used is in the form of some springs.

In terms of water quality, there are some signs of degradation, though not to a disastrous extent. Housing development is considered the main problem affecting water quality, as this has led to deforestation and hence to increased erosion, but especially to discharge of untreated wastewater. This is mainly the case in the middle reaches. For example, the water supply system of El Vergel has one of its intakes just below a group of houses that have their septic tanks close to the stream. The sewage system of Km 30 also discharges directly into the lower part of the micro-catchment, without any treatment. Additionally, there is quite serious contamination coming from pork farms that discharge their wastewater directly into the streams without treatment.

Although flows diminish in summer, they are just sufficient for the existing demands

6 This is the best estimate, drawn from a water balance study by the CVC. However, doubts exist on the quality of the meteorological data. In the catchment there is no meteorological station and data have been used from a station nearby, but in a catchment with quite a distinct micro-climate.

for domestic use in the zone. Intakes for most of the water supply systems take all the water available in the streams, sometimes even during the wet months. On the other hand, in some cases (e.g. between the upper and middle reaches of the Ambichinte), the flow recuperates rapidly due to contributions from various small streams. At some points there are conflicts over water, e.g. where individual users take water from the stream by means of a hose, leaving the intakes dry.

The administration of water resources is the responsibility of the CVC and is carried out through a system of water use concessions. Users have to ask for a concession, which is then assigned based on metering of available flow in the streams and the determination what percentage can be abstracted. The project found that a very large number (311) of concessions have been issued of which 10% are for productive uses (small scale-irrigation, cattle watering, handicraft), and the rest for domestic use only. Probably a large percentage of those concessions are not in use any more. Additionally, there are various cases of people drawing water from the streams without a concession. No monitoring is done of whether the quantities withdrawn coincide with the licensed abstraction, nor what the impact of each abstraction is on stream flow. All this has led to some downstream users having dry intakes.

In order to have and hold a water-use concession, a monthly fee has to be paid, which, according to the CVC regulations, should depend on the size of the assigned flow and the type of use. In fact, all domestic users are charged the same fee of US$ 0.44/month, whereas the assigned and withdrawn flows differ. Nearly half of the concession owners have not paid their user fees for more than 3 months. It is not known whether the fees cover the costs of the water resources protection and management activities carried out by the CVC in the area.

Drinking water supply

The water supply infrastructure (intakes and main pipelines) for the catchment is shown in Figure 2. In a relatively small area there are seven large water supply systems serving the five communities. Next to these are two supply systems that get water from other micro-catchments and serve some areas within the Ambichinte catchment. As if this were not enough, the *parcelaciones* have their own water supply, as do many individuals. This means that there has been a huge combined investment in water supply infrastructure. As can also be seen in Figure 2, the water supply networks are like a spider's web and there are sometimes 3 or 4 pipelines running in parallel. It is apparent that relatively large investments must have been made in the past.

Only Km 30 has been able to use economies of scale to get a drinking water treatment facility and this does not function adequately. Water quality tests taken in all systems showed heavy faecal coliform contamination. Despite the investments made in water supply infrastructure, none delivers water of adequate quality.

Many people are aware of the low water quality supplied; only 25% of the population considers the quality good. In an attempt to overcome the problem, about 37% of the population use alternative sources of supply, like springs, bottled water or another water supply system. These alternative sources are then used for drinking and cooking, while the main system is used for washing, showering and productive uses. This makes it clear that water quality is the main reason for accessing alternative sources. To a limited extent, people have access to two supply systems to guarantee supply at all times.

The costs associated with having access to the various sources are high. The WTP survey showed that those that use alternative sources of water spend on average US$ 2.90 each month on them, in addition to travel time to get the water. The average tariff people pay for the main water supply system is just US$ 1.64 (Pérez et al., 2003). This shows that there is a large demand for good quality water. The demand is also expressed in the willingness to pay an additional tariff over and above the tariff paid at the moment in order to get an improved service (better water quality) from the main water supply system.

To analyse the impacts on poverty of expenditures on adequate drinking water, the results of the WTP survey have been disaggregated by wealth classes (see Table 3). As might be expected, there is a significant trend (though with very high standard deviations) that the higher wealth classes are actually spending more and are also willing to contribute more to improved water supply. Comparing the actual spending on water supply with people's capacity to pay, it is noted that those having an income of less than half a minimum salary (26% of the population) spend on average 4% of their income on the main water supply system. Taking into account that many of them also use alternative sources, their total spending on adequate water can be as high as 12% of their income. Internationally, it is recommended that spending on water supply should not exceed 3% of people's income (Bolt and Fonseca, 2001). If tariffs were to increase according to the WTP, expressed by the various wealth classes, the poorest would still spend up to 6.5% of their income on water. Those that do not use the alternative sources for drinking water pay a high price in other ways. According to the registers of the Municipal Hospital, intestinal parasites formed the fifth cause of morbidity in 2001. Medics reported that diarrhoeal diseases and skin infections are among the most common illnesses in the region.

Table 3. Actual spending and WTP on water supply for different wealth classes

Income class	Actual spending on tariff of the main water supply system (US$/month)	Actual spending on alternative sources (US$/month)	WTP for an additional tariff for improved water supply (US$/month)	Standard deviation of WTP
< 0.5 min. salary	1.31	2.71	0.71	0.59
0.5 - 1 min. salary	1.76	2.36	0.97	0.79
1 - 1.5 min. salaries	1.53	4.02	0.98	0.62
1.5 - 2 min. salaries	1.86	3.07	0.93	0.68
2 - 2.5 min. salaries	2.20	2.40	1.47	1.45
2.5 - 3 min. salaries	2.40	3.19	1.11	0.61
3 - 5 min. salaries	3.51	4.32	1.07	0.69
> 5 min. salaries	1.94	4.06	1.14	0.67

Source: Univalle/Cinara - CVC, 2002

Productive and recreational use of water

In the study area, water is commonly used for productive and recreational purposes. No separate or adapted infrastructure exists for these uses. Use is made of the drinking water supply infrastructure, so in fact these can be considered multiple-use water supply systems. The amounts involved in the different uses have been estimated at household level and are summarised in Table 4.

Table 4. Water consumption for various uses

Use	Percentage of households	Estimation of consumption (l/household/day)	Percentage of total water consumption (%)
All domestic uses (drinking, cooking, washing, sanitation, cleaning)	100%	600	80
Irrigation	25%	471	16
Watering of animals (does not incluye fishing ponds)	15%	77	1.5
Small enterprises	n.a.	n.a.	n.a.
Swimming pools	8%	262	2.8
Sub-total of productive and recreational uses[7]	n.a	150	20.3
Total water consumption		75	

Source: Univalle/Cinara-CVC, 2002

7 This is the consumption taken as an average for all households, whether they use water for productive uses or not.

It is estimated that the net per capita consumption for ‘domestic’ purposes (drinking, washing, cooking, cleaning and sanitation) is about 150 lpcd, which corresponds to 600 litres/household/day. Metering data are not available, so this estimate is based on design norms and practices in rural areas (see Box 1, earlier in this paper).

Irrigation is practised in 25% of the households. Most of this is vegetable gardening on small plots (on average 386 m^2, with more than the half of them less than 75 m^2). In a few cases, people irrigate larger terrains (about 0.6 ha) with crops such as beans; all other major crops (coffee, plantain and cassava) are rainfed. The vegetables are normally sold on the market and not used for home consumption. An important percentage of water use for irrigation comes from the watering of the large gardens of the weekend houses. This is not direct production, but water has an important economic impact here. Those with weekend retreats come to the area especially for the green environment of which nice gardens form an important component. Having water for the gardens contributes to the tourist development of the zone. On the basis of cropping patterns, cropped areas and irrigation practices, average water consumption for irrigation has been estimated at 471 litres/household/day in the dry period. Of course, the exact amount used in a household depends on crop, size of the terrain irrigated and irrigation practices.

Water is also used for watering animals in 15% of the households. There is a large diversity of animal rearing activities. There are some very large pig and poultry farms, but the majority of the families have only a few animals such as chickens, pigs or cows. In addition, there are a number of fish ponds that are at times fed by water from the water supply systems. Water consumption in households with animals averages 77 litres/household/day. Here it is interesting to note that the larger pig and poultry farms have their own drinking water treatment facilities, as the owners consider the risks of the low water quality too high for their farms.

Next to the irrigation of large gardens, water use for swimming pools is an important recreational use in the zone and contributes to its economic development. Some 8% of the houses have swimming pools. Assuming that they change the water entirely once per year, this implies a daily consumption of 137 litres for a swimming pool of 50 m^3, which is the average size. Next, there is the daily evaporation to be met. In the dry periods, this can amount to 125 litres per day for each swimming pool.
In Km 30 water is also used in small enterprises such as shops, restaurants and bakeries. The amounts used in these could not be estimated.

Considering all these activities and the number of families using water for productive and recreational uses, an estimated 20% of water consumption in the area is for productive uses, with irrigation being the most important of these, both in amounts used and in number of household engaged in it.

Due to time limitations, the income generated by water in the various uses has not been determined. This was considered difficult, especially for recreational uses, in which water contributes indirectly to the economy of the area through its contribution to the value of housing conditions and job creation and not to direct production. The WTP survey, though, can give a first indication of the value of water in productive and recreational uses. In fact, it showed that 80% of the current users are willing to pay an extra amount over and above the current tariff for water supply in order to maintain their access to productive uses. The average monthly amount people are willing to pay is US$ 0.73, but with a very high standard deviation of US$ 0.71, which shows a very heterogeneous demand. Again, a slight trend was noted that the poorest are willing to pay less than the better off. However, as only existing users were interviewed, the sample was smaller and larger standard deviations were observed. More pronounced, but still not significant, was the fact that women are willing to pay 16% more for access to productive uses than men (US$ 0.79 per month and 0.68 US$ per month respectively). A possible explanation for this is that men are migrating more than women, leaving the latter with the daily production activities. Therefore, women are probably the ones that receive more benefits from water for productive uses.

Discussion

The results clearly show that in the project area there is a marked demand for drinking water of adequate quality. People are already paying for water and are willing to continue to do so, even if this will amount to a relatively large percentage of their household budget. However, individual demand has not been translated into collective demand. The history of the villages and the migration patterns result in weak community organisations. At the same time, the way in which water resources are managed has responded to the individual demands by issuing a large number of individual concessions for domestic supply. The reasons for that are not clear. Possibly, the relatively high availability of water has contributed to it.

There seems to have been little coordination between the institution responsible for water resources management and the institutions responsible for water supply. One result is a water resources administration that is difficult to manage and control. Additionally, it has resulted in large investments in water supply infrastructure serving individuals or small groups of households, but little investment in larger collective systems. Collective systems would raise the chances of providing a better quality service (especially in terms of water quality), due to the economies of scale in water treatment. Despite the large investments, it has not been possible to provide water of adequate quality, and this has meant that individuals, especially the poor, are having to spend a high proportion of their incomes on alternative sources of good quality drinking water. At the same time, water-related diseases are still an

important cause of morbidity, aggravating poverty.
There appears to be a strong demand for water for productive and recreational uses, over and above water for domestic purposes. In those uses, water has a positive impact on peoples' livelihoods. One such impact is through direct production in vegetable gardens and livestock rearing activities, in which about 25% of the families engage. Another is the supply of water for recreational development like swimming pools and ornamental gardens. Tourism development is important for the region, as one of the main sources of employment. This importance is not however reflected in the water-use concessions issued. Only a very small percentage of these allow for productive uses.

In order to reduce poverty and enhance livelihood options through water provision, a solution needs to be found that guarantees water of adequate quality at an affordable price, while at the same time providing extra water for productive and recreational purposes. It will require a detailed analysis of different options in terms of technical, economical and environmental feasibility, including a cost-benefit analysis of providing water for productive use as well. A shortlist has been made of several options with their respective advantages and disadvantages:

- A first option could be the amalgamation of the existing systems and introduction of a collective treatment system taking advantage of economies of scale. This option though could restrict possibilities for the multiple use of water. Experiences in other communities show that people may reject treatment systems when this affects the value of the water for productive uses.

- An alternative might be a system providing water of low quality for bulk uses such as washing, cleaning and productive uses. Alternative freshwater sources such as springs could then be further exploited for drinking water provision.

- Thirdly, one can think of an amalgamated water supply system, in which part of the water is treated to drinking water standard and another part is used for purposes that do not require such high quality. This would require two parallel distribution systems, which would probably raise the costs to too high a level.

Whatever option is chosen, there is a need for changes in broader water resources management to enhance the poverty/livelihoods perspective. The system of water-use concessions could be re-oriented to promote a limited number of collective solutions which embody use of water for different purposes. This would also facilitate the monitoring and administration of water-use concessions. On the other hand, it needs to be harmonised and coordinated with local policies and organisations responsible for water service delivery like the Municipal Health Secretary and Agricultural Secretary.

Conclusions and recommendations

Generally speaking, the supply of water can contribute to fighting poverty as it can address health improvement, increased production and income and job creation. Multiple-use systems can mean multiple benefits.

The Ambichinte case is thought to be ‘typical’ for the Andean environment and to spotlight some of the key issues involved in multiple-use systems, notably the balancing between water quality and quantity and the way this is related to water resources management. Although the idea of multiple use is not new, little work has been done on these kinds of systems in terms of policies, design and management. Therefore, the following general recommendations are made:

- To advocate the recognition of multiple-use systems. It is felt that in Colombia, and probably other Andean countries, the importance of multiple use of water has not been recognised sufficiently or is even officially denied. A first step to improving peoples’ livelihoods is to recognise the real potential of multiple use.

- To investigate further the social and economic importance of productive water use. This is needed to justify (or not) investments in multiple use systems.

- To identify and test possible technological options for multiple-use systems. Though various technologies exist, there are no well-documented experiences of these systems in the Andean context.

- To strengthen community organisations responsible for the administration of multiple-use water supply systems. Managing a multiple-use system is different in several respects from managing drinking water systems. Community organisations need to be strengthened to assume new responsibilities.

- Develop forms of water resources management that are more responsive to peoples’ livelihood needs. The Ambichinte case shows that water resources administration should promote solutions that generate some economies of scale and so contribute to reducing peoples’ expenditures on water. In addition, it should allow people to have concessions for both domestic and productive demands. This means joint planning and coordination between institutions responsible for water resources management and for water use.

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Productive use of wastewater by poor urban and peri-urban farmers: Asian and African case studies in the context of the Hyderabad Declaration on Wastewater Use[1]

Liqa Raschid-Sally, Andrew Mark Bradford, and Dominic Endamana

Summary

Poor urban and peri-urban farmers around the world are increasingly using wastewater for productive purposes. Wastewater irrigation contributes to household food security and livelihoods. Often wastewater is used untreated and, in spite of health and environmental risks, it is a much sought after source of water and nutrients. Case studies from Asia (Hubli-Dharwad, India) and Africa (Yaounde, Cameroon) are discussed in this chapter, and comparisons and contrasts are made between the different scenarios of wastewater use. The degree of farmer awareness on the health and environment impacts is investigated through farmer surveys. The need to confront the realities of wastewater use, create awareness and gain the involvement of stakeholders to find sustainable solutions is highlighted. In conclusion the role of the Hyderabad Declaration on Wastewater Use in Agriculture from November 2002 is presented, along with its implications for maximising the benefits and minimising the risks of wastewater use.

Introduction

Urban poverty is on the increase in the Asian and African continents. Rural-urban migration to escape from the rural poverty trap and lack of sufficient employment opportunities for the growing populations in cities have aggravated the urban poverty scene. In South Asia, data from 1998 show that 40% of the total population live on less than US$1 per day and in Sub-Saharan Africa it is 46% (ADB, 2002; World Bank data bank). Population growth rates in cities in Africa and Asia are 5% and 4% respectively, and projections show that nearly 50% of the population in Africa and Asia will be living in cities by the year 2015. From these data we can make a global assertion that a high percentage of the urban population lives in abject poverty.

1 This paper was prepared by Liqa Raschid-Sally based upon two earlier papers presented at the International Symposium on Water, Poverty and Productive uses of Water at the Household Level, 21-23 January 2003, South Africa by Bradford et al. (2003) and Endamana et al. (2003) and the Hyderabad Declaration on Wastewater use in Agriculture, November 2002, Hyderabad, India (See Annex 1)

Food security is a major issue for the urban poor. Several surveys have found that poor urban households may spend as much as 70% of their household income on food (Ratta and Nasr, 1996). In many situations growing their own food contributes to food security for the urban poor, as well as providing a source of income (Raschid-Sally and Abayawardana, 2003). As poverty increases, urban farming for consumption within the household inevitably increases too. At the same time, crops are grown for sale to supplement incomes (Ratta and Nasr, 1996). Surveys in different urban centres have shown that the numbers of households involved in urban farming can range from 15% in Hanoi to 68% in Dar es Salaam (Raschid-Sally and Abayawardana, 2003). Not all of these households may be poor or living below the poverty line, but in many instances urban agriculture has helped people to rise and remain above the poverty line. The demand for perishable food supplies to cater for the growing demand in cities is increasing exponentially and is often met by peri-urban and urban agriculture (Cisse et al., 2000).

Poverty, lack of access to alternative water sources, and poor water quality in and around cities with inadequate sanitation infrastructure are contributing factors to the productive use of wastewater by poor urban communities for agriculture in and around cities in less developed countries. A non-exhaustive rapid survey of data available in literature (Van der Hoek, 2003) indicates that wastewater use in urban agriculture is a widespread practice in both developed and developing countries. Some of the countries shown in Table 1 use treated wastewater, but many use it untreated. A more exhaustive survey of literature is being carried out by IWMI and preliminary results show that figures well exceed these initial estimates.

Table 1. Global extents of wastewater use

Country (no. of cities referenced)	**Direct Use** (ha)	**Indirect Use** (ha)	**Total** (ha)
Argentina(1)	3,700		3,700
Australia(1)	10,000		10,000
Bahrain(1)	800		800
Chile(1)	16,000		16,000
Colombia(1)		26,000	26,000
Germany(1)	2,800		2,800
Ghana(1)		11,800	11,800
India(17)	8,084	59,467	67,551
Kenya(1)	2,000		2,000
Kuwait(1)	9,000		9,000
Mexico(31)	254,565	440,140	694,705
Morocco(1)	600		600
Pakistan(national)[1]	32,500		32,500

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Peru(6)	9,346		9,346
Saudi Arabia(1)	2,850		2,850
South Africa(4)	1,800		1,800
Sudan(1)	100	2,800	2,900
Tunisia(1)	100	4,450	4,550
USA(7)	14,675		14,675
Vietnam(national)[2]	6000-9500		6000-9500

Source: Van der Hoek (2003), [1]Ensink et a.l (2003) , [2]Raschid-Sally et al. (2003)

This chapter discusses case studies from two cities: Hubli-Dharwad in Karnataka, India; and Yaounde in Cameroon (see Figure 1), to determine the profiles of wastewater use in urban and peri-urban agriculture and to compare and contrast the patterns of productive use of this resource by the poor. We consider the importance of wastewater as a source of income and livelihood under distinctly different climatic, socio-cultural and economic conditions. The potential benefits of wastewater use in any location may not however outweigh the risks involved. We discuss farmers' perceptions of risk and look at the conditions and constraints under which such use takes place and the coping strategies adopted.
Finally, we emphasise the need to spread awareness and to confront the environmental and livelihood realities of wastewater use, and highlight the potential role of the Hyderabad Declaration (Annex 1) in moving towards this end.

Case study of Hubli Dharwad in India

Background

The twin cities of Hubli-Dharwad form the second largest urban conurbation in Karnataka State in India, with a population of 800 000 and a strong traditional practice of agriculture in and around the cities. The area is semi-arid, receiving about 740mm average rainfall with a very dry season from February to May. More than 40% of the households in the cities have sewerage and water connections. The wastewater generated flows untreated via sewers and wastewater nallas (open drains) into natural water courses. The combined wastewater and base flows amount to 60 million litres daily. In Dharwad, the main wastewater nalla flows to Madihal, once an outlying village but now incorporated as a suburb due to the expansion of the city. From Madihal, the nalla generally flows east passing the peripheries of Govankoppa, Gongadikoppa and Maradagi villages. In Hubli, the main wastewater nalla flows to Bidnal, which is also now incorporated as a suburb. From Bidnal the nalla generally flows south passing the village peripheries of Gabbur, Budarsingi and Katnur.

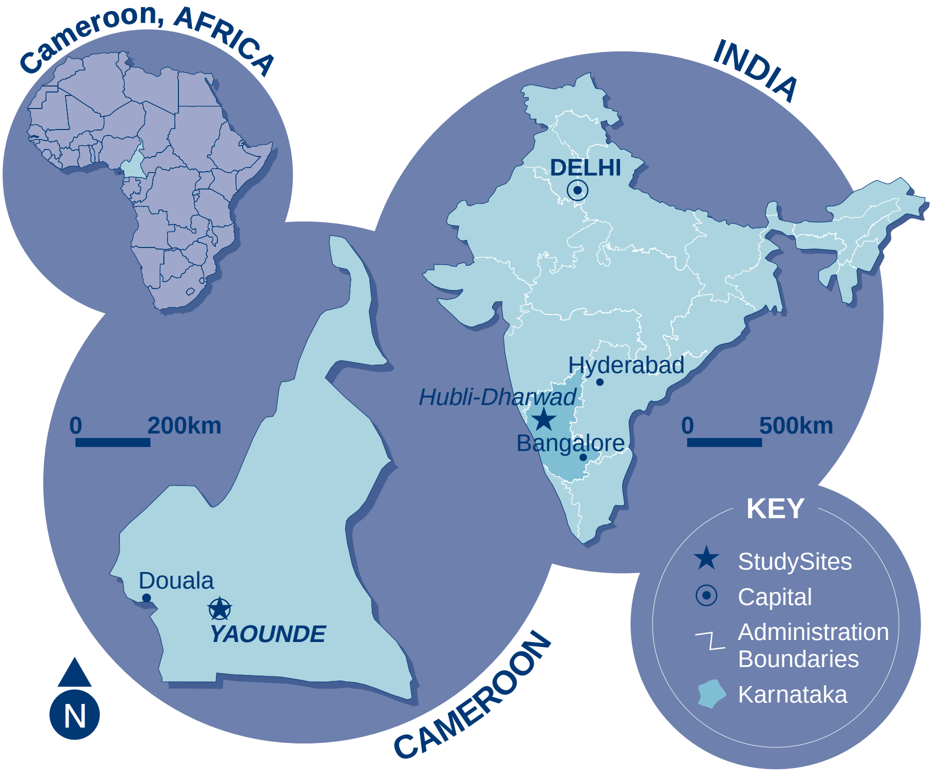

Figure 1. Location of the project area

Methodological approach

Farmer surveys were the source of information for socio-economic, health and environmental studies. A total of 25 smallholder farmers were interviewed, using tools such as semi-structured interviews, cropping calendars and on-farm transect walks. Water quality measurements were not conducted in this study.

Findings

Land-use pattern in wastewater areas: The main wastewater irrigated areas are to be found along the 2 main wastewater nallas as they flow through the suburbs of the cities. These suburbs were originally outlying villages. Smaller pockets of wastewater agriculture exist within the urban areas as well. Plot sizes vary between 1 and 2 ha (smaller for the vegetable plots and larger for the other field crops). Smallholders with plots smaller than 2 ha are considered as poor by the villagers themselves and the landless who are employed as agricultural labourers are considered very poor (Hillyer et al., 2002).

Cropping pattern and production systems: Four distinct cropping patterns were observed: vegetable production (which is highly labour-intensive) closest to cities; a mix of field crops and vegetables further away; agro-forestry still further a-field (Table 2); and a single successful fodder production system observed in the study area. The spatial variation results from a combination of factors, which include labour availability, farm size, market access, village conformity[2] and soil types. However, the overriding factor is the availability of a reliable flow of wastewater, as has also been shown by a number of studies in Asia and Africa (Beuchler et al., 2002; Keraita et al., 2002; Van der Hoek et al., 2002). With more guaranteed supplies of wastewater closer to the cities, intensive vegetable cropping takes place. Such production systems were observed predominantly at Madihal in Dharwad and Bidanal in Hubli, because of the easy access to local markets, the demand and the high prices obtained during the dry season, and because wastewater ensures a reliable irrigation source.

Table 2. Spatial variation of wastewater irrigated cropping systems

Main Nalla	Village	Distance (km)	Cropping system
Dharwad	Madihal	2.0	Vegetable production
	Govankoppa	5.4	Field crops & vegetables
	Gongadikoppa	9.2	Field crops & vegetables
	Maradagi	11.85	Field crops & vegetables
Hubli	Bidnal	2.5	Vegetable production
	Gabbur	8.9	Field crops & vegetables
	Budarsingi	10.7	Agro-forestry
	Katnur	13.5	Agro-forestry

Note: Distance is the length of the wastewater nalla from city source to village including any meander

Crop failure due to pest attacks is a major problem faced by farmers in the vegetable cropping systems. Continuous year-round cropping leaves no fallow period and this encourages the proliferation of pests. Growth of crops during the dry season means that substantial green plant mass is available at a time when land would normally be barren and arid. That allows insect populations to thrive when they should encounter a seasonal decline. The prolific multiplication of pests such as the *Plutella xylostella* (Diamondback Moth or DBM) and *Helicoverpa armigera* (Cotton Bollworm) has resulted in complete crop failures and high economic losses. Consequently, farmers in some areas have stopped growing what were once highly profitable crops, such as cabbage. Other crops like aubergine, chilli, okra, onion and

2 Many farmers will adopt farming practices that they directly observe on nearby fields and plots, which they perceive as successful and which do not pose a direct risk to their livelihood activities. As this process of 'observation' and 'replication' is their only form of agricultural information (other than contact with pesticide dealers), this results in a general village conformity in agricultural practices.

tomato are also affected but to a lesser degree. Organophosphate pesticides, which farmers are encouraged to apply by pesticide dealers, are used extensively to combat the increased incidence of pests. The situation is worsened because the climate provides opportunistic breeding conditions and a fast reproduction cycle of pests enables them to build up pesticide resistance more quickly. Studies on vegetable cropping systems in Pakistan (Van der Hoek et al., 2002) also mention the excessive use of chemicals to combat weeds.

The second type of cropping system in the study area was predominantly field crops (cotton and wheat) interspersed with vegetables. These systems have larger farm sizes (2-6 ha). As mentioned earlier, they are further downstream where wastewater flows are low, so they are essentially rain-fed and wastewater is used only to start up the season and when rainfall is erratic. This is a distinct advantage, as these wastewater-irrigated crops can be harvested earlier and fetch a better price (Bradford et al., 2003). During the wet season, the choice of vegetables being cultivated is influenced by household needs, whereas in the dry season it is dominated by market demand and prices. Problems with weed and pesticide infestations, similar to those described earlier, prevail in these cropping systems.

The third type of cropping system observed was agro-forestry. In India, wastewater irrigated agro-forestry is a recognised strategy to dispose of urban wastewater through the rehabilitation and greening of wastelands (Das and Kaul, 1992). Farmers are involved in agro-forestry for the income it provides and for the added benefit that it requires little labour and reduced irrigation requirements. The predominant types are either the tree-predominant orchard system or agro-silviculture (spatially mixed perennial crop combinations). A variety of mixed crops and fruit trees are grown in different combinations (Bradford et al., 2003). Pest and weed problems were similarly evident in these systems. Farmers attributed the spread of weeds to seeds transported in the wastewater, but this has not been confirmed.

One example of a fodder grass system involving conjunctive use of wastewater and borehole water was found on the Dharwad wastewater nalla. Napier grass is grown throughout the year on a 0.4 ha plot to feed 8 dairy cows and two bullocks, which receive some rice-based supplementary feed as well. The farmer signalled a two-fold increase in milk production from 3-4 litres/day to 8 litres/day. The fodder grass system is also common in the Mu Si river basin in Hyderabad in Andhra Pradesh, where around 40 000 ha are under wastewater irrigation. The grass variety is para grass, and well water is sometimes used conjunctively. Here, a chain of beneficiaries is directly or indirectly dependant on this for a livelihood (Buechler et al., 2002).

An additional problem reported by farmers in these production systems was the early dropping of fruit from trees and the softening of fruit while still growing. Farmers identified wastewater irrigation as the causal factor for both of these problems. Indeed, a similar problem has been reported with apples irrigated with wastewater, which resulted in 'detrimental effects on fruit quality by decreasing flesh firmness and increasing incidence of core flush' (Meheriuk and Neilsen, 1991).

Irrigation practices and water quality: Regardless of the crops grown, the irrigation method employed is overland flow and furrow irrigation using diesel or electrical pumps. The pump represents a major capital investment for the farmer. The water may be lifted as much as 500m, showing the value of the water to the farmer. The furrows are fed in a controlled manner to avoid water-logging and inundation. Further downstream, where flows are low, check dams are built to ensure sufficient water depth for pumping. During the dry season, water scarcity becomes an issue and vegetable crops are irrigated every two days, while tree crops are irrigated every ten days. One farmer had constructed a storage tank to ensure sufficient irrigation supply at times of low flow and to reduce sediment loads. Farmers also use some form of filtering device (gauze filters, pierced plastic barriers, sieve baskets, etc.) to avoid clogging of pumps and deterioration of soils from debris. The only other water sources are shallow wells and these are used for drinking purposes only.

Health and environmental issues: Health impacts have been documented by other studies in different parts of the world (Cifuentes et al., 1994; Blumenthal et al., 2002; Van der Hoek et al., 2002), but the evidence cannot be generalised given the varying climatic, cultural and social contexts in which wastewater-use practices prevail. This study did not attempt such measurements but documented visible and verbal evidence of impacts from on-farm and off-farm practices.

Debris and contaminants carried by wastewater, particularly hospital and industrial wastes were seen to pose a risk to the users. Farmers are aware of these hazards and have devised mechanisms to minimise the risk, like the use of filters described above. Contrary to expectations, the use of ridge and furrow irrigation rather than flood irrigation does not necessarily reduce the risk of crop contamination or reduce farmer exposure to wastewater. Farmers stand in the flowing wastewater in the furrow rather than damaging the ridges during transplanting and weeding operations, thus increasing their contact and exposure to untreated wastewater. Indeed, in a study carried out by Hunshal and Sindhe (1997) on the effects of wastewater on the health of 40 farmers from Madihal and Gabbur villages, anaemia was identified as "the commonest finding and was related to nutritional deficiency and to worm infestation". Although this study was not conclusive, due to the small sample size and the lack of a control, it did highlight some of the health implications of wastewater irrigation. Furthermore, in terms of reducing risk of crop exposure through this method, the results of an exploratory crop test at the University of Agricultural Sciences, Dharwad, showed that crop samples taken from a ridge were still bacterially contaminated by the wastewater flowing in the furrow (Alagawadi, 2001; Bradford, 2002). It has even been suggested that boring pests in wastewater fields would increase the risk of pathogen entry into vegetables (Alagawadi, 2001).

Overuse of pesticides in wastewater irrigated areas is both a human health risk and an ecosystem problem. In India, after the1984 Bhopal disaster, farmers are well aware of the immediate toxic nature of organophosphate pesticides. On the other hand, there is less general awareness of the accumulative effect of organophosphate pesticide poisoning, which often manifests itself in the gradual failure of the immune system, making it less detectable for health workers and epidemiologists. In a recent study in north Karnataka, it was found that 20% of drinking water supplies were contaminated with Endosulphan (Cratchley et al. 2002), a pesticide that is also commonly used in wastewater-irrigated vegetable production.

Gender issues associated with wastewater use: No studies to date have shown that gender discrimination is used to limit women's access to wastewater for crop cultivation. It was observed in farming families in India and Pakistan that family members including women are used particularly for vegetable cultivation with wastewater (Van der Hoek et al., 2002; Buechler et al., 2002). Low-cost labour in the form of women is popular with wastewater farmers, as a means of controlling weed spread. By the nature of these activities, women were at higher health risk from pathogen attack, and were a key link in the chain of transmission to family members.

Livelihood risk reduction strategies: Farmers adopt a 'quick returns' livelihood strategy which from their own perspective is 'income safe.' Such strategies may result in health risks to themselves and to others associated with the production, sale and consumption of the produce. Changing cropping systems and adopting agro-forestry, which is safer from a health viewpoint, is perceived as a high-risk strategy by many poor farmers dependent on agriculture for their livelihoods. Most of the farmers who have adopted this practice are those who can afford to test change without serious losses in earning. Diversification is however occurring with some farmers who have observed others' successes with agro-forestry and are willing to try. Empowering farmers through education and training would have a beneficial impact on the sustainability of wastewater use.

Case study of Yaounde, Cameroon

Background

Yaounde is the capital of Cameroon, with a moist tropical climate and abundant rainfall (1500-2000mm annually). There are four seasons: long dry season (November - March): rainy season (March - June), short dry season (July - August) and long rainy season (September - November). The population is estimated at 1.5 million inhabitants (DSCN, 2001). Only 34% of the households have individual tap connections for domestic water, and 47% use communal water points. Yaounde does not have a municipal sewer system. Urban wastewater from affluent households (24% have flush toilets and septic tanks) is discharged via septic tanks and sink holes. The rest have pit latrines for faecal matter but other household water is discharged into the open drainage networks. Wastewater draining from all sources finally flows into the inland valleys, where wastewater agriculture takes place. Urban agriculture is practised around densely settled shanty towns whereas the peri-urban sites are located on the edge of the city.

