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Water Markets, Commodity Chains and the Value of Water

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Abstract

The objective of this paper is to situate debates over the functioning and role of water markets within concepts of management and adaptation. This paper argues that existing water markets in South Asia are fundamentally different from the formalized, legal rights-based, water markets of the western U.S. Existing "informal" water markets are neither inherently equitable nor inherently inequitable. Much depends on how equity is defined. In most situations, only one dimension of equity: whether or not users have access to similar volumes of supply is considered. Other dimensions may, however, be equally important and lead to different perceptions of whether or not water markets contribute to the larger degree of equity within society. Key dimensions of equity that need to be considered in any evaluation of the impact of water markets include: whether or not current populations have relatively equivalent access to the common heritage resource of water, inter-generational equity, inter-sectoral equity and broader social equity. Water markets may, in some situations, increase access equity (the first dimension). How they perform on other dimensions is open to question and has not been investigated in a rigorous way. Further, equity is not only a decisive factor for evaluating the functioning of the current water markets but also an important issue which needs to be considered while valuing water.

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CORE ARGUMENT

The objective of this paper is to situate debates over the functioning and role of water markets within concepts of management and adaptation. This paper will argue that existing water markets in South Asia are fundamentally different from the formalized, legal rights-based, water markets of the western U.S. Existing "informal" water markets are neither inherently equitable nor inherently inequitable. Much depends on how equity is defined. In most situations, only one dimension of equity: whether or not users have access to similar volumes of supply, is considered. Other dimensions may, however, be equally important and lead to different perceptions of whether or not water markets contribute to the larger degree of equity within society. Key dimensions of equity that need to be considered in any evaluation of the impact of water markets include:

1. Access equity: the standard question of whether or not current populations have relatively equivalent access to the common heritage resource of water;
2. Intergenerational equity: a more complex quesiton of whether or not water markets encourage uses which contribute to the sustainability of the resource base and, therefore, maintenance of a common heritage for future generations. This question is more complicated than it may seem because equity between generations is not just a question of the sustainable use of water but also involves questions of capital formation and transformation – i.e. social equity in future generations could be increased if unsustainable uses of water are used to create other (larger and better distributed) forms of social, economic or other capital.
3. Intersectoral equity: This is a question of whether or not widely held views on how water *should* be allocated are actually present when water is used. This may involve, for example, a question of whether or not all people have access to good quality water for fundamental survival and domestic needs or whether uses that have a lower social priority (such as industrial uses) are able to capture available

supplies. This issue is also present, for example, between urban and rural users and between agricultural livelihoods and industrial expansion.

4. Broader social equity: This is a question of whether or not differential access to water over time allows better endowed sections of society to increase their rate of capital accumulation while less endowed sections remain at roughly the same level or decline. In either case, the degree of differentiation within society between the "haves" and "have-nots" will increase over time. Even in situations where *everyone* is better off in an absolute sense, the degree of differentiation may have increased and the social tensions with it.

Most discussions of equity in relation to water resources address the first, or at most, the first two dimensions. Water markets may, in some situations, increase access equity (the first dimension). How they perform on other dimensions is open to question and has not been investigated in a rigorous way. It is clear that water markets do not capture *in situ* values (environmental values, sustainability, etc...) associated with water resources. They do, however, play a valuable role by increasing access to water and the reliability of water supplies in rural areas. While clearly imperfect, in urban and peri-urban areas water markets are also an effective mechanism for shifting water from relatively lower value to higher value domestic uses while also forcing consumers to pay relatively high rates. Water markets do create strong incentives for efficiency and water conservation at the level of individual users. Furthermore, unlike most urban water supply systems, where subsidies are captured by wealthy consumers with access to both storage and the piped system, water supplied through urban markets is unsubsidized. If existing urban water supply systems can be reformed so that they deliver sufficient supplies to meet the basic needs of all sections of society, then existing water markets may be an effective mechanism for meeting the demand for more water services by the richer sections.

Overall, existing water markets represent a partial, but highly adaptive, set of institutional arrangements for meeting the water needs of urban and rural residents. This is occurring without establishment of a quantitative or other formalized water rights system that goes beyond basic rights of capture. Approaches to addressing regional water needs and problems that recognize the role being played by existing water markets may be able to identify key points of leverage for meeting urban water needs *without either fundamental institutional reforms or large-scale inter-basin transfers.*

WATER MARKETS AND THE VALUE OF WATER

Globally, the last two decades have seen an increasing focus on the role of markets as a mechanism for allocating water and communicating its value to users. Water markets are, in many water management circles, seen as an important if not essential tool for reallocating water away from agriculture, the largest user, to meet growing urban and industrial demands. More fundamentally, markets are increasingly seen as an important mechanism for communicating the economic value of water and, thus, for encouraging conservation and efficient use both within and between applications.

Debates over water markets are often clouded by confusion over what is really being discussed. The primary model for water markets has been that developing in the Western U.S. This model involves a well established, though far from perfect, set of quantitative water rights systems and substantial government involvement in regulating transfers to avoid the above mentioned externalities and third-party impacts. Although transfers between individual end users are possible under the model, much of the water market activity involves the transfer of substantial quantities of water between institutional users – such as agricultural water districts and municipal water supply authorities. The Western U.S. model is fundamentally different from the indigenous local water markets found throughout South Asia and many other parts of the world. Although often discussed using the same terminology, local water markets in South Asia are based on informal rights of capture (if you can physically pump or divert water, you can sell it), not on quantitatively defined rights systems. They generally involve very local and volumetrically small, transfers of water between individual users (adjacent farmers or farmer-industrialist, farmer-tanker owner) rather than institutional users. Finally, because the markets are "extra-legal" governmental regulation of their functioning is minimal to non-existent. (Moench 1994)

Attempts are being made to replicate the Western U.S. model in locations such as Chile, Mexico and South Africa where legislation has been passed to reform water rights and, in some locations, to register wells. The success of such approaches is widely debated. As Carl Bauer (Bauer 1998)discusses in his well researched and documented book on the Chilean case, "Chile's experience with free market water policies has been uneven." (p. 119) According to him, the new water code has worked relatively well within the agricultural sector – separating water from land ownership has enabling flexibility and encouraged consolidation of water user associations as separate entities from the state. Major problems have, however, emerged with other aspects. Equity is a concern since "Peasants generally lost out in the transition to the new Water Code" and there have been "serious problems" with "intersectoral relations at the regional or river basin scale" where the new legal framework has "done a poor job of coordinating different water uses and resolving conflicts between them." (Bauer 1998) On a more fundamental level, Bauer argues against the, often touted, proposition that "markets – as opposed to governments – are neutral, objective, and apolitical." Instead he makes the point that:

> "To exist and operate over time, markets depend not only on economic factors of supply and demand, but also on many extra-economic factors and prior definitions: such as political decisions, legal rules, cultural attitudes and geographic and environmental conditions. These factors and definitions are affected by relations of social and political power and by the distribution of wealth. Markets can be no more neutral than their surrounding social contexts and underlying institutional arrangements." (Bauer 1998)

Finally, Bauer makes a point of great relevance to the South Asian situation when he points out that water rights and market based approaches are critically dependent on the capacity of the judicial system. Because water transfers often affect basic livelihood and economic development questions and because water rights are extremely difficult to fully define, conflicts are an inherent part of any reallocation process. As a result, "the capacity to resolve conflicts effectively and with legitimacy is especially critical in a neoliberal legal and economic model, a model built around broad private rights and liberties and a minimal state. This capacity depends on the judicial system which must control state regulation and balance different private rights. The courts must be fairly independent from other branches of government, and willing and able to rule on disputes with substantive policy implications." (Bauer 1998)

Bauer's analysis highlights the importance of understanding basic market assumptions before entering any debate over the positive and negative aspects of water markets. As Frederick indicates:

> "Two conditions must be satisfied for the development of efficient markets. There must be well-defined and transferable property rights in the resource being transferred, and the buyers and sellers must bear the full benefits and costs of the transfer. Both conditions are now commonly violated for water resources. The fugitive nature of the resource makes it difficult to establish clear property rights, and the interdependence among users might cause externalities or third-party impacts when the use or location of water is changed." (Frederick 1996[M1])

The above issues are, perhaps, particularly problematic in the case of groundwater resources. With groundwater, benefits perceived by users are generally limited to *extractive* values. *In situ* values – the maintenance of aquifer levels, the insurance value of water held in stock, and environmental values such as groundwater contributions to stream base-flows – tend to be public goods. As a result, the value of these goods is generally not reflected in groundwater use patterns or prices (National Research Council Committee on Valuing Groundwater 1997). In addition to the *extractive – in situ* distinction, definition of groundwater rights in a manner that is transparent and reflects third party considerations is particularly difficult due to technical limitations in the ability to quantify water balances and aquifer characteristics. Groundwater is an "invisible resource," and key aquifer characteristics including the amount of water available on a sustainable basis are often technically impossible to determine within the parameters of available data (Moench 1995; Burke and Moench 2000).

