THE FLUID MOSAIC

Water Governance in the Context of Variability, Uncertainty and Change

A SYNTHESIS PAPER

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Contents

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Introduction

Introduction

The winter ice in streams fractures along razor sharp lines but when it melts, such lines lose meaning. The banks of the stream, the directions of flow and the fundamental processes governing that flow are far more important over the long term. So it is with most debates over water management. Debates fracture along lines of ideology or philosophy, casting local approaches in opposition to centralised ones, supply-side in contrast to demand-side, and regulatory in contrast to market. Far less concern focuses on the core questions of governance – how, by whom, and under what conditions different approaches are enabled or selected. These questions of governance are, however, central to addressing water problems in the current context where climatic, hydrologic and socio-economic conditions are subject to extreme variability and potentially fundamental change.

The core messages from our research relate to the fluid mosaic of water governance – how society may be able to address the sharp-edged, immediate constraints present at local levels and shaped by local conditions but ordered within a larger, changing, fluid and poorly understood picture.

This report summarises five years of collaborative investigation by Indian and Nepali researchers on water management needs and options in Gujarat, Rajasthan, Tamil Nadu and parts of Nepal. Our initial goal was to define the boundaries of 'local management' in a way that enabled substantive comparisons to be made between local, community-based approaches and larger-scale, government led initiatives. As often happens in such research, as investigations proceeded, the starting questions seemed less and less relevant and our focus shifted. This summary presents the result of our collaboration. The sections focus on the specific water management issues and challenges in case study areas. *The core messages, however, relate to the fluid mosaic of water governance – how society may be able to address the sharp edged, immediate constraints present at local levels and shaped by local conditions but ordered within a larger, changing, fluid and poorly understood picture.*

The Challenge

Without water there is no life. The rhythm of the seasons and the flow of water through them still shape the livelihoods of most of the world's population. For farmers, access to and control over water is the foundation of their livelihood. In much of South Asia development of water resources, particularly groundwater, has, over the past five decades, played a central role in stabilising agricultural production and reducing poverty (Moench, 2001). This foundation, however, is threatened by increasing competition over limited supplies and by the depletion/ pollution of existing sources. Groundwater conditions have both alleviated and exacerbated poverty. In many arid and hard rock regions of India, water levels in key aquifers are declining at rates of a metre or more a year, and development, driven mostly by the demand by millions of individual users for access to reliable sources of supply, continues apace (World Bank, 1998). Competition over surface water is also increasingly intense and has led to local and interstate disputes. In the weeks preceding our drafting the first version of this summary, a long-running dispute over the Cauvery River between Karnataka and Tamil Nadu underlay one apparent suicide[1], attempts by farmers to set trains on fire[2], banning of Tamil movies in Karnataka[3] and police opening fire to disperse protesting farmers[4]. Similar disputes, though not on a large scale, are common in many parts of South Asia.

Scarcity, whether absolute or induced, is not, however, the only fundamental challenge. Water quality and pollution are major, increasingly well known issues contributing to scarcity. Less publicised, however, are challenges inherent in the variability and changing nature of water supplies along with the limited nature of scientific information and technical knowledge. In many situations, basic hydrologic and other data are unavailable, making conventional analysis inappropriate. Under such conditions, analysis must proceed iteratively with an emphasis on uncertainties rather than on the 'known'. Furthermore, such challenges are not confined to water *per se* but are also inherent in the rapidly evolving management of the environment. Water problems and water management options are as much a product of the social, economic and institutional context as they are of the technical factors governing local hydrologic conditions. In addition, many of the most important water related challenges have to do with socio-economic distribution of access. For people who are able to pay or who belong to elite social groups, water is often not scarce, even in situations where the available supply is extremely limited. Since water is a cornerstone for most economic activity, equitable distribution of supplies under changing conditions is often more of a challenge than absolute limitations on the available resources. Water problems tend to reflect the development paradigm adopted.

Equitable distribution of supplies under changing conditions is often more of a challenge than absolute limitations on the available resources.

Given the above, the challenge South Asia faces is a complex one. It is not primarily about the ability of governments, non-governmental organisations (NGOs) or communities to 'choose' one or another uniform set of technically viable solutions to water problems. It is also not really about integration or planning mechanisms for resolving multiple demands on and disputes over a limited water resource base. Both technical solutions and the degree of integration required depend heavily on context and the specific nature of the water resource constraint being addressed. Instead of integration or technical considerations, both of which are equally important as outcomes, *South Asia's core 'water' challenge is one of governance, particularly the deeper 'constitutional' foundations on which day to day decisions and courses of action rest*. This is particularly true because comprehensive planning is, at best, difficult under conditions characterised by uncertainty, variability and change. Since both natural and social conditions are changing and are subject to substantial uncertainty, we cannot make linear plans that will solve water problems for our lifetimes or for future decades. Instead, we need the capacity (information, forums and processes for decision-making, legal and regulatory mechanisms, executive capabilities, and governance with embedded dispute resolution mechanisms) to enable society to respond to constraints that could be local or regional, short or long-term, political, economic or technical. This is the real challenge.

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1 http://www.rediff.com/news/2002/sep/18cau2.htm
2 http://www.rediff.com/news/2002/oct/04cau4.htm
3 http://www.rediff.com/news/2002/oct/06cau3.htm
4 http://www.rediff.com/news/2002/sep/15cau1.htm

The Intellectual Context

The world is at a juncture. Historically, most water 'problems' were solved by additional water development, that is, by focusing on the supply side. Now, development opportunities are increasingly limited and perspectives are shifting toward how the resource base can best be managed and allocated. This shift has yet to fully occur. Many in political positions, the private sector, non-governmental and governmental organisations remain focused on opportunities for supply development. As a result, substantial tension exists between those advocating management solutions designed to increase the efficiency, equity and sustainability of water use and those who still see additional development as the primary viable solution to water scarcity. The above tension is compounded by questions of control. With the exception of groundwater, which by nature is a dispersed resource, water development is generally a large-scale construction activity requiring major resources and organisation – both prerogatives of the state.

With the exception of groundwater, which by nature is a dispersed resource, water development is generally a large-scale construction activity requiring major resources and organisation – both prerogatives of the state. These characteristics have contributed to the development of many large centralised irrigation and water supply organisations that dominate the water sector in much of the world, including South Asia.

These characteristics have contributed to the development of many large centralised irrigation and water supply organisations that dominate the water sector in much of the world, including South Asia (Wittfogel, 1957; Worster, 1985). Such organisations are inherently unsuited to undertake many water management functions. Efficient water use and equitable allocation depend on the behaviour of individual users. Management for efficiency and equity is, in many ways, an inherently local activity where courses of action and the incentives to undertake them are contingent on specific local hydrological, economic, technical and social conditions. As a result, the increasingly evident need for water management undermines the position of large-scale development organisations (such as government irrigation departments) and often pits them in a struggle for control of programs, budgets and activities against more localised groups.

Beyond the shift from supply development, the increasing complexity and interlinked nature of social and water use systems at global, regional and local levels is a major factor reshaping water management needs and options. Globalisation of economic and other systems has tremendous implications for water supply and use. The factors influencing crop choice – and therefore local irrigation water demand – are, for example, heavily influenced by global market conditions. Similarly, in contrast to previous centuries, water diversions now often represent a very major fraction of river flows or groundwater recharge. As a result, uses throughout basins are increasingly recognised as interconnected and often interdependent. This recognition, a major feature in water management thinking over the past five decades, underlies the growth of integrated water resources management (IWRM) concepts and proposals. The 'need' for greater integration is now widely recognised and accepted but there is, in actuality, little practical experience regarding how integration could be achieved or of the consequences of attempts to achieve it. Furthermore, the concept of integrated water resource management remains nebulous. As the Global Water Partnership comments: '*the concept of IWRM is widely debated and an unambiguous definition of IWRM does not currently exist.*' (Global Water Partnership Technical Advisory Committee, 2000).

Definitions of IWRM range from narrow statements that any water project involving more than two factors is 'integrated' (Mitchell, 1990) to all-encompassing statements of process and philosophy.[5]

The lack of clarity in debates over integrated water resource management is indicative of a fundamental challenge. The 'need' for integration may be clear – but how it can be achieved is far less so. Furthermore, major questions exist over:

- Who does the integrating;
- Whose interests should be reflected in the integrating process and how should such a process be governed to ensure the interests of all stakeholders are equitably reflected;
- How disputes should be resolved;
- What issues need to be addressed through integrated approaches. Clearly, some water management needs (for example control over waste disposal from an individual treatment plant) can be addressed in isolation from larger systemic issues. Other needs, such as allocation of limited supplies within a major river basin, require consideration of many issues within a large-scale system.

The 'need' for integration may be clear – but how it can be achieved is far less so.

All of the above indicate the massive intellectual and practical challenges inherent in any shift from development to management. At present, effective institutions for water management are yet to evolve in much of the world. Furthermore, available institutional concepts – whether stemming from the 'common property,' community-based school of thought or the organisational theories underlying the development of governmental or private sector organisations – do not map neatly onto the functions required to address emerging water problems. The intellectual context is, as a result, marked by ferment. Groups such as the International Association for the Study of Common Property and the Workshop on Political Theory have distilled some basic principles from case studies of community-based and other forms of management – but these are often difficult to apply to regional management needs or contexts characterised by rapid social and economic change. Other organisations, such as the World Bank, emphasise economic levers, private sector based approaches and the role of large governmental organisations. The fit between theoretical perspectives and conditions or management needs on the ground is often poor. Solutions to, for example, groundwater overdraft in the aquifers of northern Gujarat (where extraction by tens of thousands of individual farmers across thousands of square kilometres threatens the groundwater resource base) have yet to evolve.

Our Research

The Local Water Management Project was conceived and designed in response to the disputes between proponents of large dams or inter-basin transfer projects and others advocating more distributed 'local' solutions to water supply needs. This debate was often conducted on the basis of limited practical scientific information on the actual nature of local water management options: physically what the water management needs were, technically what could be done

5 The Global Water Partnership, one voice for global opinion, states that: '*IWRM is a process that promotes the coordinated 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.*' Global Water Partnership Technical Advisory Committee (2000). *Integrated Water Management.* Stockholm, Global Water Partnership**:** 71. Similarly, the World Bank states that: '*The proposed new approach to managing water resources builds on the lessons of experience. At its core is the adoption of a comprehensive policy framework and the treatment of water as an economic good, combined with decentralised management and delivery structures, greater reliance on pricing, and fuller participation by stakeholders.*' World Bank (1993). *Water Resources Management: A World Bank Policy Paper*. Washington D.C., International Bank for Reconstruction and Development, pp. 10.

to address them at a local scale, what such an approach might cost, what environmental impacts might be associated with it and, institutionally, how local approaches could be implemented. By conducting detailed research in a selection of areas in Nepal and India, the collaborative group intended to 'flesh out' the degree to which local approaches to water management could address the array of needs now emerging. To ensure the compatibility of research results, all collaborators used a common set of core survey, institutional analysis and modelling methodologies (including the WEAP water analysis and planning system developed by the Stockholm Institute). Sites for research included Tamil Nadu (Palar and Noyyal basins and Chennai), Gujarat (Sabarmati basin including Ahmedabad), Rajasthan (Shekawati and Banganga basins), and Nepal (Tinau basin and Kathmandu). These sites represented a diverse selection of agro-ecological and hydrological zones.

Issues did not divide neatly along the lines of centralised versus distributed approaches to water management.

As in many ways anticipated, issues raised in the initial stages of the study did not divide neatly along the lines of centralised versus distributed approaches to water management. In several of the regions investigated, the core issues had little to do with water scarcity *per se* or whether or not water was supplied through centralised or distributed sources. Instead, on a technical level they revolved more around questions of supply variability and the presence of extreme events. Furthermore, uncertainty, the lack of knowledge regarding hydrologic system characteristics and

FIGURE 1:
Study sites in Nepal and India

Adapted from Agarwal and Narain, 1997 and Dixit and Gyawali, 1997 even the probability/frequency of key events, was a defining feature in many local contexts. Beyond this, at their root, many 'water issues' had less to do with water than with governance or the lack of transparent systems for water governance. In parts of the Palar Basin in Tamil Nadu, for example, water is 'scarce' in large part because available supplies have been polluted by effluents from tanneries and other industrial establishments.

Industries generate waste but are also sources of livelihood. The question of pollution control is a political one where those who benefit from livelihoods that generate high levels of pollution are different from those whose livelihoods are damaged. Similarly, in all the major urban areas studied, water markets are evolving into a major mechanism for domestic water supply. The issue some researchers have with such markets is one of equity and the degree to which individuals are able to capture and profit from privatisation of what has historically been a public good. Finally, in many areas no single water 'issue' dominates. Instead, as in the Tinau river system of Nepal, there are numerous specific local concerns in different areas but these have little relevance at the overall system level. Sand mining in the bed of the Tinau, for example, makes it difficult for the traditional irrigation systems to divert water. This issue comes down to a very location specific dispute between individual irrigation systems and those mining sand in specific locations. The concern is local and has little implication for those in either upstream or downstream locations. In Tinau, sand mining is a source of livelihood for low income migrant families. Long settled communities depend on the irrigation systems.

Although the contexts in which our research occurred are very different, unifying themes emerged. Social responses to water problems and governance in the context of a rapidly changing society highlighted issues such as: Who has a seat at the table? How are the impacts of variability distributed? What types of information are collected for decision-making and who has access to them? What incentives do individuals and groups face and how do those shape their perception of – and responses to – emerging water problems? As a result, our research evolved beyond the initial focus on centralised versus 'local' strategies for water management into detailed investigations of the diverse social and institutional responses to uncertainty, variability and the specific problems emerging in different geographical locations. This, in turn, led us to explore the implications of such responses for conventional management strategies and to broaden our search beyond the conventional toward strategies that are better adapted to both the nature of emerging problems and the incentives individuals and communities have for addressing them. Ultimately, the issues of most relevance in specific locations forced us to place water management firmly in the context of deeper questions of governance and human organisation.

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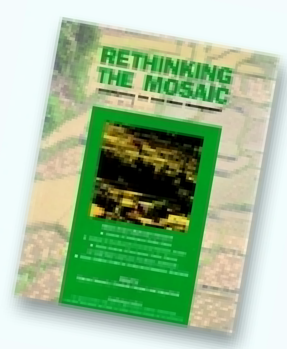
Core Arguments Resulting from the Research

The research generated a set of core insights that have broad relevance to water management in many parts of the world, particularly in developing countries. These are documented in detail in our earlier book *Rethinking the Mosaic: Investigations into Local Water Management* (Moench *et al.*, 1999) and in another book that is currently being edited. A few are, however, important to emphasise here.



First, in economies where large portions of the population are directly dependent on agriculture for their basic livelihood, access to reliable sources of water is a fundamental factor influencing the level of poverty. Our research clearly demonstrates the critical role groundwater development has played in stabilising water access for farmers (Moench, 2001; Moench, 2002). Reliable water supplies that are under the direct control of individual farmers reduce the risk of crop loss substantially and, by doing so, enable investment in agricultural intensification. This, in turn, reduces the frequency with which farmers must draw down reserves created in good years to survive the lean and catalyses a process of asset accumulation. Once underway, accumulation can enable diversification – and ultimately enable families to transition out of agriculture – through investments in education and the accumulation of resources to finance new, non-agricultural livelihoods. The above 'virtuous' transition is, however, threatened in fundamental ways by groundwater overdraft and pollution.

Attempts to comprehensively 'integrate' relevant factors into water management approaches and decision-making are unlikely to be successful in most situations found in South Asia.

The same research that indicates the central role groundwater can play in poverty alleviation also indicates the role loss of access plays in poverty creation. Household economies that depend on intensive agriculture for their livelihoods and have not diversified their income sources are extremely vulnerable when water levels fall or available water supplies become unusable. In this situation, competition over available supplies and the incentive to invest whatever capital has been accumulated in a fruitless quest to maintain access to groundwater often impoverishes communities. Often differentiation occurs, with many losing access to groundwater while a few, better situated to retain access, dominate the water economy. In parts of rural Gujarat, Tamil Nadu and Rajasthan, the intensive and wealthy groundwater based agricultural communities that have emerged over the past fifty years are now vanishing as small farmers drill deep, unprofitable, wells into the hard bedrock underlying depleted shallow aquifers. The situation is often aggravated by the entry of commercial interests who capture and exhaust available supplies. The need for effective water management – whether to maintain a sustainable source of supply or to ensure that social transitions reduce rather than create poverty – is clear. This leads to the second point.

Second, although we fully acknowledge the logic underlying conventional arguments for integrated water resources management, attempts to comprehensively 'integrate' relevant factors into water management approaches and decision-making are unlikely to be successful in most situations found in South Asia. People focus on constraints and immediate tasks, not on integration of numerous factors potentially influencing a problem. This is particularly true during periods of rapid social change when individuals and communities are being forced to deal with numerous sources of uncertainty that extend far beyond water related issues. Furthermore, integration is unnecessary as a response to many water management needs. In the case of pollution, for example, narrowly targeted efforts to control effluents may, in some cases, be more successful if they are addressed through local political processes and de-linked from wider questions of, for example, basin management.

Even where supply and flow allocation is concerned, hydrologic units such as river basins or aquifers are not always the most appropriate unit for analysis or management. Groundwater overdraft, for example, can be a localised phenomenon within a much larger scale aquifer. Similarly, water availability in streams is often as much a function of lateral inflows from precipitation or groundwater up-welling within a basin as it is a function of flow from the headwaters. Such conditions may, in many situations, make it hydrologically more appropriate to allocate and manage water at a sub-basin, watershed or even administrative unit level than at a basin level. Some issues require basin level perspectives, some do not. *The key is to think systemically and define the boundaries of analysis or management at scales where hydrologic, social, economic and institutional conditions enable effective action in response to specific needs.*

Third, much greater effort is needed to devise management approaches that can adapt to:

- Hydrologic variability;
- Limited amounts of data and basic scientific knowledge;
- Social, demographic, technical, institutional and economic change; and
- The fundamental dynamics of human organisation and politics.

In most of the areas where our research was conducted, hydrologic variability was high and data (on precipitation, stream flows, groundwater levels and other hydrologic parameters) extremely limited. This situation is common in many parts of the world. As a result of it, the nature of emerging water problems and what could physically be done to address them is often uncertain. Surprise is central to most situations. This situation is compounded by the rapid pace of social change now occurring. Many parts of South Asia are now economically 'peri-urban'; they are linked to urban areas by the flow of information and goods, by seasonal and long-term migration, and often by shared water supplies. In many situations, the incentives water users face are heavily influenced by real or perceived opportunities in urban areas and non-agricultural livelihoods. As a result, users are often oriented towards urban livelihoods and lifestyles and, as a result, frequently have little incentive to contribute to the sustainable management of water resources. Change is emerging as a core feature of the 'rural' social and economic environment.

When situations are characterised by variability, uncertainty and change, conventional planning scenarios provide little guidance regarding future needs and conditions.

When situations are characterised by variability, uncertainty and change, conventional planning scenarios provide little guidance regarding future needs and conditions. As a result, it is difficult to develop management approaches and institutions tailored to specific long-term management needs. While it may be possible to identify some emerging problems in advance, changing conditions often render specifically targeted management proposals irrelevant or impossible to implement. Because of this, our research indicates a clear need for frameworks that are 'adaptive' – that reflect uncertainties and can respond and adapt as contexts change or unforeseen problems emerge. *Specific solutions are less important than the existence of processes and frameworks that enable solutions to be identified and implemented as specific constraints arise and contexts change.* In most situations more attention needs to be given to clumsy, resilient institutions and approaches rather than tightly focused (theoretically efficient) but brittle ones. Tightly focused institutions and organisations are essential for specific tasks – but they can't govern or guide the complex, surprise laden, process of water governance central to long-term management at a regional, basin, aquifer or even local level.

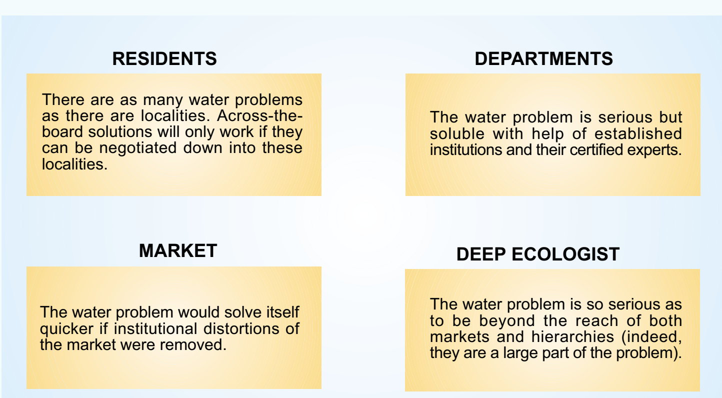
All of this suggests that a move back to basic principles of governance is central to society's ability to address water management needs over the long term. Strategic approaches based on governance concepts that recognise fundamental principles of human organisation and balance of power issues (between executive, judicial and legislative functions and between the 'local' and more 'global' interests) are essential. Structures of water rights and concepts of ownership also need to be addressed. Finally, information is a critical element mediating and conferring power within social relations. As a result, freedom of information should become a central feature of water governance.