Methodological approach

The study was conducted in three urban and two peri-urban sites in Yaounde. These were located in the five inland valleys being drained by the Abiergue, Ake, and Olezoa (urban sites were located here); and Gonlo and Mfoundi (peri-urban site locations). Socio-economic parameters were assessed through a questionnaire survey using a sample of 84 farmers from the five inland valleys. A farmer perception survey was carried out at the same time with the same sample group. Water quality was assessed by taking three samples from each site during the long dry season to estimate the worst conditions. Basic physico-chemical parameters, biochemical oxygen demand (BOD), microbiological parameters (faecal coliform, faecal streptococci) and parasites (helminth eggs and protozoa cysts) were measured using standardised methods.

Findings

Land use pattern in wastewater areas: The main wastewater agricultural sites are in the lowland area of the inland valleys of Yaounde where all the wastewater drains. Sites are found in the centre of the city as well as in densely populated shanty areas. The average area cultivated was 0.13 ha per farmer similar to the result reported by Endamana et al. (2001). The riverine areas and floodplains are technically state-owned according to Cameroon land legislation, but in some areas of the south of Cameroon customary tenure rights are also recognised (Diaw, 1997). The most frequent mode of tenure rights was through squatting (30%). Squatting occurs in particular on plots of land belonging to public institutions (e.g. National Institute of Agricultural Research in the lowlands of Nkolbisson; the University campus at Ngoa-Ekele and the land near the Presidency of the Republic at Oliga). The other modes of tenure for wastewater land were: inheritance of customary tenure rights (20%); borrowing land from customary tenure holder (18%); renting from tenure holder (18%); and share cropping and buying, which were much less frequently cited (4%). The average distance between plot and habitat was 200 m.

Cropping pattern and production systems: Vegetable cultivation and horticulture were the main production systems. The most frequently grown vegetables were the indigenous leafy vegetables. Other vegetables like salad, leeks and lady's finger, were grown by only a few farmers (less than 20% of the sample) as these have a more limited market and are generally subject to parasitic attacks. In the rainy season, salads become commercially more viable because of a shift in leafy vegetable production.

An estimated 96% of the farmers were producing for commercial purposes (both vegetables and flowers) and only 4% for exclusive family consumption. But even the commercial farmers consumed a portion of their own produce. Family consumption amounted to 18% of the total production from these systems.

The mean net annual income from horticulture and vegetable production systems was estimated at 116,444 FCFA (equivalent to 178 Euros) and the per capita income was 53,825 FCFA (equivalent to 83 Euros). These figures are per capita household earnings from agricultural activities alone. In total, 22% of the farmers indicated other sources of revenue, implying that earnings from urban agriculture alone are insufficient for these households.

Irrigation practices and water quality: Hand watering of vegetables is the typical practice, using two 10 to 15 litre watering cans carried in either hand. The water is often sprayed on the surface of the vegetables, increasing the risk of contamination. For farmers however, exposure to pathogens through standing for long hours in wastewater furrows is reduced by this practice. Watering is the most labour-demanding task facing the farmers and during the dry season crops are watered daily. Average water volume used for watering crops depends on the surface area of the plot, the capacity of the soil to retain water and the type of plant. Most farmers use 1-3 m^3 of water per week and use exclusively family labour to apply it. Use of mechanical means (motorised or manual irrigation pumps) for lifting the water was not reported.

The quality of irrigation water depends on the topography of the site. Water from water courses running through the lowland valley, which almost all the farmers use at some time, is the most polluted, as it carries the sewage flows from the city. About 20% of the farmers dig shallow wells to avoid carrying water over long distances and, as seen in Figure 2, well water quality is closer to the WHO microbiological standards for wastewater irrigation than surface water courses - indicating that there is a reduction in health risk through shallow well water use.

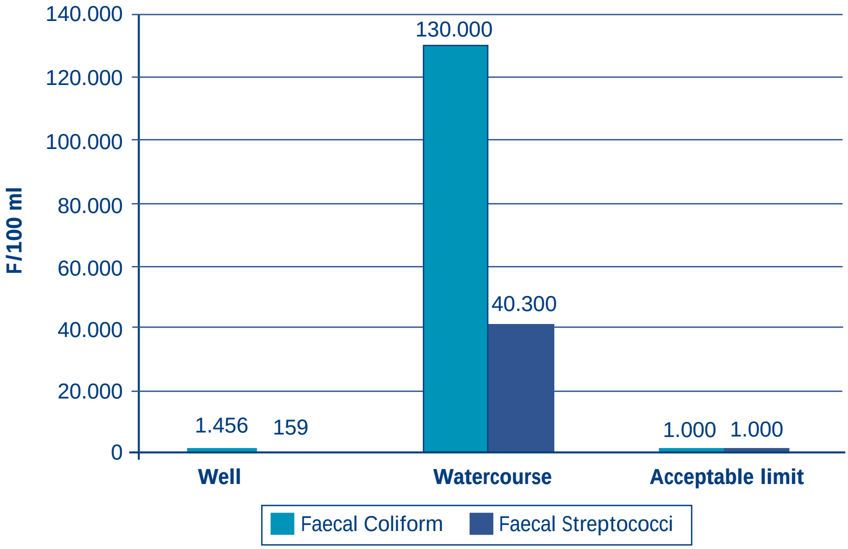

Figure 2. Comparison of faecal coliforms & faecal streptococci (ufc/100 ml) from well and water course in a densely populated inland valley. (Sources: Ngnikam, 2002, and present study).

Around 40% of farmers said they used inland valley water because of its abundance and proximity, 14% used it instead of treated piped water because it was free, while 20% of the farmers perceived it as a source of nutrients for the crops.

Health and environmental issues: An estimated 46% of farmers perceived that they had experienced some health problems in the last 12 months that they associated with their agricultural exploitation of lowland areas and exposure to wastewater. Of the 39 farmers perceiving a related health problem (Table 3), 59% cited malaria, 23% skin irritations, 18% skin ulcers, 10% bilharzias and 8% typhoid fever. Among those reporting work-related health problems, the average health cost was estimated to be €62 per year. Added to this cost was an average of 11 working days lost per year. These are high opportunity costs, given the earning capacity of poor farmers. Comparatively, the average cost of health care in Yaounde is € 83 per individual annually (DSCN, 2002).

Table 3. Health problems perceived by farmers indicating an association between illness and their agricultural work in the urban and peri-urban lowlands (n= 39).

Diseases contracted by farmers in lowland of Yaounde	**Less inhabited** (%)	**Densely inhabited** (%)	**All** (%)	**F-test** (p)
Malaria	67	52	59	0.379
Rashes/Itching	44	5	23	0.003
Diarrhoea	6	0	3	0.286

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Skin ulcers	17	19	18	0.852
Typhoid fever	17	0	8	0.053
Back aches	11	48	31	0.013
Respiratory problem	0	10	5	0.188
Bilharzias	0	19	1	0.052
Other health problems	6	14	1	0.384

Whilst Malaria incidence is high, it is less clear whether this can be associated with wastewater exposure, given the high prevalence of malaria in Cameroon. The results of previous studies conducted in south and central Punjab, Pakistan, by IWMI (unpublished data) have shown a significant contribution of wastewater treatment ponds in the generation of vectors of human diseases, including both major malaria vectors, *An. stephensi* and *An. culicifacies*. Others were *Cx. quinquefasciatus* (vector of Bancroftian filariasis and West Nile virus), *Cx. pipiens* (West Nile virus), *Cx. tritaeniorhynchus* (Japanese encephalitis and West Nile virus) and *Cx. Pseudovishnui*; but evidence is as yet inconclusive on the links between the presence of the vector and incidence of malaria in wastewater irrigated areas.

Exposure to organochlorine pesticides and carbamates used extensively in pest control is another source of concern, but this study did not explore the details of such exposure in wastewater farmers.

A further source of contamination of vegetables (not directly associated with wastewater agriculture but closely influenced by it) is the use of polluted water for washing vegetables ready for market. The lack of clean water sources is the main reason for this practice.

Gender issues associated with wastewater use: The study did not explicitly explore the gender issues related to wastewater use. However, vegetable cultivation is known to be labour intensive, particularly the weeding stage, and it is usual for women to participate in this activity, exposing them to risks even though they may not be in the farming business themselves. Their involvement in food preparation subsequently at the household level may put the other family members not directly exposed to wastewater at risk as well, if good hygiene practices are not adopted.

Livelihood risk reduction strategies: This aspect was not covered in the Yaounde study.

Comparing and contrasting the wastewater use

Looking at the two case studies, some interesting similarities and differences can be identified:

- Both cases highlighted the importance of wastewater agriculture as a food source for the farmer household and as a source of income.

- Water quality in both cases did not generally meet the WHO guidelines for wastewater irrigation (1989), although levels of contamination were much reduced through the use of shallow wells in Yaounde.

- High rates of pesticides use was observed in both cities. The Hubli-Dharwad study clearly showed that high use of pesticides was due to the continuous cropping throughout the year that wastewater irrigation allowed. In such systems, the lack of a fallow period allows pests to proliferate.

- The irrigation practices in Yaounde (hand watering) increased the risk of crop contamination, but decreased farmer exposure to wastewater. In Hubli-Dharwad, the opposite was the case where furrow irrigation reduced (but did not eliminate) crop contamination while increasing farmer exposure through standing in furrows containing wastewater during long hours of weeding.

- Family labour was used in both cases to minimise on costs, particularly in the vegetable cropping systems which are labour intensive. Similarly, women were a cheaper source of labour than men when paid labour was required. Since intensive labour was required during the weeding seasons, the women were particularly exposed to health risks during these periods.

- Both case studies deal with informal irrigation systems, though in the case of India farmers appear more organised. Farmers in Hubli-Dharwad invested in motor pumps to irrigate their fields, which constitute a high investment cost to the farmer. The Yaounde farmers did not make high investments on the land they cultivated.

- In Yaounde farmers had no secure ownership of the land and various modes of land tenure were observed. None of these mechanisms would normally encourage farmers to invest in improving the land or water resource used for irrigation. In Hubli-Dharwad though tenure issues were not studied per se, it appears that most farmers interviewed were owners of their plots. This might account for some of the investments made by the farmers, like the purchase of pumps and the construction of storage tanks for wastewater.

Maximising benefits and minimising risks of wastewater agriculture

From the two case studies the livelihood implications are evident. In Hubli-Dharwad, the importance of wastewater as a source of water for different production systems has led farmers to diversify into different cropping systems. In Yaounde, the mean net annual income from market garden production systems was estimated at 116,444 FCFA (equivalent to 178 Euros) per farmer. Other studies have also reported significant returns from irrigated agriculture utilising wastewater:

- In Kumasi, Ghana, one study reported that urban farmers earn (net) about US$ 700-1000 per year (Keraita et al., 2002) while another study (Cornish and Lawrence, 2001) in the same city reported that average family income generated from informally irrigated (mostly wastewater) agriculture was US$ 153, with the best performers achieving almost US$ 360.
- Urban farmers in Dhaka, Bangladesh, indicated that they earned US$ 447 per harvest or US$ 2234 annually (Faruqui et al., 2002).
- In Hyderabad, India, the earnings per hectare from a variety of crops grown with wastewater (para grass, leafy vegetables) ranged from US$ 830/ha/yr to US$ 2800 /ha/yr (Beuchler et al., 2002), and provided livelihoods to a chain of 48 000 beneficiaries.
- In Nairobi, Kenya, where irrigated production continues through the whole year, average annual family income generated from informal irrigated agriculture was US$ 279 (Cornish and Lawrence, 2001).

In addition to supporting incomes, wastewater use in urban and peri-urban agriculture makes an important contribution to urban food security. As we have seen, intensive vegetable cropping systems that provide perishable foods often depend upon wastewater irrigation. The water and nutrient values were recognised in both of the cases studied. Putting wastewater to productive use has become an inextricable part of the urban fabric in most cities, and its policy implications are extensive.

However, despite these attractive benefits of wastewater use in urban and peri-urban agriculture, there are serious associated health risks for farmers and consumers. Efforts to minimise the health risks remain weak in most developing country cities. In this regard, the situation in Hubli-Dharwad highlights the failures of political policies rather than bad farming practices. Diverse actors mould the wastewater irrigated farming systems that are located in the peri-urban areas, illustrating the contested political nature of urban and peri-urban agriculture. Firstly, the Hubli-Dharwad Municipal Corporation fails in its legal requirement to treat the discharged wastewater and is unlikely to implement such a programme in the near future on the grounds of cost. Wastewater treatment plants would certainly mitigate the public health and environmental risks that are associated with the wastewater nallas. However, even when the Karnataka State Pollution Control Board attempted to bring charges against the Municipal Corporation for its obligational failures, the National Government intervened and the charges were later thrown out (Bradford et al., 2003). As Cratchley et al. (2002) highlighted, the "environmental legislation is very good, however implementation is never easy and seems to be compromised". Indeed, it is compromised to such a degree that, when it suits, political decisions can override national environmental legislation.

Conclusions

In spite of its benefits, the potential risks of wastewater use are significant and they have to be addressed if pragmatic and sustainable solutions are to be sought. The outright banning of wastewater irrigation would be both unpractical and infeasible. In addition, for urban and peri-urban farmers, the poverty implications of such a measure would be vast. It is in this policy environment that the Hyderabad Declaration (Annex 1) was articulated. The rationale behind its adoption, well illustrated by the two case studies presented here, was that:

- Wastewater is a resource of increasing global importance.
- Wastewater contributes to sustaining livelihoods, food security and environmental quality.
- Without proper management, wastewater use poses serious health and environmental risks.

The Declaration embodies these principles and suggests approaches towards sustainable solutions (see also Drechsel et al., 2002):

- Where affordable, application of cost-effective appropriate treatment and guidelines are recommended (in better-off countries).
- Until treatment is feasible (in most less developed countries) develop and apply guidelines that minimise risks while simultaneously accounting for the livelihoods generating capacity of wastewater.
- Apply appropriate irrigation, agricultural, post-harvest, waste management and public health practices that reduce/limit risks to users and consumers.
- Involve stakeholders in education and awareness programme to disseminate these measures (farmers, vendors, consumers, local authorities, urban planners, health workers).
- Coordinated approaches are necessary that are embodied in appropriate guidelines that link health, agriculture and environmental quality and which, in combination, achieve an acceptable level of risk.

Such coordination can only be achieved through breaking sectoral boundaries and addressing the real demands of wastewater users. Experts from all disciplines, urban planners, health experts, environment experts, wastewater, agriculture, and water specialists, and economists will have to move towards concerted thinking to effect the necessary policy changes.

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Annex 1: Hyderabad Declaration

The Hyderabad Declaration on Wastewater Use in Agriculture 14 November 2002, Hyderabad, India

1. Rapid urbanisation places immense pressure on the world's fragile and dwindling fresh water resources and over-burdened sanitation systems, leading to environmental degradation. We as water, health, environment, agriculture, and aquaculture researchers and practitioners from 27 international and national institutions, representing experiences in wastewater management from 18 countries, recognise that:

1.1 Wastewater (raw, diluted or treated) is a resource of increasing global importance, particularly in urban and peri-urban agriculture

1.2 With proper management, wastewater use contributes significantly to sustaining livelihoods, food security and the quality of the environment

1.3 Without proper management, wastewater use poses serious risks to human health and the environment.

2. We declare that in order to enhance the positive outcomes while minimising the risks of wastewater use, there exist feasible and sound measures that need to be applied. These measures include:

2.1 Cost-effective and appropriate treatment suited to the end use of wastewater, supplemented by guidelines and their application

2.2 Where wastewater is insufficiently treated, until treatment becomes feasible:

(a) Development and application of guidelines for untreated wastewater use that safeguard livelihoods, public health and the environment

(b) Application of appropriate irrigation, agricultural, post-harvest, and public health practices that limit risks to farming communities, vendors, and consumers

(c) Education and awareness programs for all stakeholders, including the public at large, to disseminate these measures

2.3 Health, agriculture and environmental quality guidelines that are linked and implemented in a step-wise approach

2.4 Reduction of toxic contaminants in wastewater, at source and by improved management.

3. We also declare that:

3.1 Knowledge needs should be addressed through research to support the measures outlined above

3.2 Institutional coordination and integration together with increased financial allocations are required.

4. Therefore, we strongly urge policy-makers and authorities in the fields of water, agriculture, aquaculture, health, environment and urban planning, as well as donors and the private sector to:

Safeguard and strengthen livelihoods and food security, mitigate health and environmental risks and conserve water resources by confronting the realities of wastewater use in agriculture through the adoption of appropriate policies and the commitment of financial resources for policy implementation.

Background to The Hyderabad Declaration on Wastewater Use in Agriculture

The use of urban wastewater in agriculture is a centuries old practice that is receiving renewed attention with the increasing scarcity of fresh water resources in many arid and semi-arid regions. Driven by rapid urbanisation and growing wastewater volumes, wastewater is widely used as a low-cost alternative to conventional irrigation water; it supports livelihoods and generates considerable value in urban and peri-urban agriculture despite the health and environmental risks associated with this practice. Though pervasive, this practice is largely unregulated in low-income countries, and the costs and benefits are poorly understood.

The Hyderabad Declaration on Wastewater Use in Agriculture is a result of a workshop entitled ‘Wastewater Use in Irrigated Agriculture: Confronting the Livelihood and Environmental Realities’ held 11-14 November 2002 in Hyderabad, India and sponsored by the International Water Management Institute (IWMI, based in Colombo, Sri Lanka) and the International Development Research Centre (IDRC, based in Ottawa, Canada). The workshop had the following objectives:

- To critically review experiences worldwide in the use of wastewater for agriculture
- To present lessons learned from specific field-based case studies, including the environmental and health impacts and risks of wastewater use in agriculture
- To refine a methodology developed and applied by IWMI for selected countries

that seeks to assess the global extent of wastewater use in agriculture

- To evaluate the institutional arrangements, constraints, and policy implications for sustained livelihoods based on wastewater use in agriculture
- To build a wastewater ‘community of practice’ integrating a variety of research, implementation and policy institutions and partners.

In the 14 November 2002 plenary session of the workshop, The Hyderabad *Declaration on Wastewater Use in Agriculture* was adopted and signed by 47 professionals attending the workshop.

Multiple use of irrigation water in Northeastern Morocco

Eline Boelee and Hammou Laamrani

Summary

The semi-arid North-East of Morocco is one of the many parts of the country where water for domestic purposes is stored in subterranean tanks. Originally designed for the storage of rainwater, the tanks are now often filled with water from irrigation canals. A study was conducted in the region of Zaio to describe the role of these reservoirs in the daily lives of rural people.

In the study area, rainfall was highly irregular and insufficient, while groundwater was either very deep or saline. People who could afford the transport cost, collected high quality water for drinking from the municipal water supply system in Zaio town or went to the one well or one of the few springs in the area. Most inhabitants however depended on the irrigation system to provide them with all the water they need. Individual households and communities stored this water in the small (5-400m^3) tanks, locally known as *Jboub*. The tanks were filled by diverting canal water or by collecting it from the nearest canal in tanker trucks. A full tank could provide a household with water for periods ranging from one week to more than two months. The water was used for different domestic purposes including drinking, usually after simple treatment, as well as for productive activities such as watering livestock, small-scale brick making and tree nurseries.

The paper demonstrates how the multiple uses of stored irrigation water enhanced the benefits of irrigation water for domestic and productive purposes. As such, the *Jboub* contributed to improving rural livelihoods beyond the normally understood advantages of irrigation. These benefits reached people in the nearby rain-fed areas as well, albeit to a lesser extent. The paper concludes with recommendations on how the multiple use of irrigation water and storage in *Jboub* could be further developed.

Introduction

In many irrigation systems around the world, water from the canals is used for many other purposes in addition to agriculture (Ault, 1981; Yoder, 1983; van der Hoek et al., 1999). In the absence of good groundwater resources, surface water such as irrigation canal water plays a crucial role in fulfilling basic human needs for water in the semi arid rural areas of Morocco. This includes water for drinking and cooking, but also for other domestic purposes such as bathing, laundry, washing of household utensils and cleaning. In these dry regions, people have traditionally used covered subterranean or underground tanks to store rain or surface water for domestic purposes. Traditionally these tanks were designed as communal structures for the collection and storage of rainwater. In the areas where large-scale modern irrigation systems have been constructed in the last decades, parallel drinking water supply systems were often not planned. But, as the irrigation water turned out to be a much more reliable source of water than the irregular rain, the local population adapted the traditional tanks to the modern canal system. In most of the arid Haouz plain in Central Morocco, the groundwater is very deep and water storage tanks, in this area known as *metfia*, are filled with irrigation water and used for domestic purposes (Laamrani et al., 2000). In the more traditional areas the tanks were communal, while in the re-settlement areas, where new and dispersed settlements prevailed, most tanks were individual (Pascon, 1977; Boelee et al., 1999).

A similar study on water storage tanks was undertaken in a comparable but wealthier region in Northeastern Morocco to determine whether the tanks play a different role here. In the semi-arid Zaio region, rainfall is unreliable, and groundwater is deep and highly saline. Hardly any surface water resources are available other than irrigation water from the large-scale modern irrigation system that is the main origin of the stored water in the tanks. These water storage facilities, locally known as *Jboub* (singular *Joub*), are very common in the region, across the irrigated area and in the nearby areas without irrigation (Ambroggi, 1996). The stored water is used with or without treatment for various domestic purposes, such as laundry, bathing, drinking and cooking. It is also used for productive purposes, such as watering livestock and brick making. In this chapter, we demonstrate that storage of irrigation water in *Jboub* increased the benefits of the irrigation system, even for people living outside the irrigated area.

Study area

Morocco is located in North-West Africa, bordered by the Atlantic Ocean and the Mediterranean Sea (Figure 1). In the semi-arid and arid climate of Morocco, irrigation is vital for agriculture. Since the 1960s, 13 large dams, each of more than 150 mm^3 storage capacity, have been constructed for irrigation, of which eight also serve for municipal water supplies (Anonymous, 1990). However, development of rural water supplies has received little attention compared with urban water supplies. In 1990, only 14% of the people living in rural areas of Morocco had access to safe drinking water, i.e. a functioning public water supply within 100 m of the house. In the same year, only 23% of the population were reported to have private wells. Almost two thirds of the population depended for their household needs on other supplies, including rainwater collection and storage of surface water (Moudden, 1993; Benazzou 1994). In areas with deep and inaccessible or highly saline groundwater, even fewer people had access to safe drinking water within a reasonable distance. The insufficient quality and quantity of water was among the major causes of mortality of children below four in rural Morocco (Zerrari, 1993).

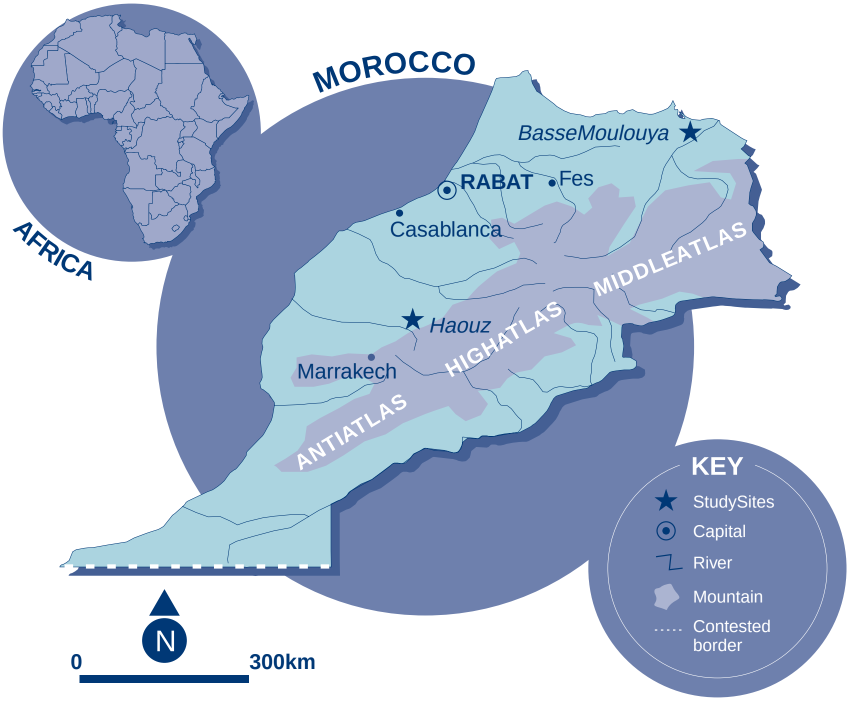

Figure 1. Major dams and large and medium-sized traditional and modern irrigation system in Morocco (after Anonymous 1990).

The present study was carried out in the region of Zaio, in the downstream (Basse) part of the Moulouya river basin. The full basin covers 335,000 ha in the provinces of Nador and Berkane in the Northeast of Morocco (Anonymous 1996 and Figure 2). The area is bordered in the north by the Mediterranean Sea, in the south by the Beni Znassen mountains, in the west by the Rif mountains and in the east by Algeria. The study covered the Zaio area, which includes the Zebra irrigation system and the nearby non-irrigated area of Hassi Berkane.

The region of Zaio has a semi-arid Mediterranean climate with an average annual rainfall of 350 mm and a mean annual temperature of 18.2 °C. The main income-generating activities of the rural population in the province of Nador are agriculture and animal husbandry. Sheep and goats are by far the most important livestock, though dairy and poultry farming is practised as well, especially in the irrigated areas.

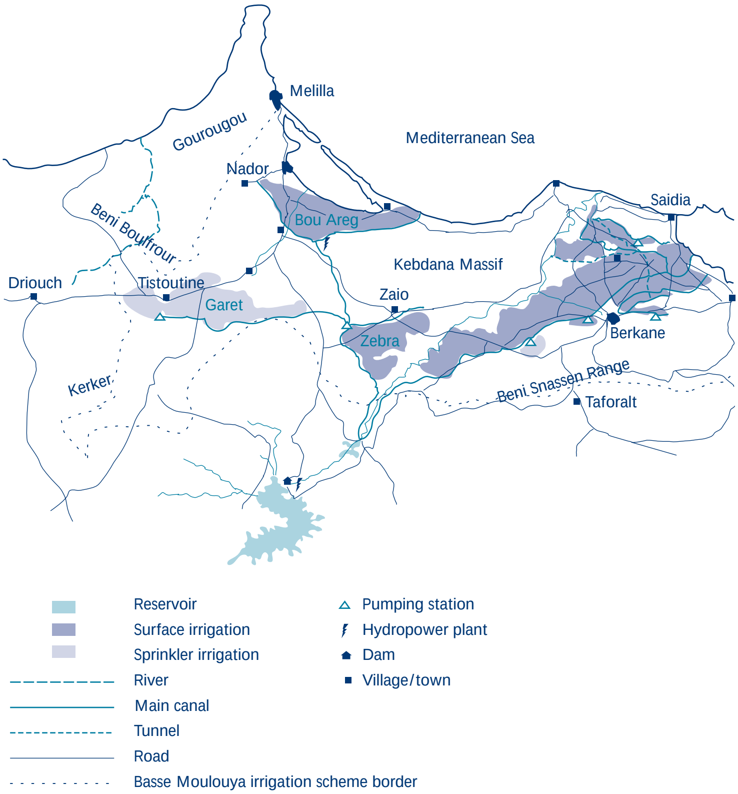

Figure 2. The Basse Moulouya irrigation system in North-Eastern Morocco (after Anonymous 1996).

Major irrigated crops in the area are barley, wheat, citrus, olives, fodder crops, grapes, sugar beet, and vegetables (Anonymous, 1996). While the dams and the irrigation scheme have increased the quantity of water available for agriculture, the ultimate source of water is irregular rainfall and there is not always enough water to irrigate all crops. In dry years, individual farmers may adapt their crop choice and priorities are also defined at the system level. After municipal water supply (see section on sources of water), the first priority is the survival of tree crops, followed by fodder (El Kassimi et al., 1998). Other field crops come last. As in most irrigation systems in Morocco, the balance between water resources and water demand is considered very fragile here (Alloaouzi & Bouaam, 1994). The Moulouya River, with an annual average runoff of 800mm^3, constitutes the major source of water to the larger Basse Moulouya irrigation scheme. The discharge is regulated by two large reservoirs and by a pumping station for recycling of return flows. Irrigation, hydropower, domestic water supply and industry all depend highly on surface water, though an increasing number of private agro-wells pump groundwater for agricultural use where this is possible.

The Zebra irrigation system is a sub-system of the larger Basse Moulouya irrigation scheme and is supplied by gravity. This means that, for the entire Zebra system, no pumps are used to get the water to the fields. The water is delivered in rotation through a system of lined elevated canals, which are all laid to a slope to get the water to the crops. Individual farmers usually receive water for their crops every 2-4 weeks, depending on the season and on water availability in the main dam. The farmers are billed annually for the water that they have actually received. The government Irrigation Agency informs them when to expect 'their' irrigation and at which canal outlet. As a consequence of these water distribution practices, water flows almost continuously in the main canals, while the smaller lower order canals convey water in turns.

Methodology

In November 2000 and June-August 2001 field surveys were carried out in the Zaio area. The first study had a more descriptive and qualitative character, while during the second study quantitative information was also gathered. This chapter is a synthesis of results from both studies.

In November 2000, informal interviews were held with farmers and other stakeholders, such as water sellers, using a semi-structured questionnaire with open-ended questions. A total of 45 randomly selected households were visited in villages in the Zaio region, both in the Zebra irrigation system and in Hassi Berkane, where there is no irrigation. Of the 45 visited households, 39 had water storage tanks. Five of the interviewed farmers were women, representative of the low number of women who own farms in the area. The questionnaire focused on storage of irrigation water for domestic purposes. People were asked: the reasons and purpose of the storage; the costs of the water itself, of its transport, storage and treatment; the various uses; treatment techniques; duration of storage; problems; and suggestions (if any) to improve water quality and availability. The questionnaire was discussed with several family members, allowing female relatives of male farmers to contribute. Some of the respondents were concise, whereas others took the opportunity to ask the team questions in return, about water pricing, water delivery and other problems such as the volume released at their fields. The participation of a local representative from the government Irrigation Agency in the field team often inspired a two-way discussion on larger water issues, leading to an open and fruitful dialogue. Because of the positive attitude of the irrigation official, most farmers felt they got satisfying answers to their specific questions related to water allocation. In addition, meetings were held in the towns of Berkane and Zaio with irrigation authorities at local and regional level, with the president and six members of the Zaio communal council, with staff at the Zaio health centre and with the local environmental hygiene officer.

In the period June - August 2001, more in-depth interviews were carried out, complemented by observations. Interviews were conducted with managers of the irrigation system at central and local level, with irrigating farmers, with spring users, with water users in 137 households randomly selected over the different sectors of the Zaio region, with farmers practising intensive husbandry (cattle and poultry), and with the owners of a traditional and a modern brick factory, an olive oil factory and a tree nursery. Team members made daily observations during four days at three different water collection sites for water sellers to estimate the quantity of water pumped out of the canal and the number of cisterns filled from the canal daily. This was compared with water distribution records from the Irrigation Agency.

Sources of water

For the population living next to the river, the irregular flow was still an important source of water. These people took water from the river for different purposes, including irrigation and domestic uses. In the Zaio area, three springs were very important sources of drinking water, although the water was less suitable for cooking and bathing because of its hardness. In Hassi Berkane, one deep well provided good quality drinking water, and Zaio town had a water treatment plant and a piped water supply system. In the peri-urban area around the town, small quantities were collected from the taps, for drinking water only. People living within a 5 to 10 km distance from one of these relatively good quality water sources, fetched water from the springs, the well or the taps by donkey, mule cart, tractor or even using scooters and cars. However, many farmers mentioned that they do not always have the means of transport or funds available to collect drinking water in this manner. Water for domestic purposes other than drinking was usually taken from the irrigation system and used directly or brought to the *Jboub*. High water-consuming activities such as laundry and washing utensils, seeds or wool were performed at the canal site whenever possible, as this was more convenient.

The two large storage dams in the Moulouya River are the most important and reliable sources of water in Basse Moulouya. From there, a network of main and smaller canals delivers water to fields and people throughout the region. The canal network as a whole stores a lot of water, because of the design and operation of the irrigation system. Water in the Basse Moulouya irrigation scheme is officially also allocated to other uses than irrigated agriculture. Figure 3 shows the amounts of water that were actually distributed for irrigation and other purposes in 2000. In the Zebra irrigation system on the left bank, some 600,000 - 1,000,000 m^3/month was allocated to the municipal water treatment plant of Nador city and less than 100,000 m^3/month went to the water supply system of Zaio town (ONEP 1996). Because of the continuous requirements of these municipalities, the main canals convey water permanently and thus constitute a very reliable source of water.

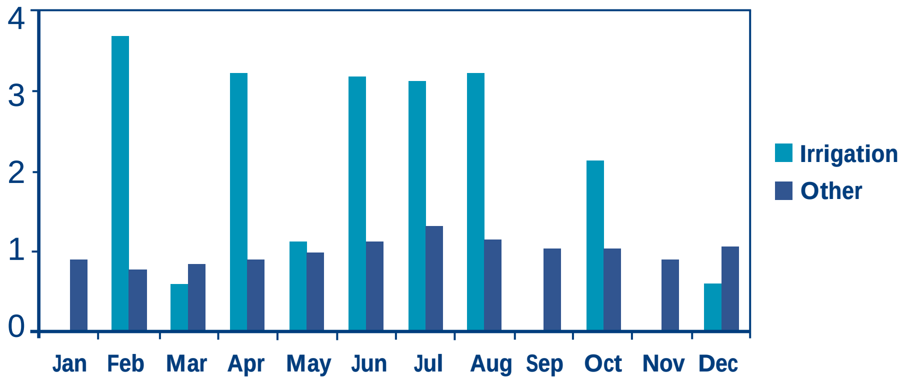

Figure 3. Actual monthly water distribution for irrigation and for other purposes in Zebra irrigation system in 2000 (large consumers only, individual water sellers are excluded) (Unpublished data, Zaio Irrigation Agency).