Due to the above types of market failures, the effectiveness and equity of water markets as a mechanism for efficient, equitable and environmentally sustainable water allocation is widely debated even in the Western U.S, the "type locality." Water markets in the Western U.S. have generally been thin – involving limited volumes of water and a relatively small number of transactions (National Research Council, 1992). There have also been major debates over impacts on the ability to protect instream flows, third parties including other right holders and areas of origin, and impacts on vulnerable sections of society including minorities, Native Americans and the poor (Nunn and Ingram 1988; Moench 1991; National Research Council 1992; Moench 1995). Conceptual concerns over the use for market frameworks in natural resource management have been expressed since such approaches were proposed. In the early 1970s, for example, Schwab indicated that : "Profit-motivated behavior in a free market framework cannot be expected to exhibit much concern for conservation. It will tend to sacrifice the uncertain future for the more predictable present. To protect society against the risk of future shortages and crises, there will have to be active government involvement..." (Schwab 1972). Finally, there are ethical concerns about the basic premise from which water markets start, e.g. individual private ownership over what has historically been a common heritage and public resource (Moench 1995).

In many cases, debates over water markets have become polarized along ideological lines. Those who believe in neoliberal economic perspectives advocate them on principle with little recognition of the complexities Carl Bauer highlights in his analysis of Chile (Bauer 1998). Many others criticize markets without providing any insights on alternative mechanisms that can provide the allocation flexibility and efficient use incentives markets enable. Markets can be seen as filling a vacuum left by states, which are unwilling or unable to provide basic resources for their citizens. They can also be seen as a framework for allocation that decentralizes decision making to the level of individuals and reduces the intrusion of bureaucracy into everyday life.

The above debates, while important to recognize, will not be resolved in this chapter. What we believe is important to recognize is the near universal agreement that changing economic and demographic patterns over coming decades combined with increased recognition of environmental needs will necessitate the development of balanced and flexible mechanisms for water allocation. As a result, probably the most critical issues are not ideological but practical. They include the following questions:

1. Do water markets, as they currently exist "on the ground" in developing countries provide some of the flexibility and incentives for water conservation that will be essential to meet needs over coming decades?

2. Are relationships across water transactions equitable or are they embedded in social relationships that create conditions for forced sales or other forms of inequity?

3. Are major third party impacts evident in the functioning of water markets? and

4. What should the role of governments and international institutions be in relation to existing, imperfect, water markets? In specific, how much reliance should be placed on attempts to create the types of private rights systems and government regulatory frameworks that represent the essential foundation for formalized markets of the type found in the Western U.S.?

To provide some insight into the above questions, this chapter will focus first on the key questions of flexibility, conservation incentives, profit and equity relationships across transactions, and third party impacts in the functioning of water markets in Gujarat, Tamil Nadu and Kathmandu, Nepal. Following this, the larger question of state roles will be investigated along with implications for global debates over management approaches based on market mechanisms.

THE STRUCTURE OF WATER MARKETS IN INDIA AND NEPAL

What is the structure of water markets in India and Nepal? In a broad sense, three types of water markets can be recognized:

- **Rural-Rural water markets:** These generally involve transactions within the agricultural sector rather than between sectors. In most cases, well owners sell water to adjacent farmers either for a cash payment or for a share in the crop. This type of water market has been extensively investigated in a number of locations but much of the resource has drawn heavily on experiences from Gujarat and Tamil Nadu (see for example, (Bhatia 1992; Shah 1993; Janakarajan 1994; Moench 1994; Palmer-Jones 1994; Moench and Kumar 1995; Palanisami 1996; Shah 1996; Shah 1996; Dubash 1999; Moench 2000). The research is characterized by on-going debates *first* over the extent to which water markets function in an equitable manner or have become sources of power and accumulation and *second* over whether or not they contribute to efficient use and the sustainability of the resource base. The debate over water markets is closely linked to debates over power pricing. Electrical power for groundwater pumping is, in many Indian States, provided either at a flat annual rate based on pump horsepower or free of charge. In this situation, the presence of water markets provides a strong incentive to extract as much water as possible in order to maximize short term returns and minimize fixed costs.

- **Rural-Urban water markets**: This type of market is increasingly common adjacent to both large urban areas and intermediate sized towns. The transfers here typically involve sale of water by well owners (generally farmers) either directly to industries or to tanker companies who then deliver supplies to end-users (smaller industries, commercial establishments and households). This type of market has, in comparison to the rural water markets, been less studied. The promotion and formalization of this type of water market has, however, been advocated as a potential mechanism for meeting the needs of urban areas, such as

Chennai, while avoiding both costly long-distance transfer projects and the political difficulty of administratively reallocating supplies from existing agricultural users (Briscoe 1996). Although possibly less studied, rural-urban water markets are very common and represent a major source of supply for many users. They are also increasingly differentiated with people purchasing everything from bulk supplies of low quality water for specific uses to high quality bottled water for drinking. The impact of transfers on agricultural users is probably the most controversial point of debate in respect to these water markets (Janakarajan 1999). The Palar and the Noyyal river basins in Tamilnadu are the typical cases where a large extent of groundwater is transported from rural to urban areas for domestic and industrial uses. Its implications for the local agriculture and the ecology are quite disastrous (see Appendix-1).

- **Urban-Urban**: These water markets have similar characteristics to the Rural-Urban markets with the significant exception that they don't involve transfers of water from agriculture to urban applications. In addition, at least in some situations, urban water markets are supplied by water from municipal utilities. In Chennai, for example, the municipal authority supplies water to large (1-5m^3) plastic tanks situated around the city. The water from these tanks is then sold in small quantities by water vendors stationed at the tank to end-users, generally families or small restaurants, for domestic use.

The demand for water met through markets in urban areas is a direct consequence of inadequate municipal supply systems. In many cities, a large portion of the population lacks in-house connections and, even for users with direct connections, water supplies delivered through municipal systems are insufficient to meet their demands. Municipal supply systems often provide water for only a few hours a day even during the best of times. During drought periods, supplies are often very erratic. This represents a major problem even for households connected to the system and able to afford substantial storage (cisterns and roof top tanks). For households dependent on public tap stands, access to water from public sources can require major investments of time and effort. In addition to supply limitations, quality concerns are emerging as a major factor driving the development of high-end markets for bottled drinking water. Quality is increasingly recognized as a substantial concern in municipal systems. Overall, where both quantity and quality are concerned, rural-urban and urban-urban water markets are, at least for the wealthy, a way of bypassing the limitations of the public supply system.

A major part of this chapter will focus in detail on the structure of rural-urban and urban-urban water markets in Kathmandu, Chennai and Ahmedabad. Particular attention is being paid here to these types of water markets because far more published information is already available on rural-rural water markets and their dynamics. Before delving into the urban context, however, it is important to highlight some of the conclusions from studies of water markets in rural areas.

KEY CONCLUSIONS FROM STUDIES OF RURAL-RURAL WATER MARKETS

In virtually all situations, the presence of a local water market increases the flexibility of water allocation within villages and enables people without wells to obtain access to water. This is of great importance for farmers because yields and income depend heavily on access to water at the time crops require. Beyond this, however, the wide array of studies on local water markets in India – most of which relate to groundwater – highlight the context dependent nature of their functioning and characteristics.

Take the case of equity. In some situations, water markets emerging under the flat price power enable small farmers to gain access to water supplies at less than the full cost of pumping and infrastructure (Shah 1993). In other situations, access to water through water markets function as part of embedded land and labor markets or are heavily influenced by the social, ecological and geographic context (Janakarajan 1994; Dubash 1999). Dubash, for example, found that prices are often uniform within villages and that equality in the terms of exchange is emphasized by both buyers and sellers – but price structures often stop at village borders and different systems are frequently followed in adjacent villages (Dubash 2000). He attributes this to differences in the spatial characteristics of aquifers and wells in addition to social differences such as land ownership patterns. As a result, while water markets can contribute to equitable access for small farmers, they can also have the reverse effect by forcing marginal farmers deeper into dependency relationships. The equity implications of local water markets functioning in an extra-legal manner regulated primarily by village institutions and geography are, thus, highly dependent on context. Dubash concludes by cautioning "against policy manipulation based on a generalized understanding of how exchange systems for groundwater operate, and particularly one based on neoclassical models of oligopolistic or competitive markets. Policy interventions aimed at concerns of equity and sustainability must be based on a sufficiently realistic understanding of the structural conditions of groundwater access and the path dependent emergence of village level institutions that regulate groundwater use and access." (Dubash 2000)