Cultural Theorists point to four basic styles of social relationships: hierarchical, egalitarian, individualist (market) and fatalist. These styles correspond, in many ways, to basic elements of governance. Hierarchical structures and organisations are often central to the executive function: organisations that 'do' something on targeted tasks – that execute policies, projects and programs – tend to be hierarchically structured with the clear chain of command necessary to organise implementation. This executive function is distinct from (and should be separated from) the guidance function: the egalitarian voices that speak for different groups of people and ultimately identify points of social consensus where group action is needed. In many governmental structures, the guidance function is held by legislatures, the elected representatives of individualists (the market of ideas and positions). Fatalists have very little influence. Within most democracies, freedom of speech and freedom of information are the 'yeast' catalysing dialogue between and within these elements of governance. Without information and freedom of speech, debate is uninformed and society has no basis to challenge factually incorrect or biased positions. Finally, most approaches to governance include a dispute resolution role generally played by court systems but also embedded in arbitration and diplomacy. This role has no direct parallel in the modes of organisation proposed by Cultural Theory. We view it, however, as a central requirement for mediating between the biases inherent in each of the four styles of organising.

Our research highlights the central role played by what we call 'social auditors'.

The above argument may appear very abstract and only distantly related to practical questions of water management in local areas. As discussed below, it isn't. Before moving into this practical discussion, however, two additional points are important to make. *First*, our research highlights the central role played by what we call 'social auditors' (Moench, 1999). As in most arenas of social debate, water management is a complex topic where key issues may not be readily evident to the general population. As a result, informed governance depends on the presence of specialists capable of identifying, understanding and communicating critical issues to the wider communities concerned with outcomes from water management. *Second*, it is important to recognise that such analysts are themselves products of the main modes of social organisation. Science is, as Dipak Gyawali argues, a three legged stool of government, market and egalitarian interests (Gyawali, 2001). Analysts who are members of hierarchical executive organisations will generally define problems and solutions in ways that reflect the executive capabilities and interests of their organisation. Individualists and organisations functioning in a market context will, similarly, tend to define issues and potential solutions in ways that reflect their capabilities and interests. Market organisations do not, generally, produce

FIGURE 2:
Four definitions of the problem



Adapted from Thompson, 1997

products that cannot be sold. Analysts working for market organisations will, as a result, generally be amenable to produce specific marketable products. Finally, egalitarian organisations also tend to produce analyses that reflect their constituent's interests and perspectives – whether that is focused on specific environmental issues or the needs of minority or other communities. Science is not neutral.

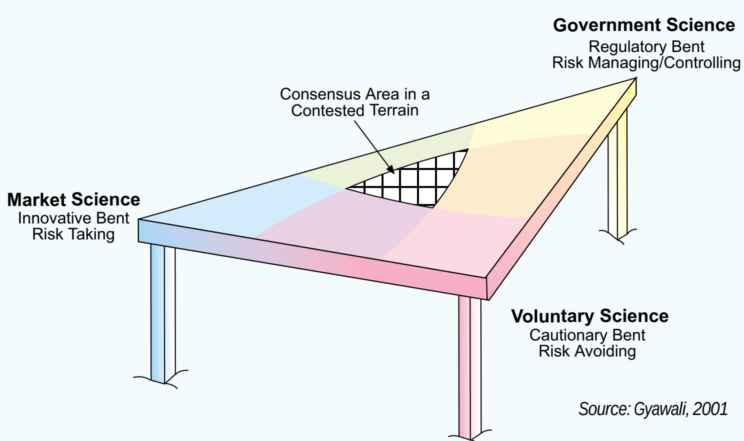
Now to the practical question of water governance: In India and Nepal, as in most of the world, basic governance concepts designed to balance the power of organisations and specific interest groups have not generally been applied to the long-term question of water management. Scientific information is almost exclusively generated and held by hierarchically structured government departments organised to address specific executive functions (such as the construction of irrigation or drinking water systems). As documented in the case of groundwater in India, this has led to a situation in which much of the available information on water resources may contain major biases (Moench, 1994). Egalitarian organisations (the NGOs, social activists and movements) are widespread but often poorly financed and lacking the capacity for in-depth analysis to say nothing of basic data generation. As case studies undertaken for our research indicate, the market is a major – if not driving – player in water development activities. This is clearly evident in the spread of pumping technology and the rapid growth of urban water markets. It is also evident in, for example, the spread of highly polluting industries that have a negative impact on water availability in locations such as Tamil Nadu. The role and interests of market actors are not, however, central in most water management debates with the possible exception of debates focusing on privatisation of irrigation/drinking water systems and on the potential role of water markets. Formal mechanisms for dispute resolution are generally non-existent or located within hierarchically organised executive agencies. *In sum, the existing governance structure for water bears little relation to the theoretical ideal. Conflicts of interest are common and there is little formal effort to develop the structures that enable dialogue or balance the power of specific interest groups.*

Elements of a new, more adaptive, governance structure are already present in some areas.

In the above context, the fundamental importance of strengthening systems for water governance is a final core argument emerging from our research. Elements of a new, more adaptive, governance structure are already present in some areas. The multi-stakeholder platform catalysed by VIKSAT in the Sabarmati basin along with a similar initiative now emerging in Tamil Nadu could be viewed as nascent institutions capable of playing the guidance or legislative function. These aren't, however, truly representative and, while they could enable adaptation (by giving voice to the immediate concerns and perspectives of stakeholders), they are not inherently forward looking. Furthermore, they are very young and have little formal power (such as budget control) to influence the activities of executive entities. This is not

FIGURE 3:
Three legs for stable South Asian water science

In moving towards a new era of contested terrain, where space is provided not just to bureaucracy but also to a dynamic and innovative market and a cautionary civil society, a new research agenda has to be laid out for South Asian water science.



Source: Gyawali, 2001

to say that such organisations are without influence. In some cases, they have catalysed major changes in water management.

Where the executive function is concerned, organisations with substantial capabilities are already present at all levels – from the community to the state. The importance of information is also widely recognised. Greater freedom of information is widely advocated and has been incorporated as a principle in, for example, some projects supported by the World Bank. While the success of such initiatives is limited, the need is at least recognised. Other critical elements central to effective water governance are, however, completely absent in most situations. Mechanisms for dispute resolution are largely non-existent. Social auditors lack both capacity and resources. Unlike, for example, the United States, there is little tradition of private philanthropy to support alternative voices. As a result, the resources are unavailable even where social auditors have sufficient capacity to propose alternatives.

We need to build the capacity of social auditors.

What does this imply in a practical sense for efforts to improve water management? On a basic level, it implies the need to focus much more strongly on the creation and strengthening of basic governance structures. It also implies the need to design responses to immediate water management needs in ways that contribute to and are consistent with the larger governance equation. Conventional approaches to water management often reinforce the role of existing hierarchical organisations while doing little to strengthen those components of the larger governance equation that are weak or absent. Furthermore, in all the basins we studied, social auditing capacity was extremely limited.

Discussion on rainwater harvesting method.

Highlights from Case Studies

Highlights from Case Studies

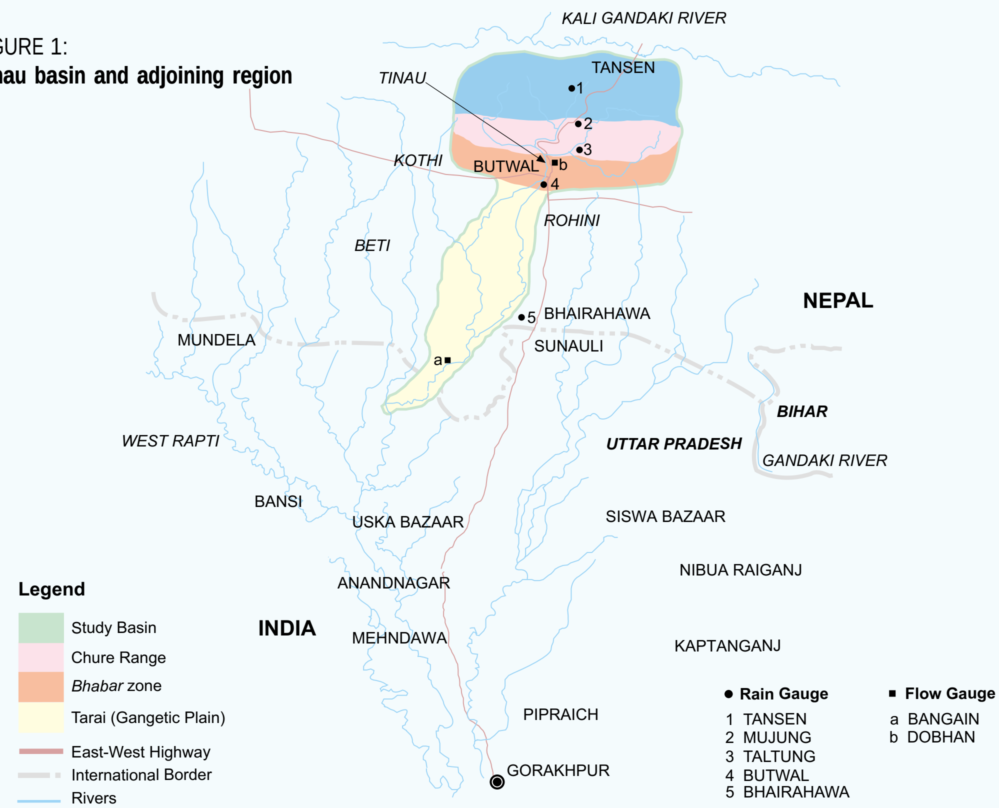
The core arguments presented above stem from a combination of basic research in case study areas and wider reviews of the theoretical and empirical literature on water management, common property institutions, political science and governance. This section focuses on the case studies themselves and the key insights they contain for water governance.

We argue that natural variability necessitates adaptive rather than "comprehensive, integrated" approaches.

THE BASINS

Research by the collaborative group focused on five basins: The Sabarmati River in Gujarat, the Shekhawati and Banganga Rivers in Rajasthan, the Palar River in Tamil Nadu and the Tinau River in Nepal. Conditions in each of these basins – and the management issues facing the populations residing within them – differ substantially. This variability lies at the heart of our argument for adaptive or enabling approaches to management that, while recognising the systemic nature of interlinked water and social systems, do not attempt to force comprehensive integrated approaches or 'basin' perspectives onto situations where this is neither required nor productive.

FIGURE 1:
Tinau basin and adjoining region



Source: Gyawali and Dixit, 1999

Tinau

In *Rethinking the Mosaic*, our first book, Dipak Gyawali and Ajaya Dixit entitled their chapter 'Fractured Institutions and Physical Interdependence'. The title is accurate but, in contrast to conventional perspectives, the most important points of interdependence are not at a basin scale but at far more localised levels. As the case study of the region undertaken by the Nepal Water Conservation Foundation (NWCF) documents, even the concept of a basin is, in many ways, complicated in the Tinau case. The case study was conducted between 1997 and 2002. It involved detailed informal interviews with key informants and formal surveys throughout the basin.

The Tinau flows out of the middle hills of Nepal's Palpa district down to the Tarai at Butwal. From there it meanders in a divided channel across the outwash sediments at the base of the Himalaya and finally into India where it joins the West Rapti near the town of Gorakhpur. Along the way the name of the river changes at various points (in some cases the local name is different depending on which bank one is standing on). Different institutions manage water use at various points. They include municipal users such as the town of Tansen, complex irrigation systems in the Madi Phant (a valley in the middle hills), one hydropower producer in the steep gorges where the river cuts through the southernmost ridge of the Chure Range, a selection of large-scale (up to 5,000 ha) farmer built and managed irrigation systems in the upper Tarai, a burgeoning municipality using the river and groundwater sources, thousands of individual farmers pumping groundwater from private wells, a few large-scale deep well pump systems, and finally, one medium-sized, government financed lift irrigation project with its own chequered history (Gyawali and Dixit, 1999).[1]

While the Tinau is embedded within a far larger system, many water use issues are fairly localised.

Hydrologically, the Tinau 'basin' is complex. Originating in the middle hills, it is a rainfed basin with distinct upper and lower sections (see Figure 2). While some degree of physical interdependence does exist, much of the stream flow in the lower Tarai portion of the basin is probably independent of that in the upper section running through the Mahabharat Range. Rainfall occurs throughout the basin and is most intense in the Tarai at the base of the Chure Range. Furthermore, the lower 'basin' is part of a complex network of outwash fans deposited by many streams and major rivers at the base of the Himalayan uplift. There is no clearly defined basin boundary; rivers shift regularly as they cross this fan. One of the most striking effects of this mobility was on the Tinau barrage. This was built in the 1960s but was bypassed by the Tinau River as its main channel bifurcated westward. Unlike modern fixed irrigation structures, traditional irrigation systems are well adapted to the dynamic nature of the river. Both large and small scale irrigation diversions have little implication for water availability downstream. Much of the stream flow in the lowest sections near the Nepal-India border and downstream is probably contributed by groundwater. Groundwater - surface water interaction is strong in this region but difficult to quantify. In addition, groundwater flow systems probably have little to do with the Tinau 'basin' *per se* but function as part of the larger aquifer systems of the Gangetic plains. And the Tinau River is part of the far larger interlinked Ganga basin system. As a result, even the identification of a distinct Tinau river 'basin' is complex. While the Tinau is embedded within a far larger system, many water use impacts are fairly localised.

1 This system was initially constructed by bisecting a long-established, farmer managed, traditional system. Shortly after construction the main channel on the Tinau shifted, bypassing the barrage. As a result, the new irrigation system never functioned. The system was rehabilitated in the 1980s through establishment of a pumping station at Marchawar, the tail end of the river in Nepal. Pumping water uphill is expensive and, as a result, recent efforts to turn the system over to users have had mixed success.

FIGURE 2:
Schematic view of the Tinau River and water uses dependent on it

Water resources in South Asia face the combined challenges of scarcity and pollution. These not only threaten the resource base but also undermine the foundation of society and community livelihood. Challenges emerge both within and between water use systems. The linkages defining the relationships within and between systems are not clearly evident, and are shaped by social, political, hydrological and economic processes.

Effective response require

- **SYSTEMIC PRESPECTIVES:** Water management approaches need to reflect both the interaction between water uses and other (environmental, economic, etc.) systems and limitations regarding how well those systems and the interactions between them are understood.

- **CONSTRAINT ANALYSIS:** Comprehensive management is an unachievable goal given the rapidly changing and dynamic nature of both hydrologic systems and the larger social context. For this reason, management needs to focus on constraints that affect key social, economic or environmental water services. In many ways, this is a formal recognition of existing practice.

- **CONTEXT ADAPTIVE RESPONSES:** Management approaches need to be able to both reflect variable local contexts and adapt as conditions change.

Ajaya Dixit

In the early 1960s the Tinau River in Nepal bypassed a recently completed irrigation barrage. The river embodies physical, hydrological, social, cultural and political variability. Total understanding is an unachievable goal.

Source: Gyawali and Dixit, 1999

Consumptive water use in the upper hill regions of the Tinau basin is unlikely to grow substantially. Most of the flat river bottom land in Madi Phant is already intensively irrigated. Municipal demands in locations such as Tansen and Butwal are growing but they remain a small fraction of the total. As such, the consumptive impact of municipal use is generally minor. In combination with the fact that much of the precipitation occurs south of the Chure Range and that groundwater contributions to stream flow are substantial, it could be argued that increases in consumptive water use in the upper basin will have little real implication for users in lower areas. Pollution is a significant concern – but at Butwal and further downstream in the river there is little industrial effluent and most of the BOD degrades within perhaps 10 kilometres downstream. Industrial pollution could become a significant basin scale concern – but again the most intensive impacts would probably be in the immediate locality of urbanising towns such as Butwal.

The Tinau dependent region is experiencing rapid social change.

The most likely point where changes in water use are likely to have major 'regional' implications is in relation to increasing groundwater development. Groundwater extraction in the Tarai has grown exponentially over recent decades. Although reliable statistics on well numbers and extraction are not available, groundwater use was insignificant two decades ago while now it is probably the single largest source in many parts of the lower basin. Across the border in India, groundwater use has grown exponentially since mechanised wells were first introduced on a large scale in the 1950s and 1960s: from a few thousand mechanised wells at the time of India's independence, official statistics indicate tens of millions are currently in place at a national level (World Bank, 1998). Assuming the growth of groundwater use in Nepal follows the path that has occurred in India, regional impacts on water quality (including the potential for arsenic mobilisation), water levels and stream flows are likely. The specific nature of these impacts is, however, anybody's guess. Groundwater levels within the complex aquifer systems of the region are highly variable. This is known as one of the major recharge zones for the southern Gangetic plains and recharge is very high. With little data on regional hydrology and water use, accurate prediction is currently impossible. Logic suggests, however, that many important impacts are likely to be localised with changes in water levels, water quality or stream flows varying according to local use patterns and the way such uses interact with localised hydrogeologic characteristics (soils, in-basin precipitation, drainage, etc.).

Even flooding is probably influenced more by local than basin characteristics; much of the precipitation in the basin occurs in the southern face of Chure, *below the narrow mountain gorges where flood control reservoirs could, in theory, be constructed.* The Tarai is flat – there are no locations in the lower basin where flood control reservoirs could be located. Furthermore, most long-term flooding is probably related to localised blocks in drainage rather than the absence of structures to regulate river flows. Even *bishyari*, floods caused when landslides block the river creating dams which then break, are localised phenomena. They can only occur in the Chure gorges below the Madi Phant and above Butwal where the flood impact is localised within the gorges and the immediately adjacent regions where the Tinau debouches into the Tarai.

Overall, the Tinau case suggests that a basin approach towards many, if not most, water management needs would be unnecessary and probably counterproductive. There is little reason why users below Butwal should care about the complex system of rights and uses upstream in the Madi Phant or vice versa. The same can be said for most other major water use and water management decisions. Proposals for Integrated Basin Management are based on the fundamentally sound point that management must respond to interactions that affect systems. In the Tinau, hydrologic interactions at the basin level appear weak and the strong interactions central to identification of hydrologic 'system boundaries' for most water management needs are much more localised. A systemic perspective is essential for management and needs to address socio-economic and institutional dynamics as well as hydrological dynamics – but the system boundaries need to be identified on the basis of strong versus weak interactions in relation to specific concerns rather than on a pre-defined notion of aquifers or basins as the 'correct' unit.

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Before closing discussion of the Tinau case study, two additional points are important to make. *First*, the basin is undergoing rapid socio-economic change, particularly in the Tarai regions. Improvements in the East-West highway are leading to the growth of urban-industrial centres in locations such as Butwal. The Bhairahawa-Butwal complex itself is urbanising at a very fast rate. In addition, the Tarai itself is being transformed through groundwater development into an intensive agricultural zone. The Nepal Agricultural Perspective Plan (APP), in fact, envisions groundwater development as the main engine for growth and poverty alleviation (Agricultural Projects Services Centre and John Mellor Associates, 1995). These long-term processes of change are overlain by recent events including the political disruptions associated with the Maoist uprising and the accompanying increase in out-migration by Nepalis in search of safe livelihoods. The region is in ferment with little attention being devoted to long-term water management questions. *Second*, even if the ferment were absent, long-term water management issues would probably not be at the forefront of the political or social agenda. Populations throughout the basin are dominantly focused on immediate livelihood questions. Water problems are generally viewed as important when they directly affect livelihoods. Most such problems are local and immediate – when two adjacent irrigation systems compete for flows, pollution damages drinking supplies or embankments block drainage. They have little to do with a distant and highly uncertain future.

Shekhawati and Banganga basins

Studies in the Shekhawati and Banganga River basins were led by M.S. Rathore at the Institute of Development Studies, Jaipur (IDSJ). They utilised a combination of secondary data and primary information collected between 1996 and 1999 through sample surveys and group interview techniques.

FIGURE 3:
Shekhawati River showing basin and political boundaries and hydrometeorological details

Source: Rathore and Mathur, 1999

Shekhawati basin

The Shekhawati 'basin' lies in a semi-arid section of north-central Rajasthan. Although the area is classified as a basin for administrative purposes by the government, it is not a hydrologic unit in the conventional sense. It is, instead, made up of six sub-basins, not all of which drain in the same direction (see Figure 3). In addition, the region is underlain by several discrete aquifers embedded in a larger regional aeolian aquifer system that extends across much of western Rajasthan. Given the universal problems associated with groundwater data in South Asia, characterising these systems at local levels is complex (see Box 1).