In addition, special water allocations were provided to a sugar factory and six modern brick factories for the same (subsidized) price as irrigation water (Figure 4). The year 2000 was somewhat unusual as this was a dry year with a relatively large amount of water for other uses than irrigation. In periods of drought, certain crops do not receive any water for irrigation, while the releases for municipal water supply and industry continue as usual. In 2000, only 14% of crop water requirements could be satisfied in the whole of Basse Moulouya (Zizi 2001).

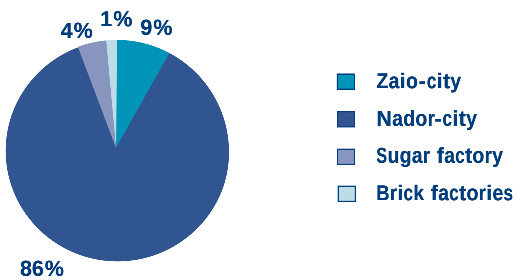

Figure 4. Total annual water distribution for other purposes in Zebra irrigation system in 2000 (excluding individual water sellers) (Unpublished data, Zaio Irrigation Agency).

Water storage structures: *Jboub*

This study revealed that storage was the main strategy in the region to address the issue of multiple unreliable sources of water. While vast quantities of water were stored in the large dams and main canals, the population stored smaller volumes in their *Jboub*.

Characteristics of storage tanks

The *Jboub* in the Zaio region are water storage tanks with a long tradition. The oldest participant in this survey recalled that they were commonly used well before the Spanish colonial period – i.e. before 1912. In addition to these structures for domestic use, small impoundments called *Majn* store rain water for watering livestock. Most of the old *Jboub* were constructed before the modern irrigation system (Figure 5). These could be easily recognised by their design and construction material, usually stones and mud mixed with straw, while the recent ones were made of cement (Figure 6). The *Jboub* were of very diverse shapes: triangular, rectangular, and circular, with horizontal, dome-shaped and semi-circular domed roofs. They also showed a great variability in dimensions and hence in storage capacity (Figure 7), with a minimum of 5 m^3 and the largest capacity of 400 m^3 observed in this study. Most of the *Jboub* were partly or entirely subterranean (Figure 8). Some tanks were placed on top of the house though, to prevent access of children. For these elevated *Jboub*, motor pumps were used to fill them and networks of pipelines delivered the water to the household tap.

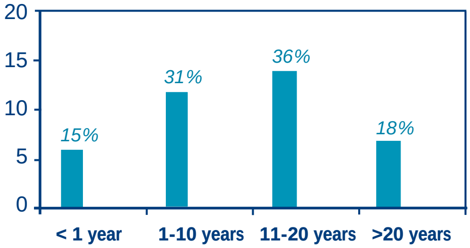

Figure 5. Age of *Jboub* in Zaio (n=39)

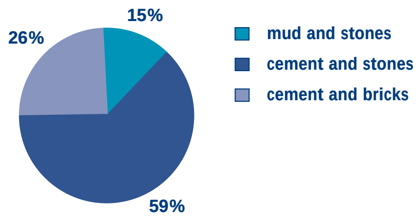

Figure 6. Material used to build *Jboub* (n = 39)

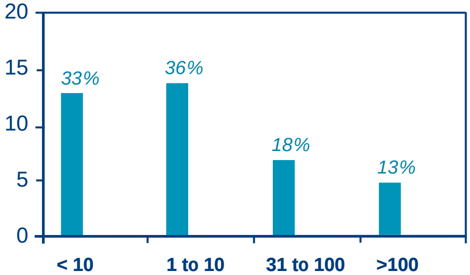

Figure 7. Capacity of *Jboub* in m^3 (n = 39).

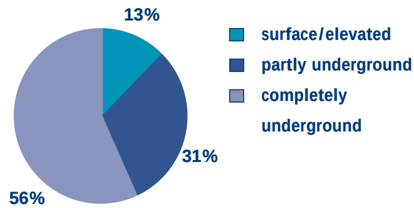

Figure 8. Types of *Jboub* found in Zebra and Hassi Berkane (n = 39).

Filling of storage tanks

Most of the *Jboub* (87%) were filled with canal water, some in combination with river water (5%) and rain (8%). The other tanks were filled by rain, a well, a spring or the river only. The ones that were filled with rainwater only were all located outside the irrigated area. The exact water source and the means of transport varied between the seasons, as both rainfall and canal water flows change over time and space. The *Jboub* in the irrigated area could be filled during the irrigation turns, with farmers using part of their private crop water allocation to fill their *Jboub*. Though this was common practice, farmers saw it as a problem to use their limited irrigation water allocation in a water-stressed area for drinking and other domestic uses. If the period between irrigation turns was too long, sometimes over a month, the farmers could also ask the Irrigation Agency to provide extra water for their *Jboub*. The farmers paid for this water at the normal irrigation fee rate of 0.023 US$/$m^3$. In those cases, the water was usually conveyed from the irrigation canal via field canals and from there via private canals, sometimes cement lined, to the *Jboub* in the village.

Outside the irrigation season and between turns, water was taken from the nearest primary canal, which has a permanent flow, but may be more than 10 km away. This meant that the water had to be taken out of the canals using buckets or pumps and transported to the *Jboub*, either by the farmers themselves or by commercial water sellers. Since 1974, in order to regulate the withdrawal of water for other purposes than irrigation and to increase cost recovery, special permits are issued by the Irrigation Agency for water collection from canals for livestock and domestic purposes. Officially this water can only be used for agricultural purposes and the local health authorities have to give formal approval before the permit can be issued, stating that the water is not suitable for drinking. Thus they cannot be held responsible for the quality. The permit is personal and specifies the maximum amount of water this person can collect from the irrigation system, as well as time and place of water collection, usually between 7:00 and 13:00 hours and downstream of the municipal water supply intake. In practice, this was not always followed. People without permits also collected water and the ones with permits often collected more tanks per day than stipulated, on more days of the year.

In 2000, 49 farmers were authorised to fill tanks from canals, but, according to the Irrigation Agency, only 13 actually paid the fees for the water. In reality more than 100 individuals collected water for their tanks regularly, on average twice monthly. Numerous people collected more water than their own household needs and sold the water to others at a profit. Approximately 30 managed to make a living from this, selling some 5 trucks of water a day depending on the demand. Together these water sellers would use their engine or a separate pump to lift 200,000 to 250,000 cubic meters of water out of the canals for the Zaio region annually. While the cost of irrigation water is US$ 0.1 for a 4 m^3 tank, it was sold for US$ 3 at a distance of 1-2 km from the canal. With distance, the market value increased and the price of one tank of water could go up to US$ 20 in places more than 10 km away from the canal. In times of drought, the price could rise further and even double.

Most *Jboub* were filled once to twice a month (Figure 9), depending on water availability and actual use. If the stored water was used for irrigation of tree crops or watering of animals (cattle husbandry and poultry), water consumption was high and the tank had to be filled more frequently. According to the users, if the water was used for domestic purposes only, the water in one tank would be sufficient for more than one month in summer and for longer in winter. In drought periods, as in

1999-2000, people and livestock depend entirely on water in the *Jboub*, so the tanks get emptied more frequently and the duration of storage is shortened. With increased transport cost per tank, the price of water may become prohibitive for productive uses and people will reduce their water use, especially in the areas outside the irrigation scheme.

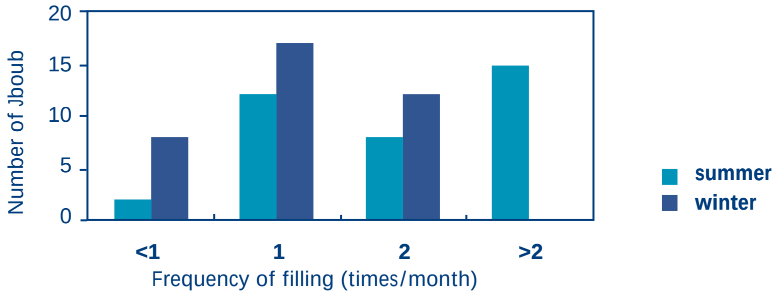

Figure 9. Monthly frequency of filling the *Jboub* in winter and summer (n = 37, excluding the rain-fed ones)

The older generation of farmers appeared to be quite satisfied with the *Jboub* as a traditional way of water storage. Three old men pointed out that the provision of water is not a real problem, as people are prepared to "travel to town twice a week to look after the television battery, while filling the *Jboub* costs the same and only has to be done once a month". Younger farmers were more critical and accused the authorities of segregated development: "When the irrigation system was constructed in an area with deep groundwater of high salinity without any prior thinking about drinking water supply, they expected that every farmer would build his own tank to store irrigation water for drinking and other domestic use. So that is what we did and that is what we will probably be doing for many years!" They would have liked separate good quality drinking water, preferably house connections. About half of the respondents (54%) were unhappy about the quantity of water available for storage in *Jboub*, and many of them (41%) thought water quality a problem too. For a fifth of the respondents (19%), the cost of water was the main problem that limited the use of canal water for *Jboub*.

Water use from storage tanks

The random sample of households visited in the second survey (n = 137) showed that the majority (85%) of *Jboub* are individual and 15% are used by two or more households. The common ones were mainly the old *Jboub* built before the irrigation system was implemented. These were usually located outside the irrigated area, but filled with canal water. Some schools and mosques also had their own tanks, which were constructed, maintained and filled by the community.
Water allocation and water use were influenced by the availability of water in the irrigation canal and in the *Jboub*. Once stored in the tank, *Jboub* water was considered very precious and intra-household competition often took place. Usually

the senior woman in the house determined the value of each water-using activity, decided what got priority and rationed the water accordingly. Water for human consumption was usually kept in separate containers, especially when it was collected from other sources such as taps in Zaio town. The water from *Jboub* was then used for other activities. This included domestic purposes such as cooking, bathing, washing clothes, utensils and seeds, but also ablutions before prayer and drinking.

The most important productive use of *Jboub* water was the watering of livestock, for which canal water was the almost exclusive source. This was reflected in the large number of cattle in the irrigated area, whereas smaller animals such as goats and donkeys dominated in the rain-fed area. Some farmers in the Zebra irrigation system used their water allocation entirely for dairy or poultry farms, a highly profitable alternative to growing irrigated crops, which was not envisaged in the planning of the irrigation system. As a result, farmers in the irrigated areas had higher income from their livestock, sometimes in addition to benefiting from higher value crops. The irrigation water stored in the tanks was also used for commercial tree nurseries and construction. The latter mainly encompassed small-scale brick making, which allowed farmer families to improve their homes without high investments.

According to the respondents, an average family of 10 members in the rain-fed area of Hassi Berkane (household sizes range from 6 to 30 in this survey) would consume 4 cubic meters in two months in winter. This represents a daily average consumption of 6-7 lpcd and is well below the desirable level set by the World Health Organisation of 30 lpcd. In the Zebra irrigation scheme, water from the canal provided more than half of the household needs, so we estimate the daily consumption to be at least twice that of Hassi Berkane. This means it was probably still below 15 lpcd.

Water quality

People in the Zaio region were very conscious of the quality of water from different sources, as was demonstrated by the extra effort they took to collect drinking water from taps, springs or a well. Flowing surface water in canals was perceived as the second best water source in terms of quality. Though this water has also been stored (at the large dam), it was considered of better quality than water stored in the *Jboub,* which is believed to deteriorate with prolonged storage. Nevertheless, water from *Jboub* was also used in mosques for ablutions, which reflects the perception of people that even stored irrigation water is “purifying and clean”. Even so, many *Jboub* owners (41%) considered water quality a problem. For some of them this was a reason not to use it for drinking, while others treated the stored water, or at least the quantity used for drinking.

Treatment of stored water

The most common way of 'treatment' was prevention of pollution. In periods of drought when water is sometimes not released into the canals for periods of more than one month, the dry canals get very polluted with dust and solid wastes. Farmers then prefer to transport water from continuously flowing main canals rather than using their precious *Jboub* to 'clean out' the irrigation system and bring highly polluted water to the village. Before they were filled, most *Jboub* (64%) were flushed out to clean them and to remove mud. The users considered this measure necessary to keep the tank in good condition and to maintain water quality. Farmers who filled their *Jboub* from a small canal or from rain often used filters to prevent floating material from entering the tank. To reduce the frequency of cleaning, some farmers built a small sand trap that allows the sedimentation of small particles before water is conveyed for storage in the *Jboub*. If the *Jboub* were filled with water from trucks, the users requested that this water should be pumped from the canal early in the morning, to minimise the effects of upstream pollution.

At two-thirds (64%) of the visited *Jboub*, the water was treated, mostly with commercial chlorine, though occasionally crushed limestone was used. Since the water was often used for several purposes, some users preferred to only treat the amount of water that was used for consumption, instead of treating all stored water in the *Jboub*. Some of the households used a cloth filter before water was used for drinking or cooking. Most of the *Jboub* users were aware that water should be treated, but expressed a strong need for information about the correct treatment dosage for drinking and cooking. Occasionally seasonal workers employed by the Ministry of Health to treat wells would come by and provide chlorine and limestone to *Jboub* users. Except for these rare occasions, the treatment was often over-dosed. Usually a litre of commercial chlorine was used to treat the entire tank regardless of its volume, which often resulted in concentrations much higher than the required 50 ml/m^3. Crushed limestone was hardly ever measured at all, leading to concentrations far higher than the desirable 5 g/m^3 (Ministère de la Santé 1990).

Options for improvement of storage

Many respondents had suggestions on how to improve the *Jboub*, either by rehabilitating the structure or by advanced water treatment (Table 1). They were interested in upgrading the structure and improving water quality through appropriate technologies such as sand filtration, home treatment or an adapted design, preferably with technical assistance (51%). The Irrigation Agency provides technical and sometimes even financial support to improve existing *Jboub*, but this is usually restricted to community structures. Several users pointed out that rehabilitation of *Jboub* would be useful only if water was delivered to the reservoirs more regularly, making it a much more reliable source. Others emphasised that since the water is also used for other purposes such as laundry, home treatment of drinking water only would be sufficient. They insisted on the need for information and training of the villagers in water treatment. In the rain-fed area of Hassi Berkane many farmers suggested that digging wells would be a durable solution but they recognised that this would be extremely expensive because of the deep groundwater table (Table 1).

Table 1. Suggestions for improvement of water storage, as formulated by 37 users of *Jboub* filled with irrigation water

Suggestions	**Percentage respondents**
Upgrading of tank	38%
Upgrading and more regular water deliveries	14%
More regular water deliveries	5%
Dig wells	14%
Water treatment	11%
None	19%

All respondents who had suggestions for improvement were willing to contribute to the cost of upgrading the *Jboub*, be it in labour, material or financially (Figure 10). While a third of these confirmed their absolute willingness to pay, most of the others only wanted to contribute under certain conditions. Many of these can be summarised as durable interventions that would indeed improve water quality. Five farmers mentioned affordability and three stated that they would pay if no recurrent investments were required. One farmer mentioned that he was willing to pay if the water treatment facility would be 'like the one I saw in southern France where the farmers use solar panels to decontaminate water for drinking'. The elected members of the community council were keen to be involved in upgrading of the existing *Jboub*, but proposed that small-scale treatment facilities for irrigation water would be more sustainable, though extremely expensive.

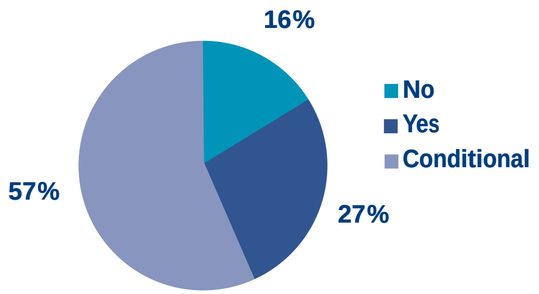

Figure 10. Willingness of users to contribute to the improvement of water storage in *Jboub* (n = 37)

Discussion and conclusions

In the study area of Zaio, with unsuitable or inaccessible groundwater, people depend on surface water for domestic purposes. The storage of canal water in *Jboub* allows for extended use of the water outside the irrigated area and at times when there is no flow in the irrigation canals. The Irrigation Agency, aware of the lack of alternative water sources in the region, facilitates and supports the multi-purpose use of irrigation water. As a result, total water use in the entire semi-arid Zaio region is higher than in comparable areas in Morocco without irrigation development. Farmers have been able to keep more livestock or poultry and develop other productive water-consuming activities, in the rain-fed Hassi Berkane area as well as in the Zebra irrigation system.

The situation in Zaio is comparable to the one in the Haouz plain in Central Morocco, where water storage tanks are filled with irrigation water and used for domestic purposes as well (Laamrani et al,. 2000). But several differences can be observed. In Zaio the *Jboub* are mostly individually owned and used, while in Haouz, most reservoirs are communal (Boelee et al., 1999). The high proportion of privately owned tanks in Zaio can partly be explained by the sparse habitation, but is probably mainly caused by the better economic situation in this region. People living in the Zebra irrigated area in particular seem to be able to afford fancy storage tanks and as much water as they need, even at high transport cost. This is comparable with other irrigated areas in Morocco (Benjelloun et al. 2002). Related to this is the more striking difference that farmers in Central Morocco raised water availability as the major problem faced by the users, while in the present study in Zaio, many more users brought up water quality as the major issue. This is probably related to wealth as well.

The use of irrigation water as a major source by most of the rural habitants in Zaio, and the users' concerns about water quality, raise questions on integrated water resources development. While large-scale agricultural development projects have been implemented and an extended network of canals has been built, domestic water supply has lagged behind. The government Drinking Water Agency is normally responsible for urban supply only, and dispersed habitations require very high investments. The Irrigation Agency has no mandate for drinking water and cannot provide the necessary quality guarantees, while the Ministry of Health plays only a minor role in guarding water quality. As a result, the region is faced with an inter-sectoral gap regarding rural domestic water supply. Farmers and water sellers, as well as local authorities, Irrigation Agency and Ministry of Health are all aware that *Jboub* storage is not necessarily what water is officially delivered for, but have so far not managed to develop a joint solution.

The reliance on water sellers, only partly controlled by the Irrigation Agency, mainly accommodates relatively wealthy farmers and people living close to the main canals. Poorer families further away are unable to pay the commercial rates of water transport. They resort to bad quality water or reduce their water-consuming activities. Most water-saving alternatives are also less profitable, such as keeping goats instead of cattle. Especially in periods of drought, between irrigation seasons as well as in dry years, the prices for water transport become unaffordable for inhabitants of rain-fed Hassi Berkane, while those in Zebra irrigation system can still find water nearby. Consequently, the development gap between those with and without irrigation increases.

Increased water allocations from the irrigation canal system for the *Jboub*, especially outside the main irrigation season, would make more water available for domestic and productive purposes. Higher water availability for domestic purposes, especially hygiene, is very important in the reduction of diarrhoeal diseases (Esrey 1996, van der Hoek et al. 2002). Since water consumption per capita is very low in the study area, increased water use would be of great benefit to human health.

Innovative solutions are required and should be investigated. Improvement of *Jboub*, based on the felt needs of the community, would increase the availability of good quality water for domestic purposes and have a beneficial effect on the health of the rural population. It would only be sustainable however, if the initial investment can be subsidised, recurrent cost and maintenance are feasible and the measures would lead to a substantial improvement in water quality (van der Hoek et al. 2001). If a more reliable water allocation to *Jboub* could be established, farmers and local community councils would be prepared to invest in improvements of the *Jboub*. Some government agencies are also willing to contribute to improvement of the storage and treatment facilities. When the water is stored for shorter periods, the quality will probably be better too. If the water could be conveyed from the canals to the *Jboub* by pipelines, much pollution would be prevented. Small but significant improvements in water quality could be achieved by educating the users on appropriate treatment techniques for the stored water. With such measures, alleviation of water scarcity and an increased availability of better quality water for productive and domestic use could contribute to better health and improvement of rural livelihoods, thereby reducing the gap between irrigated and rain-fed areas.

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Livelihoods in conflict: disputes over water for household-level productive uses in Tarata, Bolivia

Rocio Bustamante, John Butterworth, Mariska Flierman, Daniel Herbas, Marieke den Hollander, Sjoerd van der Meer, Paul Ravenstijn, Magaly Reynaga & German Zurita

Summary

In Tarata (Cochabamba, Bolivia), disputes came to a head in 2002 over the rights to use water from a multi-purpose water supply system (Laka Laka) for urban agriculture. The Laka Laka dam was planned to provide water for a large irrigation scheme and to meet the basic needs of domestic users in the town, but not specifically for productive water uses in the urban area. When the water utility started to supply water in and around the town for cultivation around homesteads, there were violent conflicts with farmers from the irrigation scheme who were determined to protect their water rights.

Almost 5% of the estimated reservoir yield (or 10% of the storage capacity) was originally allocated for urban water supply, but this could not be used for drinking water supply due to the poor water quality and high costs of treatment. The water utility organised to utilise this water instead for irrigation of *'huertas'* (small plots close to homesteads), on the basis of advice they received from local government supporting their proposals. An organisation was formed to develop the project and infrastructure to supply this water to *huertas*.

This chapter reports the findings of a case study to investigate the nature and causes of the conflict. It addresses the multiple uses of water and sources for domestic supply, urban agriculture and field-scale irrigation, and the potentially complex legislation, institutional arrangements, rights and expectations associated with these different water uses.

The conflict in Tarata

In late 2002, Tarata was the scene of violent confrontations between *regantes* (irrigators) from Arbieto and inhabitants of the nearby town of Tarata (Tarateños). Both groups damaged infrastructure associated with the Laka Laka multi-purpose project: a dam and associated pipelines, canals and treatment facilities to supply domestic water to Tarata and irrigation water to Arbieto.
A direct factor in the escalation of the conflict was the construction of a new pipeline by the water supply utility *Servicio de Agua Potable y Alcantarillado Tarata*

(SEAPA-Tarata), and the *Asociación Agropecuaria Tarata* (AGROTAR), to convey water from the dam to irrigate *huertas* (homestead gardens) in the town. In order to supply water to irrigate these gardens, SEAPA-Tarata reclaimed its share of water from the Laka Laka dam, an allocation that it had not used for the previous four years. This decision resulted in intense discussions between the *regantes* and the Tarateños over the regulations governing allocation of water from the dam. When the Prefectura de Cochabamba (the departmental government) failed to live up to perceived promises, the *regantes* decided to take matters into their own hands. This led to two cycles of violent confrontations with the Tarateños.

At the end of September 2002, the *regantes* hit the streets, protesting that compromises reached with the authorities were not being implemented. Shortly afterwards in October, the *regantes* decided to destroy the pipeline of SEAPA-Tarata and AGROTAR that ran from the water treatment plant at the dam to the *huertas* in Tarata. However, by mistake, the *regantes* actually destroyed the domestic water supply pipeline that runs between the water treatment plant and storage tanks. The mistake was made because, unknown to the *regantes*, the system of pipelines from the water treatment plant had recently been modified.

In an article in the newspaper *Opinión* on 6 November 2002 the municipal authorities of Tarata declared that the *regantes* had destroyed approximately 2 km of drinking water pipes to the town of Tarata, and that the inhabitants had thus been left without drinking water. In reaction, the Tarateños destroyed a part of the primary irrigation channel. However, the original vandalism did not actually severely affect the main domestic water supply. As we will see later, this supply comes from groundwater and not the dam.

The conflict escalated again in December 2002 after, according to the *regantes*, the *Prefectura* did not keep its promises to remove the pipeline constructed by SEAPA-Tarata and AGROTAR for irrigation of the *huertas*. The *regantes* again took away part of the piping for drinking water supply, making the same mistake as in October. This was probably because they thought that the *Alcaldía de Tarata* (the municipal authorities) had not told the truth about them having damaged the wrong pipes so as to mobilise the inhabitants of Tarata. This led to further confrontations between the *regantes* and the *Tarateños*, and the threat of reprisals (*Los Tiempos*, 28 Dec 2003).

The resulting damage to the water supply system led, the next day, to the blockading of roads by both the *regantes* and the *Tarateños*. Police managed to prevent the violence escalating. The *regantes* protested to protect their water rights, to express their disaffection with the actions of the *Prefecto* (head of the *Prefectura*), and to demand the freedom of the seven *regantes* who were imprisoned after their perceived participation in the original acts of vandalism (*Los Tiempos*, 29 Dec 2003).

Background

Tarata is located 35 km from the city of Cochabamba in central Bolivia. Lying at the edge of the Andes, the area falls within the upper part of the Amazon basin. The dam and catchment area are located in the municipality of Tarata, which is in the province of Esteban Arze in the department of Cochabamba. The nearby downstream irrigated areas actually fall within the neighbouring municipality, Arbieto. This is a productive valley, with an important agricultural tradition.

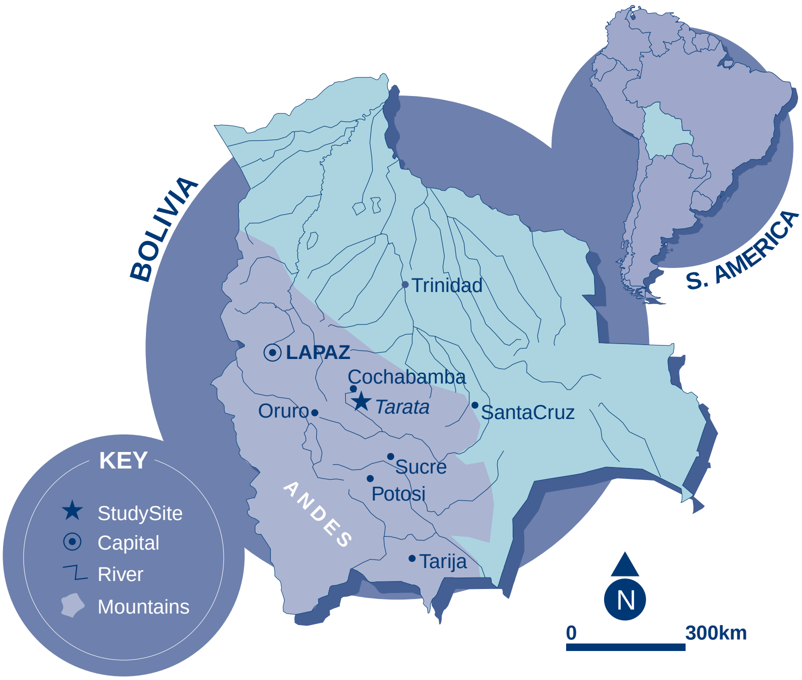

Figure 1. Location of Tarata in Bolivia

The area around Tarata has a long history. The first known inhabitants, *Tiawanacota*, were pre-Inca. Later, *Aymara- and Quechua-cultures* prospered. During the colonial period, from the late 16th century, the area became an important supplier of food for the mining area of *Potosí*, and Tarata became an important religious centre (Vargas, 1999). Arbieto was founded during this period. Products were made for regional and international markets, and today the area is still known for producing fireworks, pottery, crystal bottles and soap.

The climate is mild but relatively dry (Table 1), so irrigation has a huge impact on agricultural production. Or as one farmer said: *¡Cuándo no hay agua no hay una vida!* (without water there is no life). Most rain falls between December and February (Salazar & Soto, 1995). Traditionally, wheat, maize, alfalfa and potatoes have been the most important crops. The height of the land and access to irrigation dictate which crops are grown, with potatoes important in the upper catchment, and wheat in lower areas. In Arbieto especially, higher value tree crops like peach, pear, apple and plum are increasingly important, as are flowers and vegetables. Most landholdings are individually owned, and vary between 0.5 and 10 ha.

Besides cultivation and livestock keeping, the most important economic activities in Tarata are making and selling *chicha* (a maize drink), ceramic pottery and fireworks. Around Lake Angostura in Arbieto, a lot of families fish and sell their catch in Cochabamba city. The gastronomic kitchen and other forms of tourism are an important source of income in Arbieto (*Alcaldia de Arbieto*, 1998).

Table 1. Key background statistics for the study area

Pop. – Tarata municipality (1996)	7,881 (urban 3,786)
Pop. – *Arbieto* municipality (1992)	7,816 (urban 970)
Pop. density (province, 2000)	25.7 persons per km2 (national 5.8)
Pop. growth (province, 1976-2000)	0,16% (national 2,75%)
Annual income per person (province, 1994)	637 US$ (urban 1211, rural 577)
Mean temperature	12 – 18°C (Sep-Mar)
Average annual rainfall	478,5 mm
Pot. evaporation (at Lake Angostura)	1,883 mm
Altitude	2750-3500 metres

Relatively low returns from the main sources of livelihood in the area – 88% of people work mainly in agriculture, livestock raising or traditional craftworks – have resulted in high levels of both temporary and permanent migration. In the Chapare (the lowlands to the north east) there is work in agriculture; around Santa Cruz new developments employ seasonal labour; and many migrants found better wages in Argentina before the recent economic crisis. From Arbieto many families have relatives in countries like Israel, the United States and Argentina (Salazar & Soto, 1995).

Methodology

A range of quantitative and qualitative methods were used to investigate the conflict over water use from Laka Laka (see Flierman et al., 2003 for further details). These included:

- a literature study
- observation walks along parts of the Laka Laka system including irrigation and domestic water supply facilities
- interviews with various actors, stakeholders and key informants to obtain information on the research area, involvement in the Laka Laka system and the associated conflict

- three questionnaire surveys to collect information from the Abanico irrigators, the Tarata inhabitants of and the farmers in the catchment area of the reservoir

History of water development

Figure 2 shows a schematic illustration of the main features of the irrigation and domestic water supply systems. There are two main areas of water use: the irrigation scheme in Abanico (around Arbieto), and the town of Tarata. In the following sections, we look at the development of systems for field-scale irrigation, domestic water supply, and urban agriculture (the huertas).

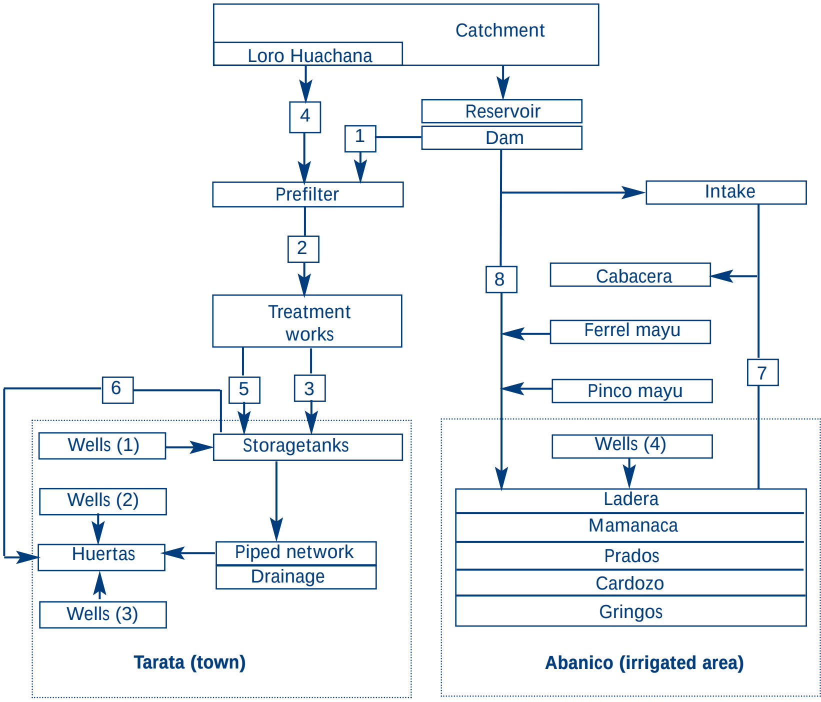

Figure 2. Schematic illustration of irrigation and domestic water supply infrastructure

Field-scale irrigation

Waters from the Calicanto River were used for irrigation before construction of the Laka Laka dam, albeit on a smaller scale, and in fact this was an early source of problems for the project. The preliminary proposal for the scheme failed to recognise the rights of traditional water users and these were only considered after protests. Irrigators with traditional rights to use water from the rivers that would supply the dam formed a *Comité Opositor* to lobby against the project.

One of the main aims of the Laka Laka multi-purpose project (Table 2) was to provide more water for irrigation in the valley downstream. Roughly 95% of the available yield was set aside for this purpose. Irrigation water from Laka Laka is supplied to Cabecera (22 ha) in Tarata municipality and the various *suyus mayores* (major irrigation units) of *Abanico*: *Ladera* (88 ha), *Cardozo* (82 ha), *Mamanaca* (203 ha), *Prado* (184 ha) and *Gringo* (324 ha). Within each *suyu* mayor, irrigation water is divided among *suyus menores* (smaller units).

From the dam, a lined primary channel (4 km long and with a capacity of 560 ls^{-1} [7[1]]) conveys irrigation water to *Abanico*, where further lined secondary channels divide the water (controlled with movable gates) among *suyus mayores*. The *Calicanto River* (*Wasamayu River in Abanico*) [8], *Ferrelmayu River* and *Pilcomayu River* also convey additional water during the rainy season and are used for traditional irrigation. Wells provide additional water in the irrigated areas during the dry season.

