Water Markets as a Demand Management Option: Potentials, Problems and Prospects

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Introduction

Water resources development and management have been the common policy agenda in many developing economies, particularly in arid and semi-arid tropical countries. Both the physical and economic scarcity of water across regions made the water resources economists and policymakers critically analyze different options to manage this precious resource. A study by the International Water Management Institute (IWMI) shows that around 50 % of the increase in demand for water by the year 2025 can be met by increasing the effectiveness of irrigation. Most of this gain in irrigation effectiveness would be in countries with a high percentage of irrigated rice. India and China together would account for as much as one-half of the world's total estimated water savings from increased irrigation effectiveness. Therefore, the capacity of large countries like India and China to efficiently develop and manage water resources is likely to be a key determinant of global food security in the twenty-first century (Seckler et al. 1998). In countries like India, almost the entirety of the easily possible and economically viable irrigation water potential has already been developed, but the demand for water for different sectors has been growing continuously (Saleth 1996; Vaidyanathan 1999). Moreover, the water use efficiency in the agricultural sector, which still consumes over 80 % of water, is only in the range of 30-40 % in India, indicating that there is considerable scope for improving the existing water use efficiency.

Moreover, in recent decades the issue of inter-sectoral water demand and allocation poses challenges to water economists and policymakers alike. Burgeoning population, expansion in the urban sector of the economy and increase in the industrial sector led to an increase in demand for water in domestic, industrial and, of course, in the irrigation sector. The problem is further compounded by environmental pollution. Under these circumstances, it is more important than ever before to use water efficiently. The existing literature on water resources management shows that the solution to the problem of growing groundwater scarcity is centered on two strategies. First, the supply side management practices like watershed development, water resources development through major, medium and minor irrigation projects. The second is through demand management by efficient use of the available water both in the short-run and long-run perspectives. Though there are a number of demand management options available, one of the demand management strategies adopted either formally or informally across regions by water markets is by reallocation of water, particularly in regions where groundwater scarcity is acute.

Water Market as a Demand Management Strategy

The water policies of many developing countries including India show that the existing policies on irrigation are mainly supply-side oriented rather than demand-side. Policies such as tariff rate, power pricing in the irrigation sector and institutional components for supplying irrigation water are far too inadequate to effectively manage the scarce water resources. Moreover, the command and control mechanism does not adequately reflect the farmers' preferences because the farmers' preferences are determined by various physical, socioeconomic and contextual factors. Under these circumstances, informal water markets emerged in order to bridge the gap between the demand and supply of water, and these markets continue to exist in many parts of the country and elsewhere as well. (Venkatachalam 2008).

Water markets have been considered as a coping strategy for managing water scarcity and reallocation of water from surplus to scarcity regions/localities/farms. Evidences show that the groundwater markets play a significant role in India's groundwater economy (Bhatia et al. 1995). It is found that in Gujarat, for instance, the value of groundwater extracted and used per year is worked out to be in the range of Rs.5,000 to Rs.6,000 million. Of the total water transacted, about 40-60 % of water is sold to the resource-poor farmers who experience the capital requirement as a major constraint in establishing their own water extraction mechanisms (Shah and Raju 1988). Evidences also show that well-developed groundwater markets have existed in Gujarat for as long as 70–80 years. Groundwater markets assume importance for three critical reasons. (i) They enable marginal and small farmers to enjoy the benefits of groundwater lifts and, thereby help enhance their incomes. (ii) Groundwater markets help their owners to improve the economic viability of their lifts and, thereby enhance their incomes. (iii) These markets help the society by minimizing investments in groundwater lifts. Under these situations, groundwater markets are considered as one of the best demand management strategies (Narain 1997).

In this context, it is argued that the markets can increase economic efficiency by allocating resources to their most valuable uses, i.e., markets create adequate incentives and lead to efficient water use (Mohanty and Gupta 2002). With only limited scope for further expansion in irrigation potential, the formal or informal water markets can play a crucial role in water allocation across villages and regions. Therefore, the study of water market and its nature, function and role in water resource management assume importance. Recognizing the importance of water markets as a strategy for managing scarce water resources, this paper analyses how water markets can be an option for managing the ever increasing demand for water.

Water Markets: Functioning, Size, Significance and Economics

Functioning of Water Markets

The literature on water markets in India dates back to as early as the 1960s. The term 'water market' has been widely used in regions where water selling and buying takes place. Literature suggests that the term has been used to describe a localized, village level institutional arrangement through which owners of the Lift Irrigation Schemes (LIS) supply irrigation service to other members of the community at a price (Shah 1986). The markets for water function in a slightly different manner to markets for other commodities and inputs. As indicated earlier the emergence of markets for water is determined by several socioeconomic and cultural factors. The water markets are typically spontaneous (initiated by private individuals to achieve mutual gains), informal (transaction of water takes place without any legal bindings and to get mutual benefits between the buyers and sellers), unregulated (no strict regulation is followed), localized (mostly functioning at the village level), fragmented (geographical separation of sellers) and seasonal (demand varies across seasons)—(Shah 1986).