Where water use efficiency is concerned, the impact of water markets remains unclear. Power and water prices are often a small factor in the overall economics of crop production. In the Western U.S., for example, energy prices are a factor in farmers willingness to invest in water conservation but play a minor role in crop choice and therefore the overall water use decision (Moench 1991). As a result, prices *per se* may only create marginal incentives for efficiency as long as they remain within ranges that are roughly equivalent to present levels. Much of the debate in South Asia is linked to questions of power tariffs – which in most Indian states consist of a flat annual charge based on pump horsepower. A comparative study of diesel and electric wells conducted in the early 1990s found, for example, that farmers paying high unit costs for diesel did use water more carefully and reduced the area under lower value/high water intensive crops than farmers using electric pumps under the flat rate tariff (Moench 1993; Moench and Kumar 1994; Moench 1995). The reductions encountered were, however, relatively marginal despite the very substantial price difference between diesel and electric power. While organizations, such as the World Bank, argue strongly for full cost pricing for power, political realities have kept power price reforms well below this. In Gujarat, for example, the new optional metered tariff for power in agriculture as of 11/10/00 was Rs

10/month plus Rs 0.5/unit.[1] In other states, such as Punjab and Tamil Nadu, power prices for agriculture have been eliminated. These free or highly subsidized charges compare to a full cost rate for power of perhaps Rs 3.5-4 per kWH in rural areas (World Bank 1998). If power prices were increased substantially, it would have a major impact on the economics of crop production and, thus, on the efficiency of water use. According to a proposal prepared by the International Water Management Institute and others, "IRMA has estimated that the Mehsana farmers use 0.38 kWh of power to produce 1 m^3 of groundwater; at Rs 2.50/kWH, groundwater pumped in North Gujarat will begin to cost over Rs 1/m^3; at this rate, most groundwater-irrigated agriculture would collapse. And so would the region's dairy economy; at Rs 1/m^3 the irrigation cost of alfalfa would rise to Rs10,000/ha and would raise 3-fold the farm-gate cost of dairy production, which is the mainstay of the region's rural economy."[2] Back of the envelope calculations suggest, however, that farmers in North Gujarat were often already paying over one rupee per cubic meter a decade ago so the more extreme projections may be unfounded.[3] In addition, due to political limitations on the prices charged for power, effective water prices are unlikely to be forced substantially higher. Nonetheless, the most general conclusion appears to be that prices established in water markets do provide some incentive for efficiency – but that prices are not sufficiently high at present to cause farmers to abandon low efficiency practices (such as flood irrigation) or to necessitate major crop shifts. Flood irrigation remains wide spread and there has been a significant expansion of the area under alfalfa to feed Gujarat's growing dairy industry. Most responses to falling water levels focus on the harvesting of new supplies, not demand side management.[4] As a result, even in North Gujarat, an area with relatively high prices for water in water markets, the efficiency of use has not greatly increased.

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[1] Times of India, Ahmedabad, 11/10/00

[2] The North Gujarat Sustainable Groundwater Management Initiative, A Proposal for Science-Based Coordinated Action, International Water Management Institute-Tata Water Policy Program, Institute of Rural Management Anand, and Gujarat Ecology Commission.

[3] In 1990-1991, prices encountered in water market surveys for an approximately 10 lps flow were frequently Rs 40/hr and occasionally Rs 70/hr. Ten lps is equivalent to 36m^3/hr or roughly Rs 1.1 – 1.9/m^3.

[4] The North Gujarat Sustainable Groundwater Management Initiative, A Proposal for Science-Based Coordinated Action, International Water Management Institute-Tata Water Policy Program, Institute of Rural Management Anand, and Gujarat Ecology Commission.

The final concern is sustainability. Under the flat rate tariff or free power supply structure for electricity in agriculture, water markets produce few incentives for increasing the sustainability of groundwater use. With the flat rate structure, farmers face declining average costs. As a result, they have an economic incentive to pump as much as they can use and, when water markets exist, to sell as much as they can. In this situation, water markets encourage over extraction as opposed to encouraging sustainable use. The impact of this structure on actual pumping levels has never been quantified, but the direction of the incentives it creates is clear. Changing to a pro rata (consumption based) system for power charges would reduce the incentive to over extract groundwater but would not necessarily eliminate it.

In sum, existing studies on water markets highlight the context-dependent nature of their impacts. While the emergence of water markets has clearly increased flexibility and the reliability of access to water for farmers, their implications for equity, efficiency and sustainability are less clear. Many of the impacts depend on local conditions or external features such as the power tariff structure. Overall, rural-rural water markets and their implications for efficiency, equity and sustainability are, as Dubash (Dubash 2000) indicates, heavily influenced by the social and institutional context in which they occur.

URBAN AND RURAL-URBAN WATER MARKETS

Now to a more detailed look at rural-urban and urban-urban water markets. The functioning of these markets is of particular importance for two reasons. *First*, India is projected to be more than 50% urban by 2020. While the absolute number of people living in rural areas will continue to grow, urban areas will grow far faster and will create huge demands on water resources. *Second*, as a result of the above shift, there will be increasing pressure to transfer water out of agriculture to urban dwellers. Urban dwellers are likely to be more educated and politically active than their rural counterparts. As a result, political power in India is likely to shift even more heavily toward urban areas. This will make their demands for adequate water supplies even more potent. While agricultural interests may resist pressure to transfer water, demographic patterns suggest that such transfers will occur by one mechanism or another. Markets represent one such mechanism and have the advantage that they generate incentives to conserve on the part of the purchaser and contain mechanisms for compensating those giving up the water.

While large scale legally structured markets for water supply to urban areas do not, at present, exist, smaller scale extra-legal markets are common. Understanding the dynamics of these markets is important in order to generate insights on the larger role water markets could play – and the issues or concerns such a role might create – in meeting projected urban demands. This section is based on case studies carried out by Shashikant Chopde and M. Srinivasan at VIKSAT in Ahmedabad, S. Janakarajan at MIDS in Chennai and the NWCF-ISET team in Kathmandu. Case study materials for each area are presented first followed by a detailed discussion of their functioning including the allocation and equity and equity issues they raise.

Case Studies

Kathmandu[5]

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.

Water supply in Kathmandu was historically delivered through traditional systems such as the wide-spread 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

[5] This section is based heavily on a field survey conducted by ISET and NWCF in the spring of 2001 and an accompanying report written by Yarrow Moench. Significant portions of this report are incorporated in the case study.

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 supplied by Rajkhulos, networks of drinking and irrigation water supply 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 show high levels of fecal coloform contamination especially during the monsoon season, likely a result of the absence of a city sewer system. 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 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 uses. 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. Kathmadu 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.

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 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.[6] Loss rates in the municipal system are very high (estimated to be over 70%). Much of this water flows back into the upper unconfined aquifer where, due to pollution, it becomes effectively unsuitable for urban supply. Overall, water supply from the municipal system is characterized 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 28 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.

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 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 primary the upper middle and wealthy classes.

[6] Gorkhapatra, July 31, 1999

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 meters of water costs Rs 900 while a larger tanker delivering 12 cubic meters of water costs Rs 1200. 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 $160NRs/m^3$ 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 meters of water.

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, where as during the rest of the year some companies make as few as four deliveries a month. Though a rough calculation it can be estimated that during the dry season the private market supplies approximately 6 MLD to Kathmandu[7]. Compare this to the official dry season supply for NWSC, 80 MLD minus 60% losses, and it becomes clear how significant a contribution the private market makes to the urban supply, nearly 19% of the estimated NWSC actual supply.[8]

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 waterspouts in the city. The market functions outside the jurisdiction of the

[7] The calculation was done using the Tanker Association's estimate of 80 tanker companies in the valley with an average of 2 trucks per company delivering 3.7 trucks per day.

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.

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 purchase. Tanker customers frequently complained of poor quality water, saying that it was often discolored, 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 300NRs and agree to abide by the Association 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

[8] The level of supply by NWSC is unknown, during the dry season ranging from 60 to 80 MLD with 40 to 70% losses. As a result, the relative supply of the private market is unknown, however its contribution is

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.

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 labor. 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. Some locations, for example, users are charged Rs 3 for a pot of water that contains 8-10 liters. This is equivalent to 300NRs/m^3 or US$4.05/ m^3. The charges at *dhunge dharas* for routine use vary depending on the community surrounding the water source. One professional washer community, *Dhobi Ghat*, has an exceptionally good *dhunge dhara*, which 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 moneybox below it for contributions.[9] Other costs are also often present. These take the form of renovation charges for *dhunge dharas*, 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 dharas* are usually charged on an ability to pay basis with contributions ranging from approximately 500 to 5,000NRs from each household. Beyond direct financial costs, the real costs associated with reliance on *dhunge dharas* 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

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significant.

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

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 liters and an implicit labor cost of Rs 15/hr[10], this is equivalent to Rs 2,000 (U.S. $27) per cubic meter. A wait of six hours implies a cost of Rs 6000/m^3 or U.S. $81/$m^3$.

One of the main problems with the traditional supply is its lack of complete coverage and the fluctuation in its supply. *Dhunge dharas* 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 dharas'* 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 household 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.

[10] Based on a monthly wage rate of 2500 Rs/day (not uncommon for women at the lower end of the office spectrum) and a 40 hr work week.

Table-1 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.