Table 2. Key statistics for the Laka Laka multi-purpose project

Height of dam	32 m
Capacity of reservoir	2,600,000 m^3
Catchment area	59 km^2
Yield of reservoir[1]	c. 6, 120, 000 m^3
Allocation for domestic water supply	270,000 m^3 (equivalent to 195 lpcd based on 1996 urban pop.) i.e. 4.4% of estimated yield
Allocation for irrigation	5,850,000 m^3 (in 1994; equivalent to 648 mm/ ha irrigated area) i.e. 95.6% of estimated yield
Irrigated area	903 ha

Domestic water supply

Although only about 1000 out of 1720 households in Tarata are connected to the main domestic water supply, these households do have access to a 24-hour water supply with household connections. The supply is better than many other urban centres in Bolivia, and most households do not need additional water storage to cope with variations in supply. Households that don't have domestic water from the main system, rely on wells or their neighbours.

Two domestic water supply storage tanks near Tarata can be filled: the reservoir (via pipelines with a capacity of 12 ls^{-1} [labelled [1, 2, 3] in Figure 2]; from two wells [wells[1]] owned by SEAPA-Tarata (with a combined capacity of 13 ls^{-1}); or from a third source, a pipeline (capacity 3 ls^{-1} [4]) from the River Loro Huachana, a tributary of the *Calicanto River* upstream of the reservoir where the river water has a lower sediment load. From the storage tanks, water then flows by gravity into the

1 Numbers in square brackets [ ] refer to references on Figure 2

domestic water reticulation network for Tarata (Zegarra, 1997).
Due to the high sediment load, treating water to drinking water standards from the reservoir was deemed to be too expensive (0.2 Bolivianos per m^3), although at 1.0 Boliviano per m^3, the cost of water to consumers supplied from the two wells that have been the main sources for the past four years is much higher. In practice only the two wells are used for the main domestic supply, and water from both the Laka Laka reservoir and the Loro Huachana is instead used for irrigation in the urban area.

Urban agriculture

In Tarata, a lot of families cultivate *huertas*, sometimes more than one in different parts of the town. Typically, these are at the back or around the family home, and may be between a few square metres and 2 ha in size. Common crops grown include maize, potato and wheat, fruit trees like peach and orange, vegetables like beans and peas, and alfalfa for livestock – either for home consumption or for sale. Not all households have *huertas*, but the number did increase significantly after the Laka Laka dam was built. Prior to construction of the dam, the *huertas* were irrigated with water from the domestic water supply system or family wells.

In the town there is now a system of pipes and earth canals to transport water by gravity to the *huertas*. There are also two pipelines (with capacities of 20 ls^{-1} [5 & 6]) from the treatment plant at the dam to supply water to the *huertas* in Tarata. These were not part of the original project design. This system is managed by AGROTAR. There are five main areas of *huertas*: *Khara Khara (Convento), Convento, Señor de Romasa, Jarkapampa / Estación Ferrocarril and Mañaseria / Coheteria.* There are now also five different sources of water for the *huertas*:

- the reservoir
- Loro Huachana river
- the main domestic water supply system supplied by SEAPA's wells
- two wells belonging to AGROTAR, [wells2] but currently these wells don't function
- individual wells [wells3] of the owners of the *huertas*

Irrigation water from the reservoir supplied to the *huertas* costs urban farmers 0.28 Boliviano per m^3.

Sedimentation of the reservoir

After construction of the dam, a major problem emerged. Very high sediment loads turn the water in the reservoir dark red during the rainy season. As well as ruling out the use of the reservoir for 'drinking' water supply because of the high treatment costs, sedimentation means that the lifespan of the dam will be short and the availability of water will decline rapidly. During the 1990s, the capacity was estimated to have been reduced by 25%, compared with a normal expected rate of around 10%. Attempts to flush out the sediments have not been successful (*Laboratorio de Hidráulica*, 2001). From an estimated supply of 5,850,000 m^3 for irrigation in 1994 it is likely that by 2016 the available water for irrigation will be reduced by more than half to only 2,550,000 m^3 (Salazar, 1996). That means that, after 2016, none of this irrigation water will be available in the dry season to meet the allocation for 'domestic' water supply year round.

Causes of conflict

The conflict in Tarata in 2002 centred on the supply of water from the Laka Laka reservoir for urban agriculture. In this section, the main causes of the conflict are examined in detail, including: the definition of what water supply for 'domestic' use meant to different stakeholders; the sale of water rights; motives of key actors in the conflict; and weaknesses in the enabling environment in Bolivia. Table 3 summarises the objectives and roles of key actors.

What are 'domestic' uses of water?

Domestic water uses are commonly understood to include the water needs of families for drinking, cooking, washing and sanitation. But what about other water uses at the household level? Are small-scale productive uses like irrigation of small gardens, keeping a few livestock or home-based micro-enterprises like beer-making also 'domestic' activities? If so, at what scale do these kinds of productive activities change from 'domestic' to agricultural or industrial or commercial activities? Differences on these definitional issues were a key factor in the conflict at Tarata.

It is clear that SEAPA-Tarata does supply water from both the Laka Laka dam and from the Loro Huachana for the irrigation of *huertas* in parts of Tarata. According to SEAPA-Tarata, the water it abstracts from the dam may be used not only for human consumption and a narrow range of domestic activities but also for urban agriculture. A letter from the Consejo Municipal de Tarata (the city council of Tarata) and the Alcalde de Tarata (the mayor of Tarata) in the newspaper *Opinión* supports this view:

"... SEAPA-Tarata will use with the goal of human consumption and for urban activities, meaning whatever use that can be given in the form of drinking water within the city limits of the town of Tarata (the centro poblado of Tarata) and other necessities of the inhabitants, which means that the water can be used for the industry, tourism, human consumption, livestock rearing, and for irrigation of pitches, gardens, pasture or land for the cultivation of crops..." (Opinión, 6 Nov 2003).

This view is contested by the *regantes* who point to the ministerial resolution of 1993 regarding the water distribution between the Asociación de Regantes del

Complejo Multiple Laka Laka and SEAPA-Tarata. This resolution states that:

"With the goal of human consumption and the established urban activities in the town of Tarata (the centro poblado of Tarata), a volume of 270,000 m^3 of water per year will be given, which will be administrated by the Servicio de Agua Potable y Alcantarillado de Tarata (SEAPA-Tarata)" (Resolución ministerial no.064/93 del Ministerio de Asuntos Campesinos y Agropecuarios).

This ministerial resolution does not clarify exactly what can be considered an 'established' urban activity. Not resolving whether urban agriculture was an 'established' urban activity has clearly been a key issue in the conflict. Can a once traditional activity that had declined (*cultivation of huertas*) be described as 'established'. SEAPA-Tarata aimed to revitalise these *huertas* to create more employment and generate more income for the *Tarateños*.

Sale of water rights, and of water that does not exist

As we heard before, to use the water from the Laka Laka dam (and from *Loro Huachana*) for the irrigation of *huertas*, the inhabitants of Tarata organised themselves in the Asociación Agropecuaria Tarata (AGROTAR). AGROTAR developed an irrigation project for the *huertas* with help from the municipality and SEAPA-Tarata (Opinión, 6 Nov 2003). The creation of *AGROTAR* and the subsequent construction of the irrigation system in Tarata, was itself possibly a violation of the regulations for the multi-purpose project. The ministerial resolution of 1993 prescribed that there were to be only two organisations in charge of the administration of the water from the Laka Laka dam, the Asociación de Regantes del Complejo Multiple Laka Laka and SEAPA-Tarata.

SEAPA-Tarata sells water from the Laka Laka dam to AGROTAR. Subsequently, AGROTAR has sold *acciones* (shares giving a right of access to water) to *Tarateños* with *huertas*. Furthermore, some of these *huertas* are situated outside the city limits (*the centro poblado*) and are owned by people who did not work in the construction of the dam. The only *Tarateños* who should receive water from the Laka Laka dam are the ones who live within the city limits or who laboured in the construction of the dam. The project regulations state that SEAPA-Tarata would administer water from the dam within the city limits. However, following the construction of the dam the town has grown significantly. The *centro poblado* has even grown beyond the limits of the watershed of the Calicanto River. According to the *regantes* these parts of Tarata do not have a right to water from the dam, though it is clear that AGROTAR is selling water in these parts.

Table 3. Analysis of roles of key actors

Actor	Brief description
Regantes (irrigators)	Farmers in irrigation scheme in Abanico supplied with water from the reservoir cultivating cereals, fodder and increasingly higher value fruit trees and other horticultural crops. Formally represented by Asociación de Regantes del Complejo Multiple Laka Laka.
Tarateños	Residents of Tarata, some with huertas and involved in urban agriculture, some without.
Servicio de Agua Potable y Alcantarillado Tarata (SEAPA-Tarata)	Autonomous but publicly-owned utility supplying domestic water and sewerage services.
Asociación Agropecuaria Tarata (AGROTAR)	Association promoting urban and peri-urban agriculture.
Alcaldía de Tarata	Local government responsible for development and administration in the municipality (urban and rural) of Tarata, run by elected officials and a mayor usually with strong political ties. Instrumental in establishment of AGROTAR and ultimately responsible for SEAPA-Tarata.
Prefectura de Cochabamba (Unidad Departamental de Riego)	Government level between national and local. Formal owners of infrastructure including the dam.
Federación Departamental de Cochabamba de Regantes (FEDECOR)	Federation of irrigation associations in the Department of Cochabamba.
Ministerio de Agricultura, Ganaderia y Desarrollo Rural	National level ministry responsible for agriculture and rural development.

Objectives	Role in conflict
Determined to protect rights to irrigation water from the reservoir, over which they feel a strong sense of ownership having been involved in the construction. Concerned that water use for urban agriculture would reduce availability of water.	Initiated demonstrations to protest against water use from the dam for urban agriculture in Tarata, and took direct action damaging water supply infrastructure to the town.
Secure domestic water supply, also water supplies for productive activities.	Mobilised in demonstrations, and involved in damaging irrigation infrastructure.
Involved in Laka Laka project from outset, and contributed to cost in order to get additional water. Later decided not to treat Laka Laka water to drinking water standard due to the high cost of treatment. Sold water rights for peri-urban irrigation to improve revenue flows.	Decided to promote creation of AGROTAR and promote use of 'domestic' water from Laka Laka for urban agriculture revitalising the traditional practices of irrigation of huertas.
To develop irrigation facilities for urban agriculture, and provide agricultural extension services.	Constructed pipeline to convey water from Laka Laka reservoir to Tarata that sparked the conflict.
To implement programmes as set out in annual (POA) and five-year municipal development plans (PDM).	Mobilised the Tarata community under the premise that domestic water supply was threatened by conflict with regantes.
To implement national policies at regional level especially through major development projects that are too big for individual municipalities.	Mediation, including formation of multi-sectoral commission in December 2002 (assisted by Centro de Investigación y Desarrollo Regional (CIDRE) and Canadian International Development Agency (CIDA)) to resolve the conflict, made up of representatives of both the regantes and the Tarateños.
To represent the interests of member irrigation associations.	Organised discussions and negotiations, mobilised regantes in demonstrations, represented views in press and worked for agreements reached to be implemented.
To develop and implement national policies for agriculture and rural development.	Legal advisor defined that urban activities could include irrigation of crops.

During the period when SEAPA-Tarata did not use water from the dam, the *regantes* had more available water, and had started to sell rights to water that could only be fulfilled whilst SEAPA-Tarata did not utilise their share. Now that SEAPA-Tarata once again abstracts from the dam there is less water available for irrigation in Abanico. The *regantes* have run into problems as they no longer can supply water to all the farmers to which they have sold rights or shares. A number of *regantes* thus do not receive irrigation water anymore even after they bought shares. Each year the amount of water available in the reservoir is also declining due to sedimentation, whilst demands on the side of the *regantes* have increased.

It is actually prohibited for both SEAPA-Tarata and the Asociación de Regantes del Complejo Multiple Laka Laka to sell water from the dam to persons who did not work on the construction (although rights are transferred in land and house sales). However, as well as SEAPA-Tarata and AGROTAR selling rights to water, it seems clear that the Asociación de Regantes del Complejo Multiple Laka Laka is also selling water in violation of these rules. In Abanico, farmers without shares can still buy water from the Asociación for approximately Bolivanos 40-55 per turn. It has been said that the Laka Laka dam was constructed for the irrigation of 400 ha of land, but today closer to 1000 hectares are being irrigated, though there is uncertainty over the true figures. This may be a result of sales of extra water by the Asociación de *Regantes* del Complejo Multiple Laka Laka, and because some *regantes* obtain more water than they are supposed to be allowed. In reality, while an irrigation turn may allow half an hour of irrigation, in practice the plot is irrigated until it is deemed sufficient. Some farmers also ‘steal’ water to irrigate extra land. Water shortages are aggravated too by the fact that the available irrigation water is not used very efficiently.

Motives, interests and entrenched positions

Why don’t the *regantes* want water to be supplied for urban agriculture in Tarata? And, why is urban agriculture so important in the town? The *regantes* are strongly opposed to the supply of water from the Laka Laka system to Tarata for irrigation of *huertas*, even though this represents a small amount of water (around 5%) compared with total availability. There are several reasons for this. First, the *regantes* feel that they have more rights to the water from the reservoir since SEAPA-Tarata had not used the water for 4 years and urban water users did not participate in construction and maintenance of the system to the same degree. Participation in construction of irrigation facilities by providing labour is a normal way of creating rights over a system and the water. Added to the perceived loss of rights, the *regantes* are concerned that in the future the town’s demands for water for urban agriculture will increasingly threaten their interests. As sedimentation further reduces the yield of the reservoir, year-round use in Tarata will also have an increasingly severe impact on the amount of water remaining for the irrigation scheme, especially during the dry season. In addition to these water resources issues, there are also strong historical rivalries between the town of Tarata and surrounding rural communities that date back decades to clashes between peasants and the landowning classes.

Weak overarching legislation, and institutional frameworks

As we have already seen, the content of water rights associated with the Laka Laka scheme (specifically whether domestic use in the town should encompass irrigation of *huertas*) are unclear and contested. As with other water resources conflicts in Bolivia, confusion over the specific understanding of water rights is largely a result of a vacuum in policy, legislation, decision-making and regulation for water management. A common situation in such circumstances is that irrigation farmers seek to create their own rules for water rights, such as linking these to investments made in construction or maintenance. In this vacuum, schemes such as Laka Laka struggle to find their own local solutions. And when water resource conflicts do arise there are not clear norms and procedures for institutions such as municipalities or the *Prefectura* to resolve the conflict. In such an environment, water users tend to seek support through other institutions and channels, often depending upon the mobilisation of political support.

Conclusions and lessons

The use of water from the Laka Laka reservoir for urban agriculture was, in the opinion of the *regantes*, against the agreed rules for operation of the multi-purpose scheme. The construction of a pipeline to irrigate *huertas* in the town and renewed use of the water from the dam by the town after a gap of four years was a direct cause of the conflict, aggravated by the lack of overarching legislation and norms, and the historic rivalry between the municipalities of Tarata and Arbieto.

The declining yield of the reservoir due to severe sedimentation is likely to lead to further pressures on the scarce water resources in the area, and potentially to continued or more serious conflict, unless strong institutions are able to manage the diminishing resource and resolve the conflicting interests. Potential solutions to help minimise or resolve the existing conflict in Tarata could include: better information-sharing among key stakeholders (including reliable information on declining future water availability due to sedimentation); more transparency in the operations of the institutions (SEAPA-Tarata, AGROTAR, the Asociación de Tiempos del Complejo Multiple Laka Laka and local government); general strengthening in institutional capacities to deal with conflicts; and, in the irrigated areas especially, measures to introduce incentives to use water more efficiently.

Although every conflict over access to contested resources has many local characteristics, some more widely applicable lessons can be learnt from the disputes in Tarata:

- Improved domestic water supplies, in this case following construction of a reservoir and associated infrastructure, will in certain cases lead to increased water use for urban agriculture and productive uses;
- Productive water uses at the household level are, as in Tarata, rarely considered in planning. These needs should be properly considered in the project design for improved water supplies and multi-purpose projects, and the rights to water for these uses should be clearly negotiated and agreed in such projects.

Decisions on whether urban agriculture, or other productive uses of water around homesteads, should be explicitly encouraged in domestic or multi-purpose water supply projects should, among other factors, be based on: an assessment of local needs; comparisons of the efficiency, benefits and costs of productive water uses; assessment of contributions to (or problems over) cost recovery and sustainability; and an understanding of whether there are particular benefits for the poor. Follow-up research has been initiated to address these wider questions, based upon detailed household-level studies in Tarata.

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Transforming access to rural water into profitable business opportunities

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Summary

More than a billion people do not have access to clean domestic water, and many other needy people lack access to affordable small-plot irrigation. Yet, the world's experts in water and sanitation on the one hand and irrigation on the other hand rarely talk to each other, much less collaborate. This is unconscionable, because integrating access to domestic water and irrigation water at the village level provides an unparalleled opportunity to provide clean domestic water for the rural poor and at the same time expanding the access of smallholders to the irrigation water they need to increase and stabilise their income from agriculture. The good news is that it appears possible that hybrid systems can be created and operated as profitable income-generating businesses by water user groups, repaying the loan required to build them in three to five years and providing a sustainable source of village income afterwards. This chapter explains the principles needed to develop such systems and includes worked examples from several different countries. By providing a source of sustainable income from user fees, hybrid systems can make a significant contribution to the alleviation of rural poverty, as well as providing an economically sustainable source of clean domestic water for the rural poor. But, to achieve these goals, major policy changes will need to be made by donors, NGOs, development agencies, and the governments of developing countries in how the provision of clean domestic water to the rural poor is conceptualized and implemented.

Introduction

Global clean water and poverty eradication initiatives

The more than one billion people in the world without clean domestic water are targeted by the Millennium Development Goal of cutting by half the proportions of national populations who do not have access to safe water and sanitation by 2015. Many of the rural poor with no access to affordable small-plot irrigation water *should* be targeted by the wider goal of cutting by half the percentage of people in the world who earn less than a dollar a day by the same time. These two groups of poor people with serious constraints in access to water share one more important characteristic. Without major changes in current approaches to alleviate poverty and open access to small-scale water supplies, the global initiatives launched in their name are destined to fail.

The rural poor will not emerge from their poverty unless they can find a way to increase their incomes from agriculture. To accomplish this they need access to affordable small-plot irrigation water, a key constraint that has not been addressed by the poverty-alleviation constituency. Village access to clean domestic water has also been severely constrained because the water and sanitation constituency has relied too much on a supply-driven approach, funded by donations and subsidies, which usually simply does not work.

Access of the rural poor to clean domestic water

For many of the rural poor, and particularly those living in remote rural areas, access to clean domestic water is as far removed as it can be from the western context of simply turning on a tap. They get it instead from a village handpump sitting on a drilled or hand-dug well. In many poor hill areas, villagers can gain access to clean water by building a gravity-flow pipe system that carries water from springs or streams. The problem is that, in most locations, a handpump on a tubewell still costs far too much for a village, much less a family, to afford. The main factor influencing the cost of a handpump is how deep the tubewell needs to go to reach the nearest water-bearing layer where clean water can be found.

In many parts of Africa, for example, a handpump on a tubewell costs more than US$1,000, and most of the people who need clean domestic water earn less than a dollar a day. The most popular solution for this situation is for either the government or a donor agency to pay for installing a village handpump, which might provide water for 30 or more families. But there is never enough donor or government money to reach all the villages, and often when a handpump is installed as a gift, it falls into disrepair within a year, either because nobody feels ownership of it, or it is too difficult to repair with the resources villagers have available. The same holds true for villages in hill areas, which aspire to piped water from a clean water spring above the village. Such a piped system starts at US$1,000 for materials, so most hill villages are still waiting for the government or a donor to come up with the money.

An important exception to this is the river delta areas like Bangladesh and eastern India, where bacteria-free water is available close enough to the surface to install a handpump on a tubewell for US$30 or less. In these areas, millions of small cast iron UNICEF number 6 handpumps have been purchased and installed by poor families. Since it is often customary for a family with a handpump to provide free access to water to the neighbours, there is a sufficient quantity of affordable handpumps in these areas to provide access to clean domestic water for most of the population (although arsenic contamination problems are severe in parts). And, when the cost of an installed handpump is in the US$60 range, it is often possible to use a variety of strategies to bring the cost down to the US$30 range, as was recently accomplished in Vietnam (Baumann, 2002).

While clean domestic water supplied through pipes to people in cities is relatively expensive because of the costs of treating it to remove bacteria, water from properly installed wells and many springs and streams is often clean at the source. Using it also for small-plot irrigation requires little added expense, although hand-pumps can themselves often represent an important restriction on the potential of high yielding tubewells. But the water and sanitation constituency has not incorporated strategies to build village hybrid systems. Such systems are capable of transforming access to domestic water into profitable businesses able to pay off a loan to cover installation costs in three to five years, and providing a continuing income stream for the village after the loan is paid off.

Access of the rural poor to affordable small plot irrigation water

A low-cost irrigation system that suits a small farm can easily pay for itself in less than a year. To have a chance of increasing their incomes from agriculture, the 75 percent of farmers in countries like India and China who cultivate less than two hectares desperately need irrigation devices that fit small plots, with a starting price in the range of US$25 (Postel et al, 2001).

What the irrigation establishment provides instead is donor-funded, government-operated multi-million dollar irrigation projects. The poor farmer who is lucky enough to gain access to one of these systems often finds himself or herself with water erratically delivered, a teaspoon at a time to the tail end of a canal. The irrigation establishment has simply failed to pay attention to the design of affordable small-plot irrigation for individual small farms, and its mass dissemination through the private sector, which could, indeed must, be the backbone of practical strategies to eradicate rural poverty.

The development and mass dissemination of affordable small plot irrigation devices over the past 15 years has begun to redress this imbalance (Polak, 2000). For example, more than two million poor rural families have responded enthusiastically to affordable small-plot irrigation devices like treadle pumps and low-cost drip irrigation systems. The exponential increase in global demand for low-cost drip systems, on the other hand, is limited for many families by a critical constraint: access to an affordable expanded source of micro-irrigation water.

Families in the hill villages around Pokhara in Nepal, for example, are already taking the first step toward hybrid systems by using excess water in domestic piped water systems to irrigate off-season vegetables (see Example 4). They irrigate with 100 m^2 gravity drip systems costing US$25 and supplied through the private sector. The crops earn them a net income of US$60 in the winter growing season. But, when they take the logical next step to expand their drip system to 500 m^2, they quickly learnt that there is not enough water in the existing village piped water system to allow them to increase their irrigated plots.

Water source constraints for affordable small plot irrigation

The problem is not confined to Pokhara. Quite often, the limitation on the spread of the systems is lack of access to a small but reliable source of water. In Nepal, 60% of the users of drip irrigation are actually using the excess water available from domestic water systems as the primary source of irrigation water. But when the farmers meet with success on their small plots and would like to expand, or when neighbours want to add their own systems, they are not allowed to because the community cannot put their domestic water supply at risk. This is the case despite the fact that there are thousands of undeveloped water sources throughout the region that could be used by tens of thousands of smallholders to increase their incomes and food security.

So what is the problem? The technology needed for these systems is virtually the same as that used for domestic water systems, and bears little resemblance to what is traditionally thought of as an irrigation system. Developing a water source and conveying water to the village usually costs in the range of US$2,000-US$5,000 and this is too much money for a typical farmers' group or community to pay for up front. So what about public sources of money? Unfortunately, this type of development can neither be paid for by money earmarked for domestic water (because it is used for irrigation), nor by money earmarked for irrigation (only irrigation systems of 10 ha or more are usually considered for funding). So the technology has changed, but the development community cannot meet the needs of the farmers because they haven't kept pace.

Integrating domestic water and smallholder irrigation

The recent development and mass marketing of affordable small-plot irrigation technologies like low-cost drip systems opens up the possibility of turning both village handpumps and gravity-pipe systems into sustainable income-generating businesses that can be financed not by subsidies, but by repayable loans. Transforming the financing of water and sanitation projects to repayable loans instead of subsidies and gifts opens up a realistic possibility of reaching ambitious goals for supplying clean domestic water to the people who need it. On the irrigation side, it creates practical possibilities of giving smallholders access to expanded sources of irrigation for their high-value horticultural crops irrigated by affordable small-plot irrigation systems.

The rapid development and dissemination of hybrid income-generating domestic water and smallholder irrigation systems makes possible both a rapid increase in the access of the rural poor to both clean domestic water and improved incomes.

Development of affordable small plot micro-irrigation technology

Recent breakthroughs in affordable small-plot irrigation devices that are adapted to the particular needs of the smallholders in developing countries provide them with new income-generating opportunities. These innovations share the following characteristics:

- relatively low cost
- simplicity of manufacture, installation and use
- highly efficient use of water
- low labour requirements compared to hand-watering
- applicable to small plots ranging from 25 m^2 to 2000 m^2
- applicable to a wide range of horticultural crops
- capable of operating on extremely low heads of 1-2 metres

These smallholder irrigation devices include treadle pump tubewells starting at US$25 (Polak, 2000), low-cost drip systems starting at US$5 (Polak, Nanes, and Adhikari, 1997; Polak 2000; Keller, 2002), and low-cost micro-sprinkler systems (Shah, 2000). Such low-cost smallholder irrigation technologies make it possible for poor families to earn significant incremental incomes from newly acquired access to relatively small amounts of water that would not be sufficient for conventional flood irrigation.

For example, in Nepal, International Development Enterprises (IDE) has developed a drip system, which ranges in cost from US$13 to US$35, is able to cover from 125 m^2 to 500 m^2, and is used mainly for growing off-season vegetable crops on the water-scarce hillsides. More than 5,000 of these systems have been produced by private sector manufacturers and sold through a private sector dealership network facilitated by IDE). Farmers are increasing their annual average income by US$75 to US$300, depending on the size of the system.

Similar systems with slightly different designs but equivalent use and results have also been developed and marketed in India by IDE (15,000 systems) and in Sub-Saharan Africa by Chapin Watermatics, IDE, and Netafim (10,000 systems). Farmers in these varying localities are increasingly finding these systems a good investment, given their limited means and limited water supply. When combined with breakthroughs in the affordability of handpumps achieved through a combination of design innovation integrated with decentralised private sector supply-chain strategies, these new affordable technologies enable the mass dissemination of economically sustainable hybrid village water systems that transform access to domestic water into an income-generating opportunity.

Domestic water and affordable small plot irrigation combined

What if the farmers could be given a loan to develop the system themselves?

If a group of 40 farmers earns an average of US$150 each per year, they should each be able to contribute US$50 per year to pay back the loan. This would be a total of US$2000 per year, and would be enough to pay back the cost of a small system in one year, or a larger system in two or three years. Combining the distribution system for small-plot irrigation with a domestic water distribution system would incur little extra cost, and provide a source of additional revenue. If the clean water source supplying the 40 farmers could also provide water distribution points for 60 village families, and each family would be willing to pay a US$10/year user fee for access to clean domestic water, the water users association would gain US$600 a year in income for a very small additional installation cost. Since access to clean domestic water is highly valued in poor rural areas, its integration in the village water system would stimulate stronger support and participation by the village.

The methodology for implementing such schemes is well developed throughout the world, and has been used regularly to implement piped domestic water schemes from springs and streams for hill villages. It involves developing water users groups and building their capacity to operate and maintain both the group and the water system. By taking a participative approach, and involving the community in both planning and implementation of the scheme, the chances of success of such schemes can be greatly increased.

The water user groups can also reduce the overall cash cost of the system by donating unskilled labour and locally available materials such as sand. External input is needed to help with group formation and mobilisation, and to teach irrigation and horticultural expertise. In parallel, the success rate can be greatly increased by a market development scheme that will strengthen the private sector's capability to supply appropriate inputs and make market linkages for selling the produce.

Examples 1-6 illustrate what could be achieved if a hybrid approach were followed in countries as far apart as Guatemala, Zimbabwe and Bangladesh. These examples illustrate the practical steps that need to be taken, and some of the issues that need to be overcome to successfully implement hybrid domestic water and smallholder irrigation systems at the village level. But to make the implementation of village level hybrid systems possible, major changes will be required in the policy of donors, development agencies and governments in developing countries.

Multi-purpose productive use rural water supply systems

The same steps used to integrate household water supply with income-generating irrigated smallholder cash crops are applicable as well to other productive small-scale uses of water, such as fish ponds, watering of livestock, and water-related livelihood-enhancing small enterprises. As is the case for effective livelihood enhancing irrigated gardens, the success of other productive water uses is tied to access to markets, access to up-to-date information and training in effective production methods. For example, in the case of fish ponds, the operators need to be taught ways to effectively prevent and treat fish diseases, ways to optimise fish feeds from locally produced sources, affordable technologies for adding oxygen to the water, and so on. When rural communities find a way to build and operate their own water supply systems, they invariably build multiple-use systems that combine access to clean household water with a variety of productive water uses. Multi-purpose rural water supply systems follow the model for multiple productive uses of water already incorporated by rural communities in the systems they build for themselves, supplemented by methods to optimise productivity and market access that fit the village context.

Contexts where hybrid systems are not likely to apply

While some two thirds of the rural families needing access to clean domestic water are likely to be able to take advantage of hybrid systems, there are several contexts where their application is unlikely. These include:

- Situations where it is necessary to treat the water with expensive methods to make it drinkable. The cost of treatment may make the water too expensive to use for irrigation purposes.
- Applications where the construction of the water system would be too expensive to make it possible to pay off a loan for construction costs from the proceeds of horticultural crops irrigated by water from the system.
- Contexts in which the village is too far removed from a sustainable market for high value crops, or where there are other unsolvable constraints to gaining the market access needed to generate sufficient volume sales to make the hybrid system economically sustainable.
- Situations where clean domestic water is available to individual families at a modest cost, such as the US$25 required to put a small handpump on a tubewell in shallow aquifer areas like much of the Gangetic plain. In such cases, rural families are likely to prefer individual access to the more cumbersome and, in many cases, more costly group solution.

Conclusions and policy implications

While the impact of hybrid village systems on sustainable village access to water is likely to be promising, their further development and mass replication requires significant policy changes. In summary:

- Mechanisms need to be formulated and implemented to convert the existing patterns of non-communication and negative competition between the water and sanitation and irrigation constituencies to one of productive collaboration. Funding mechanisms for the joint design and implementation of hybrid village systems would be an important step in this direction.

- Immediate steps should be taken for the further development, installation, field-testing and evaluation of hybrid village water systems in a systematic variation of rural contexts.
- Funding policies should shift from subsidising the cost of village water systems to short-term support for the formation of water users associations for hybrid systems, facilitation of their access to credit, and facilitating the access of smallholders in hybrid systems to markets, agronomic training inputs, and relevant information.
- An evaluation of the feasibility of installing a sustainable income-generating hybrid system providing both clean domestic water and smallholder irrigation water capable of providing a 3-5 year payback of a commercial loan covering construction costs should be the first step in the construction of future government and/or donor supported rural domestic water systems.
- A further shift in funding should take place from grants supporting village water system construction to loans based on the presentation by water users associations of sustainable business plans for building and operating hybrid systems.

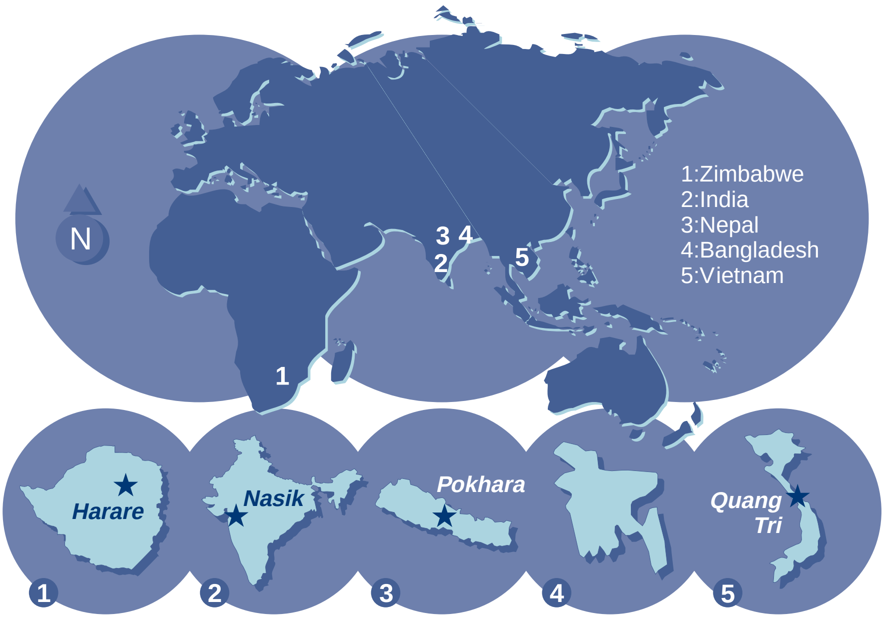

Figure 1. Guatemala, Bangladesh, Zimbabwe, Nepal, Vietnam

Example 1. The Guatemalan experience

In Guatemala there are more than 100 small-scale community-owned and operated sprinkle irrigation systems that also supply domestic water (Lebaron et al., 1987; Lebaron, 1993). They were installed by hillside farmers primarily for irrigation. Villagers installed the pipelines to convey water by gravity from higher elevation springs to their farming area and later to their homes. The communities of farmers borrowed money from the government's Agricultural Bank and were provided with engineering support from the Extension Service and USAID technical assistance.

The average system size is about 20 ha and the average farm plot is roughly 0.2 ha. Each farm plot is serviced by a pressure tap at its centre. The farmers then use a hose with a conventional brass sprinkler on a tripod stand that they move around to irrigate their land. Payback of the government loans was typically achieved in less than three years. This was made possible by growing high value horticultural crops and marketing the vegetables and fruits in Guatemala City or smaller urban areas. They also grow a mixture of grain crops for subsistence.