As a semi-arid region, the primary water management concerns in the Shekhawati area have to do with water availability, groundwater overdraft and salinity. As in the case of the Tinau, many such issues are local. Because the region is not a hydrologic unit in the conventional sense, there is little physical linkage between use patterns in many areas. Analysis by IDSJ indicates that local water harvesting initiatives have increased supply in villages adjacent to where they have been conducted while potentially reducing flows in lower portions of the sub-basins. Groundwater over-extraction has resulted in water level declines of one to three metres per year in some zones causing the mobilisation of saline water in adjacent areas.

Analysis by IDSJ indicates that local water harvesting initiatives have increased supply in villages adjacent to where they have been conducted while potentially reducing flows in lower portions of the sub-basins.

Hydrologically, the primary water issues in the Shekhawati region are local – confined within sub-basins and localised aquifers. Economically, however, water use in the basin has been heavily affected by regional economic and agricultural policies. Historically, agriculture in the region was dominated by rainfed millets and flood-irrigated barley or wheat. The introduction of new varieties of oilseeds (which, although they require irrigation, are well suited to the area) and oilseed processing facilities as part of a national program changed this. Cropping systems shifted to oilseeds which commonly generate higher revenues and demand less water than wheat or barley per unit of economic production. In addition, government subsidy programs for sprinkler irrigation encouraged their widespread adoption during the 1990s.

The combination of efficient irrigation technologies and high-value, relatively low water intensity crops such as oilseeds would appear likely to reduce water demand in comparison to the earlier irrigated wheat and barley. The case study indicates, however, that the introduction of sprinkler systems has enabled farmers to irrigate undulating dune lands and the high returns associated with oilseeds have enabled them to increase the number of wells. Furthermore, the growth of urban market linkages has generated a strong demand for water intensive vegetable cultivation. Income from oilseeds and vegetables has enabled farmers to purchase pumps and drill ever deeper wells, thus maintaining access while exacerbating resource base declines.

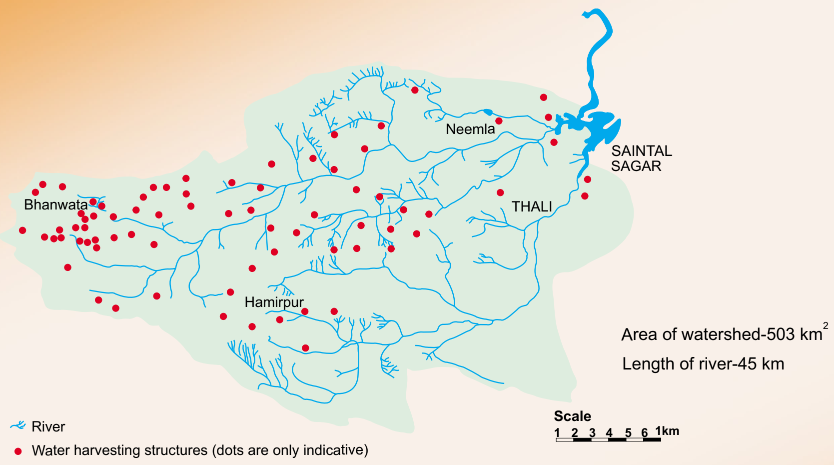

Marcus Moench

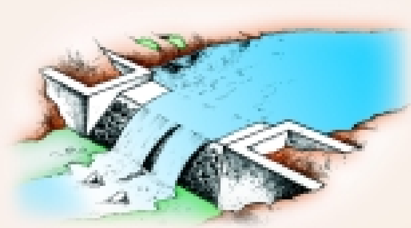
Farmers drilling deep wells in Gujarat.

Three points are clearly evident in the Shekhawati area. *First*, the hydrological units of most relevance for water management are poorly defined. Sub-basins for surface streams are the most distinct hydrological units but it is far from clear how closely they conform

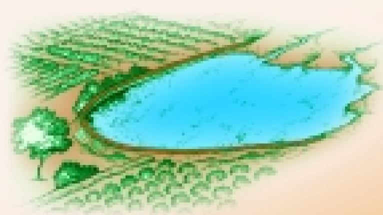
Box 1:
Arvari River, Rajasthan

The villagers of Alwar, in the Banaganga basin, began tackling the problem of water scarcity they faced. Due to excessive groundwater pumping and watershed degradation, the Arvari River had dried up. For more than a decade the villagers worked with a voluntary group named Tarun Bharat Sangh (TBS) to build 4,500 structures in 1,000 villages to collect rainwater and to augment groundwater storage through recharge. The region receives about 600 mm of rainfall a year. The villagers spent several hundred thousand rupees to build the structures but also contributed almost two thirds of the cost in kind and labour.

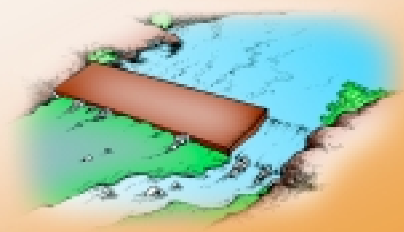




Weir - A low head overflow masonry structure built in smaller tributaries



Johad - A semi circular earthen bund of low height built in small tributaries and catchments



Small dam - An earthen embankment with a spillway built in major tributaries

Source: Dixit, 2002

to groundwater boundaries. *Second*, regardless of the hydrological unit, water use is determined on a higher level by regional economic conditions and, on a lower level, by household economics and the availability of good quality water. *Third*, the socio-economic factors affecting water demand are highly dynamic. Society is, as in the Tinau case, in the process of rapid transformation. Six decades ago, the Shekhawati was dominated by nomadic pastoralists and only a small amount of rainfed agriculture was occurring. Now, agriculture in the region is far more intensive. How this will change in the future depends as much on high level subsidy policies and economic conditions as it does on effective water management at a local level.

Emerging problems represent the starting point for analysis.

Banganga basin

Unlike the Shekhawati, the Banganga basin is a true hydrologically defined watershed. It covers 8,878 square kilometres in several districts of north-eastern Rajasthan. The general flow direction is south towards the Yamuna River in Uttar Pradesh. The watershed is well defined in the western mountainous region but the eastern plains are flat, causing extensive flooding problems in years of abundant rainfall. Groundwater outflow from the basin is minimal, causing high salinity in parts of the eastern plains.

The case study focused on portions of the basin above the Sainthal Sagar Dam. In this zone, rapid and widespread adoption of energised pumps has caused extensive groundwater overdraft. Annual declines of one to two metres in groundwater levels are common. Agriculture accounts for 96 per cent of water use, the remaining four per cent being used for domestic needs with industries accounting for negligible amounts. Within the region, two broad responses to water scarcity are emerging. The first involves the development of institutions for water management (a process initiated by a local NGO), the second is comprised of coping strategies at the household and farm levels.

In response to long-term water level declines, Tarun Bharat Sangh (TBS), an NGO, has catalysed construction of a large number of groundwater recharge structures. The objective has been to enable local level management of village resources rather than depending on state support. Traditional water harvesting structures such as *johads*, *anicuts* and field *bunds* have been constructed with significant community contributions.[2] Surveys conducted during the case study indicated that 85 per cent of these structures have benefited poor households or small and marginal farmers by augmenting groundwater supplies and contributing to the livelihoods of the local population. This has allowed farmers to increase the area under irrigation and decreased their dependency on rainfed *kharif* crops. Cropping patterns have shifted in favour of vegetables and cash crops. Recharge activities have also produced environmental benefits by resulting in increases in river flows.

Cropping patterns have shifted in favour of vegetables and cash crops.

TBS has supported the creation of local institutions to manage land, water and vegetation in the Banganga basin with a holistic perspective intended to preserve the local ecology and environment. These institutions include Village Water Councils (VWC) and the Arwari Water Parliament (AWP). Wherever the VWC functions effectively there has been a significant impact on the management of village common pool resources, such as forests, grazing lands and water bodies. These institutions have also introduced demand-side management. Under self-imposed VWC rules, members adopt water saving cropping patterns, construct water harvesting structures, and create field *bunds*. VWCs also play a useful role in settling disputes within villages.

Creation of the AWP was intended to address inter-village management issues. The AWP covers 70 villages of the Arwari sub-basin. It meets every six months and reviews the activities of VWCs and the progress made by members in implementing self-imposed rules. The AWP has been successful in creating awareness regarding water scarcity and the need for community participation for effective and sustainable water management. This has enabled many people to move beyond narrow private interests and treat water as a community resource.

Marcus Moench

Farmers building earthen dam, TBS.

Contingent valuation surveys conducted in three villages indicated that people are willing to pay for both domestic and irrigation water provided the supply of water is assured. The initial motivation for the contingent valuation surveys was to document the value local populations assign to water. The most common reaction, however, was that the state has a fundamental responsibility to provide needed

2 Community contributions for *johads* ranged between 20 and 100 per cent, for anicuts between 15 and 73 per cent and for field bunds between 50 and 100 per cent.

BOX 2:
Arwari River Parliament

The concept of a river basin approach was applied to the Arwari River basin in Alwar District of Rajasthan using a community centred water management approach. On December 28, 1998 a river parliament of 70 villages with a membership of 2,055 was formed in the catchment area of the Arwari River. The parliament meets twice a year at an interval of six months. The Arwari Parliament has met nine times since its formation. The Arwari River basin has 46 micro-watersheds. There are two major streams starting at the top of the basin and joining at the Sainthal Sagar Dam. Tarun Bharat Sangh (TBS) constructed about 300 water harnessing structures in the catchment area along with other watershed management activities.

The specific objectives of the parliament were:

1. Sustainable management of natural resources through the Arwari Parliament.
2. Controlled usage of water by treating it as a scarce resource.
3. Managing soil fertility and checking land erosion by construction of *anicuts*, *mairbandi* and *johads*.
4. Stopping illegal mining activity that is negatively affecting the land, water and vegetation.
5. Generating self-employment and alternative livelihood options through better management of land, water and forest resources.
6. Sensitising and building awareness among women's groups on water related issues and seeking their active participation.
7. Increasing agricultural productivity by growing water saving crops with local seeds and manure.


Ajaya Dixit

Women representaives from India attending a meeting at the headquarters of TBS.

Impacts

The impact of the Arwari Parliament can be categorised according to its physical, economic and social impacts. The physical impact is mostly the protection of water resources, increasing the area under cultivation, improving the quality of land and forest. The community has control over land, water, and forests.

The economic impact is manifested in a change in livelihood patterns as access to water has improved. Commercial activities such as production of tomato and other vegetables have increased livelihood opportunities.

Socially, the Arwari Parliament has empowered people to fight for their claims over resources. They question bureaucracy about its programs and plans, and the better implementation of programs. The Parliament plans for future use of natural resources. Women express their views and opinions.

The Arwari Parliament has enabled the building of social capital. It regulates patterns of resource use. It also has provided a platform to resolve disputes arising in management of land, water and forest. The local nature of the institution, rather than imposing institutions from above/outside, has made this possible.

supplies and therefore people were unwilling to pay. If, however, water is provided by the community, people were willing to pay operation and maintenance costs.

Farmers use diverse strategies to cope with water scarcity.

Now to the coping strategies: With the ongoing shift in emphasis from rainfed *kharif* crops to irrigated *rabi* crops and increasing groundwater extraction, water scarcity is likely to increase. Furthermore, farmers are deepening existing wells, boring laterally within old wells, digging new wells and increasing pump capacities, accelerating depletion. As scarcity increases, case study surveys indicate that households intend to reduce the frequency of bathing. Agricultural users prefer to first reduce the area under irrigation and then possibly change cropping patterns in favour of less water intensive crops. A few adopt water saving technologies. As a last resort, many mentioned the need to change occupations and migrate to nearby urban areas.

Palar and Noyyal basins, Tamil Nadu

Pollution, groundwater overdraft and increasing competition over scarce supplies make water a sensitive subject in the Palar and Noyyal basins of Tamil Nadu. Historically, both basins were agricultural areas irrigated through complex networks of diversion weirs, tanks and canals.

Recent decades have, however, seen dramatic changes. Industrial activities, particularly tanning and dyeing, have grown rapidly and become a cornerstone of the economy. These activities have led to extensive surface and groundwater pollution and introduced new demands into an already fully developed water resource base. They have also supported the growth of regional urban areas and, because they attract and employ social groups that are different from the agricultural communities, have changed the political balance of the region. In addition to the growth of new industries, the introduction of modern mechanised pumping technologies has fundamentally altered the dynamics of agricultural water supply and use. This is all occurring in an area with marked seasonal variations in precipitation and relatively low levels of groundwater storage. While precipitation levels average 800-1,200 mm in different parts of the region, most of this occurs in the two monsoon periods (June to September and October to December). There is a long spring and summer period when little rainfall can be expected. Groundwater is available – but most of it is contained in a thin, low storage, weathered layer overlying impermeable crystalline basement rocks.

The Palar and Noyyal River basin case studies conducted between 1997 and 2000 were led by S. Janakarajan of the Madras Institute of Development Studies (MIDS). Research consisted of a meso-survey of 51 villages in the Palar basin and 41 in the Noyyal basin accompanied by detailed surveys in a subset of eight and four villages respectively in each basin. These surveys were embedded in a much wider review of available data for the basins accompanied by interviews with key informants. As discussed further at the end of this section, the research process has led to an experimental multi-stakeholder dialogue in the basin that is intended to move debates over water problems from conflict to collaboration. Emerging problems represent the starting point.

Tanks and irrigation canals require collective action for their maintenance. Wells don't.

As noted above, historically most of the area was agricultural with irrigation provided through a complex traditional network. The declining role of this traditional system has been noted by several researchers (Vaidyanathan and Janakarajan, 1989; Janakarajan, 1993; Vaidyanathan, 1994; Mosse, 1998). Many attribute it to the rise of groundwater irrigation that occurred with the introduction of mechanised pumps as part of the larger 'green revolution' package of agricultural technologies. Energised wells are an individualistic technology with which an individual farmer can obtain water when desired, in the amounts required and without the need to collaborate or work with the larger community. Individuals are no longer dependent on any larger group – or their relationship with that group – for access to water. Tanks and irrigation canals require collective action for their maintenance. Wells don't.

The individualistic nature of pumping technology along with the tremendous value of *reliable* supplies of water *on demand* for agricultural users accounts for the rapid spread of pumping technologies. Groundwater access reduces agricultural risk and can be a major factor enabling farmers to break out of poverty (Moench, 2001). At the same time, access to groundwater is skewed toward more wealthy sections of communities. Data from the village level surveys clearly document that:

1. *Well ownership is strongly correlated with land ownership:* large landowners tend to have more wells and many of the smaller landowners (those having less than half a hectare) don't own wells.

2. *Smaller landowners often own shares in wells:* In many cases, individuals in the lowest landholding size classes (those owning less than a hectare) hold less than a ten per cent share in any given well while those in larger landholding size classes generally own larger fractions or – at the highest end, owning more than seven hectares – don't share wells at all.

In consequence, the benefits from groundwater development are unequally distributed. Larger landowners, those who can afford the cost of wells and pumpsets, have the most ability to develop groundwater and tend, as a result, to benefit disproportionately. This has two potential effects. *First,* it reduces the incentive larger farmers have to contribute to the maintenance of existing surface irrigation systems. As the input of this 'resource rich' class declines, society's ability to maintain such systems declines and all members of the community lose access to the water they once provided. Research clearly indicates an inverse correlation between the condition of tank irrigation systems and well density (Vaidyanathan and Janakarajan, 1989; Janakarajan, 1993). Now many of the traditional systems, in particular tanks and 'spring channels'[3] are in poor repair or are no longer functional. *Second,* as the number of energised wells increases and water levels decline, smaller landowners are disproportionately affected. The case study documents numerous disputes between the owners of shared wells. In some cases, large dug wells are physically allocated into portions and the individual who is able to deepen his section is able to capture all of the water (Janakarajan, 1999; Janakarajan and Moench, 2002).

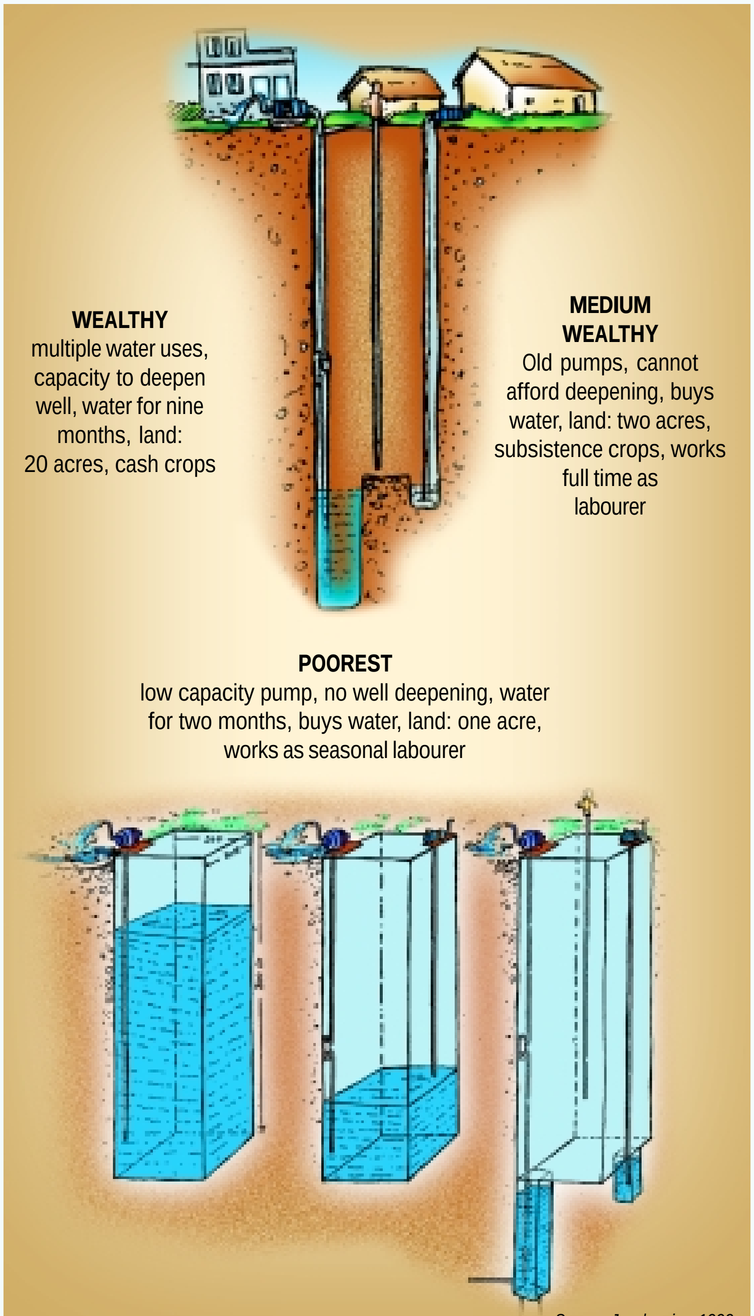
In groundwater overdraft areas many are unlucky and invest large amounts in new wells without striking water; others are unable to afford the regular cost of deepening wells each year. Such individuals either lose access to groundwater or are forced to purchase it on the water markets that have evolved in many areas as a response to scarcity, the cost of wells and differential access.

Competition and conflict over water are now increasing as water levels decline and pollution increases in many parts of the Noyyal and Palar basins. Geologically, most of the Palar and Noyyal basins are underlain by Deccan Trap basalts and other hard rocks where fracture space is limited and declines with depth. As a result, groundwater storage is low and largely confined to the upper weathered zone. In this situation, large-scale extraction for agriculture can rapidly deplete inter-annual storage. Groundwater overdraft in Tamil Nadu and similar areas has been present for decades (Bandara, 1977; Palanasami and Balasubramanian, 1993; Rao, 1995) and in the case study areas declining water levels have encouraged competitive deepening of wells. In many cases, owners have to deepen wells every year. Such attempts entail substantial risk. Once wells pass beyond the upper ten to twenty metres of weathered zone, success depends on the well intersecting water-bearing fractures in the bedrock. Many individuals are unlucky and invest large amounts without striking water; others are unable to afford the regular cost of deepening wells each year. Such individuals either lose access to groundwater or are forced to purchase it on the water markets. The latter have evolved in many areas as a response to scarcity, the cost of wells and differential access.