Table 1: Cost comparison for water sources available in Kathmandu, Nepal

Source	Cost		User Profile	Quality	water use
	monetary	Non-monetary			
NWSC household pipeline	4NRs/m^3	nighttime collection, storage system (cistern or vessels)	all incomes in houses, level of supply unconnected to income	generally considered good quality, limited contamination	all household needs unless contaminated
Private market	100 to 150NRs/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 300NRS/m^3 cash. Implicit labor cost of up to Rs 6000/m^3 when women have to wait 6 hours for 15 liters. More typical implicit cost Rs 2000/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	3500 to 20000NRs 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 500-5000NRs	collecting water manually or electrically with pump Health costs potentially significant but unknown	middle to low income	variable quality	washing, cleaning, toilets; consumed in Patan

(Source: Survey by NWCF, 1999-00)

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 (Table-2). In general, if households are unable to use a shallow well as a alternative water source, they must decide between the labor intensive and time consuming *dhunge dhara* or the expensive tanker supply. Coping strategies may be employed to avoid this situation such as asking a neighbor 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 2: Coping Strategies Employed by Kathmandu Residents

Income	Sources Available					Coping Strategy
	NWSC	tanker	private well	comm. Well	*dhunge dhara*	
High	X	X	X			prioritize 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	prioritize 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	prioritize 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	prioritize water use, washing and bathing done at community well or dhunge dhara, depend on neighbors for drinking water
Low	rare			X	X	prioritize water use, depend on neighbors for water, use community well and dhunge dhara heavily

(Source: Survey by NWCF, 1999-00)

To sum up, the tanker water market in Kathmandu primarily serves high-end customers, those with at least $5m^3$ of storage capacity and the ability to pay NRs 900-1200 for a tanker of water. Approximately 80 small tanker companies serve residents and commercial establishments dependent on the tanker water market and it meets as much as 18% 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 labor, time and the health consequences associated with pollution of wells and *dhunge dhara.* Upper levels of strategy pay by 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.

Ahmedabad

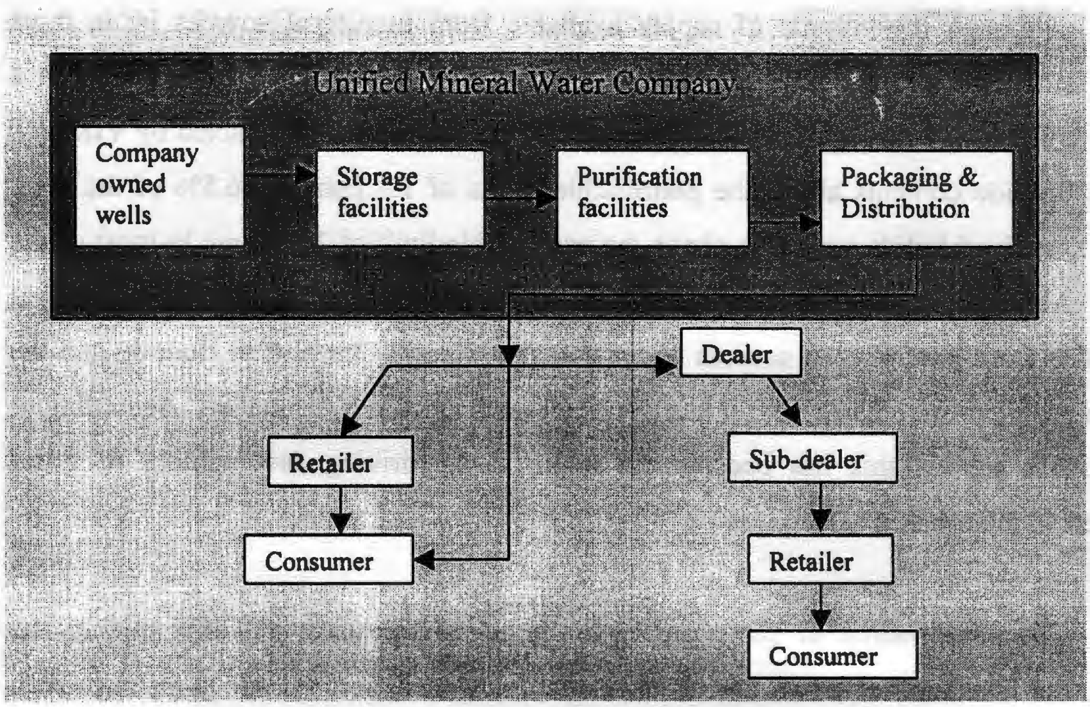
Ahmedabad is underlain by a deep alluvial aquifer. Although water levels in this aquifer have been declining for decades (Gupta 1985), physical access to water is not a major problem. The Ahmedabad Municipal Corporation (AMC) runs an extensive system for meeting city water supply needs. Water is supplied to consumers at a rate for 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 access water released from the Darhoi reservoir far upstream. Other parts of the urban area are supplied from a network of tubewells run by the municipal corporation. In addition, 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 similar 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.

Although the volume of supply available from municipal sources is, in most cases, sufficient and the price charged to consumers is highly subsidized, 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% of the area. Total Dissolved Solids were also above the permissible limit of 2000 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 demineralized water in pouches and bottles for users whose primary concern is quality; and private tanker companies who deliver larger volumes.

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 hrough 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.



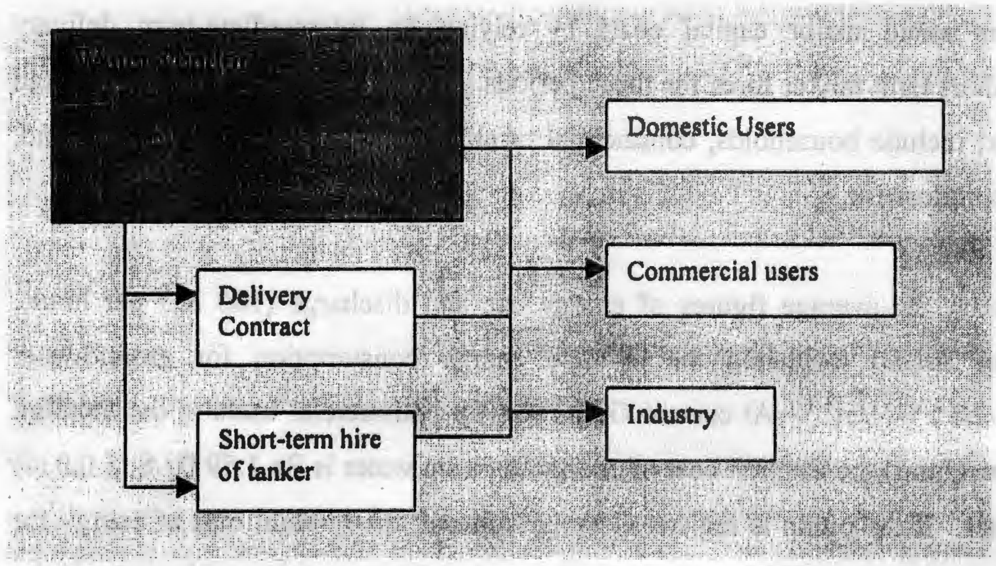
The higher quality companies maintain specific standards for the amount of minerals in the water they deliver. Volumes available are 200ml, 250ml (pouches) and 1, 1.5, 2, 5, 20 liter (bottles). The costs and profits at each stage in the above process are outlined in the table below. As can be seen, prices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

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 M3 per hour), researchers in Anand estimated the average energy consumption for groundwater pumping as 0.38 kWH/m^3.[11] At current GEB rates for commercial users in the medium block (420 paise/unit) the implicit cost of energy to pump water is Rs 1.59 (U.S. $ 0.034) per cubic meter. 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 meter if the pump is run for 2000 hours a year.[12] Rates for water to bulk consumers those purchasing tankers of 6000-12,000 liter capacity) commonly range from Rs 33 to 37.5 (U.S. $0.71 to $0.81) per cubic meter (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 liters and charge Rs. 300/month for a daily delivery. This implies a cost of Rs 222/m^3 (U.S. $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.

[11] Personal communication, Dinesh Kumar.
[12] Personal communication, Dinesh Kumar.



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 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 at tap-stands to receive supplies.

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% of the households are served. The government is able to collect approximately 85% of the charges it levies for water but the charges themselves are the lowest in the region. These charges are Rs. 0.33/m^3 while the actual cost of supply is Rs 24/m^3. The total subsidy (including uncollected charges) amounts to 85.6% of the cost of supply. While most houses (77%) have storage tanks, the relatively good and highly subsidized 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 summarized in Table-3.