According to Lebaron (1993), three main criteria were associated with the success of this endeavour: a) available credit at reasonable rates of interest along with technical assistance; b) tightly knit and relatively small groups of participants; and c) potential to grow and market relatively high value crops such as small fruits and vegetables.

Example 2. A pump becomes an income-generating opportunity for six rural families in Bangladesh

The following example shows how a group of six families living within a 300 m radius of each other could sustainably install a Jibon pump, a low-cost handpump developed by IDE Bangladesh, so they could switch from using convenient, but bacteria-infested surface water for their households to clean domestic water close to their homes.

Because the water-bearing aquifer is about 18 m deep, they estimate that it will cost US$125 to install a Jibon pump, which could produce much more water than the four to five buckets a day that they estimate each household will need. Their biggest constraint is that none of the families could afford the US$125 initial investment, and while each family could afford to pay 50 cents a month for access to clean domestic water, this would not be enough to pay back a loan to cover the installation cost.

Hybrid System Solution

The six families could form a water users group, and obtain a loan for US$125 to install the Jibon pump. In addition, each household could borrow US$20 to purchase a low-cost 100 m2 gravity drip irrigation system. The drip systems would provide new net income of US$50 a year for each family from growing off-season drip-irrigated vegetables.

From this income, each family then pays US$10 a year to pay off the drip system, and US$10 a year to pay off the pump. This allows the loans for both the Jibon pump and the drip systems to be paid off in 30 months, and continues to produce new net income of US$50 a year for each participating family. To accomplish this, however, requires a one-time grant to a local grassroots development organisation to facilitate the formation and operation of the water users group, and to train each participating family in the use of the drip system, give agronomic training, and facilitate access to markets for off-season vegetables.

Example 3. A rural village in Zimbabwe installs a rope and washer pump

In a similar hypothetical example from Zimbabwe, a village of 15 families in Zimbabwe may decide to install a community handpump to provide domestic water to replace the 2 km walk to a community well in a neighbouring village. It may cost US$600 to install a rope and washer pump on the 30 m borehole required to reach a layer capable of delivering an acceptable supply of clean water.
Consider what might happen if ten of the families were to install 100 m^2 drip kits in addition to a handpump. Each drip kit irrigates 100 m^2 of high-value vegetables, and is capable of generating net income of US$75 a year or more because of high prices for vegetables during the current food shortage in Zimbabwe.
A 100 m^2 micro-tube drip system imported from India with two 85 litre gravity tanks costs $30 to install, and requires a fence to keep goats and other animals out of the vegetable garden. A five-strand barbed wire fence combined with a thornbush hedge costs an additional US$10 for materials, giving a total installation cost of US$40 for an expandable 100 m^2 drip kit.

The villagers estimate that each of the fifteen families will use 125 litres of water for domestic use each day, making a total of just under 2,000 litres of water a day. Ten of these fifteen families elect to install drip irrigation systems growing cash crops. The 100 m^2 vegetable garden requires an average of 400 litres of water a day under typical weather conditions for the area – less when the vegetables are first planted and more as they reach maturity. The combination of drip irrigation and domestic water represents a total water need of 6,000 litres a day. At an estimated water delivery rate of 10 litres a minute, the rope and washer pump will be operated for about 10 hours a day, with the families taking turns using it. Villagers will carry water to their homes from the borehole in buckets and irrigation water to the gravity drip system in wheelbarrows carrying two 20-litre buckets at a time.

From the net annual income of US$75 from each drip system, each family growing drip irrigated cash crops will pay US$15 a year in irrigation water user fees, and US$15 a year to pay for the drip equipment. In addition, each of the families agrees to pay US$10 a year as a fee for the domestic water they use, contributing a total of US$150 a year. This provides a total of US$300 a year to pay off a $600 loan for the community-owned parts of the system, namely the pump and the tubewell, enough to pay off a US$600 loan with interest at 20% within three years. After the initial loan is paid off, villagers can consider increasing the size of their drip irrigated plots, and installing more pumps and wells.

Example 4. Gravity-fed piped water and drip systems for a village in the Nepal hills

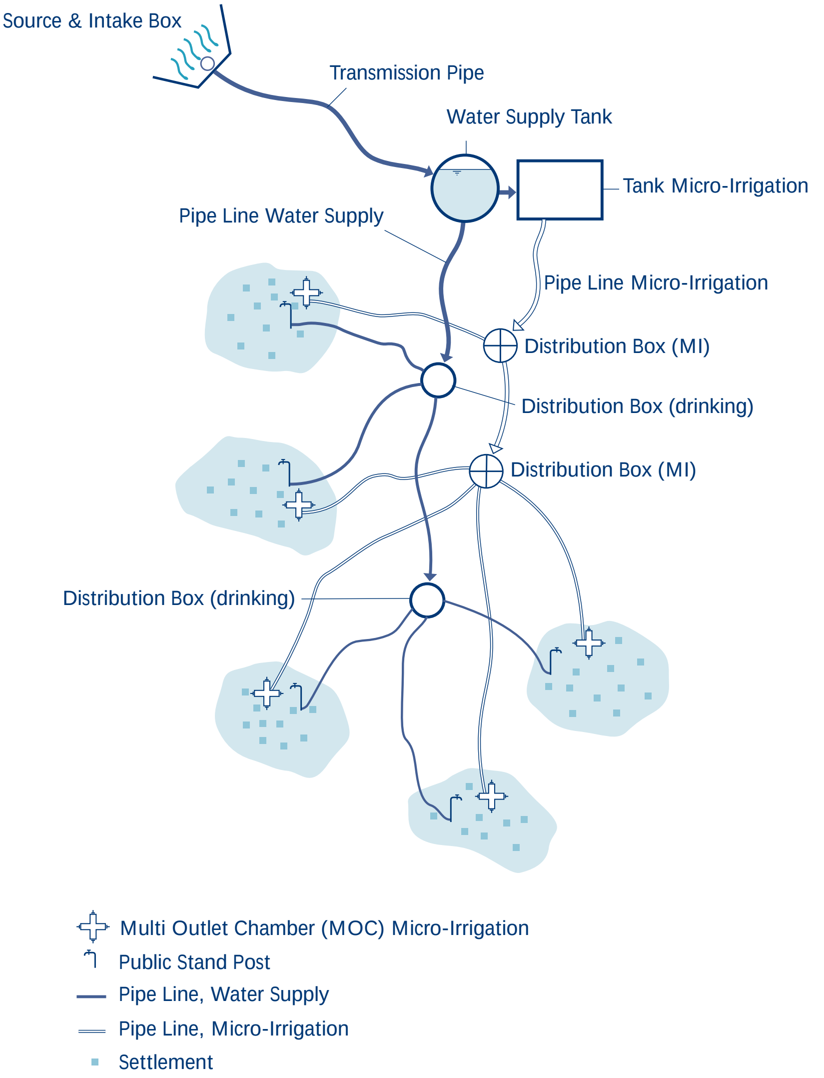

Figure 2. Typical layout plan of hybrid water sypply & micro-irrigation scheme

In another possible formulation, a village with 30 families near Pokhara is tired of waiting for the government of Nepal, using World Bank funding, to build a gravity pipeline to the village from a spring with clean water 1 km away. The long term plan is for the government to give the village a grant to pay the materials cost to construct a 1 km pipeline, with a holding tank just above the village, and six water taps each shared by five families. The village will supply the labour to build the system. But since there are many more requests for government grants to build village piped water systems than there is funding, no construction date can be set, even though the village has been on a waiting list for six years.

Instead of continuing to wait for the government grant, the village decides to obtain a loan to install a hybrid system, incorporating the same domestic water plan as before, but adding the capacity to irrigate 30 drip irrigated plots of 500 m^2 each to grow off-season vegetables like cucumber and cauliflower for the Katmandhu market, plus fruits like papaya and selected herbs. The village has already field tested 10 drip systems of 100 m^2 each, which have generated an average annual net income of US$75, but they have not had sufficient water from the current source to expand.

Hybrid system solution (see figure)
The best water source for the village is a spring with a minimum low volume during the driest time of the year of only 0.5 litres per second. But since the spring flows for 24 hours, the hybrid system plans incorporate a 6000 litre domestic water tank above the village. When that tank is filled, water flows through an overflow valve to a second 12,000 litre irrigation water tank. Following the standard domestic water system design, the separate domestic water delivery system delivers water through a pipeline to six water taps, each serving 10 families. A second pipeline from the micro-irrigation gravity tank supplies water under pressure to 30 smallholder plots of 500 m^2, through multiple outlet chambers. Because of the cool climate and 60 cm conventional spacing of cash crops, projected water needs for a 500 m^2 plot are relatively low, only 800 litres a day. Out of the projected US$250 a year in net income from two off-season cash crops, each irrigator will pay a fee of US$80 a year to repay loans for the hybrid system, drip equipment, and inputs. Each family using domestic water will pay a user fee of US$10 a year. A village committee oversees the building and operation of the hybrid system, under which a separate domestic water and irrigation committee is responsible for fee collection and operation and maintenance of each system after it has been installed.

After the loan is paid off, the village is free to use the annual income from the hybrid system as a source of further needed investment, micro credit loans for villagers, or other uses determined through the existing village governance structure.

Basic parameters of hybrid system

Number of water users (domestic) =	60 families
Number of micro-irrigation users =	30 families
Acreage of micro-irrigation user =	500 sq. m. / family
Daily water required for domestic needs =	225 ltr. / family
Daily water required for micro-irrigation needs =	800 ltr. / 500 sq. m. plot per family
Discharge of the water source =	0.5 litres per second

Projected hybrid system costs (US$)

Intake structure	US$100
Transmission pipeline 32mm Dia, 1 km	US$ 500
Storage tank	
Domestic = 6,000 & irrigation 12,000 Litre	US$ 600
Distribution pipeline	
75 mm 500 m	US$ 500
50 mm 500 m	US$ 300
20 mm 2000 m	US$ 500
Public stand posts6 Nos. @ US$100	US$ 600
Distribution box 6 Nos. @ US$50	US$ 300
Pipe fittings / accessories	US$ 500
Skilled mason for pipe laying / fittings	US$ 400
Installation labor provided by villagers	—-
Sub-total of construction of W/S Scheme	**US$4,300**
Materials for 30 fenced drip systems	US$1,500
Initial input costs	US$1,000
Total cost	**US$ 7,000**

Projected annual income and expenses for hybrid system

Household water fee = 60 families x US$10/yr	US$ 600
Micro-irrigation water users fee = 30xUS$80	US$ 2,400
Estimated annual operating expense	US$ 300
Net annual income	**US$2,700**

Estimated loan payback period = 4 yrs with 20%/annum interest

Example 5. A hybrid system for sixty families in the central hills of Vietnam

In the tribal villages of Vietnam's central hill area not far from the border with Laos, the 68 residents of Ta Leng hamlet in Quang Tri Province are able to grow only half of the rice that they need. What they do grow is on their small low yielding rainfed upland rice fields, and even smaller irrigated rice paddies. To generate the cash required to buy the rest of the rice they need, they gather rattan, firewood and grass used to make hats from the forest, usually getting very low prices for this from traders along the highway. Many villagers raise one buffalo a year and sell it for meat or as a work animal for the plains areas of Vietnam.

The household water source for the hamlet is a stream two metres wide and 20 cm deep, which never runs dry. During the dry season, they carry water by bucket from a deep spot on the stream 500 m away. During the rainy season, they carry water from a closer point in the stream.

There is a natural basin in the stream some 15 m in vertical height above the hamlet. It is a flat spot, where a small dam could easily be built to form a takeoff point for a pipeline. There is no major obstruction to bring piped water from this point to the village, although there is a gently sloping hill that the pipe would have to go over between the water source and the hamlet. The villagers have applied to the government for a grant to build a pipeline, but have no indication at present if money might be available. The government does pay for and install piped domestic water systems for villages, but if and when it does, it forbids the use of the piped water for anything but domestic use. But that is not the biggest problem. The biggest problem is that only a tiny percentage of hill villages have piped water systems, because the government simply lacks sufficient funds to meet the demand.

A third of the way from Ta Leng to the flat spot in the stream is a prosperous farmer with 4,000 coffee trees. He paid for and installed his own pipeline from the stream, and is using it to fill a newly built 700 m^2 fishpond. He uses his pipeline to irrigate his coffee and other crops, to fill his fishpond, and to supply water for his house. Instead of waiting for a government donated domestic water pipeline, the hamlet could build their own income-generating hybrid system pipeline if they could locate a source of credit to build the system.

Hybrid System Solution

The village could build a pipeline for an estimated US$4,300 in materials cost, including a tank for the distribution of domestic water and two tanks for fishponds and irrigation plots. Micro-irrigation would be provided to thirty 500 m^2 drip-irrigated plots growing coffee, pepper vines, mandarins, vegetables and spices for sale along the highway. The operation and maintenance of the hybrid system and the collection of fees from owners of fish ponds and irrigated horticultural crops would be the responsibility of a committee appointed by the hamlet governance structure.

The families of Ta Leng hamlet who have fishponds now produce only one tenth of the fish yields of comparable ponds in the plains area of Vietnam. They have little or no knowledge of irrigation or of sustainable ways to increase agricultural yields. Finally, because of their lack of a written language, and their poor trading skills, they regularly receive below market prices for the crops they do sell along the highway. Before they can be expected to earn enough income to pay off the loan to build their hybrid system, a significant investment needs to be made in training and knowledge acquisition in irrigation, agronomics, and sustainable ways to increase agricultural productivity, as well as improved access to markets for their crops, and training and support for improved trading practices. In addition, they are not likely to be able to earn enough money from their fish ponds and drip irrigated plots to pay back the loan with interest – they will need, at least in the beginning, a subsidised loan at zero interest rate.

Projected capital cost for the hybrid system (in US$)

Materials for 2 km 5-inch pipeline	US$4,423
Installation labour provided by villagers	—-
Thirty 500 m2 drip systems	US$1,500
Initial inputs for crops	US$1,600
25 small fishponds	
(Labour provided by owners)	US$ 319
Total capital cost	**US$7,843**

Projected annual income and expenses for hybrid system

Household water fee - 60 families x US$5/yr	US$ 300
Micro-irrigation water users fee - 30 x US$40	US$1,200
Fish pond users fee - 25 x US$10	US$ 250
Total Income	**US$1,750**
Annual Operating Expenses	US$ 300
Net annual income	**US$1,450**

Estimated loan payback period =5 yrs at no interest.

Example 6: A private sector investment in an open dug well and six-kilometer pipeline to Belgoan Dhaga village, Maharashtra, India

Belgaon Dhaga is a small village in Nasik District of Maharashtra State in India with a population of 1,500 people. Eighty percent of the people in the village who work are employed in agriculture, and the remaining 20 percent have jobs in neighbouring towns. Most farmers in the village cultivate less than two hectares each. This village has immense potential for supplying vegetables to the nearby town of Nasik. However, the village is situated 6 km on the upstream side of a dam, which results in an acute shortage of water for irrigation as well as domestic water. There are two large farmers in the village who lift water from the area near the dam and deliver it to their 25 ha farms through a lift irrigation system.

There are some enterprising young smallholders who would like to get together and invest in a water supply scheme that would deliver domestic water to their homes and irrigation water to their farms, and earn income from the sale of domestic and irrigation water to other smallholders in the village. The major constraint they face is technology and capital for this scheme, but they have located a possible source of credit from the Sustainable Village, a development organisation in Colorado, USA, who asked IDE to help with the design of such a system. These young farmers are organised in a self help group by a local NGO - The Human Resource Development Group.

Hybrid System Solution

IDE has conducted several meetings with the farmers and identified six enterprising smallholders who are willing to invest in the scheme. They will be the private-sector owners of the hybrid system, and plan to sell irrigation water to 100 smallholders. Each smallholder will purchase and install a 4000 m^2 low-cost drip system at an approximate cost of US$ 150, and will grow vegetables, fruit trees, herbs, and other cash crops for the Nasik market.

The hybrid system will consist of an open dug well around 10 to15 m deep.
The 6 km pipeline will be designed as a telescopic line, starting with a larger diameter (around 6 inches) and then gradually reducing in diameter as the water gets distributed on the way. Each smallholder will have access to the mainline, and will install an elevated low cost water storage tank with a capacity of 10,000 litres costing around US$ 200. Farmers will irrigate their crops from the tank by gravity. Farmers whose homes are close to their farms can use their access to the pipeline to provide clean water for their households as well as their livestock. Farmers whose homes are in the village or at a distance from their farms will transport water for household use with bullock carts.

Since in IDE's experience it is not unusual for experienced cash-crop smallholders to earn net income of 50 cents (US) per m^2 (US$2,000 per acre) the suggested loan repayment schedules can be considered to be conservative.

Sustainable access on the part of participating smallholders to markets for their crops, good quality inputs, credit at a fair market price, information, and pest management will be critical to the successful operation of the hybrid system. The provision of training and support for participating smallholders in effective cash crop selection and diversification, agronomics, pest management, marketing strategy, and timely information will also be critical.

Projected capital cost for the hybrid system (in US$)

Estimated land acquisition cost for well location	US$4,000
Estimated dug well cost	US$1,000
Estimated cost for electric motor and pump	US$3,000
Estimated cost of pipeline	US$25,000
Cost of fittings, valves, connectors, etc.	US$2,000
Cost of trenching, pipe laying, head works etc.	US$5,000
Total estimated capital cost	**US$40,000**

Investment cost and returns for smallholders

One acre drip irrigation delivery system	US$150
Ten thousand litre tank	US$200
Initial input cost (seeds, fertilizer, pest management)	US$100
Total investment for each farmer	**US$400**
Estimated net annual return for each 1 acre farmer	US$800

Projected Annual Income and Expenses for Hybrid System

Estimated total installation cost for hybrid system	US$40,000
Total estimated annual income at user fee of US$150	US$15,000
Estimated annual operating expenses	US$ 1000
Estimated term for hybrid system loan	4 -5 yrs
Each farmer gets a loan to cover cost of drip system and initial inputs	US$ 400
Estimated annual payments by each farmer on loan	US$ 100
Estimated farmer loan payback period	4-5 years

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Productive water strategies for poverty reduction in Zimbabwe

Peter Robinson, Brian Mathew and David Proudfoot

Introduction

This chapter presents an overview of government-led approaches to rural water in Zimbabwe over recent decades, the factors inducing a shift towards multiple-use and productive water, and strategic responses by donor agencies, NGOs and private sector entities. Drawing on different perspectives from three earlier papers[1,2,] key social and technical issues associated with these new approaches are discussed. Readers are referred to the original papers for further details, particularly for a richer picture of productive water experience, including details from field visits and verbatim comments from people benefiting from productive water projects.

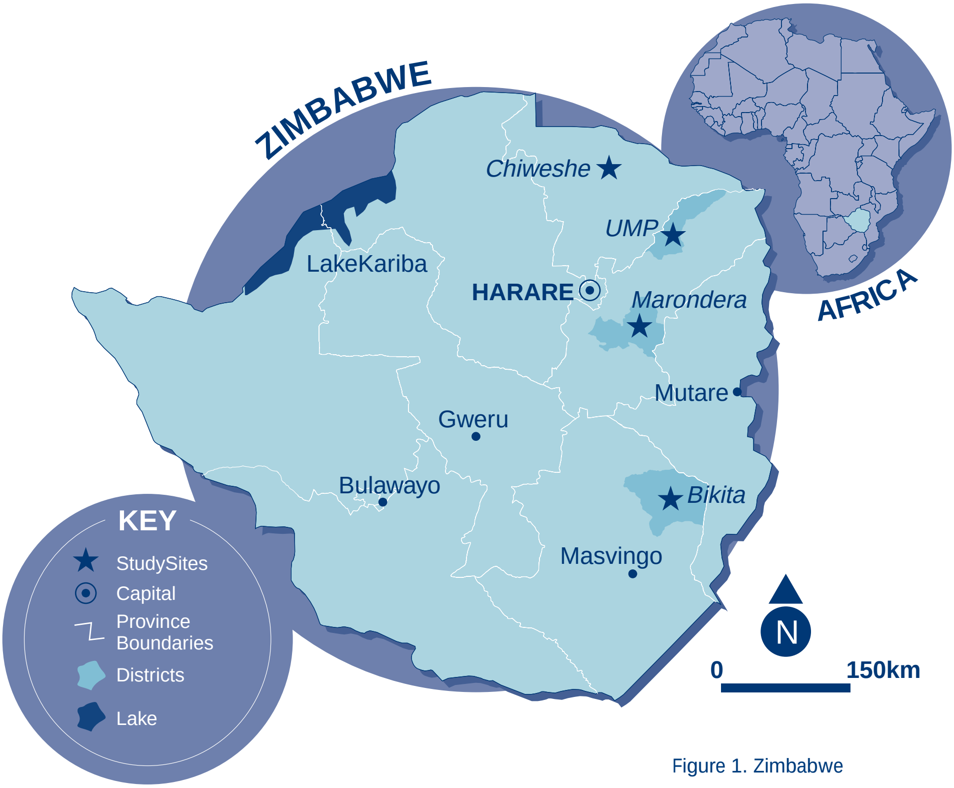

Figure 1. Zimbabwe

A brief history of approaches: domestic water and sanitation

Following the liberation struggle which led to the independence of Zimbabwe in 1980, clean water and sanitation for rural communities was one of the priorities of the new government. Independence coincided with the launch of the United Nations International Drinking Water Supply and Sanitation Decade (1981-1990), and

Zimbabwe was able to tap significant international support for its efforts. Consistent with the prevailing paradigm at that time, these programmes were mainly focused on narrowly conceived "health" benefits. These were typified by the claim that provision of clean water should make possible a reduction in water-related diseases of about 80% for typhoid and schistosomiasis and 50% for dysentery and diarrhoea in newborn babies (WHO, 1985).

It was, however, realised that it was not just water quality but also water quantity which mattered in achieving these health improvements, and that quantity in turn was dependent on accessibility. The principal aims of Zimbabwe's rural water supply programme were therefore to increase the quantity of safe water and to reduce the distance to these water supplies. The policy that was developed to meet these aims focused on communal waterpoints based upon groundwater sources. A borehole or deep well fitted with a reliable, locally manufactured, hand-pump (the Bush pump) became the standard technology option in the national programme.

The 1985 Rural Water Supply and Sanitation Masterplan set ambitious targets of

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1 This chapter was prepared by Peter Robinson based upon three earlier papers presented at the International Symposium on Water, Poverty and Productive uses of Water at the Household Level, 21-23 January 2003, South Africa by Mathew (2003), Proudfoot (2003) and Robinson (2003).

Mathew (2003) documents how a bilateral donor-funded (DFID) communal domestic water supply programme in Bikita District (1996-2000) was expanded to include productive water point gardens, and how these proved to be an important contributor to household food security in a subsequent period of drought (based upon follow-up research in August 2002 involving interviews, focus group discussions and participatory research).

Proudfoot (2003) documents how the Mvuramanzi Trust, a Zimbabwean NGO, has changed its approach in response to deepening poverty, developing new technologies for delivery of water for productive uses.

Robinson (2003) discusses the government's inability or unwillingness to incorporate the highly relevant approaches piloted by bilateral donors and NGOs in the sector into national programmes. In particular, the paper provides an analysis of the much greater and more equitable benefits which would arise from diverting resources from the government's preoccupation with conventional small-scale irrigation schemes to alternative productive water options.

2 The opportunity has also been taken to update the findings reported in these papers and to put the financial calculations on a uniform basis. With the economy being pushed into hyperinflation by poor macro-economic policies and distortion of the foreign exchange market, there are different exchange rates which can reasonably be used for converting costs and benefits into US dollar.

100% coverage in access to safe drinking water within 500 m of rural homesteads, together with Blair Ventilated Improved Pit [BVIP][3] toilets for all households. This was to involve the construction of some 35,000 primary water supply systems and 1.4 million BVIP latrines. The estimated cost was US$525 million, spread over a twenty year period.

In 1987, an inter-ministerial National Action Committee for Water and Sanitation [NAC] was established, supported by a secretariat (the National Coordination Unit) based in the Ministry of Local Government. At sub-national levels, Provincial and District Water Supply and Sanitation Sub-committees were established. A Co-ordination Handbook was prepared to provide guidelines for water and sanitation sector personnel on how to implement projects (NAC, 1998; NAC, 1998b). Despite this, the overall control of the water and sanitation programme remained in the hands of the sector ministries. The Ministry of Health was responsible for sanitation and shallow wells, including family wells (Box 1 summarises the different types of wells). The Ministry of Water Development and the District Development Fund [DDF – an agency under the Ministry of Local Government] were responsible for communal boreholes and deep wells. The Ministries of Agriculture, Local Government and Community Development were responsible for land use planning, mobilisation, finance and co-ordination of water and sanitation projects at national, provincial and district level.

Box 1. Different types of wells

Shallow wells: A shallow well is a well that is hand dug. These may be low or highyielding depending on the local ground water conditions.

Deep wells: A deep well is one in which the well is deepened by blasting with explosives to get a good source of water.

Family wells: Family wells can be shallow or deep depending on whether families employ a blasting expert. They are privately owned.

Boreholes: These are narrow drilled wells and are considered to be the most reliable sources. They are drilled normally to at least 40 m in depth and are usually communal sources of water.

3 The BVIP, as the name suggests, is a pit latrine with a vent pipe. Wind passing over the top of the vent pipe creates suction and removes foul odours from the pit. Any flies entering the toilet pit or breeding in the pit are attracted by the light coming down the vent. At the top of the vent a fly screen is fixed and prevents flies from leaving. The BVIP latrine not only acts as a flytrap but also as a barrier to the transmission of disease.

As a result of colonial land appropriation, the rural areas are sharply divided between commercial farming areas and communal areas. The Rural District Councils Act of 1988 attempted to start bridging the divide by amalgamating the Rural Councils (from the commercial farming areas) and District Councils (from the communal areas) into joint Rural District Councils [RDCs]. At the same time, new policies were brought in to change the way projects were to be implemented, with water supplies falling under the remit of the RDCs. The previous centralised system, whereby funds for activities were passed through line ministries to implement projects, changed to a decentralised system where the funds went to councils and then were allocated to implementing ministries to undertake activities on behalf of the councils. The Co-ordination Handbook was revised as the Integrated Rural Water Supply and Sanitation [IRWS&S] Management Handbook of 1998.

The national rural water and sanitation programme however continued to focus on providing clean water for domestic use from communal boreholes and deep wells and providing BVIPs to meet sanitation requirements. Activities related to rainwater harvesting, family wells and water from springs, as well as experimentation with alternative sanitation technologies, tended to be restricted to donor-funded and NGO projects. Piped water schemes were (and remain) the least preferred option for rural areas by all agencies, due to the high capital and maintenance costs of running such schemes.

A brief history of approaches: productive water

In the water component of the mainstream IRWS&S programme, the emphasis was almost entirely on the provision of safe water for drinking, cooking, washing and other household uses. Where boreholes were found to be sufficiently productive, the planting of gardens would be encouraged for cultivation of vegetables for home consumption, better nutrition being a further contribution to improved health status. However, there was never any systematic attempt in the national programme to identify the water requirements of rural communities other than for primary use. This was partly because the NAC had been given no responsibility in this area. Productive water provision fell under other agencies and ministries, notably the Department of Agricultural and Technical Services [AGRITEX], located in the Ministry of Agriculture.

In terms of promoting productive use of water, AGRITEX's approach was to provide formal irrigation schemes for groups of smallholder farmers (referred to as 'plotholders') mainly utilising surface water resources. The schemes typically involved building dams and flood or sprinkler irrigation technologies, the latter often needing large recurrent subsidies to pay for the pumping of water. There was also a high level of government extension effort, which, coupled with large direct subsidies, might be considered justified if the plotholder irrigation schemes had proved to be unambiguously viable and successful for the farmers involved. Unfortunately, while there are some schemes that have been clearly successful, significant levels of income from irrigation have not been achieved by the majority of plotholders. In a recent major study of 10 formal irrigation schemes, half had annual average incomes per farmer of less than US$420 (using an average 1997/98 season exchange rate of Z$14.4/US$). The best scheme had an average income per farmer of US$4,200 per annum (Tawonezi & Mudima, 2000).

Alternatives to the AGRITEX approach have been shown to produce comparable levels of income for the beneficiaries while involving much smaller initial capital outlays and no recurrent subsides. These have all been promoted by donor agencies, NGOs and private companies. Government has remained fixated on the old model. So much effort and attention has gone into relatively high technology formal irrigation schemes that, for many of the politicians and bureaucrats involved, the relevance of such schemes seems to have become an article of faith rather than an object of continuous scrutiny and economic analysis.

Factors inducing change

There is a widely held perception that the Zimbabwe rural water supply and sanitation strategy has been among the most successful of comparable programmes in developing countries. Indeed, while at independence only 38% of households living in the communal areas had access to safe water, by the time of the Central Statistics Office 1995/96 Income Consumption and Expenditure Survey, the figure had risen to 59% (CSO, 1998). Progress in sanitation, though more modest, has also been impressive. However, rapid economic decline both at household and national level have clearly shown that improved water and sanitation have in no way prevented increasing poverty. Furthermore, there are now grave doubts about the sustainability of the RWS&S programme.

The situation in respect of the AGRITEX small-holder irrigation schemes is even more dire. Despite expansion and replication of these schemes being prominent in government promises, by 1999 the total number of families on plotholder irrigation schemes amounted to about 20,000, or just 2% of the total households at that time (the communal population was around 5.8 million or about 970,000 households in 1999). Since that time, the chaotic land reform programme launched in 2000 has led to neglect of the small-scale irrigation sector, with schemes involving pumping of water being particularly hard hit. Not only have subsidies been reduced in real terms, there have been national shortages of fuel and electricity, as well as shortages of seeds and fertilisers, and more than usual difficulties in obtaining transport of products to markets.

The negative factors in the current environment that challenge the established rural water paradigms, include the following:

- Poverty: Already by 1995, a national poverty survey classified 88% of communal people as being poor, with female-headed households having a higher prevalence of poverty (CSO, 1998). Since that time, poverty has increased catastrophically in both extent and depth. In 2003, the economy is in its sixth successive year of negative GDP growth. By the end of 2003, GDP per capita was projected to be 40% below 1999 levels. Unemployment is at record levels (70%-80%), with 400,000 people having lost formal sector jobs since 1999 (when total formal employment was 1,316,000). Around half the population is dependent on food handouts for survival.

- HIV/AIDS: According to the latest UNAIDS statistics, 33.7% of the adult population are HIV positive and 780,000 children in Zimbabwe have lost either one or both parents. During 2001, an estimated 200,000 people died of HIV/AIDS in Zimbabwe, many of them educated, productive adults. A large proportion of rural households have chronically sick people and/or are hosting orphans. It is these households that are particularly food insecure. This exacerbates the condition of HIV/AIDS sufferers, as the symptoms and vulnerability to opportunistic infections can be greatly reduced if patients have nutritious food in adequate quantities.

- Budget provisions for rural water: At the national level, budgetary allocations for the maintenance of rural water infrastructure have been cut dramatically in real terms. The official rationale for such cuts has been the promotion of community-based maintenance [CBM] as the solution to the problem of pump breakdowns and greater community responsibility for meeting pumping costs and maintenance on AGRITEX irrigation schemes. However, besides a variety of practical problems with community maintenance in a Zimbabwe context, the requirement for communities to assume responsibility comes at a time when their resources are more stretched than ever.

The above realities have resulted in considerable pressures for change in the nature and focus of Zimbabwe's rural water and sanitation programme. Economic collapse, growing poverty and the HIV/AIDS pandemic have forced viable rural households into increasingly desperate 'coping strategies' in order to survive[4]. This situation cries out for rural poverty to be tackled directly at its roots by shifting and expanding the emphasis in rural water from safe supplies for domestic needs, and moving away from providing a small number of households with access to plots on formal irrigation schemes to strategies that provide productive water on an equitable basis for the overwhelming majority of rural families.

Coupled with assistance in other areas (input supplies, marketing), this would enable rural households to enhance their production of food and, ideally, also provide commodities to sell, thereby improving cash income. By changing the paradigm from a narrowly defined health focus to one which puts 'productive water first', households and communities will achieve improved food security, increased incomes and better health status. One of the consequential benefits is that they will be better placed themselves to take care of their safe water and sanitation needs, thereby allaying concerns about the lack of sustainability of previous rural water supply and sanitation technologies installed through government, donor and NGO projects.

Despite the severity of the crisis in Zimbabwe, the government has so far remained within the old policy framework. To date, the successful alternatives that are described in the remainder of this paper have all been promoted by agencies outside government.

Productive water responses

Bikita - adapting a communal domestic water programme

Bikita district covers an area of approximately 10,000 km^2, and has a population of around 200,000 people. About 80% of the district is classified as belonging to the poorer endowed natural regions (4 & 5), with mean annual rainfall ranging from 400mm to 700mm. The district was hard hit by the 1992 drought, which was of once-in-a-century severity. In response, the UK Department for International Development (DFID) provided emergency assistance for water supply to the communal areas of the district through the NGO WaterAid. This was followed in 1996 by the Bikita Integrated Rural Water Supply and Sanitation [BIRWSS] Project, which was also funded by DFID. This project, which came under the National IRWSS Programme, was decentralised to and managed by the Bikita Rural District Council, with support from the district offices of agricultural extension [AGRITEX], health, environment, community development and the District Development Fund's water department. The project came to an end in December 2002.