Agricultural water markets in rural areas of Tamil Nadu are double edged. On one side, the existence of water markets enables farmers who don't have full or part ownership in a well to obtain access to water, a resource that is essential for agriculture. On the other side, water purchasers in Tamil Nadu are predominantly in the smallest landholding categories and sellers are often in a quasi-monopolistic position. Informal norms require purchasers to buy

3 Spring channels are, essentially, diversion canals designed to capture the sub-flow in dry river channels.

FIGURE 4:
Competitive deepening of a shared well



Source: Janakarajan, 1999

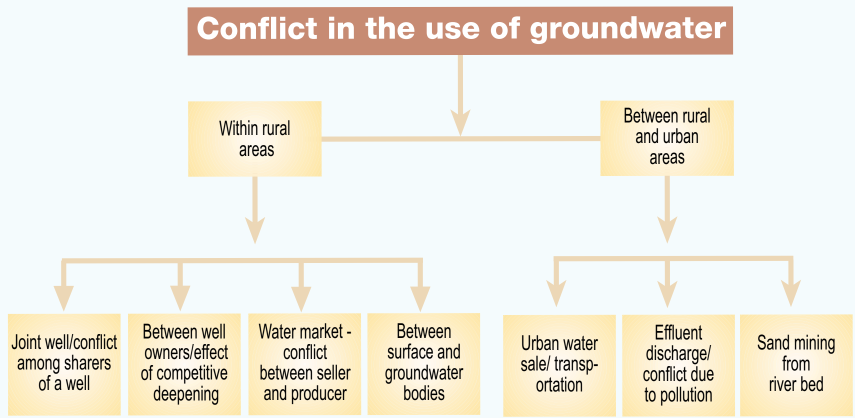
Deep dugwell in Tamil Nadu.

water from the nearest well. Furthermore, water markets often exist as part of interlocked land and labour markets in which small farmers – who often depend for much of their income on work from larger farmers – are at a competitive disadvantage (Janakarajan, 1994). In such cases, purchasers are often required to provide labour, lease land or share crop at rates particularly favourable to the water seller. Overall, the degree to which the existence of agricultural water markets benefit small farmers probably varies greatly in response to the specific situation, in particular the relationship between adjacent farmers. In some cases markets provide access to a basic resource and enable farmers to maintain an agricultural livelihood, in others water markets become a mechanism for gaining control over small farmers.

The above situation is further complicated in the context of groundwater level declines. In agricultural areas, farmers only sell surplus water. As water levels decline and well yields become increasingly unreliable (a situation commonly exacerbated during the pre-monsoon summer period), sales are often discontinued and water purchasers run a substantial risk of losing their crop. This is also the case where pollution and newly introduced urban and industrial water demands increase competition for available supplies.

Industrial and urban water use and pollution have increased rapidly in the Noyyal and Palar basins during recent decades. Tiruppur town along the Noyyal is an extreme example. With over 750 dyeing and bleaching units operating, all of which require high quality water, the town exerts substantial demand on surrounding areas. To supply this demand, a fleet of 900 to 1,000 tankers from villages now operates in a 30 km radius around the town. These transport approximately 120 mld into the urban area – equivalent to the water required to irrigate perhaps 4,400 hectares of irrigated rice.[4] This is less than four per cent of the 163,615 hectares of irrigated area in Coimbatore district. Approximately 22 per cent of Coimbatore district is currently under irrigated agriculture.[5] Assuming this percentage is accurate for the area in a 30 km radius around Tiruppur, the total irrigated area in the zone tankers transport water from is approximately 62,200 hectares.[6] This suggests that the demand from Tiruppur consumes the water required for approximately seven per cent of the irrigated agricultural area in a 30 km radius surrounding the town. While the above estimate is admittedly rough, it does not suggest that water demand from industry and urban consumption is a fundamental cause of agricultural water scarcity at an aggregate level. Average annual rainfall in this region is about 850 mm, nine per cent below the state average of 930 mm. This makes the region more vulnerable to scarcity than some other areas – but again the difference is not huge in relation to the aggregate regional balance between industrial and agricultural use.

FIGURE 4:
Groundwater disputes- a Tamil Nadu perspective



Despite the fact that diversions of water from agriculture to urban use are, in aggregate, a relatively small portion of total agricultural water use, *transfers may be having a significant impact on agriculture.* Seasonal differences in water availability are significant and industrial/urban demand may represent a much higher fraction of total water availability during the dry season than the aggregate estimate suggests. Furthermore, most urban demand is focused in a few specific locations and on particularly high quality water supplies.

During the dry season, a time when agricultural users already experience scarcity, industrial demand is a far larger percentage of available supply than at other times of the year.

Where seasonality is concerned, industrial and urban water demand patterns tend to be relatively constant. In Tamil Nadu, however, groundwater use following the monsoon leads to the failure of many wells during the late spring and hot summer seasons. This period is critical for agriculture. Rice seedlings require intensive water supplies if they are to be transplanted when the monsoon arrives. Other hot season crops also require regular water. Little rainfall can be expected from December until the pre-monsoon showers begin in June. At this time of the year, a time when agricultural users already experience scarcity, industrial demand is a far larger percentage of available supply than at other times of the year.

4 120 mld is equivalent to 4,380 hectare-metres/year. If one assumes an irrigation depth of one metre (common for rice in India) this is equivalent to roughly 4,400 hectares of irrigation.

5 Coimbatore district area is 7,469 square kilometres and the total irrigated area in 1998-1999 was, according to statistics provided by the Government of Tamil Nadu, 163,615 hectares. http://www.tn.gov.in/deptst/nic/t05_03.pdf accessed on 10/25/02

6 Total area in a 30 km radius = 2,827 km^2, 22 per cent of this is 62,200 hectares.

Where location is concerned, water demand from Tiruppur and other urban areas is concentrated in a few locations having good access to transport and high quality groundwater. In villages where demand is concentrated, the impact on available supplies can be very substantial. The case study results indicate that there are approximately thirty such villages in the area around Tiruppur. There, many farmers have installed high capacity pumps and now sell the water to tankers for transport to urban and industrial users. Local residents attribute declining groundwater levels and the failure of many adjacent wells to the growth of rural-urban tanker markets. No quantitative studies have, however, been done that document the relative balance between local consumption for agriculture and transport out of village areas for industrial use. What is clear is that water diverted to industry changes the structure of water use – and the populations who benefit from it – in fundamental ways. Diverting water from agriculture reduces not just agricultural production but also the wage labour it generates. Water is the foundation for rural agricultural communities. At the same time, the growth of industrial textile and dyeing units has created new livelihoods in other locations for other community groups. Those who gain and those who lose are often from quite different sections of Tamil Nadu society and reside in different locations. In this context, conflicts and widespread protests over water sales and transport are emerging between local farmers and industrial water users. Farmers and rural residents are on one side. Industrial water users are on the other side.

In areas adjacent to textile, dyeing and tanning industries, all water sources, including groundwater, are heavily polluted.

The division between agricultural and industrial water interests over groundwater use is greatly exacerbated by the pollution industrial uses currently generate. In areas adjacent to textile, dyeing and tanning industries, all water sources, including groundwater, are heavily polluted. Furthermore, as the accompanying box on the Noyyal documents, the effects of this extend far downstream. The situation in much of the Palar basin is even worse than the Noyyal. Approximately 750 tanneries are concentrated along both sides of the river from Visharam to Vaniyambadi town. In addition to other pollutants, the tanning process uses and disposes of large amounts of chromium – for which safe disposal methods are, reportedly, yet to be identified. The riverbed aquifer of the Palar is a primary source of drinking water supply for hundreds of villages and many towns. This has now become extensively contaminated with large negative impacts on human and animal health.

Dyeing unit, Tamil Nadu

Concern over pollution is nothing new. Even in the 1980s, environmental groups were highlighting the impact of pollution on agriculture (Murthy, 1987). By the 1990s, this led to court cases in different parts of Tamil Nadu. In the area around Karur on the Amaravathi River, for example, a case was filed with the High Court in Tamil Nadu that led to the closure in 1997 of some 600 dyeing and bleaching units. This order was, however, rescinded in 1998 due to the economic impact it was having on the town economy (Janakarajan, 1999). Although the industrial units were required to install treatment plants or obtain access to a common effluent treatment plant (CETP), many of the units were small and treatment remains at best partial. Action by the courts and environmental activists to enforce existing anti-pollution laws and to pressure the Government of Tamil Nadu has been

Box 3:
The Noyyal basin

In the Noyyal basin, the Orathapalayam Dam, which was constructed in 1992 for irrigation supply, has essentially become a holding tank for extremely polluted water. In addition to large amounts of organics and salts, pollutants include high concentrations of heavy metals and other industrial chemicals. Similar pollution problems are widespread and have been the subject of action by the courts for decades. A Government Order (G.O No 213, I, dated March 30,1989) prohibits establishment of any polluting industry at a distance of less than one kilometre from the rivers. This has not been enforced and now even groundwater along the river course and downstream is polluted. Before construction of the dam, farmers grew irrigated crops of tobacco, coconut, turmeric, maize, cotton and vegetables. At present, primarily rainfed cultivation is carried out in these villages and the wet crop cultivation has become the luxury of a select few whose wells are yet to become polluted.


S. Janakarajan

Orathapalayam Dam

widespread since the mid-1990s and includes a multitude of cases directed at industries in the Palar and Noyyal basins as well as other parts of Tamil Nadu. In 1995, for example, the Supreme Court ordered the closure of all tanning units that lack facilities for effluent treatment.

The situation is polarised with agricultural and environmental interests in conflict with industry.

This has led to proposals for widespread development of CETPs and the establishment of subsidies for their construction. Even if these are established, however, the problem will not be solved. Existing CETPs primarily address biological oxygen demand, pH and suspended solids. They do not reduce the total dissolved solids (salinity)[7], one of the most important factors affecting agricultural users. They also do not remove heavy metals such as chromium and disposal of sludge from CETPs (which contain very high levels of heavy metals as well as organic pollutants) remains problematic. Furthermore, even after the installation of CETPs, plant capacity is insufficient. Most do not function because monitoring mechanisms are ineffective. Overall, most effluent remains untreated. The effect of pollution on water availability for agriculture probably far outweighs the impact of increased water demand *per se.* Although many of the industrial groups recognise that pollution threatens their economic base and the lives of their managers and employees, the situation is polarised with agricultural and environmental interests in conflict with industry.

As a follow-up to this study an attempt was made to initiate a multi-stakeholder dialogue within the currently polarised water using communities. To initiate this, MIDS undertook a detailed stakeholder analysis in the Palar basin to identify key players and met with many of them on an individual basis before attempting to hold any initial meeting. Many stakeholders were reluctant to join in the initial meeting. As the Secretary of the All India Skin and Hide Tanners Merchants' Association (Chennai) commented: 'Although the economy has gained through the leather industry over a long period of time, every one uses every single opportunity to destroy us; an often suggested solution is closure, which will destroy not only tanners but also all those who are supported by this industry


Marcus Moench

In Tamil Nadu mechanised looms are sources of new livelihoods of farmers.

7 Dilution is the most common way to reduce salinity concentrations – but this requires additional water. Desalination technologies are expensive and are not part of most conventional waste treatment systems.

directly and indirectly.' Similarly, government officials were reluctant to join, calling the discussions 'sensitive.' Although five government representatives did ultimately attend the first meeting, none stayed for more than half a day. The meeting ultimately attracted 120 participants drawn from many concerned communities.

The formation of Social Committies may represent a significant step towards the negotiation of solutions to water pollution and allocation issues.

The initial meeting was heated with presentations from across the spectrum of opinions. At one stage, the discussion was intense and one of the tanners stood up with an outburst: 'We (tanners) are treated like Afghan refugees; what sin have we committed except involving ourselves in this dirty business.' The degree of polarisation, however, declined as the meeting went on. This is reflected through the tone of another tanner's comment that: 'So far, we (farmers and tanners) were meeting only in the courts. For the first time we are meeting in a same platform with a view to sharing the concern.' Farmers at this stage were also yielding and recognised the need for a solution, other than closure of all tanning units. The meeting closed with a joint decision to form a 'Social Committee' (later renamed the Multi-Stakeholders Committee of Water Users of the Palar River Basin) comprising 24 members representing all the major stakeholders.

The objectives of this committee are to:

- Document water and environmental conditions in the Palar Basin with particular emphasis on water availability, use patterns and flow details;
- Monitor pollution levels in surface and groundwater at strategic locations;
- Monitor the volume of water treated in CETPs and the volume that remains untreated;
- Measure the volume of water consumed by different sectors;
- Develop proposals to reverse ecological degradation in the basin (including mechanisms for pollution control, revitalisation of traditional water sources, removal of riverbed encroachments, and control of sand mining);
- Develop a rapport with key government agencies; and
- Assess the findings of the 'Loss of Ecology Authority' – a body recently established by the central government that is currently evaluating the impact of pollution and other water problems in Tamil Nadu.

Although the committee was only formed in January 2002, it has already met five times and made substantial progress. Within the committee, four points of agreement stand out: *One*, it has been unanimously agreed that the closure of tanneries is not the solution. The members have committed themselves to finding solutions not only for pollution problems but also for restoring the ecology of the basin. *Two*, different stakeholders have agreed to share information among themselves so that more useful and concrete decisions can be made; in particular, tanners who had been denying access to information have agreed to share details pertaining to tanneries and CETPs, and have also agreed to open access to tanneries and CETPs so that committee members can visit sites at any time. This is considered one of the most positive outcomes of the committee in a short span of time. Access to data – and therefore access to understanding – is one of the most fundamental challenges limiting the development of effective solutions to water problems in Tamil Nadu (Janakarajan, 2002). *Three*, all members agree that the prevention of any further pollution in the basin is essential. *Four*, the committee is investigating the possibility of handing over of effluent treatment to a private water treatment company and paying according to the services provided by them. The committee is already in touch with two such companies, one Indian and one Malaysian. It also proposes approaching the central government for subsidies to support treatment since the cost, at a Rs 350/m^3 (US$ 7.30/m^3) rate quoted by the Malaysian company, is very high. To achieve this they have submitted their proposals to the All India Hides Skin Tanners Merchants Association – an industry association that lobbies the government at the national level. The biggest advantage of this method of water treatment by a third party is that accountability rests with the water treatment company and no longer with the individual tanneries.

The stakeholder forum has been recognised as one of the first positive steps to resolve, rather than perpetuate, the inherent conflicts over water in the region.

Establishment of the stakeholder forum and committee has received substantial coverage in the regional press. It has also been recognised in some official circles as one of the first positive steps to resolve, rather than perpetuate, the inherent conflicts over water in the region. As part of this, World Bank officials have recommended to the State Water Resources Organisation that several committee members should be included as unofficial members of the Palar Basin Board (a recently established governmental basin authority) and vice versa.

Overall, establishment of the stakeholder forum and social committee may represent a significant step toward the negotiation of solutions to water pollution and allocation issues in the Palar basin and, if it succeeds there, in other areas as well. Interest groups, such as the tannery owners, are probably willing to negotiate and search for solutions because of the legal pressure they face, but their involvement is essential to identify potentially effective solutions such as the proposed subsidised treatment by third party companies. While such an approach has its own issues (including accountability and subsidies), many small dyeing units would be forced to close if required to treat their own waste. In addition, inclusion of the industrial stakeholders and the identification of common points of interest opens substantial new ways to influence policy. Chances of success may be far better if the All India Hides Skin Tanners Merchants Association is lobbying for policy changes *with the support of farmer and environmental groups* rather than in opposition to them.

Over the longer term, organisations such as the stakeholder forum could become a venue for informed dialogue over many water issues in the region. An initial attempt to apply this approach to the long-standing interstate dispute over sharing of Cauvery River water will occur in April 2003. If they are actually successful in opening access to information, enabling new types of quantitative analysis concerning water use and (most importantly) ensuring that all stakeholders 'believe' the results of such analyses, then the nature of debates over water may shift away from ideological positions and more toward common values. Many key debates are currently unresolved: Should water be allocated according to the services it provides (livelihoods, environmental values, etc.) or should, as state law currently provides, it be allocated by sector with domestic users taking priority over agricultural uses and agricultural uses taking priority over industrial uses? How should water be allocated? As the case study documents, at present, land ownership and water markets are the primary factors determining access. While these may not be inherently equitable, alternative mechanisms that can be widely applied in local village contexts remain to be demonstrated. Whatever approach is ultimately taken, governance structures that ensure key stakeholders have representation as water use and demand changes in concert with wider social and economic changes are essential. Conflict and competition are inherent in this process but they should be seen as a potential force for change rather than implying physical violence or long-term deadlock.

Sabarmati

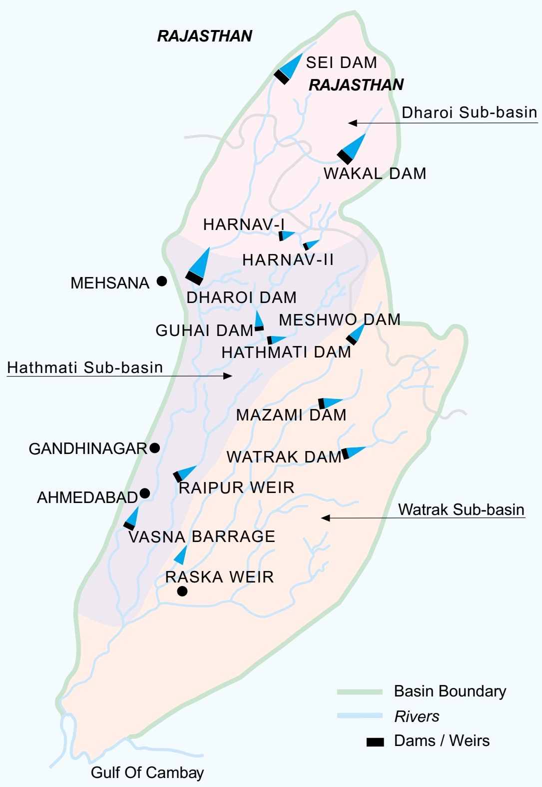
The Sabarmati basin case study was led by Srinivas Mudrakartha of VIKSAT, an NGO in Ahmedabad. Field surveys were conducted from 1997 through 2001 and consisted of formal and informal interviews combined with collection of secondary data.

In Gujarat, the Sabarmati River flows westward from the Aravalli Mountains on the Rajasthan border and down across the deep Mehsana alluvial aquifer past the state capital, Gandhinagar, and major city of Ahmedabad to the Arabian Sea. Much of the river flow is controlled by the Dharoi Dam, finished in the 1970s to provide irrigation to headwater regions and to regulate water supply for downstream communities, including Ahmedabad (see map).

In Sabarmati, most urban demands are met from a combination of groundwater wells and surface sources.

The Sabarmati is a classic arid-zone river. For much of the year, flow downstream of the Dharoi Dam is minimal and below Ahmedabad often consists primarily of sewage and industrial effluents. This situation changes for a few weeks each year when, swollen with monsoon precipitation, the river flows strongly. Beneath the Sabarmati lies one of India's largest sedimentary aquifers outside the Gangetic basin. This deep wedge of inter-bedded alluvial and marine sediments dips toward the ocean and feathers out at its upper end against the hard rock of the Aravalli hills on the Rajasthan border. Groundwater quality is good where the alluvium is shallow in upper areas but declines substantially in deeper areas and locations towards the east where marine sediments are common.

FIGURE 5:
Major and medium irrigation projects in the Sabarmati basin



Source: Mishra, Chopde, Srinivas and Anjal, 1999

Aquifers underlying Ahmedabad are hydrologically linked to the Sabarmati and, until controlled releases from the Dharoi Reservoir were started in the mid 1970s, there was a strong correlation between surface flows in the Sabarmati and groundwater extraction (Patel, Sharma *et al.*, 1979). In 1984, it is estimated that induced seepage from the Sabarmati River accounted for roughly 19 per cent of the groundwater pumped in Ahmedabad city limits (Gupta, 1985; Gupta, 1989). Upstream-downstream interactions were strong during most of the 1980s and 1990s. As a result, direct extractions from the river and deliveries to the command area of the Dharoi irrigation project were limited so that releases from the Dharoi Dam could be delivered directly to collector wells in the riverbed above Ahmedabad to meet a portion of the urban area's supply needs. With construction of the Sardar Sarovar Project, a major trans-basin diversion from the Narmada River in south Gujarat to northern portions of the state for irrigation and drinking water supply, Ahmedabad has become less dependent on supplies from Dharoi. Now most urban demands are met from a combination of groundwater wells and Narmada water deliveries. Available supplies from Dharoi have been allocated to meet rural water supply needs.

Despite import of Narmada water to the lower portion of the Sabarmati basin, water availability in the region is limited. Groundwater extraction has exceeded recharge since the early 1970s and water levels throughout the Mehsana aquifer have been dropping for decades, with declines substantially exceeding one metre per year in many areas (United Nations Development Program, 1976; Moench, 1992; Moench, 1992). In addition, water quality has been declining in many areas, salinity has been increasing and fluoride concentrations are frequently well above potable standards. The situation is complex. In addition to major urban areas, tens of thousands of individual farmers have wells tapping the Mehsana aquifer complex. The conditions these farmers face with regard to both water levels and water quality differ greatly depending on their location and the level of extraction in their immediate area. As a result, the impact of groundwater overdraft and water quality deterioration differs greatly across the basin. Furthermore, the impact is closely connected with the role groundwater has and continues to play in livelihoods and basic needs.