Table:3 Regional Variations in the Urban Water Markets in Ahmedabad

Attributes	Hard Rock Region	Central Alluvial	Southern Water Abundant
Public Sector			
User perceptions of Public supply quality	48% pressure adequate, quality generally good	58% pressure adequate, quality generally unsatisfactory	72% pressure & quality good
Cost of supply to Govt.	Rs 7.81/m^3	Rs 6.8/m^3	Rs 5.7/m^3
Tariff charged by Govt.	Rs 1.61/m^3	Rs 1.23/m^3	Rs 1.21/m^3
Percent tariff recovery reported by Govt.	60%	61%	60%
Loss to government	Rs 6.84/m^3	Rs 6.04/m^3	Rs 4.97/m^3
Percent willing to pay more	51%	36%	39%
Private Sector			
Users depending on private sources due to inadequacy of government supply	25%	18%	2%
Cost of supply in private sector	Rs 20/m^3	Rs 26/m^3	Rs 23/m^3
Tariff charged by private sector	Rs 45/m^3 summer Rs 34/m^3 non-summer	Rs 41/m^3 summer Rs 33/m^3 non-summer	Rs 44/m^3 summer Rs 34/m^3 non-summer
Profit for private sector	Rs 25/m^3 summer Rs 14/m^3 non-summer	Rs 15/m^3 summer Rs 7/m^3 non-summer	Rs 21/m^3 summer Rs 11/m^3 non-summer
Percent supporting privatization of govt. water services	25%	25%	22%

(Survey by VIKSAT, 1999-00)

The above table 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 subsidized and only collect a fraction of the charges they do impose. Overall, the subsidy to consumers from government sources is 87%-89% 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% of the cost of supply while in the hard rock region it is 125%. Even in the relatively water rich southern region, the profit margin is 91%. Even in the non-summer period, profit margins range from 27% to 70% of the cost of supply in different regions. While a large part of the profit margin reflects service (e.g. 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 recognize in the Gujarat situation is that, at least in one aspect, it is very similar to Kathmnadu: 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. The market is highly fragmented.

Chennai

Water supply for domestic use in 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 Table-4.

Table:4 Official Water Supply Conditions in Chennai

YEAR	Pop. 10^6	WATER Req. (MLD) @158 LPCD	Demand (MLD) @460 LPCD[13]	ACTUAL SUPPLY (MLD) Domest + Ind.	Cost of supply to MWB per cubic meter (RS)	Supply as Pct. baseline req.	Supply as a Percent 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%

Source: Metro Water Board, Government of Tamilnadu

As the above 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 subsidized 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 lpcd. In response the Metro Water Authority installed 4525 tanks and hired 400 trucks of 9000-12000 liter capacity to make water deliveries to under served areas.[14] 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.[15] This situation has created the conditions for a flourishing and extensive water market in the Chennai urban area.

[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.
[14] *The Hindu*, July 7th, 2000
[15] *The Hindu*, August 8th, 2000

During the rainy seasons approximately 2000 private tanker trucks of 12,000 liter capacity supply raw water in the Chennai urban area. In addition, there are about 150 private companies that purify and deliver drinking water in 12 liter cans, 1-2 liter bottles and plastic packets. The tanker trucks alone are estimated to make at least three trips/day during the rainy season, equivalent to delivering 72 mld and this doubles to approximately 144mld during the dry season. When 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% of the total demand and their supply capacity is approximately 54% of the Metro Water Authority supply capacity.

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 independent of any external check on the quality of the water they supply.

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 liter tanker load of water (Rs 33/m3) and during the dry season Rs 450. The rate is higher for occasional customers; approximately Rs 500 and Rs 540 respectively. During droughts the rate increases still further up to Rs.800 per tanker load. Although market data are not available, Metro Water Officials have reportedly[16] demanded Rs 600 (as bribe) for sending 9000 liters tankers to some localities. It reflects pretty much the scarcity induced market conditions. This is equivalent to Rs 67/m^3 or U.S. \$1.48/m^3.

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.

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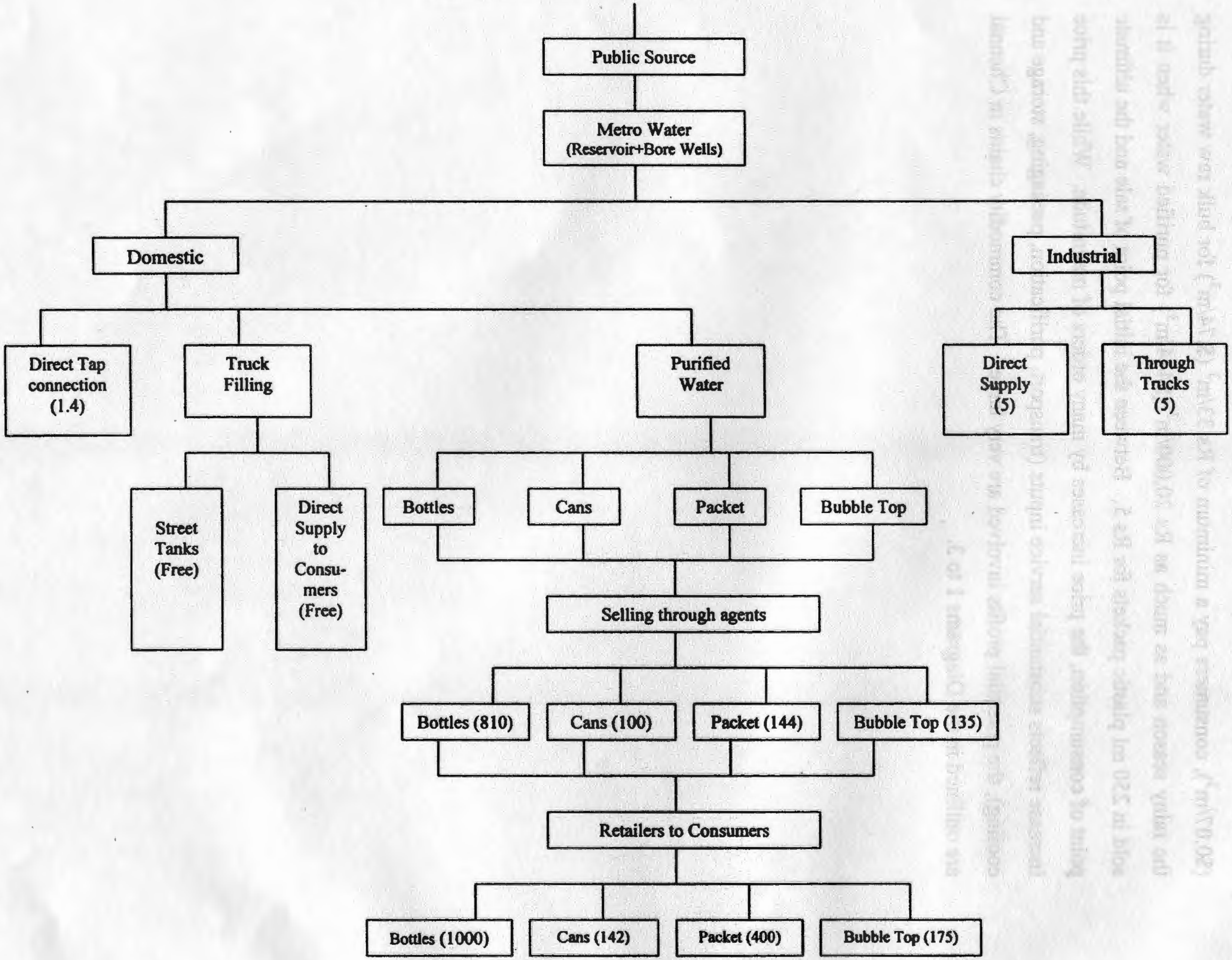
[16] *The Hindu*, August 8th, 2000