The BIRWSS project's main aims were the provision of safe domestic water supplies, sanitation and health education. However, recognising the importance of productive water, the project also promoted productive water point gardens. These were

4 A survey in rural Zimbabwe conducted in March 2003 found that 'Over half of households report borrowing food, borrowing money to buy food, or buying food on credit during the last 30 days. Over three-quarters of households are reducing the number of meals they eat every day. A large percentage of households skip entire days of eating at least 1-2 times per week. Households regularly reduce the amount of food for adults so that children can eat normally' (C-SAFE, 2003).

regarded as pilot sub-projects to diversify livelihood strategies and move away from valuing water solely for domestic purposes. A high yielding water point was considered ‘productive’ when it had the capacity to deliver more water than was needed for the domestic uses of the community it served. In total, 33 communities who were managing their high yielding water points effectively and had suitable land available were offered the opportunity to establish irrigated community gardens. The project also supported a significant number of households to upgrade their family wells, many of which were also used to water vegetable gardens.

At the time of the evaluation of the project in August 2002, conditions in the district were severe. The 2001/02 rainy season had been extremely poor for agriculture. Early rains, which allowed seed to germinate, were followed by a prolonged period of drought. When the rains did come, they were too late and of insufficient duration to sustain another crop. The result was a total crop failure across the district and much of the country. The rain was, however, sufficient for wild grasses to grow and this has helped to maintain the cattle stocks of the area, unlike the drought of 1991/92. The problems of crop failure were exacerbated by the national political and economic crisis. High inflation had made the purchase of basic necessities, including grain, increasingly unaffordable.

Research clearly demonstrated that the productive water point gardens were of great importance to the participants. This was particularly so in the wake of the 2001/02 drought, as the produce from the gardens became a crucial part of coping strategies of families, not least for exceptionally vulnerable households such as those with grandparents looking after HIV/AIDS orphans. In addition, the gardens also proved to be newly established means of production within the communities, and it seems likely that they will be maintained for the betterment of the lives of the members. The value of production on the schemes was found to vary between US$2,500 and US$8,000 per hectare, this translating to annual gross income for participants varying between US$18 and US$80 per annum per family.

The intervention was found to be to a significant extent ‘pro-poor’, assisting the poorest members of the community more than the wealthy. The processes that allowed the gardens to be sustainable were found to be related to collective ownership and the development of a common purpose. Recognition within communities of the value of the social capital that materialises from working collectively itself appears to have become an incentive to work together and make the gardens a success. The unity amongst members is exhibited in joint working on plots, sharing of inputs and management duties.

Further analysis of the Bikita productive water point projects is given later and full details are available in Mathew (2003).

Mvuramanzi Trust – extending and diversifying household water programmes

The problems now so evident in the national water and sanitation programme were anticipated in the early 1990s by staff of the government's health research unit (the Blair Research Laboratory). Solutions were sought which would be less expensive in terms of initial investment costs and would give a high degree of assurance on sustainability over the long run. The most successful option that was developed at Blair, and subsequently tried and tested by the same team working outside government as the Mvuramanzi Trust, was the upgraded family well.

In most cases, upgraded family wells are used both to provide water for domestic purposes and to water a garden of vegetables for the home. Given a choice of communal or household water supplies, most families in the Trust's experience opt for the upgraded family well because it is more convenient in providing water closer to the home for a variety of purposes. Since family wells provide easy access to water supplies, the family tend to use more water, especially for bathing and washing. As well as gardening, the water is sometimes used for other productive purposes, such as beer brewing and watering small livestock.

However, where water is required in larger volumes, for activities such as brick making or market gardening, these activities are usually done away from the homestead near a river or dam (or occasionally a spring) where the families collect the water in buckets and cans. In meetings with families it is clear that a large amount of women's time is often spent lifting and carrying water to such gardens. There was need to find a pump that had a high extraction rate as well as being affordable and easily maintained by the farmers themselves.

About two years ago, the Trust identified the rope pump as a possible option for reducing labour burdens on farmers. The first trials conducted by the Trust were in Marondera District. The families were delighted with the pump and could immediately see the advantages, such as less time to carry water and the ability to pump water into a tank and then use a hosepipe to irrigate their gardens. A subsequent refinement has been to add a low cost drip irrigation system to the technology package, so that plants can be watered on a drip-feed basis once the supply tank has been filled using the rope pump. Details of these technologies are given later. What follows here is a brief overview of experience to date with field trials of the rope pumps and drip irrigation systems - a complete account is available in Proudfoot (2003).

The Marondera rope pump project involved just 4 families, chosen on the basis that they were dependent on subsistence farming, were caring for orphans and had access to open wells which were being used to water gardens. The project demonstrated the suitability, effectiveness and social acceptability of the rope pump and showed that with increased water availability, the families could improve their crop yields, food security and incomes.

Insufficient data is available to make precise calculations about financial returns from these schemes, but the indications are that revenues vary widely between US$500 and US$5,000 per hectare. Returns per household will depend on the crop mix chosen, the area planted and costs incurred. The revenue figures are based in part on data on returns to family members with access to a spring, who were assisted to exploit this water for productive purposes in the form of 200 m of 50 mm piping, help with protection of the spring and construction of a brick water tank.

Mvuramanzi's drip-feed irrigation pilot projects have in several cases been carried out collaboratively with the Uzumba Orphan Trust. Ten drip-feed irrigation systems, together with training and a seed pack for a $100m^2$ garden, have been installed in Uzumba Maramba Pfungwe (UMP) District. One of the recipients, Chitimbe School, provides a good example of the positive benefits. Before the donation of the drip-fed irrigation scheme the school garden was used mainly for growing vegetables for the teachers. Not much benefit was derived for the school because of the labour requirements for watering the garden. The school has now set targets for the garden, based on expected harvests and clear plans for cropping patterns to produce crops for consumption and for sale. While the scheme is in its infancy, a trend has clearly been set that will benefit the school in generating income for the procurement of educational materials. UMP district has a high incidence of bilharzia among school children and this may partly explain why a lot of children sleep in class. The drip-fed irrigation scheme reduces contact with water and may help reduce incidences of infection among children, especially if similar technologies were adopted in home gardens.

Market access - enabling high value-added crops

The frequent lack of viability of the AGRITEX small-scale irrigation schemes is often directly attributable to plotholders growing low value subsistence crops, rather than the sort of high value commodities which could generate margins commensurate with the capital investment and recurrent subsidies put into these schemes. In devising options for individual farmers with access only to water from wells, the choice of crops to take advantage of the best market opportunities is a crucial factor to consider. By concentrating on producing high value commodities, even farmers with limited water and hence only small irrigated areas can still generate incomes that are comparable with their counterparts in the formal schemes.

In Zimbabwe, rather than NGOs, the crucial intermediaries in enabling access to high value crops have been private marketing companies such as Hortico, Olivine, Selby and Shona Products. Perhaps the most successful communal area smallholder outgrower scheme is run by Hortico, a company formed initially to export horticultural produce from the large-scale commercial farming sector to European markets. Seeking to expand and diversify its production base, Hortico initially approached groups on some of AGRITEX's formal schemes, but had mixed experience with these plotholders. Not only was the water supply and hence continuity of production frequently disrupted, but there were disputes about the grading of produce and sharing of income.

Hortico then developed a system of working with individual communal families. Working in 2002 with about 3,000 communal households, Hortico has a network of small depots, each located close to 200 farmers, with the depots feeding one of two main packhouses from which produce is sent ready packed and labelled directly to supermarket shelves in the UK. The crops produced include sweetcorn, babycorn, mangetout, fine beans, butternut and hot chillies.

Hortico addresses all the constraints the farmer faces (except water availability) in a systematic fashion: it invites farmers to produce crops which have high margins; it provides packs of all the inputs required for a specified production area (carefully weighed quantities of seed, fertilisers and crop chemicals); it trains local extension staff to assist the farmer in producing the crop; it provides on-the-spot grading and payment when the crop is brought to the local collection centre; and it completes the cycle with provision of transport, packaging and exportation.

The areas specified for production vary by crop, but are small (300 to 600m^2). Farmers are initially allowed to produce only one crop at a time. The inputs are actually a loan and there has to be confidence about the farmer's commitment and ability before the level of loan is increased. If limited to hand-watering, returns are clearly going to be limited. A household with 2-3 people to water using buckets from a well can readily manage a plot of 300 m^2 (0.03 ha) at a watering rate of 25 mm per week, but double this size is difficult. However, the addition of a simple rope and washer pump effectively increases watering capacity from 0.1 litres per second to around 1 litre per second. This makes it possible to water an area of at least 2,400 m^2 (0.24 ha) – eight times the area that can be managed with buckets, with eight times the returns. Well organised, hard-working farmers can irrigate even larger areas and achieve even higher incomes.

Potential for enhanced incomes through growing high value crops does not only lie in horticultural export markets. There are also remunerative opportunities in the domestic market, particularly for exotic crops such as garlic and English cucumbers, but also for more conventional vegetables and fruit previously supplied to domestic markets by the large-scale commercial farms. The importance of designing income-enhancement strategies by starting at the market and working back to the production and input requirements has been recognised and supported by a number of donor-funded initiatives in Zimbabwe, including at present a Dutch NGO "Crop Enterprise Support Project" and a USAID promoted project called "Linkages for the Economic Advancement of the Disadvantaged" [LEAD]. These projects are opening new opportunities for communal production and marketing of paprika, chillies, granadilla and black-eyed peas.

Water delivery technologies

Bush pump

As mentioned earlier, the recommended handpump for boreholes and deep wells in Zimbabwe is the locally manufactured 'bush pump'. Drilling and complete installation of a borehole and bush pump costs US$1,500-2,000. Of this amount, the beneficiary communities usually provide almost nothing.

Pump standardisation has important advantages for maintenance. The bush pump was designed for rural conditions and has proved to be very robust and reliable, requiring relatively little maintenance. On the pump head, it is important to ensure that all bolts are kept tight and to carry out inspections for wear. After about three years, it may be necessary to change floating washers in the pump head and after about a decade it may be necessary to change the hardwood bearing block. The 'down the hole' parts require most of the maintenance and include replacing worn seals and attention to faulty pistons, worn pump rods, worn rising main, faulty foot valves and faulty and worn cylinders. Depending on the number of users of the handpump, it should take about two years before the seals need changing (Morgan, 1996).

The original design was such that raising the below-ground components required specialised equipment and communities were thus dependent on DDF for major repairs. To facilitate community-based maintenance, a new design, the B-type extractable bush pump, was developed and gradually introduced in projects such as the Bikita IRWS&S project. The extractable bush pump is designed to have the piston removed by pulling its hook-and-eye-connected pump rods up the rising main, facilitating the ease of rubber seal replacement on the piston. This can readily be done by community members, the whole operation typically taking less than half an hour. One problem that has arisen with the new design (as reported in Mathew, 2003) is that aggressive water results in eating away of the rods, especially the hook connection. It is likely that the damage to the rod linkages in some B-type extractable pumps will eventually cause major problems, leading to the need for expensive repairs.

In terms of the efficiency of using human labour to pump water, it has been said that handpumps can restrict the productive potential of the water points they are fitted to, effectively limiting the productive capacity of high yielding boreholes and wells. However, the bush pump's main advantage is that it is made in Zimbabwe and does not require fuel to operate it. Although supply chains do break down, spare parts are generally available at community level and poor rural communities are able to operate and maintain the pump. One of the implications of using existing domestic communal water points for providing water to productive water point gardens is that there will be more wear and tear on the pumps, and thus the cost of maintenance will be greater.

A question addressed in the Bikita project evaluation was whether increased maintenance is likely to be a problem in the future. If communities acknowledge the increased importance of their pumps, because they are using them for their gardens as well as their domestic requirements, there could be a strong incentive to ensure that the pumps are kept operational. The productive capacity of the garden itself generates financial capital, which can be used to pay for repairs and maintenance. The acknowledgement by a community of the enhanced use of a water pump may lead to greater funds being made available for pump maintenance, to the benefit of all, garden members and non-members alike.

The Bikita evaluation report included positive findings about the current performance of the bush pumps. Indeed, the report comes to the somewhat ironical conclusion that bush pump maintenance has become a victim of its own success. "The bush pumps that we visited were, apart from one, in good shape and had given long years of service. We found one A type bush pump which had repairs made on it in January 2002 (a section of new 2" pipe had been fitted along with two new leather cups), but prior to this had been operating continuously since its installation without any breakdowns for 14 years. When pumps are as reliable as this, there must be some question within communities over what function a water point user committee actually has, and so perhaps not surprisingly many committees become inactive and forget to supervise the less important task of keeping the surround clean." In the case of the one garden which did have a poorly functioning pump, the community had failed to repair the pump because the pump committee was no longer organised and motivated and the members could get by with alternative sources of water.

Bikita typifies a district where DDF responsibility for maintenance has officially been replaced by community-based management [CBM]. Water point user committees have been trained to manage their water points, raising funds for spare parts and spotting problems as they arise. Teams of community bush pump mechanics have been trained from all the village development committees [VIDCOs] in the district, to take apart and replace broken seals and other parts and keep the pumps in good working order. In addition, the District Development Fund's Water Department have 9 'pump minders' equipped with bicycles and tools to provide more specialised assistance should the need arise.

The problem with this 'ideal' is that the community bush pump mechanics often get little chance to undertake repairs because of the reliability of the pumps. This means they forget how to do the repairs and lose confidence in their own abilities. Many refuse to undertake repairs without the presence of the DDF pump minders. The bush pump mechanics also expect to be paid for their services, and this can lead to disputes and problems when the water committees don't want to pay them. The latest problem to hit CBM in the district was when DDF decided in May 2002 to lay off the entire pump minder staff. These highly experienced individuals have day-in-day-out knowledge of the pumps and the communities. By laying them off, the safety net for the maintenance of village water supplies has effectively been lost. It was suggested and agreed that the RDC pay the salaries of the pump minders, though whether this will be accepted as a long term solution remains to be seen.

Family wells, the rope pump and other pump options

Shallow wells are traditional water sources throughout Zimbabwe. Often they are not lined, resulting in collapse, and are not protected so water quality can be poor. Upgraded family wells are based upon improvement of these wells, rather than replacement with different communal sources and technologies. The upgraded family well is a lined well about a metre in diameter, with an apron, a tin lid, and supports for a windlass, chain (rope) and bucket. Mvuramanzi Trust, in its family well programme, typically provides the family with technical training on upgrading, material support in the form of 3 bags of cement for well lining, the windlass and the tin lid. The direct material support (excluding transport) is worth about US$15-US$20, which is around 15%-30% of the cost of upgrading the well. The family's contribution is normally the digging of the well, paying the builder, providing the bricks, sand and reinforcing wire. This contribution is estimated to be between US$50 and US$80 depending on the depth of the well, sophistication of the lining and rate paid to the builder.

The rope pump was developed to allow people to draw higher volumes of water from such family wells, whether protected wells installed primarily for domestic use or other unprotected wells close to lands suitable for cultivation. Pumping is not unduly arduous from a rope-and-washer pump, while the total cost is only about US$60-US$120 (depending on whether the well digging and lining is included - see Box 2). These pumps are intended for family use and are designed to allow the family to carry out all the maintenance on the pumps. The materials used are all readily available and farmers for whom this technology is providing additional income will ensure that it is kept in working condition.

Box 2. Costs for a well with rope pump

Well digging and lining down to 12 m	US$ 60
Windlass	US$ 6
15 m of 50 mm class 10 pvc	US$ 9
30 m of 8 mm nylon rope	US$ 4
20 bags cement for storage tank	US$ 17
4 gate valves, 40 m poly-pipe, 4 b/nipples	US$ 24
Total - rope pump only	**US$ 60**
Total - well and pump	**US$120**

Mvuramanzi's experience in supporting families to install and use rope pumps in Marondera shows that, if installed on protected wells, these pumps can help provide good clean drinking water to households. In such circumstances, the extra water that can easily be extracted once the pump is installed is used for productive activities, especially gardening. The pumps can also be used on an incline to draw water from ponds, dams and rivers. The feedback from the Marondera projects indicates that families are happy with the pumps, especially the high extraction capabilities. It is important to consider the yield of the well when installing these pumps and on low-yielding wells the family should settle for a bucket and windlass. The other option that some families have taken is to deepen the existing well or dig a new well before installing a rope pump.

The rope pump is by no means the only technology available for improving access to water at the household level. Other hand-driven options include sand abstraction pumps deployed in the sandy rivers of Matabeleland, and treadle pumps. There are also externally powered pumps (photovoltaics and small petrol or diesel pumps). In respect of treadle pumps, for example, there are at least three companies in Zimbabwe manufacturing localised versions of a pump which is very widely used in other countries (such as Bangladesh, Kenya, Malawi and Zambia). The treadle pump in Zimbabwe is more expensive than a rope pump (including piping, it is about one and a half times the price), but has the advantage that it can pump water into a reservoir above the pump level for gravity feed or via a hosepipe directly to the field. Although the focus in this paper is on groundwater, all the pumps mentioned are also used to lift water from surface water sources in various parts of Zimbabwe.

Drip-feed irrigation

The drip-feed irrigation kits being piloted by Mvuramanzi Trust have been tried out in many developing country settings[5]. A typical configuration in Zimbabwe starts with a rope pump fitted to a well or pond. The water is pumped into a 200 litre metal drum, from which a 110 litre storage tank for the irrigation system is filled.

From the storage tank, the water passes through a filter and then is distributed directly to the plants via the drip tubes. In the case of the installation at Chitimbe School, the 110 litre plastic water tank is removed each evening from the garden, as the teachers believe it would otherwise be stolen. The Trust was informed that the tank is ideal for dispensing traditional brewed beer, as it comes with a tap!

The purpose of drip-irrigation systems is to provide water directly to plants and thus save water by minimising wasteful evaporation from the soil. The other perceived benefit is reduced labour requirements since, once the system is in place, the water storage tank is filled, and it is confirmed that the system is supplying water to all the plants, the operator is free to carry out other activities. Operation of the system does require some new skills in which the Trust provides training. The cost of the tank, filter and feeder lines (which are assembled locally from imported components) is between US$25 and US$40 per system.

Experience to date is short. Initial indications of performance and social acceptability are mixed, in part because many of the kits have been distributed to HIV/AIDS families who have been grappling with many problems and have not always given the drip systems the attention required. Families who have used the drip-irrigation systems successfully have a clear understanding of the value in terms of labour saving and water conservation. The skills to operate and maintain the systems can be readily acquired when people are motivated to learn. In UMP and Chiweshe Districts, for example, families have been observed operating their drip-irrigation systems with ease. In other cases, there have been problems, resulting in farmers resorting to using watering cans in addition to the irrigation systems. It may be that some families will find it easier to water vegetables with watering cans and hosepipes, as is the practice in the Marondera rope pump project.

AGRITEX communal irrigation schemes

This section presents a comparison of the costs of the conventional AGRITEX small-scale irrigation schemes with the family well and rope pump option. The orientation is a forward-looking one, comparing the costs of the government's declared policy of expanding irrigation through building two medium-sized dams per district per annum, along with associated small-scale irrigation schemes (which also absorb on-going recurrent subsidies) with the alternative of using the same funds for an alternative approach. The comparison is between a relatively high-technology approach to irrigation and a much more equity-oriented solution (with many more beneficiaries), based on simple technologies.

The medium-sized dam plus irrigation scheme option has been costed on a unit basis

5 See Polak et al. (Chapter 7).

at around US$3.6 million for a 400 ha scheme benefiting 400 families, that is a capital cost of US$9,000 per family with 95% of this (US$8,550) being financed by some form of subsidy. Plotholders' domestic water needs would typically need to be met by additional investments. By comparison, the unit cost of an upgraded family well and 0.03 ha homestead garden would be US$50-100 per family, with only US$10-20 being subsidised. For the purposes of the calculations in this section, the upper values of these ranges have been assumed.

The addition of a simple water lifting device, such as a rope and washer pump, would conservatively require a capital outlay of about another US$100, with perhaps 80% being subsidised (or extended as a loan to the recipient). bringing the total investment cost per family to US$200 for an irrigable area of 0,24 ha. The costings are necessarily notional, because (as discussed in the previous section) in practice families are likely to have an upgraded well for domestic purposes and have a different well or wells for production purposes. If the productive well(s) have to be deeper and lined, the cost would be considerably higher than quoted. On the other hand, if there is readily available groundwater or the pump is fitted to the upgraded well, the additional cost could be kept below US$60 (see Box 2).

The cost comparison is carried out over a project horizon of 25 years. The result of the capital costs per household of the family well option being only 1%-2% of that for the formal scheme is that the number of beneficiaries of the more equitable water strategy (including one pump per family) could grow to 56,000 by the end of the planning horizon. Assuming that modest returns of US$700 per hectare remain the norm for the rope pump families, while income rises at 6% pa on the formal schemes, by the end of the period average returns for each of the 400 plotholders in the formal scheme are much higher than those assumed for the equitable strategy (US$2,118 per year as compared with US$168 per year). Nonetheless, the total income (on a net present value basis) from the formal scheme is only US$0.8 million as compared with US$9.4 million in aggregate for the equitable strategy where many more families are included. It is evident that a large proportion of the equitable scheme participants would be women, whereas the AGRITEX schemes typically have men registered as the official plotholders, even if much of the work is in fact done by the unacknowledged women.

With the equitable option having 140 times as many beneficiaries (with a high proportion of women) and 59 times the net income (as reflected in the net present value calculations), there would seem to be no justification at all for choosing the conventional route[6]. There are also no environmental disadvantages - rope pumps do not pose any major threat of the water table being lowered on a regional scale. Yet prejudices in favour of high technology solutions, and spurious notions of equity (exemplified, by 'two dams per district', irrespective of relative hydrological and agronomic suitability in different parts of the country) remain entrenched in the policy positions of the incumbent government.

Social and economic issues

Participation and targeting

In the Bikita project discussed earlier, the choice of villages was made on the basis of the following three criteria:

1. The village needed to have a water point that was capable of providing sufficient water over and above that required for domestic purposes.

2. The village had to have an active water committee with a banked water maintenance fund.

3. Suitable land had to be available in close proximity to the water point, with the full agreement of the whole community.

In the evaluation, a major focus of interest was to determine how people benefited in households with different levels of resource base. The divisions considered were between households with cattle, those with goats but no cattle and those with neither goats nor cattle. This simple method of categorisation proved to be usefully correlated to various indicators of relative household wealth. In all rural development initiatives, wealthier households are generally able to take greater advantage than poorer households. A key element of the Bikita productive water point project – that allocation of garden plots was the same for each household irrespective of household size or influence – meant that the poorest members of the gardens were benefiting proportionately more than the wealthier cattle owners with their generally larger households. This and other aspects of the evaluation indicate that the gardens did have a significant pro-poor bias.

The study indicated that garden membership was made up of a fair cross-section of the community, including the poorest, many of whom are from female-headed households (divorced or deceased husbands) with no rainfed fields at all. The reason why people decided to join gardens seemed to depend on their personal willingness to work alongside others and their perception of how doing so might lead to a better, or at least more secure, life. Destitute people may have been excluded from the gardens, but there was no evidence of this during the research and many obviously extremely poor people had joined the gardens.

6 More detail on the assumptions and calculations is available in Robinson (2003).

The Mvuramanzi paper documents the approach the Trust has had in the past to working with people and communities and analyses the changes that are now necessary. In its traditional mode of working in a district to promote water, hygiene education and sanitation, the Trust's main interaction is with the Rural District Council (RDC) and the Ministry of Health and Child Welfare (MoHCW). The RDC has Ward Councillors who represent the community at ward and village level and the MoHCW has Environmental Health Technicians (EHTs) at ward level. The EHTs work at village level through the village community and health workers. The Trust relies on these people to mobilise the community to participate in projects and this is usually done through meetings. The majority of the projects have a high level of householder participation. An example of this is the upgraded well project where families dig the well, line the well and pay the builder. Using this approach, in ten years the Trust has been able to achieve over 33,000 upgraded family wells.

In a situation where orphans are the focus for water and sanitation projects, it is not possible to use these established methods of participation. For example, if a meeting is held for identification purposes, it is unlikely that it will attract orphans or those looking after the orphans. Even if it does it would be the wrong venue to discuss their problems. In the UMP district, the Trust was able to identify orphans through the Uzumba Orphan Trust, which kept records of families. By using their records and an information base, Mvuramanzi could build a profile of these families.

In Chiweshe District, the Trust is implementing an orphan-oriented project but does not have an NGO such as Uzumba Orphan Trust to work through. Out of ten beneficiary households identified, it was found that four families did not fully meet the criteria. A more appropriate methodology for identifying the poor (and orphaned) families urgently needs to be developed to replace the normal approach of calling people to a meeting that is likely to attract the better off families - even though they could be classified as poor. For a more transparent process of selection, a promising direction is to involve the Councillor, the environmental health technician, village community and health workers together to analyse and discuss the situation and comment on any information sheets which may be available. This will help not just to prioritise families, but to give a better idea of the specific forms of assistance that families need.

Choice of crops

Once family nutritional needs have been met, increasing income from access to productive water depends crucially on households growing crops which give the highest returns from scarce inputs, which are usually water and labour. A major attraction of being an outgrower for a horticultural export company (as described above) is that the farmer can concentrate on farming, and not spend large amounts of time on procuring inputs for production and subsequently marketing the produce.

However, those willing to understand and produce for the local market, without the sort of tailored assistance the exporting companies offer, could well end up with even higher rewards.

The experience documented in the Bikita and Mvuramanzi papers illustrates, however, that for farmers in very vulnerable situations decisions about crop mix are heavily influenced by perceptions of risk and severely downplay potential returns. In the Marondera case studies, families are growing rape (kale) because they see it as a low risk crop. They do not have to buy seed as they plant from cuttings and they use organic fertilisers and compost. The investment in the crop is low and they hope that the market prices will allow them to survive. Families only begin to grow higher value crops when they feel their income is secure. If assistance is to be provided, it is important to consult with families on possible crops to grow and the type of income they can expect, as well as a risk assessment. The church group in UMP district was able to identify cucumbers as a crop that could be grown in a short time and provide cash to support some of their orphans.

Communal versus household interventions

The basis for the development of the upgraded family well was the observation that the key to the success of Zimbabwe's sanitation programme lay in the Blair latrine being owned and maintained by the individual household, rather than by the community at large. For similar reasons of ownership and commitment, working with individual households has proved a very successful strategy for horticultural exporting companies such as Hortico.

Success in these areas has led Mvuramanzi Trust, in its productive water programme, to develop family-oriented technologies (notably the rope pump) and to advocate a personalised project strategy, whereby each householder becomes central to the design of his or her water supply project. If the new approach is to be successful, it will require training to develop capacity in water sector organisations. It will take more time to identify and work out a plan of how to deliver water supplies to families. However, the end result should be a water supply that is in line with what families would like see in place and that families are committed to using to full potential and maintaining over the long haul.

This strong family orientation should not preclude other options. As clearly illustrated by the Bikita paper, the addition of communal gardens to a communal domestic-water oriented programme has resulted in considerable benefits for the participants, including evidence of communities working effectively together. One of the main limiting factors in the Bikita case was whether a communal water point was sufficiently productive to warrant the addition of a garden. For future communal borehole projects, this should be reversed into a design criterion requiring wherever possible that boreholes be sited and designed to provide sufficient water for productive as well as domestic uses. Without this requirement, many potentially productive possibilities will likely be foregone.

As the Bikita example also shows, having a communal focus should not preclude giving assistance to households with family wells. The owners of two up-graded family wells visited during the Bikita evaluation were found to be better off than most of the communal gardeners, with more land for rainfed agriculture, more livestock and more vegetable beds. This in part reflected the relative wealthy status of households who had invested in upgrading family wells. During the drought, one of the family well households had increased vending of vegetables to generate cash to buy grain, while the other had increased home consumption of garden produce. Both emphasised the increased importance for their livelihoods of being able to water their gardens during the drought.

Conclusions

Traditional water and sanitation programmes, of which Zimbabwe's is supposedly one of the most successful examples, have a narrowly conceived health orientation. They do not in themselves contribute to reduction of rural poverty and can in fact be progressively undermined by economic failure at the national level. Any serious concern with issues of poverty, equity, the impact of the HIV/AIDS pandemic, improved gender equality and improved health status must lead to a paradigm shift that emphasises access to productive water and investment resources being used to provide opportunities for the largest number of beneficiaries.

This can take a number of different forms. The Bikita communal gardens project has useful lessons for communities in other places where rainfall is unreliable, but existing communal water supplies can do more than provide for drinking, cooking and washing requirements. Such water supplies can, if the conditions are right, be used for productive water point gardens. What are the required conditions? Communities must be fully involved from the outset and empowered to take advantage of what is available, in a spirit of unity and equality. Prior to work commencing, there must be full agreement of all parties over the change in the use of the land, and all plots held by members within the garden should be of the same size. Taking conventional domestic water supplies and using them to supply water for gardens is already a reality, scaling up is the next thing to be done.

In the household-level approach to productive water being advocated by the Mvuramanzi Trust, the immediate objective is also to improve food security for the family, either through direct food availability or increased income. Initial successes in the programme have resulted from treating households as specific planning units and moving away from the blanket approach in which community needs are taken as uniform. Some HIV/AIDS-affected families and orphans are so poor that they need special assistance. However, the programme has also demonstrated that, with adequate support, food security in such households can be improved with contributions from other families. The provision of safe drinking water and sanitation facilities is not sufficient in itself to improve the health and living conditions of the poor. Rather, people need multi-purpose water supplies that enable them to grow food and earn money.

The studies summarised in this chapter provide encouraging evidence on what can be achieved at low cost and with more than reasonable prospects of being sustainable. In the case of communal gardens dependent on boreholes, additional maintenance requirements arising from more intensive use of the pumps may cause problems in the future. On the other hand, if the gardens remain important contributors to family welfare there will be strong incentives for the pumps to be maintained.

Another problem is the risk of exacerbating social differentiation. Care needs to be exercised in ensuring participation by all strata in the projects, where feasible giving preference to the poorest households but without prejudicing the options of families who may be better placed to take advantage of productive water. The gradations are relative, as almost all households in the communal areas of Zimbabwe are poor in absolute terms. The issue of choice of crops, which on paper is a strong determinant of the returns which can be achieved from productive water, needs to be handled with sensitivity, as farmers need also to take into account the riskiness of different cropping mixes. Here too, the better-off farmers are in a stronger position to take on risk and are thus likely on average to reap higher rewards than poorer farmers.

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Linking water supply and rural enterprise: issues and illustrations from India

A.J. James

Summary

This chapter draws on two studies carried out in India: one in Banaskantha district in Gujarat; and the other in Anantapur district in Andhra Pradesh. It makes four key arguments.

(1) People can transform water into money through time saved

Improved domestic water supply can reduce water collection time – which can be used in rural enterprises to generate income. This increased income can reduce poverty and empower women to participate more in decision-making in their households. Also, women feel this income is special, because it is earned outside the cropping season and it is drawn upon to survive in crises (droughts, illness, emergencies, etc.).

(2) Economic and social benefits of domestic water supply can be high

The cost of breakdowns in water supply is one measure of the benefits of improving the supply. Over the three months of summer in 2001, temporary breakdowns in water supply cost women in Gujarat an average of Rs. 162 (3 Euros), which is equivalent to 4 days of labour at the minimum daily wage of Rs. 40 (0.80 Euros), and 14 hours of time that could have been spent on personal and other domestic activities. Additionally, if water supply was improved such that rural women needed to spend only one hour a day on water collection, each woman could have saved around Rs. 750 (Euro 15) - Rs. 5500 (Euro 110) per year

(3) Promoting rural enterprises is tricky. The study of water-using rural enterprises such as brick-making, pottery, livestock rearing and tea-making found that:

(a) total annual profit varies widely across enterprises, as does the profit per unit of water used; (b) enterprises may show losses if own input costs are included; (c) most enterprise activity is seasonal; (d) some enterprises are expenditure-saving while others are income earning; and (e) to villagers, enterprise is still only supplementary activity.

Thus, clearly, ‘productive water use’ needs more than water; it needs an enabling environment, including economic opportunities, skill and quality enhancement, market demand, access to credit, efficiency of production, economies of scale, and effective conflict resolution.

(4) Need to look before one leaps into enterprise promotion

Even given time and funding, new entrants into an existing rural enterprise activity like brick-making, pottery or poultry rearing, could mean competing with established enterprises, often run by the rural elite, who have better access to credit, information, skills, health, and above all, business experience. New entrants into enterprise activities not common to the region may also face risks, since the enterprise perhaps has not yet started because the rural elite (who usually have the money and the expertise) has decided not to invest in that activity, and usually for good reasons. Promoting rural enterprise thus needs good facilitation – whether promoted by government or NGOs. And if the target is the rural poor, the facilitation is even more demanding.

The chapter concludes that such insights into the characteristics of existing rural enterprise must play a major role in determining official policies on improving water supply and promoting rural enterprise. Put simply, making more water available or reducing water collection time can help develop rural enterprise, but will not do so unless several other factors are addressed. These include profitability, the availability of water, skills and cheap credit, the capacity to take risks, the ability to respond to market conditions, etc. Thus, 'making water work' for poverty alleviation can be a viable policy guiding the promotion of domestic water supply, but it requires broad interventions that encourage enterprise development – especially if potential beneficiaries are poor, illiterate, socially deprived and less able to bear the risks of enterprise.

Introduction

In rural India, as in other parts of the world, domestic water supplied through standposts and handpumps is used for drinking, cooking, bathing, and washing vessels, clothes and floors. But, as in other places, domestic water supply is also used for household-based enterprise activities like pottery, livestock rearing and handicrafts. Water is also taken from water bodies around villages for productive activities, for instance by washer men, brick-makers and salt-panners. All such activities are collectively referred to here as 'rural enterprise', and the use of water for such rural enterprises, as 'productive water use'.