The impact of groundwater overdraft and water quality deterioration differs greatly across the Sabarmati basin.

Prior to the wide-spread introduction of mechanised pumping, pastoralism was the dominant livelihood in northern Gujarat, including the Sabarmati basin.

Prior to the widespread introduction of mechanised pumping, pastoralism was the dominant livelihood in the Sabarmati basin. Rainfed crops of millet and fodder were commonly grown but they served primarily as support for the livestock based economy. This changed in the 1950s, 1960s and 1970s with land reforms and the Bhoodan Movement that ceded village common lands to low caste landless families for agriculture (Chen, 1991). Equally important were the spread of mechanised pumping and governmental policies designed to support the introduction of commercial crops and 'green revolution' technologies. These policies, accompanied by other changes such as the spread of dairy cooperatives, fundamentally transformed the nature of livelihoods throughout much of rural Gujarat. Although pastoralism remains important, the role of intensive irrigated agriculture has increased tremendously. Furthermore, the nature of the pastoralist economy has changed substantially. Many nomadic groups have settled and the role of stall-fed livestock amongst commercial milk producers has increased substantially (Cincotta and Phangare, 1994). Now much of the economy is agro-pastoralist. Irrigated fodder production is a common component of intensive agricultural systems that also include oilseeds, grain and other commercial crops. A far smaller proportion of the population depends primarily on traditional forms of pastoralism. Instead, the rural agro-pastoralist economy runs on intensive, groundwater-dependent forms of production.

In rural areas, as in the Tamil Nadu case study, agricultural transformation has both alleviated and created poverty. Where farmers are able to obtain and maintain groundwater access at investment and risk levels they can afford, the dependability of groundwater reduces agricultural risks and enables farmers to move out of poverty (Moench, 2001). When, however, farming systems become dependent on groundwater and, whether due to water level or quality declines, the resource becomes unreliable, then the fight to maintain access can be a major factor increasing poverty. This is well demonstrated by research conducted for the present case study in Satlasna taluka in the upper portions of the Sabarmati basin.

Marcus Moench

The Sabaramati River in Ahmebad is augmented by water from the Narmada canal.

Satlasna lies on the fringe of the Mehsana aquifer where alluvial sediments feather out over hard crystalline basement rocks of the Aravalli Hills. Water levels have been declining rapidly by more than a metre per year in the region for over a decade – but until recently, well yields were often high and farmers were able to pump as much as needed from the unconfined aquifer overlying bedrock. This changed suddenly during the 1998-2000 drought. In one village, Bhanavas, while close to 100 per cent of the land was irrigated in 1999, only 10 per cent remained irrigated by winter 2001. Similar shifts occurred throughout much of northern Gujarat. Regionally, the area under *kharif* declined by 14 per cent between 1998 and 2002 while the *rabi* area decreased by 90 per cent over the same period. As part of their strategy for coping with the drought, farmers have shifted from castor and mustard to fodder crops in *rabi* in order to ensure some supplies for livestock, an essential element of their dairy-based livelihood.

Groups of farmers have also responded to the drought by harvesting rainwater in small dams and drilling deep wells in an attempt to restore lost supplies. The former interventions have made little regional difference – Satlasna lies on the margins of the deep Mehsana aquifer where extensive pumping has caused regional declines in water levels. In this case, local efforts to increase supply have little chance of ameliorating regional overdraft problems. Drilling new wells is also at best a temporary, expensive and highly risky proposition. Deep wells are often unsuccessful because the hard bedrock underlying the upper alluvial aquifer contains few fractures. As a result, the savings accumulated by farmers over decades are rapidly disappearing in a futile search for water. In many cases when wells are unsuccessful farmers are unable to repay the loans and are forced to abandon agriculture.[8] Consequently, seasonal out-migration has increased substantially. This pattern is common in many areas where shallow alluvium overlies hard rock formations and groundwater levels are declining. Loss of groundwater access and futile investment in a desperate attempt to retain access are increasingly causes of poverty.

In areas where groundwater levels are declining rapidly, livelihoods are shifting in response.

In areas where groundwater levels are declining rapidly, livelihoods are shifting. Twenty years ago in Mahudi village,[9] for example, Rajputs, the dominant land-owning caste, were engaged exclusively in agriculture. Water levels in aquifers underlying the village have declined from 20 to 25 metres below ground then to current depths of 120 to 140 metres. Now, although they still retain ownership of their agricultural lands, 57 per cent of the Rajput households in the village have shifted their primary dependence to other forms of livelihood, including agricultural labour, business and particularly services (including government jobs) which account for 48 per cent of the families that no longer depend on agriculture. This shift of focus is common in other communities as well. Approximately 58 per cent of the Scheduled Caste population have shifted to the service sector and some 250 families from all caste groups have migrated permanently out of the village. This pattern is repeated – although with substantial variation from village to village – throughout the Sabarmati basin.

Only part of the above transition is related to changes in water availability and the viability of irrigated agriculture. Gujarat is India's wealthiest state and the industrial and service sectors of the economy have developed rapidly over the past five decades. Work opportunities outside of agriculture have, as a result, increased. Communications and exposure to the outside world have also increased. Electricity, telephones and television were unavailable in most areas until

8 Last year, farmers spent a total of Rs 355,000 on five new tubewells and a submersible pump in Bhanavas and Samrapur villages. Only one tubewell was fully successful while two had low yields and the remainder were dry. The money required for this was borrowed from local moneylenders at 24 per cent interest per annum with household jewellery provided as collateral.

9 Mansa taluka, Ahmedabad District

the 1970s or even 1980s. Now even remote villages have access to a daily barrage of information. As a result, aspirations have also changed and many individuals aspire to images (realistic or not) of urban incomes, urban lifestyles and access to urban services such as high quality education. As farmers have commented at various points during the fieldwork: 'Why should I care about declining water levels, my son is getting a degree in engineering, we won't be here in five years.'

Documenting the extent to which the above patterns are repeated on a regional basis and the relative balance between push and pull factors would require data beyond that collected in the case study. The point, however, is that livelihoods and the water use patterns they entail are responding in a dynamic manner to a wide variety of influences. First, intensive agriculture emerged from a dominantly pastoral economy. Now, as water availability becomes increasingly limited, the economy diversifies and people's aspirations and livelihoods are changing again. Changes in water use – and the incentive to manage water – are embedded in an ongoing process of social and economic transition. Arguments that because farmers depend on water they should have a *universal* incentive to manage it on a sustainable basis are flawed. Some farmers do, others don't. Furthermore, unless water management systems can be developed that clearly enable agricultural livelihoods to be maintained on a sustainable basis, even those farmers who wish to remain in agriculture may still have a strong incentive to use as much water as they need to increase or maintain current incomes. At the individual farm level, leaving water in the ground makes little sense when others can pump it out or immediate needs dominate. Activities to increase supply and use whatever water can be captured as efficiently as possible appear far more attractive. Both are part of the regional response to water scarcity occurring throughout the Sabarmati basin and much of northern Gujarat.

Arguments that because farmers depend on water they should have a universal incentive to manage it on a sustainable basis are flawed.

To illustrate, in Satlasna VIKSAT utilised the opportunity of the severe drought of 2000 and, as part of a drought proofing program, created a large number of water harvesting structures in this area of low density of such structures. The villages in the subsequent years did have some rainwater captured that supported agricultural crops in the current drought spell since 1998-99. Looking at the impact of these structures (Mudrakartha, 2003), the local federation, the Gadhwada Jal Jameen Sanrakshan Sangh, promoted by VIKSAT, has influenced the local leaders and is planning to tap resources from the local MP and MLA in addition to some from the local philanthropic trusts. The point is that instead of just direct implementation, the Sangh has preferred to adopt the scientific approach of proper technical surveys, estimations and implementation which VIKSAT has already provided.

Throughout northern Gujarat, water harvesting has emerged as a major social movement in response to drought, declining groundwater levels and water quality problems. Religious leaders, politicians, NGOs, government departments and community groups at all levels from the local to the national all promote it as a major part of the solution to water scarcity (Raju, 1995; Central Ground Water Board, 1996; Agarwal and Narain, 1997; Kumar *et al.*, 1999; Central Ground Water Board, 2000). As part of the movement, a wide variety of water harvesting structures are being constructed in villages and on individual farms across the region. The scale of the movement in rural areas is impressive. In the state as a whole, a total of 1,237 micro watershed projects have been implemented in 16 out of the 19 districts (excluding Surat, Gandhinagar and Kheda) by about 111 PIAs (Project Implementing Agencies) of which

BOX 4:
The Sabarmati Basin Stakeholder Forum

Towards the end of 1997, it became clear to researchers at VIKSAT that there were two key reasons for the persisting water/groundwater problems. First, numerous government and NGO organisations were working on a wide variety of water management activities with little or no dialogue between them. Second, in absence of dialogue, especially during the planning and policy formulation stage, many water management initiatives failed. This led to the idea of creating a stakeholders' forum for the Sabarmati River basin.

To initiate the forum, VIKSAT met many types of organisations at both local and regional levels having a stake in water management in the Sabarmati basin. Each of these formal meetings was preceded by visits to the individual groups and discussions of their problems. Through these discussions it became clear that the Basin Level Stakeholders Forum should be an apex federating body comprising members nominated by stakeholder subgroups from all over the basin. Such an apex forum would have a consultative, autonomous status in the water management arena and would function as an essential interface between policy and the local contexts.

After a year of operation of the stakeholder subgroups, the basin level Sabarmati Stakeholders Forum (SSF) was formed on March 17, 1999 in Ahmedabad. Sixty participants attended the first forum. They represented *Panchayati raj* institutions, the farmer community, industry, academics, municipal corporations, government departments, dairy cooperatives, and NGOs. The next meeting of the SSF, held on April 17, 1999, focused on the forum's goals, objectives and strategy. Consensus was reached around the following:

Goal*:* To work towards efficient, equitable and sustainable management of water resources in the Sabarmati River basin.[10]

Specific Objectives:

- Strengthen the understanding of water scarcity and pollution problems in the basin through local groups.
- Increase awareness of water issues across the basin through the media, structured interactions and publications.
- Promote and strengthen essential research to enable the social transformation needed for water conservation and pollution abatement.
- Work towards policy changes.

Strategy:

- Strengthen networking between institutions, groups and existing networks in the basin.
- Encourage improved approaches in implementation contexts, including all projects which have something to do with the Sabarmati River basin such as the Sabarmati River Front Development Project, the Indo-French Collaborative Project, and a World Bank project.

VIKSAT adopted a flexible approach to the creation of the forum derived from its experience working in the state. Formation of the forum evolved over a year. Key groups who operated in the basin were 'identified' based upon VIKSAT's own information and from other sources, such as the news media, published and unpublished information and individuals. Over a period of interaction with these groups, the Sabarmati Stakeholders Forum has evolved with nominated representation from the groups. The forum has representation from both government and non-government organisations (NGOs, research, academic, semi-government, etc.) though this is not strictly formalised. Persisting attendance of the members shows that interest continues.

A key part of VIKSAT's ability to attract individuals to the forum is the access to information and analysis it provides members. VIKSAT generated an initial base of information for dialogue through a review of the published literature – much of which was not accessible to other organisations. In addition, VIKSAT was able to obtain access to basic water resources data. In most cases, data is generated and held by government departments which are reluctant to provide access to it for a variety of reasons (ranging from conflicts with departmental interests to concerns over accuracy). The key point in VIKSAT's ability to obtain data was its rapport with the government departments and the overarching desire to improve the water management situation. VIKSAT supplemented data collected in this manner with new primary information collected through its own field surveys. Analysis of the data using WEAP and other methodologies provided a starting point for forum members to initiate substantive discussions. Conversion of data from various sources into a user-friendly format has helped the forum to raise its understanding of the need for management based on the nature of the problem, water scarcity and pollution.

A key product of the stakeholder forum has been improved understanding amongst all parties regarding the nature of problems in the region and the generation of new ideas regarding how they might be solved. Stakeholder perceptions of problems are summarised in the table below.

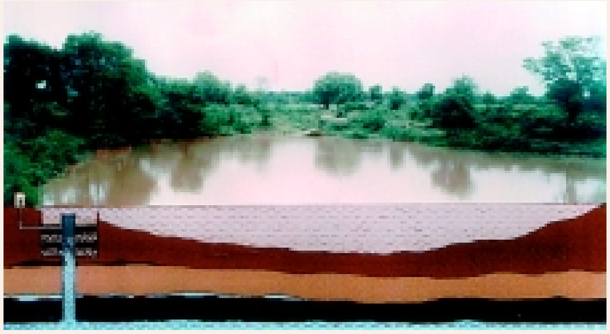
People's perception of potential solutions were quite different from conventional ones. For instance, farmers suggested change

VIKSAT

Participation in the Sabarmati Stockeholder forum.

10 Use, conservation and distribution.

in the irrigation rotation system as a solution for achieving higher distribution efficiency, especially in the context of tail-end and head-end problems. A typical engineer's perception would be that such problems would exist in any distribution system; increase in supply is the solution. Interestingly, on the question of energy supply, farmers expressed their willingness to pay more for electricity charges if water supply were to be available when needed during the day instead of retaining the current system of night supply. Discussions led to debates between industrial and farmer groups who held the other party responsible for wastage and indiscriminate use of water. The common official perception is that the farmers are interested only in obtaining free electricity and that they would not be willing to pay extra.



Artificial recharge through a village tank: Gujarat.

The above examples illustrate the typical differences in the perceptions of the users and the suppliers. Historically, such differences in perception have led to the harbouring of misunderstanding and suspicions amongst the governmental and the 'other set of groups' whom we have referred to as the stakeholders. The absence of significant common ground has led to a general stand-off as seen from various contestations that are held in both the general, social and legal arenas which are too obvious to necessitate any elaboration. Now, perhaps, common ground is being created.

TABLE 1:
Problem diversity table in the Sabarmati River basin as perceived by different use sector groups

Agriculture sector	Problems	Reasons
N-W (Mehsana, Banaskantha)	Excessive fluoride; seasonal groundwater scarcity; excessive groundwater salinity; groundwater depletion; untimely canal water supply; inadequate canal water supply	On-farm over-application of irrigation water, water intensive crops; availability of electricity during night time
S-W (Pollution Affected Group of 11 villages) (Kheda)	Polluted water in canal system; drastic decline in crop yield; groundwater to great depths is unusable	The Industrial waste finds its way into canal water; polluted canal water is used in fields; use of hybrid seeds; use of chemical fertilisers
East (Sabarkantha)	Seasonal scarcity; unavailability of potable water; untimely availability of canal water; increase in land salinity; unavailability of adequate canal irrigation water; water logging conditions	Over-application of water; mismanagement of canal water and groundwater; excessive groundwater salinity; non-filling up of surface irrigation structures; silting of surface irrigation schemes; interception of runoff in catchments of irrigation schemes; availability of electricity during night time
Central (Ahmedabad)	Groundwater depletion; excessive groundwater salinity; polluted water in canals; untimely availability of canal water; reduction in land fertility; surface water bodies are polluted	Upcoming farmhouses in great numbers; excess application of irrigation water; availability of electricity during night time; use of chemical fertilisers; use of hybrid seeds; partially treated sewage from Ahmedabad joins the river; thermal power stations waste join river
South (Kheda)	Water-logging; untimely availability of canal water; reduction in land fertility; insufficiency in availability of canal water	Over-application of canal water; availability of electricity during night time; water intense crop; chemical fertilisers; use of hybrid seeds
Industrial sector Vatwa, Odhav, Naroda, Narol Estates, Sabarmati thermal power station, Gandhinagar thermal power station	Insufficiency in water availability; mixing of water from supply network with drainage water; cost of managing CETP is high; increasing problems with fly-ash disposal	Distribution losses are high; constraints in increasing selling price of supplied water; great quantity of water (about 10 times the ash generated) is required for carrying the fly-ash to ponds; cost of energy required for supplying water has increased; effective management of CETPs is as high as 50-60 per cent of capital cost
Urban domestic sector Ahmedabad & Gandhinagar cities	Groundwater depletion; increased groundwater salinity & fluoride content; inadequate AMC supply	High distribution losses; water supply is not metred; high water salinity inhibits proper functioning of metres; water charges are on percentage of property worth and not on volumetric basis; rise in number of private tubewells (especially in the western part of the city); insufficient water availability at infiltration/ French wells in Sabarmati River; significant water lost in transmission from Dharoi to Ahmedabad city (165 km river stretch); high water use rates in pockets of Ahmedabad and Gandhinagar cities; low ground -water recharge; assured continuous energy availability leading to greater extraction

76 are NGOs. At an average size of 500 hectares, these projects together cover approximately 266, 000 hectares. The approximate investment at the rate of Rs 5,000 per hectare (US$ 104/ ha) works out to more than Rs 300 crores (US$ 62 million) for Gujarat alone for a period of 3 years. Structures to capture and recharge runoff are even being incorporated into urban building design and building codes in locations such as Ahmedabad.

Such structures can in certain circumstances[11] have a significant impact on water availability in local areas. It is, however, important to evaluate the degree to which they could serve as a 'solution' to water scarcity at a regional level. Analytical work undertaken by VIKSAT as part of this project using the WEAP modeling system[12] suggests the potential is limited. Based on their analysis, intensive development of water harvesting structures across the Sabarmati basin could, by itself, meet less than one per cent of the gap between demand and supply over the next two decades (Kumar, *et al.*, 1999). In contrast, efforts to control demand by changing crops and adopting efficient irrigation technologies in currently irrigated areas could reduce the gap between supply and demand by approximately 50 per cent. Achieving this would, however, depend on the irrigated area remaining constant and not expanding. Agriculture in Gujarat is water, rather than land, limited. While many farmers in the Sabarmati basin are shifting to low water use crops such as castor and some are adopting sprinkler or drip irrigation technologies, strong incentives exist to maintain or expand the cropped area wherever possible. As in the Shekawati basin, there is no guarantee that increasing water use efficiency will reduce total water demand.

Activities to increase supply and use whatever water can be captured as efficiently as possible appear far more attractive to users than demand-side management

Three further points emerge from the water harvesting movement in Gujarat. *First*, the obvious: for water harvesting to work there has to be rain. Precipitation in Gujarat is highly variable. As Dr. Pisharote notes for Kutch, half the annual rainfall typically occurs over a period of 2-3 hours during the monsoon season. There are generally only 8-10 rainy days in the year and rain actually falls for an annual average of 12-15 hours (Pisharote, 1992). Under these conditions, runoff is intense and only lasts for brief periods. The area near Mandvi received 654 mm over a four-day period in July 1992 after receiving only 185 mm total in 1991.[13] Even in high rainfall sections of the state, precipitation is highly seasonal. Out of an annual average of 51 rainy days in south Gujarat, 48.5 (accounting for 94 per cent of the total rainfall) occur in the period June through September.[14] The average intensity of rainfall in arid sections of India is one cm/hr and has a very high coefficient of variation both within and between years (Pisharoty, 1993).

Second, the viability of water harvesting depends heavily on local conditions. Research conducted by Mitch Anderson, an intern at the Aga Khan Rural Support Program in the early 1990s, clearly documented evaporative losses as high as 60 per cent from some water harvesting structures constructed in hard rock areas.[15] Similar levels of evaporation are to be expected from any structure in the arid conditions of northern Gujarat when water cannot infiltrate rapidly.

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11 Water harvesting may be particularly effective in hardrock areas where lateral groundwater flow rates are slow (i.e. it doesn't make any difference if the region is experiencing overdraft – water harvested locally 'stays put'). It may also be effective in alluvial areas where the nature of the sediments does not allow rapid lateral flow or where the amount that can be captured represents a substantial fraction of the excess extraction.

12 Developed by the Stockholm Environmental Institute

13 Personal communication, Dr. K.C. B. Raju, Director, Central Ground Water Board (retired), 1992.

14 Calculated from data in Phadtare (1989, p. 7). Phadtare, P. N. (1988). Geohydrology of Gujarat State. Ahmedabad, Central Groundwater Board, West Central Region: pp 103 + Appendicies.

15 Personal communication, 1992

Third, there are increasing concerns that water harvesting in higher sections of basins is reducing flows to lower sections. This concern has emerged in Saurashtra, the heartland of Gujarat's water harvesting movement and in other areas as well. To some extent, attempts to increase supply are a zero sum game. Flows captured in one area would otherwise have been used downstream. Much, however, depends on the specific characteristics of the area. As in the Tinau case discussed above, whether or not water harvesting in higher regions affects flows in lower regions depends on precipitation patterns in the basin as well as a host of other factors. At present, the scientific information required to resolve such issues is generally unavailable.