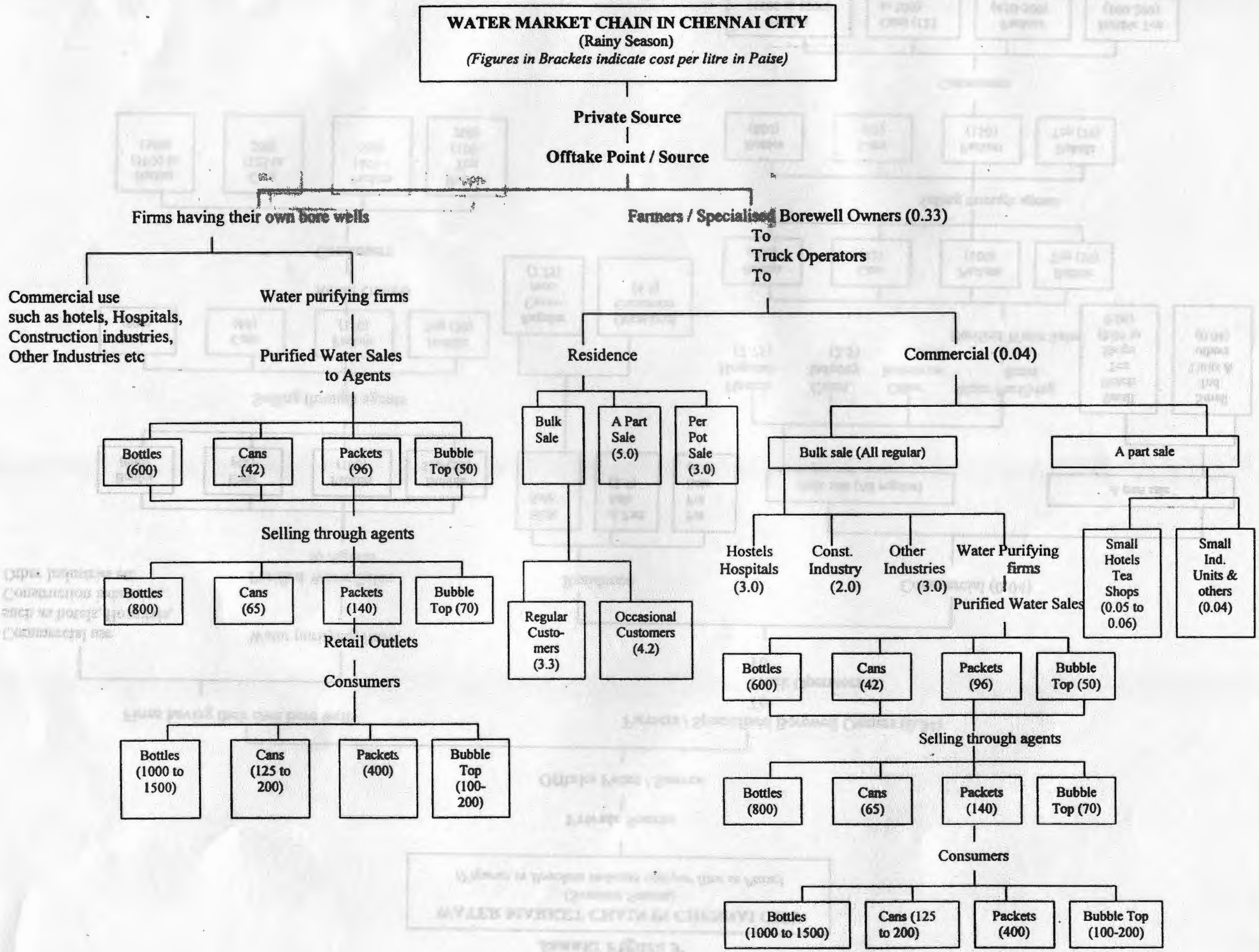
Farmers and other well owners typically sell water to transporters at Rs. 3.3/m^3 (\$0.07/m^3), consumers pay a minimum of Rs 33/m^3 (\$.74/m^3) for bulk raw water during the rainy season and as much as Rs 20,000/m^3 (\$444/m^3) for purified water when it is sold in 250 ml plastic packets for Rs 5. Between 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. The commodity chains in Chennai are outlined in the Diagrams 1 to 3.

Janak: Figure 1

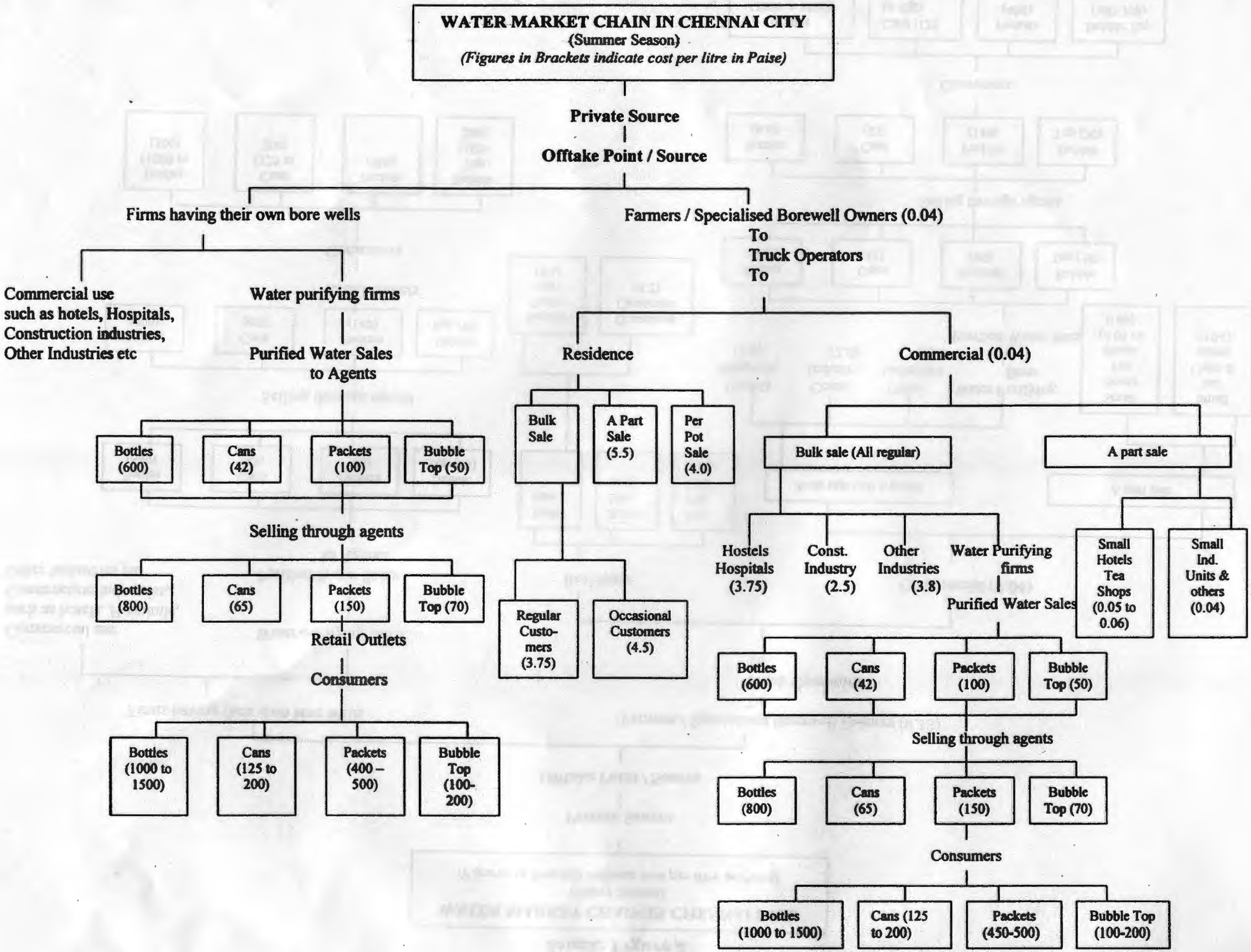
WATER MARKET CHAIN IN CHENNAI CITY
(Figures in Brackets indicate cost per litre in Paise)



Janak: Figure 2



Janak: Figure 3



The extent and depth of the water markets in the Tamil Nadu Urban area has been known for some time and has led to formal proposals for greater reliance on market transfers as a source of supply. According to the World Bank: "Estimates suggest that up to 400 million cubic meters 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 Veeranam projects that would supply a similar amount of water to Madras city. 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 Veeranam 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).

Market and State Supply Synthesis

The picture that emerges from the above three case studies of urban water markets is one that highlights the growing role private sources of supply play in meeting the everyday needs of people in urban areas for water. Common themes emerge from all the case studies including:

1. **The increasing role private supply is playing within the overall water sector.** The case of Chennai where, during some periods, private sources already provide as much as 1/3 of delivered urban water is extreme. In all locations, however, private sources have been growing and play a critical role in meeting many water demands. There is clearly a strong dynamic interaction between public and private sector supply systems. Private sector supply systems move into the gap in service left by the public systems.

2. **The highly subsidized nature of piped public water supply systems.** Water from public systems is generally very highly subsidized *and those subsidies are captured, in large part, by the wealthy and upper-middle classes.* People who can afford large amounts of storage, particularly a cistern, are freed from the

need to spend time and incur large opportunity costs capturing water when it comes. Furthermore, because they have storage, they are able to take whatever is available through the public system before purchasing water from outside sources. When they do need to purchase water, they buy in bulk and pay lower rates than those purchasing smaller quantities.

3. **The increasing differentiation and the high-end nature of water markets:** Most of those purchasing both bulk water in tankers and purified drinking water in cans, carboys, bottles and packets are high-end consumers. Water from these sources, particularly the bottled drinking water, costs far more in monetary terms than that from public supplies. High end consumers are increasingly willing to pay this for reasons of convenience and quality, not, except in the most extreme instances, because water *per se* is unavailable at lower cost from other sources.

4. **The absence of any external assurance regarding the quality of water supplied through markets:** In most cases, tanker markets and bottled water suppliers operate independent of any external check on the quality of the water they supply. The Water Tanker Association in Kathmandu is the first evidence of self regulation that we're aware.