There are two main links between improved water supply and rural enterprises. The direct impact is to stimulate or make possible water-based productive enterprises like kitchen gardening or keeping livestock. The indirect impact is to release time previously tied up in water collection, which can be used to promote rural enterprises (not necessarily water-based). But, both impacts on rural enterprises require extensive facilitation, if the additional input of water or time is to translate into additional output and hence into sustainable income. This paper discusses the direct and indirect benefits of improved water supply, and the kind of facilitation needed to transform improvements in water supply into sustainable income.

The study areas

Two different sources of data have been used: one being a study conducted in Santalpur and Radhanpur blocks in Banaskantha district in the western Indian state of Gujarat, and the other a study conducted in Kalyandurg Mandal in Anantapur district in the south Indian state of Andhra Pradesh (see Figure 1).[1] Although two separate studies were conducted in these areas, Banaskantha and Anantapur districts have several similarities.

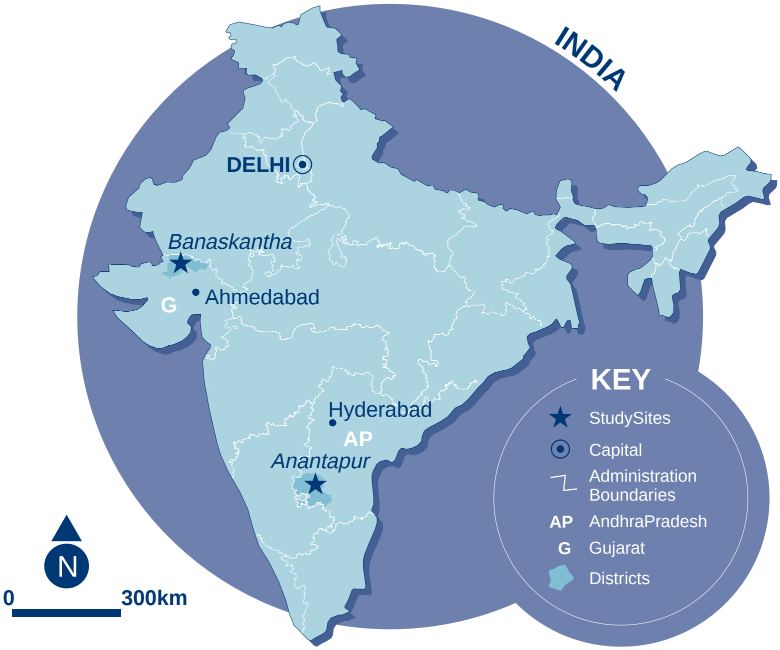

Figure 1. Study areas

General background

Both Gujarat and Andhra Pradesh are relatively developed states in India, according to overall indicators such as per capita income, industrial growth and investment in urban infrastructure, but they also have regions that are among the most backward in the whole country and are threatened by an ever-growing water crisis. In Gujarat, droughts are estimated to occur every three years on average and in 1999 a large part of Gujarat suffered from the worst drought in 50 years. Banaskantha is one of the poorest and hardest hit districts in this respect, with frequent droughts eroding

1 Although a new district of Patan has been recently carved out of Banaskantha, and the two blocks where the study was carried out, Santalpur and Radhanpur, are now in Patan, the project area is referred to Banaskantha in this paper to minimise possible confusion.

any interim livelihood gains. Anantapur district is, similarly, one of the poorest districts in the state of Andhra Pradesh. Five out of every ten years are drought years, generally, with two years of severe drought and one year of catastrophic drought.

In addition, both districts have:

- A semi-arid climate with low and variable rainfall (less than 600 millimetres a year),
- A large proportion of the population dependent on agriculture and livestock rearing, with nearly 75% of village households comprising the landless and small farmers (owning less than 2 hectares)
- A majority of farmers relying on dryland agriculture since there is limited access to irrigation, although those with access to credit are over-exploiting groundwater for irrigation.
- A single crop economy, with low employment opportunities and low wages in the non-crop season, and hence regular seasonal out-migration.
- Relatively high incidence of poverty and illiteracy (especially among women), social discrimination against the lower castes, and traditional social structures where women have little say in household and community decision-making.
- Extremely under-developed social and economic infrastructure, with many villages lacking even the most basic infrastructure such as safe drinking water, electricity, and schools.

Domestic water supplies

Most villages in both states have multiple sources of domestic water, including handpumps and public standposts. But, in both areas, there has been a concurrent neglect of traditional water sources such as ponds, wells and tanks (in Andhra Pradesh). In addition, excessive groundwater use, mostly by richer farmers, has led to a rapid fall in the groundwater table in both states. Although a comparative study has not been done, the domestic water supply situation appears to be worse in Banaskantha than in Anantapur. In Banaskantha, there are multiple water sources, including public standposts and handpumps, but these are unreliable and so women still have to spend three hours a day on average to collect water (up to six hours a day in some villages), perhaps including walking to a neighbouring village (FPI et al 2000; 5). In Anantapur, a more detailed study of user perceptions found that although water supply was inadequate in several villages in peak summer, they were more easily able to fetch water from nearby agricultural borehole wells instead (Rao et al., 2003). Fluoride is also a problem in several villages in Andhra Pradesh, with debilitating health impacts like dental and skeletal fluorisis.

During the drought of 2000, most households in Banaskantha managed to get sufficient drinking water and water for other domestic uses, but the failed rains had a severe impact on rural livelihoods. The direct impact was that agriculture and dairying almost came to a complete standstill. The indirect impact was that women and girls spent even longer to fetch water, thereby losing time that could have been spent on income-generating activities (or in school), and suffering from health problems as a consequence (DMI and Verhagen 2000). Anantapur has also suffered under a severe drought recently, with the monsoon having failed in four out of the last five years, and consecutively, in the last two seasons of 2002-03 and 2003-04.

Methods of data collection

This chapter draws upon data from different projects with which the author is involved in order to make its arguments.

Gujarat

Direct and indirect links between improved water supply and rural enterprise were examined in the Gujarat study, which was conducted by three organisations: the IRC International Water and Sanitation Centre (Delft, Netherlands); the Foundation for Public Interest (FPI); and Self-Employed Women's Association (SEWA) (both based in Ahmedabad, Gujarat, India). The study was funded by the Swedish International Development Agency (SIDA) and carried out in two phases: August - September 2000 (monsoon) and March - May 2001 (summer).[2]

The study was conducted in ten villages where SEWA, a non-governmental organisation, works with rural women promoting rural enterprises, and in five control villages, where SEWA did not work. For each of the five types of rural enterprises supported by SEWA, viz., handicrafts, plantations, gum production, dairying and salt production, two villages were selected, totalling ten 'SEWA' villages. In addition, five other villages were selected for control purposes, using the criteria of roughly similar stages of development, to see whether SEWA's interventions had made a significant difference to the economic and gender relations of village women.

Within each SEWA village, focus group discussions were held with the 10-15 member micro-enterprise groups, and semi-structured interviews were held with group leaders. More detailed discussions were held with seven women from each enterprise group and seven women from each control village, using participatory rural appraisal (PRA) tools.[3] Existing PRA tools were used to collect information on time/activity profiles, women's degree of control over time and income, and typical household economic profiles. New participatory tools, designed jointly by the

2 The results of this study are more fully presented in the research report referred to earlier (IRC, FPI and SEWA, 2001), and the main findings published as James, et al., 2002.

research team and women from enterprise groups, were used to discuss enterprise-related issues, such as the cost of fodder, number of cows, distance to gum trees, and additional income from the sale of fodder. Some semi-structured interviews were also held with the husbands of enterprise group members and other men in the village.

Andhra Pradesh

The information presented on various rural enterprises in Andhra Pradesh was collected during April - June 2002, as part of the Water, Households and Rural Livelihoods (WhiRL) project (www.nri.org/whirl). It was carried out in four villages where the non-governmental organisation, the Rural Development Trust, has been working for the past 25 years or more. Individual enterprise owners from different villages were interviewed in order to collect information on water use and annual profits for various water-using rural enterprises.

Information on livestock was collected using household questionnaires in February 2002. Data on returns from livestock are averages from the sample of 83 households, which is a 10 percent stratified random sample drawn from the population of each of the four villages.

Data on returns to irrigated and rain fed farming were collected for a sample of 63 farmers randomly selected and interviewed individually by research teams from the Central Soil and Water Research and Training Institute (CSWCRTI), Bellary, Karnataka, India, during 2002, as part of the Water Resources Audit of the Andhra Pradesh Rural Livelihood Project (APRLP).

Findings from the Gujarat Study

Economic costs of breakdowns in water supply

Inadequate, irregular or unpredictable domestic water supplies mean that users have to spend more time and effort on their water-collecting chore, as they have to locate and use an alternative more distant or inconvenient source. Women who are employed (e.g., in handicraft enterprises in the village) sometimes prefer to pay someone to collect water or to buy it, in order to continue working (see Table 1).[4] Poor water supply thus has a cost, which can be offset by improvements in domestic water supplies.

3 These focus groups of seven women each were purposely chosen (in consultation with group leaders in the case of micro-enterprise groups), giving a total of 77 women from 11 micro-enterprise groups in the 10 SEWA villages, and 35 women chosen from the control villages. All data used here are based on averages calculated from the responses of these two groups of women.

Table 1. Costs of water shortages in the summer of 2001 in study villages in Banaskantha, Gujarat

Village	Days without water supply	Hours spent per woman to collect water	Hours taken from Productive work	Hours taken from Other work	Average potential income lost per user (Rs.)*	Average spent to buy water per user (Rs.)	Average economic cost per user (Rs.)	Average social cost per user (hours)**
Par	13	0				186	186	
Dhokawada	7	0.5	-0.5		16	5	21	
Madhutra	46	2		-2		121	121	92
Parsund	3	4.5	-4.5		73		73	
Patanka	13	2		-2				26
Zanzansar	3	2		-2				6
Zandala	13	0						
Moti Pipli	7	2.5		-2.5				17.5
Garamdi	46	3	-3		683	300	983	
Ramnalpura	46	2.5	-1	-1.5	228	4	232	
AVERAGE	20	1.9	-0.9	-1	100	61.6	161.6	14.1

* This is only for time taken from productive work for the entire period, valued at Rs. 40 per day, the minimum wage, which works out to Rs.5 per hour. Note that 100 paise = 1 rupee, and 1 Euro = Rs. 50 approx.

** Time taken from other activities (e.g., personal, domestic, etc.)

Table 1 shows that the water supply shortages over the three months of summer in 2001 cost each woman employed in enterprises in these 10 villages an average of Rs. 162 (3 Euros) or four days of labour at the minimum daily wage of Rs. 40 (0.8 Euros), and 14 hours of time she could have spent on personal and other domestic activities. If these estimated costs (of summer shortages alone) are extrapolated to the 40,000 women working in SEWA promoted handicraft enterprises in the area, all of whom face breakdowns in water supply during the three summer months but some for longer periods, the loss of potential income is about Rs. 6.5 million (130,000 Euros).

Economic benefits of reduced collection time

Benefits have been calculated for the hypothetical situation where service is improved such that each woman needs to spend only one hour per day collecting

4 The situation is worst in summer, and hence a similar calculation was not done for non-summer months. The number of summer days has been taken as 92.

water, instead of nearly three hours per day currently (see Table 2). Table 2 presents the time spent on different activities by women in the study villages. This data was collected using a participatory tool called a 24-hour clock (also termed an 'activity calendar'). Note that the summer months are from March to May, and the non-summer months include the monsoon months of June to September.

Table 2. Average time spent daily on different activities by women in study villages

Activity type	Description	Hours per day	
		Summer	Non-summer
Productive activities	Income earning (e.g., enterprise work, wage labour)	7.9	3.7
	Expenditure saving (e.g., livestock rearing, garment making, agricultural work on own land, etc.)	1.1	3.6
Domestic activities	Water collection (for domestic and productive uses)	2.8	2.8
	Other (e.g., childcare, cooking, cleaning, etc.)	2.3	4.3
Personal activities	Socialising, sleeping, etc.	7.5	8.6
Management & development activities	Organising and attending meetings, training programmes, managing enterprise activities, etc.	2.0	0.9
Total[5]		23.6	23.9

If she has the freedom to allocate such newly created free time, and if additional economic opportunities are available, a woman can invest this time in a productive activity, which need not be water-based.[6] In the present case, financial returns of such investment are calculated on the basis of returns per hour from the activities currently available in these villages, viz., plantations, salt making, handicrafts, dairying, gum collection and daily wage labour. Table 3 gives the potential income that a woman could earn in a year given a reduction in water collection time to one hour a day.

5 The total is not 24 hours, as respondents could only guess daily figures for a period of several months.

6 Water, however, is used in small quantities even in seemingly non-water-based activities, like handicrafts (chiefly traditional embroidery on cloth), where water is used to wash hands so that craftwork is not soiled.

Table 3. Potential annual economic returns to enterprises from improved domestic water supply

Activity	Village	Gross return per person per year (Rs.)*
Gum collection	Parsund	5,520
Handicrafts	Madhutra	4,741
Plantation	Zandala	3,313
Handicrafts	Dhokawada	3,114
Salt making	Ranmalpura	2,573
Salt making	Madhutra	2,535
Plantation	Zanzansar	2,150
Dairying	Moti Pipli	1,250
Gum collection	Patanka	1,152
Dairying	Garamdi	750

* No costs have been deducted from the annual revenue received by each woman.

** Rs. 51 = 1 Euro, approximately.

The table illustrates the following:

- *Annual returns can be high:* If collecting water for domestic uses takes only one hour a day, and if economic opportunities and skills are available, the potential extra income that women can earn ranges from Rs. 750 to Rs. 5,500 a year, depending on the enterprise. For all the 40,000 women working in SEWA enterprises in Banaskantha district, the total annual benefits could be as high as Rs. 30 million (€600,000) a year at even the lower figure of Rs. 750 per person.[7]
- *Returns vary widely, even for the same activity:* Gum collection in Parsund brings in about Rs. 5,500 per person, while it brings in only around Rs. 1,100 in Patanka. The chief reason for the variation is the availability of gum trees near the village, although the time invested by each woman, the quality of the gum, and the price received are also factors affecting annual revenue received. Nevertheless, the point that returns can vary widely is an important one, especially for replication or scaling up.
- *Income earned by women from enterprises is special:* Women interviewed in the field felt that income from enterprises (particularly handicrafts) is special, since it is earned during the dry season and used during times of special hardship, when no other source of employment or income is available.

7 Note that this is an illustrative calculation, since the realisation of this income will require a scaling up of activities in the region, which may or may not be economically feasible (given demand for these products). This is also true of SEWA activities in the region, especially the buy-back system practised in the case of handicrafts.

Note that the benefits from a water supply improved so that there are no breakdowns in service can be included when calculating the benefits from a water supply improved such that it takes only one hour per day for women to collect water. Hence, the two measures of benefits are substitutes of a sort – capturing different aspects of improved water supply that may not be mutually exclusive – and so cannot be added together.

Findings from the Andhra Pradesh Study

At the village level there are many water-using activities besides domestic and agricultural activities. These include brick making, pot making, dairying, rope making, individual or community gardens and plantations, salt making and running tea stalls. Some use more water than others, and some bring in more profits than others. The results in Table 4 and interviews with those engaged in these enterprises bring out the following:

- Total annual profit varies across enterprises, as does the profit per unit of water. Brick making brings the operator a profit of Rs. 188,000 during the four months of the enterprise, which is around 40 paise per litre of water, but tea making during the 'peak' groundnut season (December to February) yields Rs. 4,500 to the tea-stall owner, at a rate of 52 paise per litre of water used.

- Enterprises run at a loss if all inputs costs are included. If own inputs like human labour, implements, equipment, work space and storage are valued at opportunity cost (i.e., the cost of hiring these in the village), nearly all enterprises would be shown to make losses. Livestock, in particular, is sustained because of 'cashless' transactions: dry fodder is taken from the owner's field, while women cut and bring green fodder. Men and women typically spend two hours a day on their animals.

- Livestock accounts for a large proportion of domestic water use in rural areas. Repeated household surveys of a 10% sample of households from the four villages showed that water collected and brought home to clean livestock and for them to drink comprised around 35% of all water collected from water points by these households. That is, of 45 litres collected per person per day, 15 litres are used for livestock and 30 litres for domestic uses (drinking, cooking, bathing, washing clothes, vessels and houses, etc.).

Table 4. Characteristics of some water-using rural enterprises

Activity	Unit of activity	Water used for	Number of days/ year	Litres used/ unit/ day	Total litres used	Total profits[8] (Rs.)	Profits/ litre (Rs)
Tea making	A single owner tea stall	Cleaning vessels and making tea	270 90	36 96	9.720 8.640	1.350 4.500	0.07 0.52
Pot making	A single potter	Mixing clay and washing the wheel	365	120	3.800	4.700	0.12
Livestock rearing	2 bullocks + 1 buffalo	Bathing animals and drinking water for animals	120 240	65 38	7.800 9.120	4.750	0.28
Brick making	A single brick maker	Mixing clay Washing moulds	100	4.800	480.000	1.88.000	0.40
Blacksmithing	A single black-smith	Wetting metal and washing tools	120 160	15 2	1.800 320	6.700	3.16
Toddy tapping	A single toddy tapper	Diluting the toddy collected	60	4	240	6.000	12.50
Rope making	A single rope maker	Soaking cut agave sticks to yield fibre after beating	30			30	
Washing clothes	A single washer man	Washing clothes	365				

- Most enterprise activity is seasonal, with a peak of 2 to 4 months (e.g., blacksmithing, tea making, brick making), though some other activities last the year around (e.g., washing clothes, pot making).

- Some enterprises are expenditure-saving while others are income-earning. Activities that bring in income either in the form of cash or kind (e.g., for some

8 Total profits = (Total Revenue – Total Cost) for the number of days the enterprise runs per year (e.g., 90 days).

types of agricultural work) are termed income-earning activities, while those that help the household avoid making such payments (for goods and/or services used by the household) are called expenditure-saving activities. Rope making was a purely expenditure-saving activity, while livestock rearing and vegetable growing are both expenditure-saving and income-earning enterprises. But different types of animals contribute in different ways. Buffaloes and cows are reared for dung and milk, though yields are generally low at around 5 litres per day on average. Bullocks provide dung and draught power. They are used not only for field operations on own fields or other farmers' fields, but also to transport material to and from the field, and to the local market.

- Enterprise is a supplementary activity: Villagers still consider cultivation as the basic activity, and other enterprise activity is considered supplementary. This is borne out by the fact that most enterprise workers do their enterprise activities during the 'off season', and suspend them during the cultivation season, in order to work either on their fields or on others' fields as labour. This is the case even with those working in enterprises like salt making, gum collection and craftwork in Gujarat. Although livestock rearing continues throughout the year, there is a shift in responsibility during the cultivation season, with the woman taking on more of the manual work of looking after animals (e.g., cleaning the cowshed).

- Enteprises earn more per unit of water than irrigated agriculture: The profit per unit of water for the most profitable irrigated crop in Kalyandurg (the kanakambaram flower at around Rs. 70,000 per hectare) is only around Rs. 0.02 per litre of water used. This is less than the profit per litre of a teashop in the off-season, which was the least remunerative of activities studied. Of course, the volumes of water and profits are much higher for irrigated agriculture.

These are facets of existing rural enterprises that need to be borne in mind when designing policies to promote enterprise activity in villages, especially as a means of alleviating poverty. This is the subject of the next section.

Implications for policies

When a water supply service is improved, users not only save money because they do not have to buy water, and/or time, since fetching water is quicker – but the time saved can be used for other activities: either productive (economic), domestic (such as looking after children, cooking and cleaning), personal (sleeping, socialising, etc.), or development and management-related activities (e.g., attending meetings, carrying out group work, and participating in community activities). But improving water supply can translate into more enterprise income only when there is an enabling environment, especially economic opportunities. The SEWA model in

Banaskantha district of Gujarat captures this approach (Figure 2).

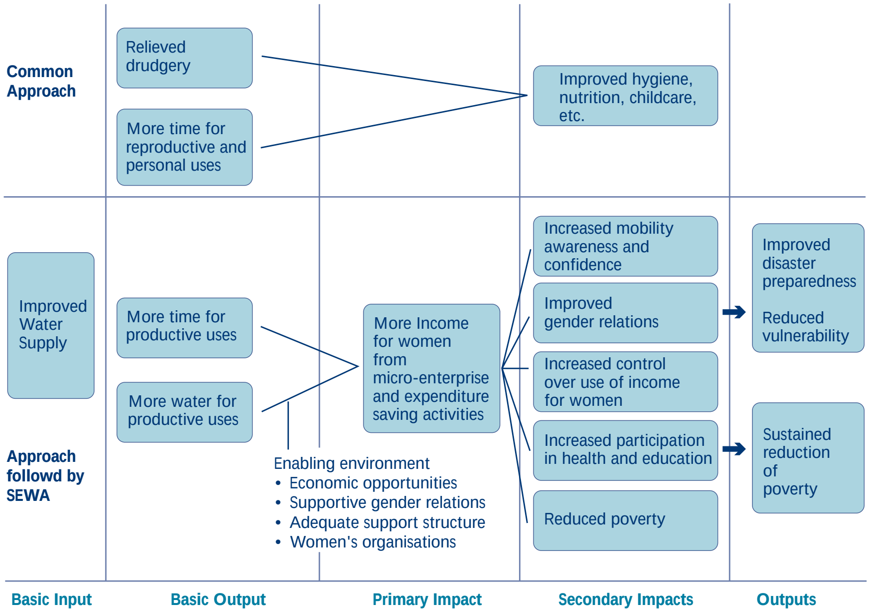

Figure 2. Conceptual framework for SEWA's work linking water supply with women's enterprises

Source: IRC, FPI and SEWA (2001) Figure 2, page 23

As shown in Figure 2, the common justification for improved domestic water supply in villages is that it relieves women's drudgery and improves health and hygiene. But such a perspective not only ignores the fact that health and hygiene improvements need further facilitating inputs beyond improving water availability (e.g., awareness generation, training, discussions with women, monitoring of impact, etc.), but also overlooks a powerful economic justification for improving domestic water supplies. The SEWA intervention of providing an enabling environment to women in SEWA-supported villages (including enterprise opportunities, training, support services, etc.) enabled them to translate time saved into household income.

Facilitation is vital for water-based and non-water-based enterprises to make them yield sustainable incomes for the rural poor. In other words, 'productive water use' needs to look beyond mere provision of additional quantities of water. It needs to focus on providing an enabling environment, including economic opportunities, skill and quality enhancement, and effective conflict resolution mechanisms, etc. (see Table 5).

Table 5. Factors affecting sustainable enterprises

Factors affecting sustainable rural enterprise		Threats to sustainable rural enterprise	
Factor	**Significance***	**Threat**	**Significance***
Market demand	Critical	Slackening of market demand	Critical
Effective facilitation (by governmental or non-governmental organisations)	Critical	Withdrawal or lack of guidance, support and facilitation	Critical
Working capital credit /creditworthiness	Critical	Indebtedness following losses	Important
Input availability (including water)	Important	Input shortages (including water)	Important
Time to invest in the activity	Important	Demands on time (e.g., water, fuel and fodder collection)	Important
Skill to carry out the activity	Important	Accidents or illness	Important
Effective conflict resolution mechanisms: • Domestic (within the house) • Social (within the community)	Important	Domestic conflicts or lack of support from home Social conflicts	Important

* Significance is interpreted as follows: **Critical**: A factor or threat is Critical if the enterprise will not run without that factor, or in the face of that threat, and individuals operating the enterprise cannot influence the factor or mitigate the threat on their own. **Important** if individuals operating the enterprise can influence the factor or mitigate the threat on their own, thus making the enterprise run, albeit with more effort and difficulty (e.g., less time spent on other activities, investment in protection against conflict, etc.). For instance, a shortage of water may be overcome by investing extra time or money. Low skill levels can be overcome by sufficient training, but this may have monetary and non-monetary costs.

One of the most critical factors affecting the sustainability of the enterprise is facilitation. If the enterprise is to be run by the poor, with the usual concomitants of low literacy, awareness, credit-worthiness, skill levels and health, the need for support and facilitation is much greater. There are two simple indicators of the extent of this need. First, if others have been doing the enterprise (e.g., raising poultry) in the village, the initial competition a new enterprise faces will usually be from the rural elite in the village itself, with their better access to credit, information, skills, health, and above all, business experience (since they as a class usually run or fund most rural enterprises). Second, if the enterprise is new to the region, it is likely (though not necessary) that the rural elite have decided not to invest in that activity, and usually for good reasons. Since investment is for profit, those with money to invest (e.g., the rural elite) are usually on a constant lookout for enterprise opportunities. If they do not invest in a known opportunity, then it could mean that it may not yield sustainable income.

Of course, the two other major factors why the rural elite may not invest in a particular activity are (1) the financial returns are positive, but lower than those from other investments, and (2) they are not aware of the potential of the investment. The SEWA-supported investment in handicrafts in rural Gujarat is one example of the latter. But, it is possible that other rural entrepreneurs may enter this activity in future.

The two major policy implications are:

- In contrast to current water and sanitation policies that focus on uni-sectoral investment (e.g. providing systems for drinking water or irrigation), new generation water supply schemes have to focus on integrated benefits, including productive uses of water. Broadening the conceptual framework of domestic water supply policies is the first step towards such integrated thinking on water supply provision and rural development at a more general level.

- Policy makers wishing to 'make water work' by promoting integrated water supply and rural enterprise systems would do well to study the reasons for the failures of rural small-scale community enterprises in the past, in addition to the few success stories that exist, unfortunately few of which seem to involve water.[9]

Conclusions

This chapter highlights the links between improved water supply and rural enterprise – links that are often overlooked by policy makers. Importantly:

- First, improvements in water supply can release time previously spent by households to collect water, which can then be used in rural enterprise to

9 The major success story is the Rural non-farm sector development agency (RUDA) of the Government of Rajasthan, which has focused on just four rural enterprises (chosen from more than 150 options), and provided technical know-how to improve quality and organised buyer-seller meets to introduce rural groups to urban buyers. Thereafter, however, the groups have been on their own.

generate additional household income. Results from one of the poorest parts of the western Indian state of Gujarat, the district of Banaskantha, showed that this additional income is an important part of household income, largely because women who earn this income use it to support the household during times of distress. Although the returns per enterprise vary widely (even among villages) existing rural enterprise has the potential to generate nearly Rs. 3 million for the 40,000 SEWA women members in the district.

- Second, breakdown in regular water supply during the three summer months, in villages where women are engaged in rural enterprise, can cost each woman, on average, the equivalent of four days of labour at the daily minimum wage, as well as around 14 hours of time that could have been spent in other personal or social activities. For all the 40,000 SEWA women in Banaskantha together, this is a loss of around Rs. 2 million.

Although these two are alternative measures of benefits of improving water supply and therefore cannot be added together, these findings open up possibilities for poverty alleviation through the improvement of domestic water supplies, and the provision of opportunities for rural enterprise. This brings in a more powerful argument for improving domestic water supply, income generation and livelihood enhancement, in addition to the earlier justifications based on reduced drudgery and improved health and hygiene.

While these are certainly powerful arguments to link domestic water supply development and rural enterprise promotion, a study of existing rural enterprises reveals a need for care while developing policy initiatives. In particular, this analysis shows that:

- Total annual profit varies across enterprises, as does the profit per unit of water.
- Enterprises run at a loss if all inputs costs are included, particularly own inputs like human labour, implements, equipment, work space, storage etc. They are profitable only because they use own inputs, which are otherwise idle (e.g., during the off-season).
- Most enterprise activity is seasonal, with a peak of 2 to 4 months.
- Some enterprises are expenditure-saving while others are income-earning, and are viewed as such by villagers.
- Enterprise is supplementary to cultivation, which is still considered the basic activity.

Perhaps the most important insight is that water is only one of many inputs to generate income from water-based productive activities. Even existing activities may not generate additional output or income if they are only given more water. Factors such as market demand, access to credit, efficiency of production, and economies of scale are critical considerations to transform a set of inputs into sustainable output and income. In short, the real target of facilitation is to foster entrepreneurship among the target beneficiaries. If the target is the rural poor, the facilitation is even more demanding.

In conclusion, providing rural enterprise opportunities alongside improved water supply is a promising way to utilise freshly released time for income generation, but it is not a 'silver bullet' that will work well everywhere and get rid of poverty once and for all. 'Making water work' requires due consideration, not just of the inputs required, but also of the larger environment for enterprise development. Given such care, it can be a way out of poverty for millions in developing countries all over the world.

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A multi-sectoral approach to sustainable rural water supply: the role of the rope handpump in Nicaragua

J.H.Alberts and J.J. van der Zee

Summary

A low cost rope handpump for boreholes and hand-dug wells up to 70 m deep has been developed, marketed, and subsequently mass-produced in Nicaragua (figure 1) by local, small, privately-owned workshops since the early 1990s. It is easy to maintain and highly efficient at the family and community level. The pump has met with high social acceptance amongst rural users ever since the early, rudimentary models were first made available. By 1995, the technology had become an integral part of rural water programmes implemented by NGOs and government agencies. Rural water supply coverage since then has doubled from 27.5% to 54.8%. Of this 27.3 percentage point rise, rope pumps account for 23.6% (or 85% of the total increase).

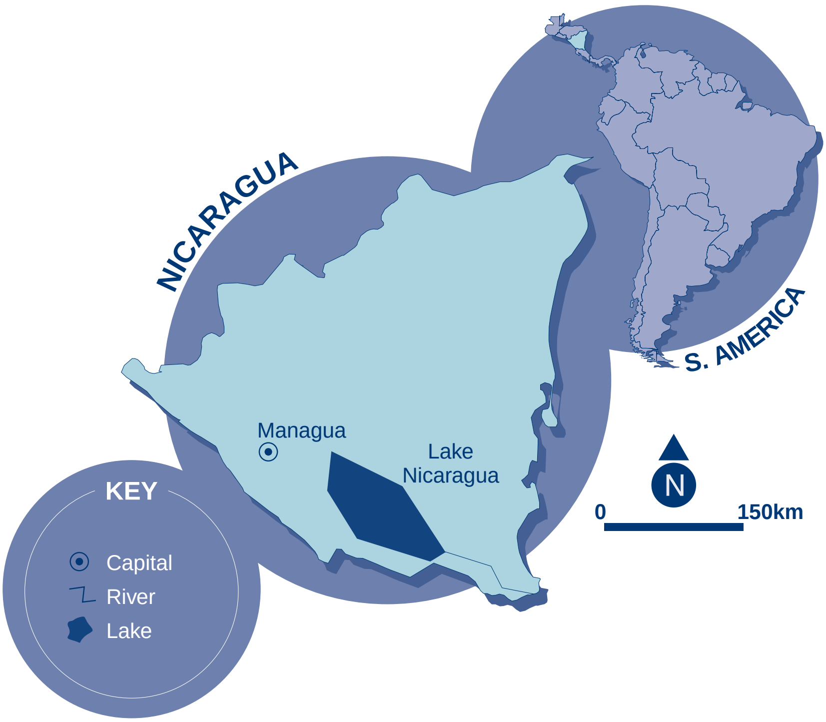

Figure 1. Nicaragua

The income-generating capacity of the rope pump, making possible small-scale irrigation, watering of livestock and other productive uses, has been an important reason for its acceptance and successful introduction. In addition, credit schemes linked to the introduction of the pumps have proved successful, and comparative studies of farm income show that families with a rope pump generate an average US$225 of additional annual income, which can represent up to 50% of the total income for the lower income groups.

Production of the technology by about a dozen private workshops has made Nicaragua the country with the highest handpump density per rural capita. Though broad international interest has been received, inclusion of the technology in rural water supply programmes on other continents has encountered serious institutional barriers. Widespread introduction elsewhere requires a multi-sectoral approach in a context somewhat broader than the policies of the traditional water and sanitation sector. In particular, the impact of income generation on sustainability has to be understood and capitalised on, while alliances with the private sector are required for promotion and production. Collaboration is fully justifiable between poverty-reduction initiatives and the water supply sector. However, symbiosis between private-sector users and private-sector producers is the essential foundation to make development an economically viable proposition.

Introduction

One pump fits all: current universal strategies and policies

Solutions to rural water supply in developing countries, in remote areas in particular, are characterised by the installation of community handpumps. In their Global Water Supply and Sanitation Assessment 2000 Report (WHO, 2000), WHO/UNICEF presented progress made on rural water supply coverage around the world during the last decade. In Africa, rural coverage rose from 44% to 47% or by a mere 3 percentage points between 1990 and 2000. In Latin America, there was a six percentage point rise over the same period (from 56% to 62%), and in Asia, the improvement was eight percentage points (from 67% to 75%).

Traditionally in developing countries, rural water supply is governed by the national water and sanitation sector (W&S sector). Strategy is dominated by the installation of relatively expensive handpumps, supposedly for exclusively domestic water use, at a cost ranging from several hundreds to over a thousand US dollars, depending on the type and brand. Relatively high costs mean that these pumps are usually only procured within the context of a project, more often than not funded by a donor, or through an international loan. In exceptional cases they are bought by a private-sector user. Most developing countries do not produce these kinds of pumps themselves, which means that they must be shipped from India where mass production was established in the eighties through ‘special’ financial initiatives. In practice, national W&S sectors import and install all handpumps, including spare parts, as no one else has the required liquidity and administrative capacity to acquire them in sufficient bulk. The limitations of this situation are well recognised and described in the background articles presented around the Supply Chain Initiative of the Water and Sanitation Programme of the World Bank (World Bank, 2000).