In combination, the massive interbasin transfer of Narmada waters, the movement for water harvesting and the ongoing problems related to drought, groundwater overdraft and water quality have generated substantial controversy surrounding alternative approaches to water management. The Sardar Sarovar project on the Narmada is, both internationally and within India, one of the most controversial water projects in the world. It is the only project where, after financing an independent review (The Independent Review, 1992), the World Bank has withdrawn financing. The project has, however, been carried forward by the Government of Gujarat and, although still the subject of much controversy and opposition from environmental and social activists, is now delivering water to northern Gujarat including portions of the Sabarmati basin. Demand for the water, however, far outstrips the new supply. The region as a whole is highly vulnerable to drought and water levels in most of the Meshana aquifer are declining rapidly. Although the Government has attempted (or considered attempting) to control overdraft for decades, restrictions on wells or pumping rates are widely opposed and agricultural power supplies remain heavily subsidised – a factor widely recognised as contributing to excess extraction (Moench, 1993; Moench, 1995; World Bank, 1998).

The politics of this are intense and proposals to increase power tariffs have led to riots and other forms of civil disobedience in Gujarat. Water harvesting is, in itself, relatively non-controversial (local increases in supply tend to be popular). Activists, however, often point to it as an alternative 'solution' to interbasin transfers or reductions in groundwater extraction. As VIKSAT's analysis indicates for the Sabarmati basin, water harvesting alone is likely to have a minimal impact on the overall demand-supply gap. In this context, water management is a politically sensitive subject where practical courses of action are often unclear.

Water management is a politically sensitive subject where practical courses of action are often unclear.

In response to the controversial, often deadlocked, nature of debates over water management in the Sabarmati region, VIKSAT has supported the formation of a basin-wide stakeholder forum. Their goal is to catalyse informed dialogue between a wide variety of interest groups in the region and, by doing so, reduce the level of polarisation between the advocates of different water management approaches. To put it another way, they hope to encourage the development of social consensus regarding practical courses of action as a basis for proactive management. The accompanying box discusses the forum and its specific activities. What is important to recognise is that it has emerged as a representative forum that provides a link between micro-level activities and perspectives in different parts of the basin and state policy. It has also enabled the participating organisations to reach a much higher level of understanding regarding the nature of water problems in the basin and the array of potential solutions to them. Central to this has been VIKSAT's apolitical nature, its ability to encourage data sharing, and its analytical capabilities. VIKSAT has used the WEAP modeling system to organise much of the quantitative data in a way that participants can improve their understanding of management options. In many ways, the model results and data have become the substantive text around which problems and potential management options can be discussed.

THE CITIES

In all of the case study regions, growing urban demands are a significant factor in regional water debates. Research undertaken through the Local Water Management Project covered three urban areas: Chennai in Tamil Nadu, Ahmedabad in Gujarat and Kathmandu in Nepal.

Despite the large cultural and other differences between these urban areas, all three face similar sets of water related problems. Water 'scarcity' is a major practical and political issue with urban supply systems incapable of meeting the expectations of urban residents. Pollution and water quality concerns are major and reduce the water supply that is effectively available for meeting basic needs. All three cities have either implemented or are considering interbasin transfers to meet their growing demands and reduce current scarcity conditions. In addition, water markets have emerged as a spontaneous response to 'scarcity' and much of the urban population now purchases at least a portion of the water they require from private suppliers. Finally, options may exist for water harvesting that could, at least in some cases, represent a more economically viable alternative to meeting water supply needs than regional transfers.

Water 'scarcity' is a major practical and political issue with urban supply systems incapable of meeting the expectations of urban residents.

Chennai

Water supply for domestic use in the Chennai urban area has been a source of concern for decades and, in recent years, the ability of the Metro Water Board to meet demand has fallen far short of available supply. The official supply situation is highlighted in the table below.

As the table indicates, water deliveries are approximately half the government norm for urban water supply requirements in the Chennai urban area and only a small fraction of the demand that would probably be present if supply were unrestricted and delivered at the highly subsidised rates found in other urban centers. Demand is also restricted because in water short years piped water supply does not reach significant portions of the city on a regular basis. In July of 2000, for example, piped water supply was only 59 lcpd. In response, the Metro Water Authority installed 4,525 tanks and hired 400 trucks of 9,000-12,000 litre capacity to make water deliveries

TABLE 2:
Water Supply in Chennai

Year	Population (10^6)	Water required @ 158 LPCD (mld)	Demand** @ 460 LPCD (mld)	Actual Supply Domest+Ind. (mld)	Cost of Supply to MWB per cubic metre (Rs)	Supply as baseline required per cent	Supply as a per cent of probable demand
1995	4.19	662	1927.4	300+65	8.8	45	16
1996	4.28	676	1968.8	295+65	8.23	44	15
1997	4.37	690	3015.3	345+68	9.3	50	11
1998	4.46	705	3144.3	381+48	10.2	54	12
1999	4.56	720	3283.2	413+37	15.11	57	13

** *This is a reference figure based on actual use in one city, Gandhinagar in Gujarat, where supplies are unrestricted. It is indicative of the demand that might be present if supplies were completely unrestricted.*

Source: Metro Water Board

to under-served areas.[16] These, however, proved insufficient to meet demand and residents could often only obtain deliveries after payment of substantial bribes to drivers and Water Authority officials.[17] This situation has created the conditions for a flourishing and extensive water market in the Chennai urban area.

During the rainy season approximately 2,000 private tanker trucks of 12,000 litre capacity supply raw water to the Chennai urban area. In addition, there are about 150 private companies that purify and deliver drinking water in 12 litre cans, 1-2 litre bottles and plastic packets. The tanker trucks alone are estimated to make at least three trips a day during the rainy season, equivalent to delivering 72 mld, and this doubles to approximately 144 mld during the dry season. When The Metro Water Authority is only able to deliver 59 lcpd to the 4.56 million residents, their total delivery capacity is approximately 269 mld. In this situation, the private tankers are supplying 35 per cent of the total demand and their supply capacity is approximately 54 per cent of the capacity of the Metro Water Authority supply.

The tanker and private company market is highly fragmented. Numerous small companies run one or two tankers. They bring water either from their own wells or purchase it from farmers and other well owners. Many small purification companies are also present, each with their own facilities and each operating independently of any external check on the quality of the water they supply.

The water tanker and private company market in Chennai is highly fragmented.

Prices charged for water supply in the public and private sector vary greatly. The official charge for water from direct tap connections is Rs 0.14/m^3 and for supplemental deliveries by tanker Rs 50/m^3. During the rainy season, tanker owners charge regular customers approximately Rs 400 for a full 12,000 litre tanker load of water (Rs 33/m^3) and during the dry season Rs 450.[18] The rate is higher for occasional customers: approximately Rs 500 and Rs 540 respectively. During droughts the rate increases still further. Although market data are not available, the Rs 600 bribes Metro Water officials reportedly[19] requested for sending 9,000 litre tankers to localities is indicative of market conditions. This is equivalent to Rs 67/m^3 or US$ 1.48/m^3. The direct charges for water are, however, only part of the cost residents face. In the case of municipal services, it is very difficult to guess when the tanker carrying metro-water will arrive. It may arrive in the early morning or at midnight. Surveys by MIDS indicate that, in each family, one member must always keep an eye out for the tanker. Many women sleep outside their houses to catch the tankers. Tankers do not supply water everyday. They arrive once in two days or once in three days. On average, at least one person in a family spends about 3 to 4 hours a day fetching water, either from tankers or from public taps and wells (saline water for washing, etc.).

The private and public water market chains are shown in the figures below. These indicate the massive increase in the cost of water between initial purchase and Farmers and other well owners typically sell water to transporters at Rs 3.3/m^3 ($ 0.07/m^3), consumers pay a minimum of Rs 33/m^3 ($ 74/m^3) for bulk raw water during the rainy season and as much as Rs 20,000/ m^3 ($ 444/m^3) for purified water when it is sold in 250 ml plastic packets for Rs 5. Between the initial point of sale and the ultimate point of consumption, the price increases by many orders of magnitude. While this price increase reflects substantial service inputs (transport, purification, packaging, storage and cooling), the potential profits involved are very large.

16 *The Hindu,* July 7th, 2000
17 *The Hindu,* August 8th, 2000
18 Suring the recent dry season (May 2001 to September 2001) it went up to Rs 850 per tanker load.
19 *The Hindu,* August 8th, 2000

The extent and depth of the water markets in the Tamil Nadu urban area have been known for some time and have led to formal proposals for greater reliance on market transfers as a source of supply. In Chennai, according to the MIDS survey, about 60 per cent of the total water needs are met from groundwater – either through municipal wells private sources. Imported and local surface sources supply the remainder. Much of the groundwater in Chennai is polluted or has quality problems due to saline intrusion. As a result, major attention now focuses on ways of obtaining additional supplies. According to the World Bank: 'Estimates suggest that up to 400 million cubic metres of water could be purchased from farmers for less than US$ 20 million. This compares with the US$ 400 million cost to Tamil Nadu of the proposed Krishna and Veeranumm projects that would supply a similar amount of water to Chenni. Similar opportunities are present in other locations such as Jaipur and Hyderabad.' (World Bank, 1998). According to the World Bank, other sources such as bringing water to Chennai from the Cauvery River via Veeranumm tank would cost roughly Rs 16/m^3 in comparison to the perhaps Rs 2/m^3 cost of water rights purchased from farmers (World Bank, 1998).

Ahmedabad

Ahmedabad is underlain by a deep alluvial aquifer. Although water levels in this aquifer have been declining for decades (Gupta, 1985), physical access to the water is not a major problem. The Ahmedabad Municipal Corporation (AMC) runs an extensive system for meeting city water supply needs. Water is supplied to consumers at a rate of Rs 1.23/m^3, well below the Rs 6.8/m^3 cost to the government for supplying the service. Parts of the urban area are provided with water from French wells in the Sabarmati River and parts from Narmada water through the Sardar Sarovar project which has recently been completed up to Ahmedabad. In addition, portions of the urban area are supplied from a network of tubewells run by the municipal corporation. Many commercial establishments, private residences and housing societies own their own wells. Most middle and upper class residences also have cisterns for water storage. Given the relatively extensive network of sources, physical scarcity of water is a significant concern only for those who live in lower-middle class and poor areas where private wells are infrequent and storage is limited. In most cases, the AMC delivers water twice a day for several hours. In dry seasons, deliveries to tap stands and households can be insufficient to meet basic domestic needs but in most cases the volume of water available is sufficient. As a result, most demand for additional water supplies is from users who require a high volume for marriages or other events involving large numbers of people. Commercial establishments and hotels that lack their own wells or are situated in an area where groundwater quality is poor are another source of regular demand. In this case, the volume of supply from municipal sources is insufficient to meet needs.

The volume of supply from municipal sources is insufficient to meet needs.

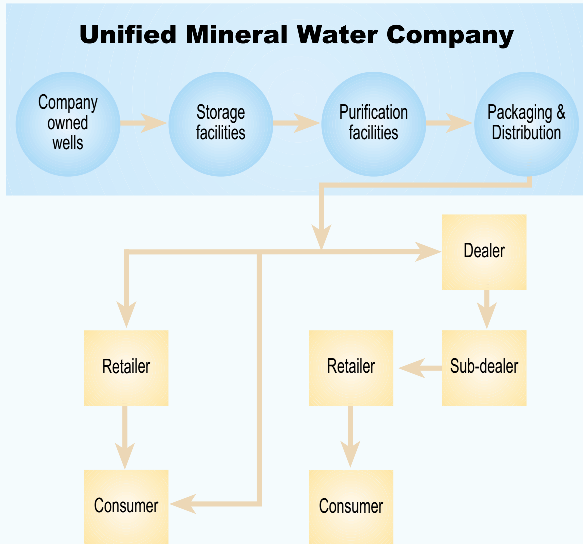
Although the volume of supply available from municipal sources is, in most cases, sufficient and the price charged to consumers is highly subsidised, quality is a major concern. A survey of water supply sources in Ahmedabad conducted by VIKSAT found fluoride contents above the permissible limits of 1.5 ppm in 86.5 per cent of the area. Total Dissolved Solids (TDS) were also above the permissible limit of 2,000 ppm in most of the area. Ahmedabad residents have long been aware of the high TDS level in supplies available from groundwater sources under the city. Recent attention to fluoride and the health problems associated with it has also increased concern over quality. According to VIKSAT's survey, this has become the major factor driving development of water markets in the urban area.

The combination of short supply for large-volume users and low quality has driven the formation of a two-tier water market in Ahmedabad: Private companies with purification facilities who sell partially demineralised water in pouches and bottles for users whose primary concern is quality; and private tanker companies who deliver larger volumes. At present there are nearly 500 tanker companies supplying water in Ahmedabad (Consortium of Resource Persons of the Consultative Group led by Katar Singh, 2000).

Mineral water suppliers

There are six main brands of mineral water for sale in Ahmedabad. Each of these has its own wells, storage, purification and primary distribution system. They then market water either directly through their own distribution system to retailers and consumers or through a network of dealers and subdealers to retailers and ultimately consumers. The structure of this type of company is shown below.

Figure 6:
Water companies



The higher quality companies maintain specific standards for the amount of minerals in the water they deliver. Volumes available are 200ml and 250ml pouches and 1, 1.5, 2, 5 and 20 litre bottles. The costs and profits at each stage in the above process are outlined in the table below. As can be seen, prices within the market are stable with most retailers charging Rs 12 for a one litre bottle, Rs 17 for a 1.5 litre bottle and Rs 20 for a two litre bottle. The end cost consumers pay for water is Rs 1,200/m^3 (or $ 26/m^3) in the case of single litre bottles or Rs 800/m^3 ($ 16.7/m^3) if they purchase the larger 20 litre bottles. Profits generated for the different actors at each step in this chain range from a few per cent to as high as 25 per cent.

The higher quality companies maintain specific standards for the amount of minerals in the water they supply.

Private water vendors

Most private water vendors own their own source of supply, typically a borewell of 500-650 ft depth. They also typically operate their own delivery tankers. In some cases, however, well owners also contract with private tanker owners to deliver water to consumers for them. This is common in high demand periods, such as the marriage season, festivals and during droughts. Since these times of high demand are intermittent, water vendors avoid major capital costs by relying on intermediate-term delivery contracts or short term tanker hires for these periods. Most suppliers have a set of fixed customers that include households, commercial establishments (hotels, restaurants) and, in some cases, industries.

Based on the average figures of energy use and discharge (100 m^3 per hour), researchers in Anand estimated the average energy consumption for groundwater pumping as 0.38 kWH/m^3.[20] At current GEB rates for commercial users in the medium block (Rs 4.20/unit) the implicit cost of energy to pump water is Rs 1.59 (US$ 0.034) per cubic metre. If the pump is registered as agricultural, the implicit cost of energy for the well owner to pump water at the well head is only 0.33 rupees per cubic metre if the pump is run for 2,000 hours a year.[21] Rates for water to bulk consumers (those purchasing tankers of 6,000-12,000

20 Personal communication, Dinesh Kumar.
21 Personal communication, Dinesh Kumar.

litre capacity) commonly range from Rs 33 to 37.5 (US$ 0.71 to $ 0.81) per cubic metre (excluding transportation). One supplier, however, provides water for Rs 30/m³ and includes transport. Smaller consumers often purchase water from distributors in *carbas* (small human pushed tanks). These carry 45 litres and charge Rs 300/month for a daily delivery. This implies a cost of Rs 222/m³ (US$ 4.83). Most of the purchasers for these smaller volumes are small restaurants and hotels. The market structure for private water vendors is shown below.

What emerges from the above outline is a market structure within Ahmedabad that is driven primarily by concerns over quality and shortages for larger volume users. In most situations, access to water *per se* is not driving the development of the market. Instead, at the household level, the market is driven by the high salinity and fluoride found in wells and much of the municipal supply. Lower volume commercial users and those most concerned with quality (i.e. those purchasing bottled water) pay the highest prices. The market structure is significantly different from that in Chennai and Kathmandu in several aspects: (1) much of it is driven by quality rather than consumer shortages; (2) there appear to be far fewer water vendors; and (3) low-end users don't face the large implicit costs that stem from having to wait hours to receive supplies.

To make use of tanker deliveries, purchasers must have the capacity to store from five to twelve cubic metres of water.

Surveys conducted by VIKSAT in other urban portions of the Sabarmati basin show distinct regional variations in water market characteristics. The best served area is Gandhinagar, the capital. Supply from government sources there is 460 lpcd (the highest in the basin) and 98 per cent of the households are served. The government is able to collect approximately 85 per cent of the charges it levies for water but the charges themselves are the lowest in the region. These charges are Rs 0.33/m³ while the actual cost of supply is Rs 24/m³. The total subsidy (including uncollected charges) amounts to 85.6 per cent of the cost of supply. While most houses (77 per cent) have storage tanks, the relatively good and highly subsidised supplies from government sources have resulted in a situation where there is little demand for water from outside suppliers. Demand for private supplies is, however, strong in other, less privileged, urban areas in the basin. Conditions in these areas are summarised in the table three.

FIGURE 7:
Private water vendor

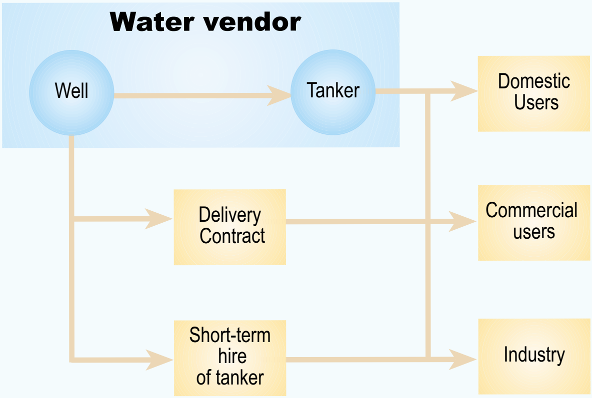


Table three highlights the regional variation in conditions and domestic water supply markets within Gujarat. The private tanker market is relatively well developed in areas where either water is scarce or quality is poor. Private markets are, however, generally thin. Their costs of supply, which includes transport by tanker, are far higher than government sources. In addition, government sources are heavily subsidised and only collect a fraction of the charges they do impose. Overall, the subsidy to consumers from government sources is 87 to 89 per cent of the cost of supply. Despite the high government subsidies, profit margins in the private sector are very high. During the summer months, the profit margin in the central alluvial region is 58 per cent of the cost of supply while in the hard rock region it is 125 per cent. Even in the relatively water rich southern region, the profit margin is 91 per cent. Even in the non-summer period, profit margins range from 27 per cent to 70 per cent of the cost of supply in different regions. While a large part of the profit margin reflects service (i.e., the convenience of having water delivered to the household), it probably also reflects the opportunity costs of time and labor for households to gain access to water when government supplies are insufficient.

A final important point to recognise in the Gujarat situation is that, at least in one aspect, it is very similar to Chennai and Kathmandu in that the private tanker and water supply markets is highly fragmented. People drill wells and tankers supply water with no assurance of quality beyond their own personal reputation. Private purification companies operate with little oversight. There are, however, substantial differences between Ahmedabad and the other case study cities.

People drill wells and tankers supply water with no assurance of quality beyond their own personal reputation.

In Ahmedabad, as in the other cities, increased attention is being devoted to water harvesting. Some of the new construction in the city, for example, includes water harvesting as a core part of the design. There are, however, no suggestions that either local water markets or water harvesting could supply the bulk of Ahmedabad's urban water needs. While aquifers under Ahmedabad do contain substantial amounts of water, much of this is saline and groundwater levels underlying the city have been

TABLE 3:
Comparision of cost per m³ in different regions

Attributes	Hard Rock Region	Central Alluvial Public Sector	Southern Water Abundant
User perceptions of Public supply quality	48 per cent pressure adequate, quality generally good	58 per cent pressure adequate, quality generally unsatisfactory	72 per cent pressure & quality good
Cost of supply to Govt. (Rs/m³)	7.81	6.8	5.7
Tariff charged by Govt. (Rs/m³)	1.61	1.23	1.21
Per cent tariff recovery (per cent)	60	61	60
reported by Govt.			
Loss to government (Rs/m³)	6.84	6.04	4.97
Per cent willing to pay more (per cent)	51	36	39
		Private Sector	
Users depending on private sources due to inadequacy of government supply (per cent)	25	18	2
Cost of supply in private sector (Rs/m³)	20	26	23
Tariff charged by summer (Rs/m³)	45	41	44
Private sector non-summer (Rs/m³)	34	33	34
Profit for private sector summer (Rs/m³)	25	15	21
non-summer (Rs/m³)	14	7	11
Per cent supporting privatisation of govt. water services (per cent)	25	25	22

declining for decades. As a result, groundwater cannot be relied on as the primary local source of supply. Flow in the Sabarmati is highly seasonal and already fully utilised. As a result, meeting Ahmedabad's water demand either requires imports from the surrounding region that, as in the Chennai case, would displace existing agricultural users or it would require the type of transbasin import 'solution' that has been implemented by bringing in Narmada water.