5. **The high real cost of water for poor consumers:** Although water markets dominantly serve high-end consumers, low-end consumers often pay a far higher real price for water if the time and labor they must spend in obtaining it is taken into account. In Kathmandu, for example, despite the relatively ready availability of traditional sources, the time women spend in obtaining access to water is equivalent to an implicit price of $27/m^3 (or higher in times of real scarcity when waiting times can stretch to six hours or more). Actual cash prices when water is purchased by the pot at NRs 3/pot or $4.05/m^3 are also not inexpensive. Furthermore, the quality of low end supplies is often more open to question than that for high-end users. Only at the highest end of the market, that for bottles and packets of water are the wealthy, those who purchase water in this

highly packaged form, paying more on a regular basis than the poor. Even there, the small 250 ml packets, the form most likely to be purchased by less well-off sections of the population, cost far more on a per liter basis than the larger bottles and cans.

6. **The absence of any focus on sustainability of the resource base:** Water markets are a reaction to scarcity or poor quality but they do little to address the root causes of that scarcity. All of the water markets function in the absence of any formal rights or regulatory system designed to protect the resource base. They allocate supplies to individuals based on their ability and willingness to pay.

7. **The presence of water markets demonstrates a high willingness and ability to pay for water supply in the middle and upper income levels of urban populations:** In all the case studies, the cost of water from private suppliers is an order of magnitude or more higher for consumers than the cost of water from piped systems. Except at the low-end where people pay for water through time (not cash), urban populations demonstrate a strong willingness and ability to pay far higher rates than those found in municipal systems for water. Interestingly, some of the largest demand in locations such as Ahmedabad is coming for improvements in quality, not the volume of water supplied.

8. **The absence of much recognition in official circles of the dynamic role the private sector is playing in meeting urban water needs:** In all of the cities, private suppliers are meeting a significant portion of the demand for water services. Except in the case of Chennai where the potential role of urban water markets in meeting demand is beginning to be investigated, the potential role of existing private water markets is not reflected in urban water supply policy and development planning. Major supply projects such as Melamchi (Kathmandu), Krishna (Chennai) and Narmada (Ahmedabad) are being designed or implemented to meet urban water "demands." These projects will supply water

at the same highly subsidized rates now prevalent in urban water supply systems. At present, however, most of these subsidies are captured by the wealthy and Upper Middle Classes, the same classes that have firmly demonstrated their willingness and ability to pay for high quality water from private sources. While the poor will benefit from new sources of supply, the wealthy will still pay far below the real cost.

More Fundamental Implications

Although the urban water markets described in the preceding three case studies are dynamic and do address certain types of demand for water, their functioning raises a number of questions related to equity, sustainability and how well such considerations are reflected in both the way markets function and the price of water found in them.

ALLOCATION AND EQUITY

The equity of water allocation through market systems, particularly the informal systems outlined in the above case studies, is a complex question. As a starting point, however, it is important to recognize that existing patterns of water allocation are not inherently equitable. Rights to water, particularly groundwater, are in all the case study areas based on rights of capture. Land owners, particularly ones who already own wells, have in effect water rights that are only limited by their ability to pump. As a result, current patterns of water allocation are heavily biased with little inherent equity. From a practical point of view, therefore, the question that should be asked of water markets is whether or not they increase the degree to which water is equitably allocated or introduce new patterns of inequity.

On a broad level, equity may be reflected in the value for water as reflected in different uses and in the number of people benefited. In both Kathmandu and Chennai, water used for urban consumption is essentially taken out of rice. As a result, two measures of the equity involved in such a transfers are the relative value of the water to different groups and the population benefited. When looked at in these terms, the case of Chennai is illustrative.

Tables 5 and 6 were constructed using back of the envelope calculations and data from the Chennai water market survey. Assuming that each hectare yields about three tones of rice, requires a meter of irrigation and that the value of rice is Rs 20/kg, the total value of rice produced works out to about Rs 6/m^3, not counting other costs (see Table-5). Farmers sell water to urban areas for about half this rate at the well head. Given the other costs involved in producing rice, particularly labor, water sales probably generate more income for farmers than growing rice. At Rs. 0.14/m^3, the subsidized rate at which the Metro Water Authority sells water to customers through the piped system is, however, likely to be far lower than the returns to water even when it is used in rice production. This subsidy, which goes primarily to the wealthy portions of the urban population who are attached to the piped water system, is likely to encourage water allocation to uses that are below its current value in agriculture. Willingness to pay for water in bulk deliveries, as indicated by the cost of supply from private tankers and the bribes paid to water officials is five to ten times higher than the value of rice produced through the use of the same amount of water in agriculture. Overall, except for the highly subsidized supplies delivered through the urban system, it is clear that the economic value of water in domestic applications is far higher than the economic value of water in rice production.

Table-5: Value of Water for Different Economic Activities

Indicative Estimates from Chennai		
	$/m^3	Rs/m^3
Value of rice produced/m3 water	$0.13	6.00
Value of water at rate Metro Water Authority charges to customers	$0.003	0.14
Rate at which water is sold by farmers to transporters	$0.07	3.15
Cost to Metro Water Authority of supply	$0.34	15.11
Water sale charges (bulk private)	$0.73	33
Water sale as represented by metro bribes for bulk deliveries, drought periods	$1.48	67
Water sale in cans (at Rs 1.25/liter)	$27.78	1,250
Water sale rate bottles (at Rs 10/liter)	$222.22	10,000

(Source: Calculated from the Official and Survey Data)

Table:6 Contrasting water use in Agriculture and Domestic Supply based on different use levels found in Chennai: Indicative Calculations

Base water use rates

Basis for estimate	Water use MLD	Water use equal to Hectares irrigated to 1m depth/yr	Rice production if water used in agriculture	Rice value if water used in agriculture	Population fed if each person eats one kilo of rice per day	Population whose domestic water needs can be met if water is transferred to domestic use		Ratio People Watered/People Fed	Value of water in drinking at MWA cost of supply (a conservative estimate well below private water market rates)	Ratio Value Water to Value Rice
Private water -- rainy	72	2628	7884000	$3,504,000	21600	360000	Assuming each person uses 200 lpcd	17	$8,824,240	3
Private water -- dry	144	5256	15768000	$7,008,000	43200	720000	Assuming each person uses 200 lpcd	17	$38,544,000	6
metro supply 1999	413	15074.5	45223500	$20,099,333	123900	2736000	Assumes 60% of Chennai pop. served	22	$223,102,600	11
Total metro req at 158 lcpd	720	26280	78840000	$35,040,000	216000	4560000	Assuming all of Chennai population supplied	21	$7,300,584,000	208
Total metro req at 460 lcpd	3283	119829.5	3.59E+08	$159,772,667	984900	4560000	Assuming all of Chennai population supplied	4.6	$266,285,114,900	1667

(Source: Calculated from the Official and Survey Data)

The value of water in agriculture and domestic uses can be looked at from another perspective as well – the population whose basic requirements are met. In Chennai, the amount of water that would be supplied through the private tanker market if the wet season delivery rate continued for a full year is roughly equivalent to the water required to irrigate 2600 hectares. If this were used to produce rice, the amount grown would be sufficient to feed perhaps 22,000 people for a year. The same amount of water could, however, meet the basic domestic water needs of 360,000 people – even if each person uses as much as 200 lpcd, well above survival requirement levels (see Table-6). Even if urban populations used water at the 460 lpcd rate found in Gandhinagar (Gujarat), the number of people whose basic water needs would be met still exceeds by a factor of 4 to 5 the number of people whose basic food needs would be met by using the same water in agriculture.

Water and food are equally fundamental needs. If water is viewed as a common heritage to which current users have no more right than any other people, then it is hard to argue that water transfers out of agriculture to urban areas are inherently inequitable. Under almost any scenario, the number of people whose basic need for water is met will far exceed the number of people who are displaced from agriculture by such a transfer. The economic value of water in urban domestic uses is also far higher than in agriculture. As a result, well owners are able to sell water from their wells and earn a significant profit in comparison to their returns when the same water is used to grow rice. The relationship across each link in the chain of transactions is, as a result, one of mutual benefit, not coercion. While the above arguments could be taken too far (food is just as important as water), water transfers out of agriculture *to meet real domestic needs* appear easily justified on a social equity basis. It is important to recognize that this perspective is based only on the current number of people benefited and the economic returns to water. It does not incorporate potential implications for future generations or whether or not individuals may be unjustly benefiting -- or reaping excessive profits -- from their ability to capture and sell a common heritage resource. Finally, it does not reflect any third party impacts – environmental, cultural or economic (including impacts on other users or agricultural labor) – that occur in the area of origin.

The main point where water markets probably do not contribute to equity in access is with regard to low volume consumers, those without storage or in-home access to the piped water system. These consumers generally pay the most either in terms of cash (for small volumes of supply) or in terms of time and labor.

EFFICIENCY & SUSTAINABILITY

In the absence of a volumetrically based water rights system or other enforceable "cap" on pumping, the presence of a water market is likely to provide strong incentives for extraction. As discussed above in the theoretical section on Water Markets and the Value of Water, prices in water markets generally reflect *extractive values*, not the values associated with leaving water in aquifers or streams. This is certainly the case in all the three study areas discussed above. In each area, water has a high value relative to the cost of pumping and there are no restrictions on extraction that could reflect *in situ* values. As a result, the water markets are likely to contribute to over-extraction of groundwater and unsustainable use patterns. It is important to note, however, that urban water markets are not significantly different in this regard from agriculture.