An active role of consumers or handpump users is usually absent. Though they have an important role to play in the use and maintenance of the pump, the choice of technology will have already been made for them. In recent years, important initiatives have been taken around so called ‘Demand Responsive Approaches’, a key objective being to increase community participation and allow users to take informed choices. This initiative has certainly helped to initiate discussions, but so far has not made a tangible difference to pump technology selection in most countries.

Impacts of handpumps at the grassroots

In practice, an improved rural water supply and safe water typically mean a water source with handpump near the centre of a settlement or within reasonable walking distance. The water quantity delivered per person is limited because of the high number of users and low norms for ‘domestic’ water supply. A standard of 250 persons per pump is most common: providing yields in the region of 20-40 lpcd. The highest priority is put on improved health, which is linked to standards of hygiene (education), water quantity and water quality, the combination being much more effective than the sum of the parts.

Generally speaking, with few exceptions, communities are located in the vicinity of water sources such as rivers, streams, springs, ponds, dams, and hand-dug wells. Installation of a central source of high quality water is an important improvement and a must for the eradication of water borne diseases. However, in practice the population, including young children, will still use their traditional and more abundant water sources for washing, bathing and other uses. The positive health effect therefore is often practically wiped out. In case of failure of the pump, the urgency to have it repaired is minimal because other sources can be used, causing the well-known maintenance and sustainability problems. In fact, the much less common, albeit striking success stories about health improvement and sustainability of water supply are limited to communities who depend on a handpump as their only source.

A need for alternative strategies

Considering this background, present policies do not appear conducive to increasing the present rate of rural water supply coverage or to having a noticeable impact on health. Principal obstacles include a high dependence of host countries on funding by bilateral and multilateral organisations, and control of funds, procurement, and maintenance by the state national W&S sector. The private sector will only get involved if there is a purchase order, or when they are contracted to install the handpumps. The role of users or communities has been marginalised. On the other hand, initiatives by private enterprise to improve the existing situation are not an option. Given the cost of required investments versus expected returns this is just not viable, especially in the context of the high risk with regard to credit repayments by poor communities.

Efforts in Nicaragua during the past 15 years have focused on attempts to lower and, if possible, eliminate these barriers. More specifically, this has meant local development of a multipurpose rope handpump made of locally available materials at a fraction of the cost of traditional pumps, and easy to install and maintain. So far 25,000 units have been installed, built by a dozen workshops. They are principally used on farms for domestic purposes, watering of livestock, and irrigation. Individual use has brought water supply to a significant number of families who live and work beyond the boundaries of communities, and who normally are not included in the customary water supply projects or official statistics. Total rural water supply coverage at present amounts to 54.8%. Total coverage with rope handpumps represents 23.6%, while coverage through other technologies is 31.2%. The coverage achieved by rope handpumps in such a short time span is considerable. How it was done and what impact this has had, is the subject of this chapter.

Profile of Nicaragua

Dependence on agriculture and livestock

The economy of Nicaragua is largely dependent on the agriculture and livestock sector, which accounts for 26.5% of the Gross Domestic Product. Its importance is underlined by an almost exclusive dependence on agricultural (mainly coffee) products, beef, and timber for exports. The country is 80% self-sufficient in food. Of the remaining 20% that the country imports, 76% are staple foods. Of the economically active population, 35% are employed in the agricultural sector. However, another 25% depend on this sector through part time labour, agro-industry, agricultural services, transport, and marketing.

Table 1. Socio-economic indicators for Nicaragua (2000)

Area (km^2)	121,000
Population	5,000,000
Rural population	1,850,000
Rural population density (pers/km^2)	15.3
Income per capita (US$)	480
Income distribution - top 20% : bottom 20%	65:1*
Human Development Index (country ranking)	117
Agriculture as % of GDP	26.5
% Labour force in agriculture	35

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Access to safe water in rural areas (%)	(54.8)
Number of hand dug wells	(100,000)
Life expectancy at birth (years)	67.5
Mortality rate children < 5 years old	50
Illiteracy (%) official	18.8
Rural population functionally illiterate (est.)	49[+]

Source: Human Development Report (UNDP,2000)
* Dierckxsens (1994)
+ van der Zee (2001)
( ) Estimate by the authors

The bulk of meat and staple foods is produced on farms of less than 20 ha. These farms account for: 77% of beef production; 70% of pork, poultry and eggs; 80% of maize; 90% of beans, and 95% of sesame. Their share of coffee production amounts to 50%, also 50% of sorghum and 70% of the banana and plantain crop is grown on small farms.

Nicaragua will remain an agricultural country until full economic integration of the Central American countries can be achieved as a prerequisite to industrialisation. Its prosperity meanwhile will largely depend on how it can increase agricultural production for domestic consumption and for export. Development of abundant groundwater resources on the Pacific Coast, that can be developed at an affordable cost by low-income smallholder producers, will play a crucial role.

Poverty

Poverty has different definitions in different countries. In Nicaragua the poverty line has been defined as the sum of the cost of minimum food requirements equalling 2,226 kcal a day, minimum clothing, shelter, health, education and transport. That gives a figure of US$ 425 per capita per annum. Absolute poverty is defined on the basis of minimum food requirements per capita, corresponding to US$225 per annum. Table 2 gives an impression of the average cost of minimum annual basic needs for a family of six, which is more or less the average national family size. When using the previous criteria, poverty amounts to 47.9% with urban poverty at 30.5% and rural poverty at 68.5% (INEC, 1998). Chronic malnutrition in rural areas ranges from 20% on the Pacific Coast to 28% inland.

Independent random sampling, by one of the authors, of 2216 families in 9 municipalities covering roughly 50% of the farms (Table 3) show a reasonable comparison between the national average and the regional average where these municipalities are located. However, if poverty figures can be presumed to be correct, this means that the average income per capita in Table 1 is too low. This is most likely due to not including income from a considerable informal sector in the Gross National Product.

Table 2. Minimum annual basic needs for 3 adults and 3 children

Cash requirements	US$
Food and house cleaning	776
Health	188
Schooling 2 children	283
Clothing	176
Transport	113
Agricultural inputs	235
Sub total	1771
Sub total per capita	295
Requirements supplied on farm	
Minimum food production	376
Farm inputs (animal feed)	197
Opportunity cost house rent	95
Opportunity cost water	36
Opportunity cost firewood	31
Minimum cost electricity	41
Sub total	778
Sub total per capita	130
TOTAL	2549
Total per capita	425

Note: Expenditure as related to line items and the total of US$2,549 in Table 2 reflect averages of real expenditure of 5,025 families on the Pacific Coast surveyed by one of the authors, and further closely corresponds to the poverty line established by the Government of Nicaragua and UNDP.

Table 3. Percentage absolute poverty and poverty based on farm income and total income of 2216 families surveyed in 9 municipalities

Municipalities	Based on Farm income per capita		Based on Total income per capita	
	US$225	< US$425	< US$225	< US$425
S. Tomás	48	87	30	77
S. Pedro	29	78	24	73
S. Francisco	17	59	10	51
Cinco Pinos	45	71	21	60
Villa Nueva	70	89	27	79
Somotillo	61	84	41	77
S. F. de Cuapa	59	75	25	35
LPC/NAG	48	61	23	48
Weighted average	54	77	28	65

Evolution and adoption of the rope handpump in Nicaragua

Leading role of private enterprise and rural entrepreneurs

Water supply strategies in Nicaragua took a radical departure from the previously described common international approach from 1990, prompted by a need to find more satisfactory solutions and facilitated by a change of government which promoted decentralisation and private enterprise.

Rope pump technology has been known for centuries in different parts of the world as a means to draw water for private and communal use, the mining industry and even on merchant vessels. However, its application was always restricted to water depths of only a few metres and as such was described in the World Bank - UNDP standard book by Arlosoroff (1987): "The rope handpump is essentially a very low lift pump with a high discharge rate." In Nicaragua the first steps towards technological improvements had already been made by the end of the 1980s through different projects involving national institutions, multilateral donors, universities, and cooperatives.

Initial social acceptance of the rope pump was high for a number of important reasons. First, although the pump's development was undertaken to make clean water available to rural populations, farmers and cattle owners saw it as an opportunity for irrigation and, even more importantly, for watering of their livestock. In fact, it was the dual-purpose nature of the pump that made its production economically feasible. Second, the pump was manufactured and marketed by private enterprises from the start, without undue interference by government, with its cumbersome bureaucracy. Third, the cost is within reach of even the poor (though not the poorest), and users can themselves repair the pumps at hardly any cost. Workshops can even make the pumps to people's private specifications. It nevertheless took several years of intensive marketing and promotion through fairs and house-to-house visits to make the existence of the product known, and to generate sufficient demand to make production a profitable undertaking. Also, important technical improvements were still required to increase efficiency and durability, and to broaden its application to wells of greater depth. For additional information on the history of developing the rope pump in Nicaragua the interested reader is referred to the earlier publications of Sandiford (1993) and Alberts (1993).

Adoption by the government sector and NGOs

This economic process, based on the demand of private users and supply by private manufacturers, and the accompanying promotion campaign during the initial stages, caught the attention of several NGOs and later on the national W&S sector. By the mid-nineties, the rope pump was accepted by the W&S sector as an additional option in rural water supply activities. At this stage, the network of independent rope pump producers grew to a dozen workshops throughout the country. Whereas initially customers were a mix of small farmers, wealthier farmers, and some owners of weekend cottages on the beach, subsequent market expansion saw the introduction of the pump for water and sanitation purposes at the family and community levels on hand-dug wells as well as on boreholes. By the time the W&S sector got involved, the population was already familiar with the technology and an infrastructure of small workshops was in place. This was a principal factor in preventing the sustainability problems so frequently encountered in the traditional uni-sectoral community water supply strategies.

Widespread use of the pump, accompanied by basic training and readily available spare parts, undoubtedly contributed to overcoming maintenance and repair problems. However, the productive use of the pump was one of the main reasons for its social acceptance and consequently the need to maintain or repair it when required. The supply chain limitations, mentioned earlier in relation to the traditional handpump and its spare parts, never existed for the rope pump.

Involvement of other organisations

The private sector introduced the rope handpump, partly aided at critical moments by a local NGO. Once this was achieved, government and civil society organisations involved in rural development followed by including the pump as part of their different activities, so that the pump became practically the national standard by the year 2000. Multilateral organisations like UNICEF and larger NGOs like CARE were among the first to use the pump on a significant scale for water and sanitation. Even more important, thanks to the local availability and social acceptance, many organisations traditionally not involved in rural water supply included them in their activities, thus giving an important boost to the national water supply coverage figures.

In rural water supply projects, the distribution of handpumps is in most cases through grants, but in rural development programmes it is common that credit schemes are used to recover capital costs. Experience of these credit schemes with rope pumps is quite positive.
A variety of conditions and down-payment periods are used, but commonly a recovery percentage of 90 to 95% of the amount agreed on is reached. An outstanding example is the Nicaraguan CARE-PALESA project, where the users pay the cost of the rope pump and contribute with labour. This financial contribution represents 40% of the overall costs, which include the well improvement. The PALESA project itself includes hygiene education, sanitation and support to income generation through small agriculture activities. These high cost-recovery percentages can be attributed to the low price and the income-generating capacity of the rope

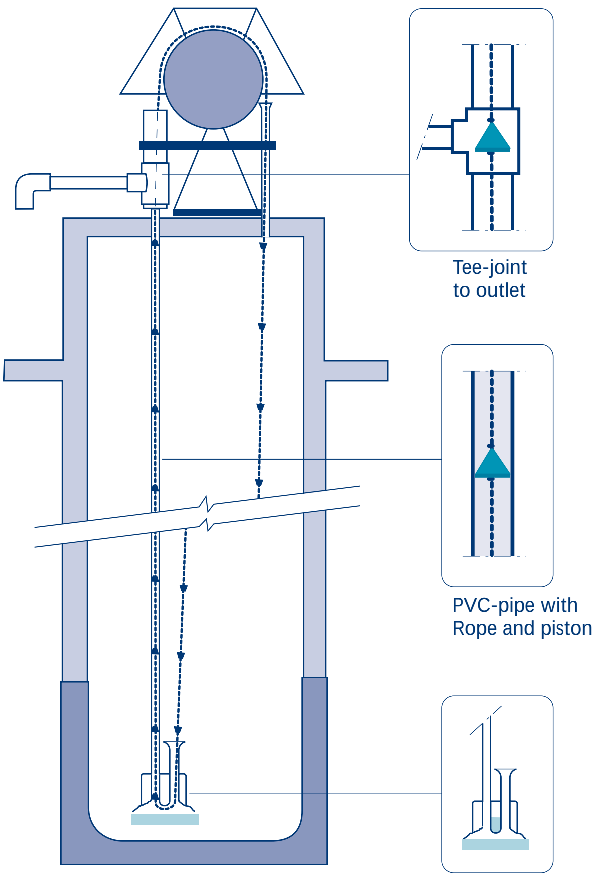

Figure 2. Rope Pump

pump at the family level. Cost-recovery percentages in community water supply usually aim at 5-10% of the capital costs.

Rope handpump technology

Description of the technology

The pumping elements of the rope pump are the pistons and the endless rope, which pull the water to the surface through the pumping pipe made of PVC or plastic. Rotation of the wheel, moved by the handle, pulls the rope and the pistons. The pistons, made of polypropylene or polyethylene injected into moulds, are high precision to prevent hydraulic losses. The structure is basically made out of angle iron, piping and reinforced concrete. The pulley wheel consists of two internal rings cut from lorry tyres, joined by staples and spokes. A guide box at the bottom of the well leads the rope into the pumping pipe. The guide box is made of concrete with an internal glazed ceramic piece to prevent any wear. It is a high efficiency and low cost technology, but includes some pieces of high precision and high quality. Rope pumps are installed on hand-dug wells and on drilled wells or boreholes. There is no need for the pumping pipe to be installed vertically, which means that rope pumps can also be installed near riverbanks or dams for irrigation.

The type of rope pump required differs according to its application, and cost is in the range of US$50-100, depending on the model. In general, the rope pump used at community level requires the highest technical standard. The least expensive and simplest model will do for domestic use or irrigation at the household level. However, all can be fitted with the same spare parts. Maintenance costs are minimal - in the range of US$0-5 per annum for the family well pump and up to around US$10 for the very intensively used community pump.

Field performance

The maximum standard depth reached by the rope pump is normally 40 m. This can be increased to 60 m with adjustments and a double crank. Presently, experiments are being conducted to reach a depth of 80 m.

The minimum water depth required for a rope pump in a well is only 10 cm. The guide box is positioned on the bottom of the well, as, unlike other pumps, sand does not affect the functioning of the rope pump. During the dry season, when the water table goes down, the rope pump will keep working until the well really dries up. This has been found to be an important factor related to social acceptance. When the water table in a well goes down and the traditional pumps can't reach the water any more, users blame it on the pump, as they can still draw water with their rope and bucket. Actually it is not the pumps, but the need to place the foot-valve at a certain distance above the bottom of the well to prevent sand coming into the pump that causes the problem.

A hand-dug well should preferably contain at least 1 m of water. In practice the older wells have a depth of about 1 m below the groundwater level of the driest season during the last decades. Of the hand-dug wells in Nicaragua 45% have a depth of less than 10 m; 30% have a depth from 10-20 m; 15% from 20-30 m, and 10% are deeper than 30 m. The maximum depth of hand-dug wells is about 100 metres, although these are only found in exceptional cases.

A 100 mm casing is normally the minimum diameter for drilled wells to install standard rope pumps. However, if necessary this can be reduced to 50 mm, and a rope pump with a small diameter guide adopted.

Table 4. Pumping capacity of the rope pump according to depth

Depth (m)	Adult (L/min)	Child (L/min)	Time needed for an adult to fill a 200 l barrel (min)
10	41	19	5
20	20	10	10
30	14	6.5	15
40	10	4.8	20

Table 4 shows the pumping capacity of the rope pump, based on operation under normal conditions. Even for children it is easy to fill a bucket, thanks to the high efficiency of the pump. This too is an important factor in social acceptance of the technology.

Impact of the rope handpump on people and poverty

Impact of water on farm incomes

Table 5 shows the differences in income among 1,469 farms of different categories with and without a well in 8 municipalities on the Pacific Coast. These are the non-rented farms smaller than 21 ha, from a total database of 1,806 farms. Approximately half the wells are equipped with a rope pump. The impact of the wells and rope pumps is clear. In the six municipalities that make up the north of Chinandega, poverty disappears on farms with a well and a pump from 14 ha upwards, whereas in the two municipalities of La Paz Centro and Nagarote this occurs at 7 ha. As yet there is no complete analysis available to differentiate between the impact of a well by itself and a well in combination with a rope pump, according to property size. However, on average in the range from 0-21 ha the difference in annual income made by the rope pump alone amounts to US$225. The impact of a well or alternative source in combination with the rope pump could be greater if soil fertility were improved, which at the smallholder level means an organic approach. Preliminary results obtained by one of the authors indicate that through this method yields of rainfed staple crops, fruits and vegetables can be doubled, and probably trebled. In Nicaragua, like elsewhere in Central America and many parts of Africa, soils are exhausted and/or depleted by slash and burn practices, followed by monoculture, and often subject to erosion. Trials conducted by local universities and the Ministry of Agriculture in conjunction with FAO in Nicaragua have shown average production increases of maize of 66% when adding manure (10 tonnes per ha) and 100% when maize is cultivated in association with legumes. Informal trials, however, have shown that the use of compost (two handfuls in each planthole) is more effective than manure, as well as a buffer against unreliable rainfall and drought.

The role of water and the rope pump in a strategy for poverty alleviation

The impact of water in terms of basic needs like food or conversely undernourishment is proportionally highest for the smallest categories of farms with the lowest incomes. Also, for families living in absolute poverty this may mean a change of status, though they'll still be poor. For the poor it is an opportunity to rise above the poverty line.

As can be seen from Table 6, a major part of the income obtained from these small properties comes from the so-called 'patio'. A patio can be compared with a kitchen garden, but is not quite the same. It's an area around the farmhouse varying between 900 and 1800 m^2, surrounded by fruit trees, firewood species, and shrubs. Within the area, one finds a dozen or so chickens, a few pigs, herbs like basil and mint in flowerpots, the washing area, the social area, and perhaps a well and a latrine. The patio in general is the domain of women.

Table 5. Farm income (US$) according to property size with and without a well

Farm category (hectares)	No Farms	Well US$	No well US$	% incr.	No Farms	Well US$	No well US$	% incr.
0 – 0.7					11	640	514	25
0.7 – 1.4	324*	740	542	37	22	843	713	18
1.4 – 2.8	324	1224	951	29	42	2040	1059	93
2.8 – 4.2	108	1572	1189	32	57	1366	868	57
4.2 – 7	120	1752	1384	24	65	1762	1605	10
7 – 14	156	1747	1519	13	117	2389	1575	52
14 – 21	60	2599	2019	29	63	2530	1175	115

Note: * These data concern the sum of the categories 0 - 0.7 and 0.7 - 1.4 ha.

Average patio income is approximately US$280 without water in the municipality of San Francisco de Cuapa and US$740 with a well and a pump in the municipalities of Nagarote and La Paz Centro. In the latter case, this is further related to good soils, sufficient space, two local markets and one metropolitan area with good access roads and producers who derive their income almost exclusively from the farm. Well developed patios (found on approximately 25% of the farms), with incomes up to US$2100, are characterised by a poultry component and 5-10 pigs as a basis, fruit trees as the next component, and irrigated vegetables as the final stage of development. The availability of water and a pump in this type of scheme is essential.

Table 6. Patio as a percentage of farm income for different farm categories in 3 municipalities

Category (ha)	Nagarote-La Paz Centro	S.F. de Cuapa
0 - 0.7	56	40
0.7 - 1.4	48	37
1.4 - 3.5	47	40
3.5 - 7	31	29
7 - 21	28	19
21 - 35	21	9
35 - 70	15	4

Between 1999 and 2002, socio-economic data were collected for 5,025 families in 23 municipalities along the Pacific coast of Nicaragua. The minimum sample of farms in each municipality was 15%. The database is available from the Universidad Politécnica de Nicaragua and includes information on the 2216 families in nine municipalities considered in this chapter. Based on this database, a scenario has been developed, which shows that under the right conditions a patio of 1800 m^2 with a well, pump, a rudimentary low pressure irrigation system, and a groundwater table of no more than 10 m depth (quite common on the Pacific Coast of Nicaragua) can easily produce an annual gross income of US$3500 at an investment cost of US$837 and a recurring annual cost (seeds etc) of US$760 excluding labour. Daily labour requirements are three hours a day. Patio development around the limits of the big cities of Managua, León, and Chinandega offers the best potential in the struggle against poverty, given that a sizeable proportion of the poor and very poor are concentrated here. Good soils and water are abundant, and there are ready markets available for produce. Selection of the right beneficiaries for a programme of this kind must be limited to those of proven vocation. Normally these amount to about 50% of all landowners.

Specific findings of two related studies

In her study of the rope pump in Nicaragua in the context of financing rural water supply systems from a rights perspective Blackman (1999) reached the following conclusions:

- The rope pump has user and institutional acceptance. The common belief that sustainability is dependent on recovery of capital costs is brought into question, given that rope pump users take responsibility for maintenance and repair regardless of whether they paid for the capital cost of the pump, facilitated by the fact that this is simple and inexpensive to do. Therefore government donation of rope pumps to beneficiaries should not come under fire, although the study finds that this limits coverage, especially as subsidies are not targeted effectively.
- User financing of the capital costs of the rope pump should be encouraged

where possible, especially as its low cost is affordable for many. Findings show that credit programmes have been successful at facilitating this, although the importance of a flexible repayment mechanism is emphasised.

- The study finds that user financing does not have to conflict with the labelling of water as a basic right. The state has a responsibility to see rights met, but other development actors, including the people themselves, have an obligation to contribute to the practical fulfilment of their rights.
- The study concludes by recommending that the experience with the rope pump in Nicaragua be transferred, promoted and implemented in other developing countries.

Evaluation of the rope pump in five community water supply projects in Nicaragua and one in El Salvador (Post Uiterweer, 2000) showed that a majority of families maintain and repair their rope pumps whether they paid for the pump or not. Also the dropout rate of the pumps is low. Only 6.6% were found to be out of order due to technical failures or negligence by the users. The pump proves to be a sustainable solution for water supply in rural Nicaragua.

Improved health

The objective of improved rural water supply is generally limited to improved health. Implementation should, where possible, be based on scientific and field studies. Before and during the development of the rope pump, an integrated research programme on the causes of diarrhoea with an emphasis on children was conducted by Gorter (1998). The study concluded that water quality improvement does not generally have as great an impact on health as interventions that increase the availability of water or provide facilities for disposal of human faeces. Interventions that improve hygiene behaviour at the household and/or community level seem to have the greatest impact. Improving the level of hygiene practices may be highly effective, but depends on preconditions such as the mother's level of education, facilities for water, and ability to dispose of faeces. Social and cultural factors may also have a reinforcing or a restraining influence.

Based on the previous studies and literature surveys there are three main points to support the rope pump strategy. These are requirements to:

- make more water readily available, thus improving hygiene conditions (water-washed diseases).
- improve water quality (waterborne diseases).
- keep the population away from rivers and streams (possible by making water easily accessible).

The water quality delivered by a rope pump on a borehole fits well within the standards for drinking water quality (< 3 Coliform/100 ml). On hand-dug wells the quality of the water delivered depends on the additional infrastructure improvements made on and around the well. Replacing the traditional rope and bucket by a rope pump without additional infrastructure considerably improves the quality of the water delivered, and makes more water easily available.

It would require an extensive stepwise design of random control trials to establish conclusively the impact of different interventions on the improvement in health conditions. Studies of this type have not been conducted for rope pump related interventions. However, after hurricane Mitch, USAID financed an environmental health project implemented by several NGOs that included the installation of 2,500 rope pumps (USAID, 2001). Monitoring of diarrhoea incidence among children under four was included before, during, and after implementation and it is interesting to note that the incidence came down by 60 to 100 percent.

Rural water supply coverage

Rural water supply coverage is currently defined as the percentage of the population with access to an improved water supply. The definition of what should be considered as coverage is subject to discussion. The earlier mentioned WHO/UNICEF Global Water Supply and Sanitation Assessment 2000 Report (WHO, 2000) tries to narrow down this definition. The report attempts to present survey-based coverage figures rather than estimates provided by those who carried out the improvements. In the Nicaraguan case the first important reference is the national census of 1995 (INEC, 1996). The previous census was taken in 1971.

According to the 1995 census, 27.4% of the rural population had access to a piped water system in or outside their house or through a public source. Another 37% obtained water from a community- or private well, which could be considered as improved water supply in only a few cases. The questions used in this survey were not very specific, leaving room for different interpretations. A second source of information is SINAS (a national system that produces the statistics for rural water supply) which has been in operation since the end of the 1990s. This system includes all the larger improvements, the performance of which is subsequently monitored on a three-monthly basis. The organisations and/or contractors who carried out the projects provide the data. Only improvements that are operational and reported are included in the statistics.

In order to determine the contribution of the rope pump to total coverage, a third database was established, based on the rope pump production figures provided by the leading workshops, earlier evaluations and other sources. These data were cross referenced with information provided by the SINAS statistics. For example, the average number of users per drilled well with a rope pump is known from the SINAS figures, and the total number of rope pumps on drilled wells is obtained from the rope pump producers.

By 2001 the total of rope pumps installed was about 22,000. However, this figure does not take into account the number of pumps installed by other sectoral programmes such as, for example, rural development. Also, most workshops don't keep reliable figures with regard to output. In fact, Holtslag (pers.comm.) estimates that the total of various types of pumps produced may be in excess of 30,000.

Based on the SINAS figures, figures obtained from the rope pump producers, and various evaluations by independent parties, it is inferred that 90% of the pumps installed on drilled wells are operational, whilst this is 80% for pumps on hand-dug wells. These conservative figures take into account pumps of lesser quality produced by the smaller workshops, and at times the higher estimates reached by evaluation missions.

Table 7 shows the number of operational rope pumps and users per pump divided into three categories, based on the projects included in the SINAS statistics, projects carried out by NGOs, and clients from the private sector. Coverage of the number of persons that benefit from each pump is derived from the SINAS figures, evaluation studies, and some rough estimates. Rural water supply coverage as related to the total rural population is shown in Table 8.

These results lead to some important conclusions. By 2001, 23.6%, or almost a quarter, of the rural population received its daily water needs through a rope pump. Needless to say, this is impressive, especially considering that the vast majority of the pumps were installed during the past seven years. The sum of the coverage by other technologies and the rope pumps included in the SINAS statistics gives a number of 38.6%, which is close to the 41.6% coverage presented by the Nicaraguan Government (2001). The WHO 2000 report on the other hand presented rural water supply coverage of 44% for 1990 and 59% for the year 2000. These figures are considered rather high.

Table 7 further shows the very important role of NGOs and different projects. They contributed to over 50% of the rope pump coverage reached in the country, while the government sector contributed 31%. It is perhaps worth mentioning that in other countries NGOs have steadily withdrawn from rural water supply, whilst in Nicaragua they were given the opportunity to show their worth, and responded to the challenge by making the largest contribution.

Technology dissemination internationally

A number of dissemination products produced since 1993 have generated contacts with over 70 countries, with more than one thousand formal letters and e-mails sent. Trials with rope pumps sent over from Nicaragua were conducted in Ecuador (2), Angola (3), Zambia (6), Madagascar (3), and Mozambique (8). Production subsequently got underway in some of these countries, as well as in Laos and Ghana. Other countries started independent initiatives based on the documentation provided, of which the initiatives taken in Zimbabwe are probably the most conspicuous.

Table 7. No. of rope pumps, users per pump, and total beneficiaries by category

	Users per pump	Number of pumps		Total beneficiaries	
SINAS *	96	1711	9.4%	164.407	31.5%
NGOs	31	9303	51.3%	286.639	54.9%
Private sector	10	7118	39.3%	71.176	13.6%

Note: SINAS, pumps included in the national statistical system concerning rural water supply

Between 1996 and 2001 the Swiss Agency for Development and Cooperation (COSUDE) supported the transfer of technology through various activities:

- Documentation which includes (i) Rope Pump Production Photo Manual; (ii) Manual of Technical Drawings; (iii) Installation and Maintenance Manual; (iv) Experiences and Tolerances in Rope Pump Production; (v) Guide for Introducing the Rope Pump, and (vi) Requirements to Start Production of Rope Pumps. All are available in Spanish, English and French. A video of the Central American experiences with the rope pump is also included.
- Financing the construction of a training centre, used for meetings and to receive international trainees.
- Financial support to keep up international communication.

Table 8. Rural water supply coverage

	Rural water supply coverage (%)		
Coverage with rope pumps not included in SINAS	16.1%		
Coverage with rope pumps included in SINAS	7.4% +		
Total Coverage with rope pumps		23.5%	
Coverage through other technologies		31.2% +	
Total rural water supply coverage			54.7%

In May 2001, the 'First International Rope Pump Policy Workshop' was held in Nicaragua. Representatives of governments, international support agencies, NGOs, and private sector enterprises from 23 countries attended the workshop (Keen, 2001). The Workshop was jointly organised by COSUDE, the Regional Water and Sanitation Network for Central America (RWSN-CA), the Network for Cost Effective Technologies in Water Supply and Sanitation (HTN), the Technology Transfer Division of Bombas de Mecate SA, the World Bank Water and Sanitation Programme (WSP), and the IRC International Water and Sanitation Centre. The Swiss Development Cooperation (SDC) financed the event. The organising institutions are all directly involved in water supply activities.

Although the rope pump has widespread acceptance by civil society organisations, international NGOs, users and potential users, private enterprise, and a majority of bilateral donors, this is not necessarily the case with multilateral donors and recipient governments. It is understood, as a matter of course, that management of the complex system constituting the W&S sector cannot include the rope pump without careful prior consideration and study. However, indifference and consistently leaving the debate about the rope pump off the agenda suggests that vested interests are at stake in favour of the traditional pumps.

Conclusions

Cooperation of private sector users, private sector producers, and the national water and sanitation sector in Nicaragua has proved successful for various reasons, and additionally NGOs were involved as important actors in rural development and rural water supply. The characteristics of the Nicaraguan rope handpump, such as low cost, easy maintenance, high efficiency and local production were a prerequisite to make this development possible. The initial introduction took place independently of the water and sanitation sector, while its successful widespread use was made possible through the adoption of the pump as an additional option in rural water supply by the water and sanitation sector. Later on it became a de-facto national standard. The two most important areas of impact are on income generation, including poverty alleviation, and overall rural water supply as evidenced by significantly increased coverage, which presumably includes improved health.

Of the total of over 25,000 rope pumps that were installed, at least 20,000 can be considered to generate an additional income of US$225 a year, which results in a minimum additional annual rural income of US$4.5 million (roughly 0.5% of the country's GDP). This figure is at least twice the total cost of all the rope pumps installed. Given the simple technology and wide range of operating environments – with proven effectiveness to depths of 70m, there is no reason to believe that similar success and cost effectiveness should not be met in other countries. The cost to set up a rope pump production unit in a new area, including promotion, is estimated to be in the range of US$50,000 to US$100,000 depending on the local conditions.

Cost comparisons with more conventional handpump-based rural water supply are striking. Traditional handpumps cost somewhere around US$500, whilst maintenance amounts to between US$60 and US$100 in countries where these have been installed. In Nicaragua, roughly 3500 rope pumps are installed on community wells (drilled or hand-dug) with an average of approximately 100 users per well at a cost of US$350,000 in high quality rope pumps or US$100 per unit. If traditional handpumps had been used, this would have cost US$1,750,000 - a difference of US$1,400,000 without taking into account the added benefits of saving foreign exchange, generating local employment, and improving local skills. Additional annual savings of around US$250,000 are made, as maintenance costs of the rope pump are minimal.

Because of the cheapness and versatility of the rope pump, a minimum additional 10% of the rural population has been provided with improved water supply (cases of up to 20 users per pump), than would have been the case with costlier handpump designs.

Many organisations and individuals around the world know the experience in Nicaragua and most of the results presented in this paper. This has generated new initiatives in other countries, but so far has failed to result in the adoption of rope pump technology as a viable alternative in the rural water supply sector. In fact, traditional, donor-supported technologies and related policies are blocking the process, and excluding the rope pump from rural water supply policies. There are a variety of likely reasons for this blockage, ranging from institutional inertia and rigid sectoral thinking to vested interests and corruption (importing and having a monopoly on expensive handpumps is an often lucrative business).

International acceptance of the rope pump may perhaps be aided by its introduction through rural development activities. Generally this sector is more open to innovation, with recent examples of innovative approaches including animal traction, post harvest silos, and the treadle pump, which has had such a large impact in Bangladesh. Nevertheless, resistance is expected to remain until the barrier can be levelled by sheer critical mass.

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Beyond domestic:

Case studies on poverty and productive uses of water at the household level

Is something missing from your work in water supply? Do individuals and communities that you work with use their water supplies for multiple purposes? Are you challenged by how to help the poor gain access to water (beyond 'traditional' domestic or field-scale irrigation needs) for activities that generate food and income like fruit and vegetable production, keeping livestock, brick-making and building, and a wide range of informal micro-enterprises? Do you search for ways to improve cost-recovery?

'Beyond domestic' contains:

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The book will inspire and support professionals seeking to move beyond sectoral boundaries in domestic or irrigation water supply, and contains many suggestions for an agenda of policy change, implementation and further research.
'Beyond domestic' is jointly published by IRC, the Natural Resources Institute (NRI) and the International Water Management Institute (IWMI).

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ISBN 90-6687-044-3
9 789066 870444