Kathmandu*

Kathmandu, Nepal's largest city and capital is facing a stage of rapid development and expansion. These conditions started with the opening of the country in 1951 and the subsequent flood of modern development and population growth. In recent years, rural-urban migration has increased due both to economic opportunities and deteriorating political conditions in rural areas. Kathmandu's population is now estimated at approximately one million, an estimate that will undoubtedly experience a rapid increase over coming years.

In Kathmandu physical scarcity of water is a significant concern only for those who live in lower-middle class and poor areas where private wells are infrequent and storage is limited.

Water supply in Kathmandu was historically delivered through traditional systems such as the widespread network of stone water spouts or *dhunge dharas*. The oldest of these, located at Hadigaun, was built in 554 A.D. Although it is almost 1500 years old it is still working and in use. Others were built up through at least the late 1800s. These stone spouts were part of a systematic system for water supply that was fed by *rajkulos*, networks of drinking and irrigation water channels. The rapid development Kathmandu has witnessed in the last twenty years has lead to the failure of a number of the *dhunge dharas*. Construction has cut off water supplies in places and the growing population generates more waste, contributing to the likelihood of the water's contamination. Nearly all the water spouts show high levels of fecal coliform contamination especially during the monsoon season. Due to the religious purity of the *dhunge dhara* water, most people consider the water clean enough to drink straight from the stone spout, although some do boil or filter it before consumption if they have the capacity. Although this traditional system is increasingly overwhelmed and polluted, it still supplies a significant portion of Kathmandu's population with water for domestic use. In addition to stone water spouts, many users also rely on local wells that have been dug or drilled into the upper aquifer underlying the city. These are generally viewed as polluted and the water is used for bathing, washing and other non-drinking uses. Kathmandu is located geologically on the sediments from a lake that once filled the valley. As a result, the city is underlain by relatively productive aquifers. The upper unconfined aquifer is increasingly polluted but does serve as a primary source of water for many local shallow wells.

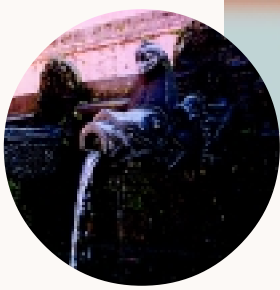

Marcus Moench

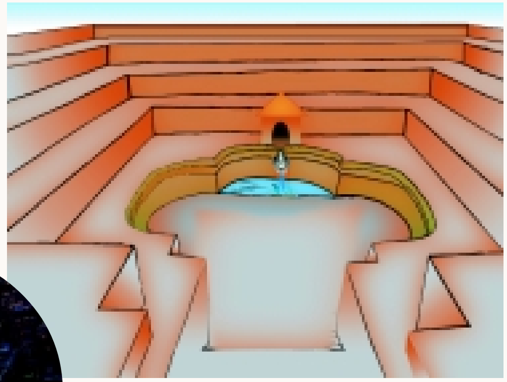
The rural areas around Kathamdu are getting urbanised at a very fast rate.

Modern pumped water supply systems were introduced on a minor scale approximately 100 years ago to provide water to royal and other high-status residences. This nucleus was subsequently expanded into a general municipal supply system, currently operated by the Nepal Water Supply Corporation (NWSC), which receives water from rivers flowing into the valley and a network of wells tapping lower confined or semi-confined aquifers beneath the urban area. The ability of this system to meet demands is limited. Most of the water flowing into the valley is already being used and the deeper, unpolluted aquifers under the urban area are suffering

* In the Kathmandu case all currency is in Nepali Rupees (NRs) as opposed to Indian Rupees elsewhere (Rs).

FIGURE 9:
***Dhunge dhara* of Kathmandu**





Open conduits transfer water from springs and/or aquifers to taps located in a depressed rectilinear pit usually three to nine metres below ground level.

A survey in 2001 found 350 spouts in Kathmandu, Patan and Bhaktapur. In August 2001, 250 of them collectively yielded about 10 million litres of water a day. Their yield generally decreases by about two thirds in the dry months. Some of the taps provide good quality water, while that from others is of low quality. Many *dhunge dhara* have deteriorated due to poor maintenance. Others have been damaged by urban encroachment.

Source: Dixit, 2002

from overdraft. Estimates suggest that demand for water in the Kathmandu valley exceeds 155 million lpd while, according to newspaper reports, the municipal supply system can only deliver 120 mld in the wet, and 60-70 mld in the dry, seasons.[22] Loss rates in the municipal system are very high (estimated to be over 70 per cent).[23] Much of this water flows back into the upper unconfined aquifer where, due to pollution, it is unsuitable for urban supply. Overall, water supply from the municipal system is characterised by growing uncertainty and variation in the amounts delivered; during the dry season some households receive 0.5 to 2 hours of water a day while others get water once a week or not at all. To compensate for shortages and losses, the government is investing in a major scheme, the Melamchi Project, to divert water from a stream outside the valley and deliver it to Kathmandu through a 26 km long tunnel. There have also been a variety of initiatives to reduce losses, with little effect to date. Regardless of these long-term plans, most current residents in the Kathmandu urban area experience significant shortages and disruptions in the supply they receive from the modern system. As a result, the poor continue to depend on stone water spout systems and local wells into the increasingly polluted upper aquifer while those who can afford to purchase water from what they hope are higher quality sources.

Water supply from the municipal system is characterised by growing uncertainty and variation in the amounts delivered.

Kathmandu's private water market functions through tanker trucks that deliver water from a limited number of wells within the urban periphery to end users. The private tanker market has developed in response to the failings of the municipal supply system. It feeds directly into the gap left by the municipal pipe system by delivering supplies reliably to private

22 Gorkhapatra, July 31, 1999
23 The NWSC mentions a lower percentage of loss. According to its General Manager, the loss is 34 per cent. See Kantipur February 28, 2003.

residences, hotels and other businesses in the valley. *Dhunge dharas* and private wells continue to play a vital role in serving the middle to lower income portion of the population which never had adequate access to piped water supplies. These sources also affect the shape of the private water market by acting as a low cost alternative to the insufficient municipal piped supply and the expensive supplies delivered by tankers. The water source or sources households decide to use depends on their preferences for water quality and quantity in relation to their location, water availability, and financial status. The tanker-based water market is, unlike in many other urban areas within South Asia, a relative luxury serving primarily the upper middle and wealthy classes.

Water from private tankers varies in cost depending on the water source, the location of the customer and the size of the truck. In general, a small tanker delivering six cubic metres of water costs NRs 900 while a larger tanker delivering 12 cubic metres of water costs NRs 1,200. This corresponds to a cost of between US$ 2.25/m^3 and $ 1.35/m^3. In contrast, NWSC has a small tanker service that supplies treated municipal water at NRs 160/m^3 or $ 2.16/m^3. Despite the high cost, NWSC tankers offer legitimacy customers respect and some are willing pay for it when faced with shortages from the piped municipal supply. Tanker water is generally not used by the middle to low-income portions of the city's population for two reasons, cost and lack of storage capacity. To make use of tanker deliveries, purchasers must have the capacity to store from five to twelve cubic metres of water.

Water from private tankers varies in cost depending on the water source, the location of the customer and the size of the truck.

Tanker companies are usually small operations owning an average of two tanker trucks per company and functioning on a seasonally lopsided demand. There are approximately 80 such companies operating in the valley. In direct accordance with the fluctuations of the municipal supply, the tanker market's busiest time of year is the dry season when the municipal supply is particularly low. During the dry season a tanker truck can typically make from three to five trips per day, whereas during the rest of the year some companies make as few as four deliveries a month. Through a rough calculation it can be estimated that during the dry season the private market supplies approximately 6 mld to Kathmandu.[24] Compare this to the official dry season supply for NWSC, 80 mld minus 60 per cent losses, and it becomes clear how significant a contribution the private market makes to the urban supply, nearly 19 per cent of the estimated NWSC actual supply.[25]


Marcus Moench

Dug wells are a common source of domestic water.

Kathmandu's private water market is an unregulated system of water tanker companies that have found a niche between the insufficient municipal supply and the public water spouts in the city. The market functions outside the jurisdiction of the government and has no price or water quality regulations. As a result, the private market lacks official legitimacy and accountability, forcing individual companies to create their own standards to ensure the trust of their customers. Needless to say, there is a wide range of standards within the market and little means of verification.

24 The calculation was done using the Tanker Association's estimate of 80 tanker companies in the valley with an average of two trucks per company delivering 3.7 truck-fulls of water per day.

25 The level of supply by NWSC is unknown, during the dry season ranging from 60 to 80 mld with 40 to 60 per cent loss. As a result, the relative supply of the private market is unknown, however its contribution is significant.

As previously mentioned, water sources used by tankers range from springs at the valley's edge to borewells in or adjacent to the city. These sources, according to an NWSC official, have a high iron and ammonium content. The majority of the water sold by tanker companies goes untreated to the customer, spring water is never treated while well water sometimes goes through a rudimentary purification process. When asked, customers seldom knew the source of the tanker water they purchased. Tanker customers frequently complained of poor quality water, saying that it was often discoloured, smelled bad and a number of people reported bad skin irritations and sores from the tanker water. The lack of market regulation creates a need for a governing body to maintain customer trust while at the same time support the interests of the tanker companies.

In response to this lack of legitimacy, a number of the tanker companies have formed a Tanker Association to ensure quality water to their growing customer base and to unite their voice in the face of government restrictions. The Tanker Association was formed in 2000 after several disputes between tanker companies and the police over city driving permits for their large trucks. According to a Tanker Association representative, member companies pay a monthly fee of NRs 300 and agree to abide by the Association's rules, thereby gaining a degree of legitimacy in the eyes of their customers and ensuring support against increased government restrictions. This fee also gives tanker owners the right to fill their truck at the site controlled by the Association. One step the Association has taken since its formation is to establish a standard quality of water for the private market. Currently, it requires all its member companies to use one water source that is tested every three months by the Association. The water source used by the Tanker Association is an unfiltered spring source in Chobar, which is considered by consumers and tanker owners to be the cleanest source in the Valley. The Association is interested in establishing another water source, a borewell, due to the insufficiency of the current supply during the dry season.

A Tanker Association was formed in 2000 after several disputes between tanker owners and the government.

In addition to the tanker-based water market segment, the overall supply system in the valley can be viewed as a set of institutions and supply systems competing together. Virtually all sources of water supply entail costs to users. Take, for example, the case of the traditional *dhunge dharas*. Costs associated with *dhunge dharas* are primarily in terms of time and labour. In a few instances, however, communities require users to pay and the charge varies depending on the type of use. This is uncommon, but the cost is comparatively high. In some locations, for example, users are charged NRs 3 for a pot of water that contains 8-10 litres. This is equivalent to NRs 300/m^3 or US$ 4.05/m^3. The charges at *dhunge dhara* for routine use vary depending on the community surrounding the water source. One professional washer community, *Dhobi Ghat*, has an exceptionally good *dhunge dhara* that attracts people from all over the surrounding area. They charge people outside the community for use of their water; a sign at the source states the charges with a money box below it for contributions[26]. Other costs are also often present. These take the

Marcus Moench

A tanker collects water from a location close to Kathmandu.

26 The sign states charges according to transportation capacity, not water quantity specifically. A bike costs NRs 10 and a car NRs 20 for water collection, washing up to seven clothing items is NRs 10 and bathing is NRs 2 per person.

form of renovation charges for *dhunge dhara*, construction costs for a community well, or minor charges according to use for maintenance of a community source. Renovation or construction costs in the case of *dhunge dhara* are usually charged on an ability-to-pay basis with contributions ranging from approximately NRs 500 to 5,000 from each household. Beyond direct financial costs, the real costs associated with reliance on *dhunge dhara* are the time and energy spent collecting water, waiting in line and carrying water back for use within the household. Water collection is almost exclusively a woman's job, a job that becomes significantly more difficult during the dry season. Depending on the location within the city, some women spend up to 45 minutes walking to the nearest *dhunge dhara*, often waiting in line for six or more hours. To avoid the long lines, some women collect water in the middle of the night, gathering water for her whole family of usually four or more people. The figures noted are extreme cases captured during the dry season, but it is common for women to collect water at four in the morning and often wait in line for two hours. If one assumes a wait of 2hrs, collection of 15 litres and an implicit labour cost of NRs 15/hr[27], this is equivalent to NRs 2,000 (US$ 27) per cubic metre. A wait of six hours implies a cost of NRs 6,000/m^3 or US$ 81/m^3.

One of the main problems with the traditional system is its lack of complete coverage and the fluctuation in its supply.

One of the main problems with the traditional system is its lack of complete coverage and the fluctuation in its supply. *Dhunge dhara* are primarily located in the low-lying, older areas of town, leaving much of the urban population out of reach of their supply. The supply at each *dhunge dhara* varies according to its location and source and like the municipal supply, most *dhunge dhara's* dry season flow is considerably lower then the rest of the year, creating a time of extreme scarcity within the city. Some areas of the city, specifically Patan, have extremely good supply with sufficient water flow year round, while others, such as a *dhunge dhara* in Thamel where the municipal supply is bad, serve a large area with very low flow.

A survey on women's perceptions of water conducted as part of this research demonstrated that the issues associated with *dhunge dhara* are common with other water sources as well. All water sources except tanker water and locations with a sufficient NWSC piped supply coupled with substantial storage capacity, require a significant amount of time and energy, a cost generally born by the adult women of the household. The non-monetary costs associated with water supplies vary from nighttime water collection from the NWSC tap to walking up to 45 minutes to the nearest *dhunge dhara* or waiting in line at a tap stand. Water costs are relatively high at all income levels, requiring households to regulate their water use and to conserve whatever water they have available.

Table four gives the general profile and costs associated with different parts of the Kathmandu water market. As can be seen, the market is relatively unstructured and fragmented. Costs and service characteristics within it vary greatly.

The cost and other problems associated with all forms of water supply in Kathmandu have generated a wide range of coping strategies. These are outlined according to income source in the table below. In general, if households are unable to use a shallow well as a alternative water source, they must decide between the labour intensive and time consuming *dhunge dhara* or the expensive tanker supply. Coping strategies may be employed to avoid this

27 Based on a monthly wage rate of NRs 2,500/day (not uncommon for women at the lower end of the office spectrum) and a 40 hr work week.

TABLE 4:
Cost comparison for water sources available in Kathmandu, Nepal

Source	Monetary	Non-monetary	User Profile	Quality	Water use
NWSC household pipeline	Rs 50 for first 10 m^3; Rs 11.90 for each additional m^3	nighttime collection; storage system (cistern or vessels)	all incomes levels level of supply unconnected to income	generally considered good quality, limited contamination	all household needs unless contaminated
Private market	Rs 100 to 150/m^3	5m^3 storage capacity; Health costs potentially significant but unknown	high income to high middle income, with 5m^3 storage capacity	variable quality, unfiltered spring or borewell	all household purposes
dhunge dhara	free to Rs 300/m^3 cash. Implicit labor cost of up to Rs 6,000/m^3 when women have to wait 6 hours for 15 litres. More typical implicit cost Rs 2,000/m^3	labor intensive: walking, hauling, waiting in line; health costs potentially significant but unknown	middle to lower income	variable quality	all household purposes
Private well	Rs 3,500 to 20,000 initial cost to dig	manual or electric pump collection; health costs potentially significant but unknown	high income to low- middle income; residents with property	usually low quality, select areas high quality	garden, cleaning, toilets; seldom consumed
Community well	initial contribution Rs 500-5,000	collecting water maanually or electrically with pump; health costs potentially significant but unknown	middle to low income	variable quality	washing, cleaning, toilets; consumed in Patan

situation such as asking a neighbour for water or stretching what is received through the taps. It is quite common for people to give away small quantities of either drinking water or low quality well water if they have a sufficient supply themselves. Of those interviewed in our surveys, it appeared as if there was a mutual respect between the water-givers and the water-takers. Those giving understood the necessity of the resource and were willing to share, while those receiving did not take advantage of the source and respected the giver's generosity. Primarily this dynamic emerges between higher income and lower income households.

TABLE 5:
Coping Strategies Employed by Kathmandu Residents

	Sources Available					
Income	NWSC	Tanker	Private well	Community well	*Dhunge dhara*	Coping Strategy
High	X	X	X			prioritise water use, well water for non-drinking, electric pump on pipeline, storage capacity of at least 5m^3
High-middle	X	X	X	rare	rare	prioritise water use, well water for non-drinking, *dhunge dhara* water collected in cars, washing done at relative's house, electric pump on pipeline, storage capacity of 5m^3
Middle	X		X	X	X	prioritise water use, well water for non-drinking, storage capacity 5m^3, hand pump on pipeline, use of *dhunge dhara* and community well
Low-middle	X		X	X	X	prioritise water use, washing and bathing done at community well or *dhunge dhara*, depend on neighbors for drinking water
Low	rare			X	X	prioritise water use, depend on neighbours for water, use community well and *dhunge dhara* heavily

To sum up, the tanker water market in Kathmandu primarily serves high-end customers, those with at least 5 m^3 of storage capacity and the ability to pay NRs 900-1,200 for a tanker of water. Approximately 80 small tanker companies serve residents and commercial establishments dependent on the tanker water market which meets as much as 18 per cent of total demand during the dry season. This market has emerged to meet the demand for supply convenience created by the gap between traditional but often low quality supply sources, and the poor coverage of the modern, but poorly functioning piped system. Part of the demand is due to low supply availability from the municipal and traditional systems, part is due to the low quality of water from local wells. The net result is a mosaic in which the lower economic strata of society largely pays for water through women's labour, time and the health consequences associated with pollution of wells and *dhunge dhara*. Upper levels of society pay through the direct cost of tanker water and also through potential health consequences associated with using water from unknown sources. Only a few sections of the city are able to rely on NWSC water for all their needs. These generally wealthy sections pay the lowest cost in both monetary and non-monetary terms.

Loss of water already available through the high rate of municipal supply system leakage is a major part of the problem.

The Melamchi project, a major trans-basin project to divert water to the valley through a 26.5 km long tunnel, is the primary 'solution' to Kathmandu's water supply problems that is currently being implemented by the government. This project has been questioned on a number of grounds ranging from technical feasibility to cost. Perhaps the most relevant criticism, however, is that the project doesn't really address the institutional problems. Melamchi is designed to resolve Kathmandu's water supply shortage – but Kathmandu isn't short of water *per se*. Loss of water already available through the high rate of municipal supply system leakage is a major part of the problem. Furthermore, estimates by NWCF indicate that renovation of existing local sources, conjunctive management, conservation combined with a major program for water harvesting in Kathmandu could meet significant part of the urban area's water needs at a fraction of the cost of Melamchi. Kathmandu valley, for example, receives about 2,000 mm of rainfall each year. Harvesting less than three per cent of this on less than 1.5 per cent of the valley's land area with an average depth of 2 metres would meet domestic water requirements of large section of the population.[28]

Marcus Moench

Community managed stone spout at Dhobi Ghat, Lalitpur; Hoarding board displays fees for potable water.

28 For details see Gyawali (2001).

BOX 5:
Melamchi Water Supply Project

His Majesty's Government of Nepal is implementing the Melamchi Water Supply Project with assistance from Asian Development Bank, NORAD (Norway), SIDA (Sweden), the Japan Bank of International Cooperation, OPEC Fund and the Nordic Development Fund. The project aims to overcome the deficient water supply of Kathmandu. The dry season water demand in the urban areas of Kathmandu Valley, with an estimated population of 1.1 million, is about 180 million litres per day (mld). The supply capacity of the existing systems in the wet months is about 120 mld, which is reduced to only about 80 mld in the dry season.

Source of Water

In the first stage 170 mld of water will be added to the daily supply of Kathmandu Valley from the Melamchi River. Subsequently 170 mld will be further added from the Yangri and Larke rivers thus supplying 510 mld of water to the valley

Project Components

The Project is divided into five major components: Melamchi Diversion Scheme, Water Treatment Plant, Bulk Distribution System, Distribution Network Improvement and Wastewater Management.

Diversion Scheme

This component mainly consists of a diversion weir to be constructed in the Melamchi River to divert the flow and a 26.5 km long water transmission tunnel to deliver the water to the Water Treatment Plant at Sundarijal.

Water Treatment Plant

Water will be treated in a conventional type treatment plant built at Mahankal of Sundarijal VDC in Kathmandu.

Bulk Distribution System

For distribution of water, several distribution reservoirs will be constructed at strategically high points around the valley rim. Ductile iron pipes of 300 mm to 1,400 mm diametre will be laid to carry the water to these reservoirs from the water treatment plant.

Distribution Network Improvement

The existing distribution network inside Kathmandu Valley will be rehabilitated and expanded. The main objective of this component is to attain an equitable distribution of water supply, reduction of leakage and prevention against contamination action during distribution.