In Tamil Nadu, electricity for groundwater extraction in agriculture is provided free of charge and in Gujarat it is provided at a flat rate based on pump horsepower. There is, as a result, no marginal cost associated with irrigation. The incentives this provides for over-extraction have been well documented elsewhere (Moench and Kumar 1995; World Bank 1998). At least officially, pumps being operated for water sale and domestic use are supposed to pay for the power they use. While the cost of this is relatively low in relation to the market price for water, it may discourage excessive pumping when urban water demand is low. Given the value of water in the urban markets, however, the impact of this is likely to be relatively small. Overall, under current legal and other institutional arrangements, the difference between urban water markets and other groundwater use patterns where incentives for over extraction are concerned are unlikely to be major. There are strong incentives to pump as much as possible in both situations and little incentive to conserve.

Although water markets encourage excessive extraction, they also encourage efficient use at the consumer level. No survey has been conducted that contrasts water use in houses where highly subsidized municipal supplies are good and water use in households dependent on water purchased from markets. Anecdotal evidence, however, indicates that price and availability differences *do* provide a strong incentive for conservation. The highest water use rates are found in Gandhinagar, Gujarat, where charges for water are the lowest and supply availability through the piped systems is good. In Kathmandu, many houses use low quality water from local wells for all uses other than cooking and drinking. Rooftop water harvesting structures are becoming common in Gujarat. Furthermore, Most of the water from these sources is used for gardens, clothes washing or toilet flushing and displaces higher quality – higher value water that would otherwise often need to be purchased. High prices established in water markets (or large amounts of time spent collecting water) appear, as a result, to have a very significant impact on consumption patterns and do encourage conservation and efficient use at the household level.

Comparing the functioning of local water markets with large-scale inter-basin transfers for urban water supply raises a series of interesting equity questions. If inter-basin transfers – which frequently divert water that would otherwise be utilized in agriculture or for instream flows – are used to pressurize municipal systems and deliver water to urban dwellers *at current highly subsidized rates*, urban users will be delivered with water at charges that are probably below the opportunity cost of that water in agriculture. This would provide a very little motivation to restrict wasteful practices ranging from passive neglect (not fixing leaks) to use of high value treated drinking water to low value uses such as car washing or gardens. This type of behavior almost certainly underlies the high water use levels found in Gandhinagar, the capital of Gujarat. In addition to encouraging wasteful use patterns, there are equity issues inherent in the high costs associated with inter-basin transfers. The World Bank, for example, estimates that water from the proposed Krishna and Veeranumm projects in Tamil Nadu will cost roughly \$1/m^3 or at current exchange rates Rs 45/m^3 (World Bank 1998). This is far higher than the Rs 3.15/ m^3 rate at which farmers currently sell water to urban dwellers or even the Rs 6/ m^3 market value of the rice that could be produced using this water. Since government funds for the construction of transfer schemes ultimately come from the population as a whole and, when used for one purpose, become unavailable for other social uses, building large projects of the above type when there are local sources available is highly inequitable at a societal level. Inequity inherent in the inefficient use of public funds is further increased by the lack of effective compensation to local populations in areas of origin that is commonly found in inter-basin transfer projects.

Overall, current urban water markets play a major role in meeting local water demand and, when compared to major inter-basin transfers, appear relatively equitable. While unregulated local water markets do provide strong incentives for the development of groundwater overdraft and other unsustainable use patterns, other aspects appear beneficial from an overall equity perspective. Private water sales through markets have an inherent mechanism for compensating those who lose access to water (e.g. farmers) while official compensation systems in the case of water transfers are known to be unreliable and often ineffective. Markets also encourage equitable allocation of water since those who use more are at least paying for it and not using public funds (in the form of subsidies) to support wasteful or low value uses.

POLICY IMPLICATIONS

The case studies and above analysis of the impacts of local urban water markets on water allocation equity and the efficiency and sustainability of use have important implications for urban water management policy.

First, the fact that wealthy consumers with storage and in-house connections almost certainly capture most of the subsidies for water supply in all three case study locations suggests that such subsidies may be unjustified. If reductions in subsidy levels enabled water supply systems to be expanded so that all customers had access to good quality water in sufficient quantity to meet basic needs, equity would be increased.

Second, equity in water access could be improved by ensuring that all customers have access to adequate storage facilities. Programs that provide water storage to lower income portions of the population would increase their ability to "capture" their full share from the public distribution system. It would also increase the ability of such communities to purchase water in bulk and at a far lower volumetric charge rate than at present.

Third, equity could be increased by rationing supply through the public piped system while ensuring that all portions of the network are equally well served while encouraging the market to meet needs above that basic level. If the public system can deliver sufficient water to meet basic needs (but not more) to all portions of the urban population, then private water markets will tend to serve high-end customers and will force them to pay relatively high rates for the additional water services they demand. In this case, subsidized water through the PDS would increase equity by ensuring that the poor – who often pay the highest rates in terms of time, if not cash, for water – obtain access to water at an affordable price.

The primary problems inherent in the functioning of water markets relate to sustainability and the lack of any guarantee that the water being delivered is suitable for human consumption. There is clearly a need for regulation to ensure that the amounts of water being extracted are sustainable, that there are no major impacts on other users and that the water delivered is suitable for drinking. It is important to recognize, however, that the need for regulation does not necessarily imply that the government would need to take a lead role. Regulation could, for example, be undertaken through local organizations such as a strengthened version of the Tanker Association in Kathmandu.

If effective mechanisms for regulating extraction to sustainable levels can be identified, there is no inherent reason why any new or more detailed form of rights system would need to be developed in order to enable urban water markets to function effectively. While systems of tradable water rights could have advantages, their development is, at best, a long-term process. Current water market structures already enable reallocation of available supplies from lower to higher value uses and, at least in relation to other forms of urban supply, appear to function in a relatively equitable manner.

BACK TO GLOBAL DEBATES

Global debates over water markets are rooted in economic theory and institutional experiences derived from the western U.S. and similar locations. Approaches derived from such debates tend to emphasize, as a starting point, the need for water rights reform. Clear water rights that are quantifiable and transferable are seen as a fundamental requirement for the efficient functioning of markets. Viable processes for establishing such rights, particularly on the short to medium-term time scale required in order to address many water needs have, however, yet to be identified. Furthermore, analysts focusing on current attempts to reform water rights and establish functioning water markets in other regions point out that markets are often no more efficient or equitable than their surrounding social contexts. Markets, as Carl Bauer points out: "on many extra-economic factors and prior definitions; such as political decisions, legal rules, cultural attitudes and geographic and environmental conditions" (Bauer 1998). Attempts to create new water rights and rights-based market systems are, as a result, highly complex with unpredictable results.

Information on informal water markets presented in this paper suggests a different approach from that involving large-scale institutional reforms. Rather than taking the necessity of institutional reforms as a starting point, the approach suggested here would be sequential and would start from analysis of the existing situation. It would focus on the services water markets currently provide, the impacts (both positive and negative) they have, and the role they could play in meeting water needs on a larger scale. Key criteria for evaluating the functioning of current water markets should include equity. Questions related to this might include:

1. Are there major third party or environmental impacts associated with water markets as they currently exist?
2. Are relationships across transactions relatively equitable? Are transactions coerced or are market structures skewed in a way that discriminates against the poor or other marginal populations?
3. Do water markets provide key services in ways that are more or less equitable from a societal perspective than alternative avenues of providing the service?

Answers to the above questions will result in the identification of relatively closely targeted areas of concern or opportunity. Concerns can then be addressed incrementally through governmental or other forms of action as appropriate. In the case of urban supply, for example, helping marginal populations to afford storage for water could greatly reduce the price they pay and, as a result, increase the overall equity of urban water markets. Similarly, urban water supply systems that strictly ration the amounts delivered through piped connections while ensuring that all sections of the community have access to that basic minimum could greatly increase equity. In this way, all members of the urban population would have access to a basic (and possibly subsidized) minimum amount of supply while leaving those who wish to user more to obtain additional supplies on the market. Environmental and third party effects could also be addressed through very targeted action (such as pumping restrictions within vulnerable areas) rather than through a much wider process of institutional reform.

At the highest level, the above approach suggests a very different role for the State from that common in most discussions of integrated water management. Rather than viewing the State as the primary implementer or as providing a fully integrated framework for water markets and water management, this approach casts the State and civil society in a tinkering role. In it, the role of the State and civil society would be to take a "proactively reactive" stance – seeking out potential problems, responding to constraints, building off the opportunities water markets present. When viewed from this perspective, existing informal water markets represent a highly adaptive resource for meeting many local water needs. Whether or not and how they might need to be strengthened, regulated, enhanced or left to function undisturbed will depend heavily on the local context.

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