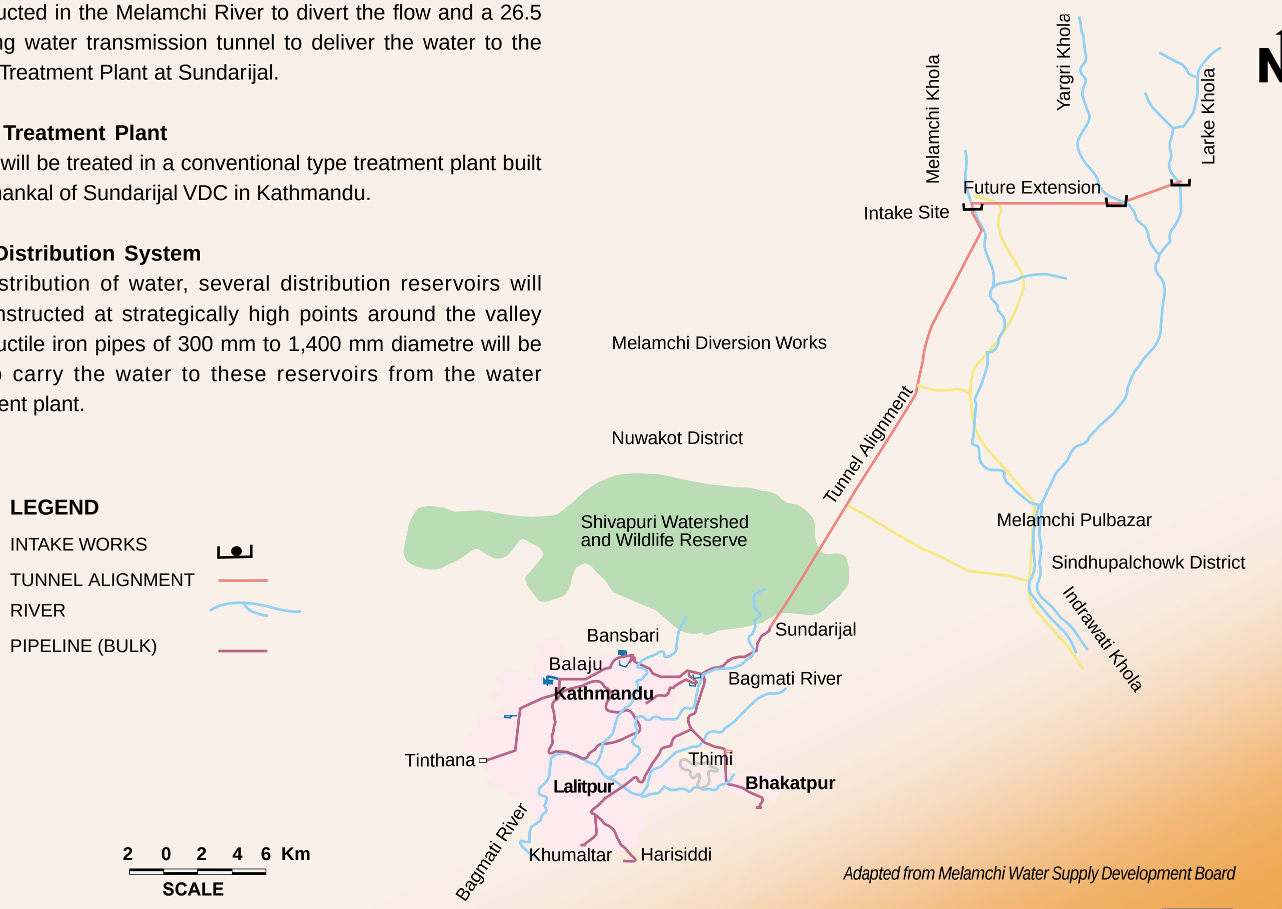
Wastewater Management

The Wastewater Management component includes rehabilitation of existing treatment plants and a portion of the sewer system, construction of some additional interceptors and construction of a sewage treatment plant.

Social and Environmental Aspects

The project also includes a social and environmental component to be undertaken in the 14 affected VDCs of the Melamchi Valley. The program includes activities related to (i) income generation (ii) health (iii) education (iv) buffer zone management and (v) rural electrification.

Figure 8:
Melamchi Water Project Location Map



Adapted from Melamchi Water Supply Development Board

Return to Wider Perspectives

Return to Wider Perspectives

Ongoing debates over water management approaches do not capture the dynamic, complex nature of water use documented within the case study areas. Taken together, the case studies suggest that many global debates miss fundamental points. Disputes over such issues as privatisation versus community-based strategies, large versus small structures, supply versus demand-side solutions, centralised versus decentralised and integrated versus single purpose management and so on do not reflect fundamental issues of governance. The question isn't what is decided – but how it is decided. Unless fundamental principles of democratic governance are in place, outcomes will not reflect the ever changing needs for water management solutions.

Ongoing debates over water management approaches do not capture the dynamic, complex nature of water use documented within our case study areas.

The above rural and urban case studies indicate the tremendously dynamic nature of water use in the context of rapid social change. In less than fifteen years, the urban population in developing countries is projected to surpass the rural population (Pinstrup-Anderson *et al*., 1999). While India and Nepal are still 'rural' countries, they are in the process of tremendous social and economic transition. In India, the population in urban areas grew by 31.2 per cent between 1991 and 2001 in contrast to the 17.9 per cent growth in the rural population[1]. The population of Kathmandu has been growing at a rate of six per cent or more over the last decade. Perhaps more importantly, the urbanisation of 'rural' areas is increasing. According to R.P. Mishra and Kamlesh Mishra:

> 'Cities like Mumbai, Pune, Surat, Vadodra and Ahmedabad are coalescing to form a vast urban region wherein the boundaries of individual cities overlap each other. This coalescing begins with the evolution of urban corridors connecting two or more large cities. Among these corridors Chennai-Bangalore, Kanpur-Lucknow, Calcutta-Asansol and Delhi-Ambala corridors are on the way to megalopolisation' (Mishra and Mishra, 1998).

At the other end of the spectrum, according to them, 'over 10,000 urbanised villages with populations ranging from 2,500 to 10,000 or more will show up as micropolises to serve rural India before this century [the 1900s] comes to an end'(Mishra and Mishra, 1998).

Fifty-nine per cent of the population in the Sabarmati basin now lives in urban areas. In the Noyyal basin the urban population is over 65 per cent of the total. Even in Nepal urbanisation

1 http://www.censusindia.net/press/pr200701.html

is changing the face of the country. Butwal, in the Tinau case study area, is typical of the many new small urban areas springing up along the East-West Highway in the Tarai.

Urbanisation is only one dimension of the transition countries face. Two decades ago, television, telephones and transport networks were rare in most rural areas. Now, satellite TV delivers images to even the most remote locations while landlines and cell phones enable an unprecedented degree of direct communication by individuals in many areas. Other forms of globalisation – from trade and wage labour migration to lifestyle advertisement and the availability of consumer goods – are changing the options and aspirations of individuals and communities. Such changes have complex but important implications for both water use and the viability of water management approaches.

Demand for water and for water management solutions is socially constructed. In rural South Asia, irrigation demand is heavily influenced by crop selection. Crop choice, in turn, is a product of social decisions and values. Oilseeds and dairy, for example, are common in Gujarat, in large part because of decisions to support processing and marketing – which are in turn a product of the cultural values Indians place on specific food types. In urban areas, the demand for water is influenced not just by subsistence requirements but by the amenity values (washing machines, piped tap water, flush toilets and recreation) that residents associate with urban lifestyles. Demand for water management solutions is also a social construct. The incentive to invest in local management institutions is lower when populations are physically or economically mobile. If people don't view themselves as dependent on the long-term sustainability of the resource base, then they may have little incentive to manage it. Similarly, calls for state versus private sector management of water resources grows out of socially constructed ideologies that may, or may not, reflect fundamental aspects of human behaviour.

Strategies that reflect and are capable of responding to ongoing change processes are essential.

Overall, the dynamic social changes now taking place are reshaping both water use and institutional arrangements for management. The emergence of water markets and the water harvesting movements are cases in point. Both represent complex, dynamic responses to specific contexts. Most conventional proposals for managing water resources are incapable of addressing these complex dynamics. Strategies that reflect and are capable of responding to the ongoing change processes are essential. This is the larger context, but what does it imply?

IMMEDIATE

Transition is an ongoing process: Fifty years ago populations in all of the case study areas had different livelihoods than today. In rural areas, however, agricultural intensification based largely on groundwater resources has played a major role in the transition from subsistence livelihoods to diversified and much more market oriented agricultural economies. Access to groundwater has been central to economic growth and poverty alleviation (Moench, 2001). Groundwater – or more correctly the risk reduction associated with groundwater access – is an enabling or catalytic resource for rural agricultural populations. The benefits of groundwater for rural farmers have not, however, been equally distributed. Now, with depletion and water quality degradation emerging in many areas, attempts to maintain access to groundwater are causing social differentiation and impoverishing many. In rural agricultural areas, water is of fundamental importance to livelihoods and thus to social equity, to issues of power and issues of control in local communities. This point, which is clearly evident in all the case studies, is of immediate relevance for attempts to manage the resource base.

Because water is fundamental to livelihoods, attempts to manage it – to change or regulate the way it is used – are inherently sensitive. As a result, the incentives and perspectives of users, those with *de facto* control over the resource, are the single most important factor influencing what can actually be done.

A second implication of all the case studies is the 'disconnect' between the objectives or perspectives of 'managers' and those of local communities. Conventional management proposals focus on basins and aquifers. In all of the above cases, however, user perspectives are shaped by considerations that have little to do with hydrologic units. In some locations, as in the Tinau, Palar and Noyyal basins, most water issues actually have little to do with the basin as a whole. Instead they are related to local groundwater pumping, localised and industry-specific pollution problems or the dynamic interaction between systems at a sub-basin level. In sum, proposals for comprehensive integrated management at a basin/aquifer level don't match the social and, in many cases, physical management reality encountered in the field.

Approaches need to be adaptive, capable of changing as conditions change. Responses of this nature are key to 'closing the gap' between management concepts and the realities of water use.

New management realities are evident in the complex institutions, initiatives and physical interventions now emerging in many areas. The water markets of Kathmandu, Ahmedabad and Chennai along with the water harvesting movement now spreading across much of India are examples of this. Water markets, water harvesting movements and to a large extent the spread of wells for groundwater development were not initiated as part of any 'planned' governmental or NGO response to water problems. They have, instead, emerged as technologies diffuse and as local individuals and communities react to the contexts in which they find themselves. While far from perfect, they have evolved as 'local responses' to local conditions and local sets of incentives. Rather than any formal management proposals, such features are the clearest indication of 'what people do' in response to water problems.

All of the above responses are highly 'adaptive.' Even in the case of water harvesting (where village groups often collaborate), local responses generally don't involve the creation of large permanent organisations or groups to manage the resource base. Individuals 'opt in' or 'opt out' depending on their own needs/values and the financial or other resources they have. As a result, the responses are dynamic and flexible. They are also highly inequitable – allocating water to those with the greatest ability to pay.

For those interested in long-term management of the water resource base, the dynamic nature of social responses and the great variability between local areas is a challenge. Uncertainty is high, conditions are changing and local populations are responding to incentives many of which lie far beyond the control of government departments or water management professionals. Rather than hoping that governments will 'show political will' and implement conventional proposals, it suggests that such proposals need to evolve out of processes that respond to local needs and perspectives. It also suggests that the approaches themselves need to be adaptive, capable of changing as conditions change. Responses of this nature are key to 'closing the gap' between management concepts and the realities of water use.

What are the processes that could be implemented over the short term that would lead to improved water management? The Tamil Nadu and Gujarat case studies suggest that the development of stakeholder forums could be one such avenue. Stakeholder forums are important not as a mechanism for local interests to 'participate' in state defined programs but as a representative activist/advocacy body that evolves 'solutions' in their own right and play a role in the political processes of solution advocacy. Such forums provide a space for groups to negotiate and to identify solutions that match stakeholder incentives as well as the political and social realities in a given area. The forums themselves are reactive and informative – they respond to immediate problems and force all the groups involved to become informed and recognise the interests of others. As a result, while imperfect they can be a crucible for the identification of innovative new solutions.

Stakeholder forums are not, however, solutions in their own right. For any dialogue to move forward, the information on which it is based needs to be accurate. Improving access to and the quality of basic water resource and associated economic, institutional and other information is, as a result, a key immediate point of leverage.

Crisis is a window of opportunity for change and for engaging stakeholders in substantive dialogue. Even drought can be a window of opportunity.

In addition to the need for information, it is important to recognise that stakeholder forums may emerge and function most effectively in the context of crisis. In Tamil Nadu, many of the stakeholders are participating in discussions because they face basic practical threats. Industry owners are facing court action and potential closure. The livelihoods of farmers are being destroyed by pollution. None of the important stakeholders can afford to wait. Similarly, in the Gujarat case, the long-term process of groundwater overdraft has reached a crisis point due to drought. Gradual or even rapid declines in water levels don't elicit much action in themselves. When drought hits, however, wells go out of production, crops fail and livelihoods are threatened. In this context, individuals and organisations may be far more willing to consider drastic changes in the status quo than during the normal course of events. Crisis is a window of opportunity for change and for engaging stakeholders in substantive dialogue. Drought can be a window of change and possibly a window of opportunity.

A final implication of the case studies is that water management 'solutions' emerging at the local level are, as with larger-scale centralised approaches to water management, partial. Water markets in urban and rural areas, while they do enable individuals who don't have their own well or other direct access to water to obtain supplies for domestic or irrigation use, are highly inequitable. As currently structured, water markets effectively allocate ownership and control over supplies to relatively wealthy sections of the population. For many people, the existence of a water market 'solves' their immediate need to obtain water – but it doesn't 'solve' the larger question of equitable access to a common heritage resource. Similarly, local movements for water harvesting represent a partial solution to water scarcity problems. As VIKSAT's analysis of water harvesting in the Sabarmati basin indicates, they often don't do much to resolve the rapidly growing gap between demand and supply. The viability of local water harvesting depends heavily on the specific hydrological context. In sum, local approaches to management, while important, are not sufficient in themselves. Furthermore, they leave larger questions of equity and the balance between local and wider social interests unaddressed. This brings us back to wider questions of governance.

GOVERNANCE

Critics of integrated water resource management often question it on the basis of issues such as: Who integrates? Whose interests are represented? How is the process of integration governed? Who decides?

The same questions apply to both centralised and local approaches to water management. Government departments are often criticised as 'out of touch with the people' and driven by their own institutional interests or culture. Local organisations and the water management approaches that evolve in local contexts are unaware of the larger context and equally open to criticism on a variety of counts. Questions over equity surrounding water markets have already been mentioned. In many cases, such questions apply equally well to other community-based initiatives. Water harvesting structures are not always community initiatives designed to help the larger group. Instead they are designed to provide water to the wells and fields of key (often wealthy) beneficiaries – either by design or due to the inherent nature of water moving to lower reaches where the land is owned by the rich. Even where water harvesting is equitable at the community level it can come at the expense of downstream communities. Depending on the hydrological context, effective water harvesting in the areas where precipitation occurs can reduce flows to downstream users.

Hierarchical structures tend to be guided by the perspectives of a narrow group of leadership elite.

Writing on the Western United States, Nunn and Ingram (1988) outlined some of the basic tradeoffs that exist between markets, state legislative bodies, the judiciary and water agencies, and locally governed districts as different social mechanisms for water management. Their research indicated that:

> 'All five forums are found to have biases regarding the type of information used. Markets process information on direct economic costs and benefits well but ignore third-party costs; legislative bodies are sensitive to information about indirect and nonuser impacts but distort information on direct benefits and costs; neither the judiciary nor the water agency is likely to consider community and social impacts of water transfers. Special districts could consider both direct and indirect values but are often controlled by a leadership elite, pursuing narrow goals with minimum membership participation' (Nunn and Ingram, 1988).

The biases experienced in the Western United States context are very similar to the biases encountered in South Asia generally and in the case studies documented above. Taken together they suggest that effective water management depends on fundamental questions of governance. We need to frame approaches to water management in ways that move beyond static concepts of 'local' versus 'centralised' or 'integrated' versus 'single purpose' and to think in terms of governance processes.

If one returns to the different ways of organising identified by Cultural Theory, the tensions that need to be balanced to address any resource management issue become clear. In most situations, the majority of the population is passive, focused on their immediate livelihoods and not directly engaged in the details of water management beyond the household or farm level. Markets evolve, often spontaneously, where individuals can trade goods such as water to their mutual benefit. While such markets can become structured, they are, at their heart, individualistic and driven by the incentives of individuals. More structured group responses can emerge at the community and group level. Such structured responses can either be hierarchically organised – as businesses or government departments guided by individual leaders – or as community activities on the basis of common incentives.

Each of these forms of organisation is in tension with the others. Markets are inherently based on the pursuit of individual interests. Egalitarian initiatives are driven by wider concepts of community rights and goods. Hierarchical structures tend to be guided by the perspectives of a narrow group of leadership elite.

Water governance consists of structures and processes that balance the power of the interests underlying each mode of organisation while enabling practical courses of action to emerge. At present, comprehensive models for water governance (or any other form of governance) do not exist. Key elements of any effective governance structure must, however, include:

Freedom of information: How information is generated, disseminated, analysed and controlled establishes the text on which perspectives are formed and solutions negotiated. Information is not neutral. Different institutional contexts are biased towards generating the information (or disinformation) that supports their world views. As a result, diverse sources of information are important and organisations that produce primary baseline information (such as groundwater level or stream flow data) need to be institutionally isolated from implementation functions and the biases those create. In addition, baseline data need to be accessible to all. Data itself is, however, only of limited use unless it can be interpreted and analysed. This is where our earlier book *Rethinking the Mosaic* highlights the role and key function of social auditors. Particularly in fields such as water resources where management options depend on a combination of basic scientific and wider social factors, existence within society of the capacity to analyse and identify needs and alternatives is critical.

Existence within society of the capacity to analyse and identify needs and alternatives is critical.

The right to organise: Unless the right to organise is widely recognised and accepted as a basic governance principle, many stakeholders won't be able to play an effective role in water management. Equally importantly, unless the right to organise exists, water management approaches cannot evolve over time in response to changing conditions. From a social perspective, organisations and the institutions created to respond to one set of problems at one moment in history are likely to be inappropriate as responses to other problems or other contexts. As a result, the larger governance framework needs to be structured in such a way that organisations can emerge and die as the social demand for their existence waxes and wanes.

Explicit or implicit mechanisms to balance power in society: National constitutions generally contain core mechanisms to balance the power of individuals and interest groups. Divisions between legislative, executive and judicial functions are, for good reason, at the foundation of most democratic governance systems. Balance of power concepts are equally important in the more constrained realm of water governance. When the mandate for setting the water management agenda (i.e. the planning and policy making function) is located within an executive agency (such as a government irrigation department or implementation NGO), the agenda will tend to match the implementation mandate of the executive organisation. Ideally, the responsibility for setting the water management agenda should reside in a body that *represents* all key interests. This function would be distinct from executive and judicial (dispute resolution) mechanisms. How this can be actualised in the water resource context remains to be explored. Conceptually, stakeholder forums could evolve into representative 'legislative' bodies that set water management priorities while independent specialist scientific organisations (similar to the United States Geological Survey) could play the role of neutral arbiters.

Enabling financial mechanisms: The right to organise, the existence of social capacity and social auditors, freedom of information and mechanisms to balance power will not translate into effective courses of action unless individuals and communities have access to resources. In the United States, debates over water management and many of the innovative solutions to emerging problems have been enabled by the existence of philanthropic foundations. These foundations, each of which is governed by its own board of directors, provide a large portion of the financial resources for social auditors and egalitarian groups. Similarly, once organised, local groups such as water districts can obtain quasi-governmental attributes, including the ability to tax. Mechanisms that enable social auditors and management groups to obtain the resources for organisation, analysis, implementation and monitoring are essential. Without such mechanisms, diverse perspectives on water management needs and options cannot evolve or be tested.

Our insights are an admittedly partial and preliminary listing of the factors required for effective water governance.

The above bullets are an admittedly partial and preliminary listing of the factors required for effective water governance. The point, however, is that effective responses to evolving water problems cannot emerge unless they are founded on basic principles of democratic governance. Water problems emerge and wane. Contexts vary. Crises shock systems. Standardised 'solutions', packages of institutions and technologies, cannot be expected to apply to different contexts or as conditions change over time. The challenge is to develop and institutionalise sets of basic governance principles that will enable society to organise effective and equitable responses when and where they are needed. This question is often explored by those seeking to devise effective systems for governing the nation state. It remains relatively unexamined in the far more focused world of water management. Exploring it is the core challenge.

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