Studies on groundwater markets are not a new development as many have attempted across regions and countries to address the wide range of issues such as functioning of water markets, equity and efficiency in water sales, size and structure, allocative efficiency, monopoly power and determinants of monopoly power, impacts of water markets and policy-oriented issues such as power pricing and so on. Studies have also attempted find out the conditions under which water markets emerge. For instance, studies have revealed that markets for groundwater have emerged where well-owners have a surplus of water and there is high demand for irrigation water (Kolavalli and Chicone 1989).

Water markets are actually not uncommon. Wherever people have more water than they need they sell it to others. In the USA, rural water markets have become institutionalized, with farmers' associations selling water to each other and to urban centers in need of water. Farmers' markets exist in India where prices are fixed through negotiation, and payments are made by different modes such as cash or kind. Water sales by well-owning farmers have occurred as long as wells have been in existence, but the first reports of widespread sales appeared in studies of well irrigation in the1960s (Moosti 1970; Patel and Patel 1969 cited in Kolavalli and Chicone 1989). The main focus has been on the monopoly power of the water sellers / well-owners and the impact of high-priced water sales on the non-well owners or the poor (Asopa and Tripati 1975; Shah 1985). However, much deeper examination of the operation and functioning of water markets were formally done by Shah (1985) and Bliss and Stern (1982). The water markets in India are highly imperfect and the prices are determined by the marginal cost of pumping and elasticity of water demand (Shah 1985).

Experiences show that the key determinants of monopoly power in groundwater markets are rainfall, cost of water extraction mechanisms, density of water extraction mechanisms, spacing norms, cropping pattern, access to canal water and electricity and lined water conveyance system (Shah and Raju 1988). Empirical evidences confirm that the water markets in rural areas fairly reflect natural oligopolies (Shah 1986). Of course, there are several reasons to support these types of markets. The density of LIS tends never to be so high as to make the individual water sellers completely powerless. Topographical barriers and seepage losses through unlined channels prevent the sellers from enjoying full monopoly power, and the huge capital investment acts as a natural barrier in preventing the entry of new firms to the market. Moreover, enforcement of spacing norms and electricity boards either directly or indirectly limit the operation of water markets and, thereby make water markets operate as oligopoly markets.

In places where there are fragmented holdings and parcels of land (far from each other), often coupled with the surplus of water in the wells, well-owners are motivated to sell their surplus to the neighbors (Kolavalli and Chicone 1989). Similarly, groundwater markets emerge in regions where well-owners have a surplus of water and an increasing demand for water due to the growing of water-intensive crops and adoption of improved agricultural technologies such as high-yielding modern varieties, fertilizers and plant protection chemicals etc. (Abbie et al. 1982). Since, the buyers seem to be price takers and primarily depend on sellers' decisions; the sellers enjoy the monopoly power as there is no immediate alternative available for the buyers. In addition, the price discrimination is also observed in the form of different prices for crops of different value, seasons, and locations. A study conducted in the Gujarat State of India, found that the capital appears to be the major constraint for the emergence of water markets in groundwater abundant areas. The lack of capital is seen as the primary barrier preventing smallholders entering the water market. It is also found that the water sellers are unable to enjoy a monopolistic position because of the simultaneous existence of many markets in the rural areas (Kolavalli and Chicone 1989).

Size and Significance of Water Markets

Experiences from different parts of the country and elsewhere show that water markets function in varying size from much localized areas to regions. Though the water markets are prevalent in many parts of India such as Gujarat, Punjab, Uttar Pradesh, Tamil Nadu, Andhra Pradesh and West Bengal, they are most developed in Gujarat. The extent of area irrigated through water markets, which is often considered to be a surrogate for the magnitude of water traded, varies across regions as well as over time, influenced by many factors like rainfall, groundwater supply, cropping patterns, and the cost and availability of electricity (Saleth 1994). As such it is difficult to assess the size and nature of the groundwater market as a whole. The major part of the problem is the limited attention paid to this issue in the past. Whatever is known, however, indicates that up to half or more of the land area served by private modern water extraction mechanisms (WEM) in many parts of India is likely to be owned and operated by the buyers of water themselves (Shah 1993).

Earlier estimates have shown that over 12 million private WEMs, which depend on small surface water bodies and on groundwater, serve a gross irrigated area of some 30 mha at an average of around 2.5 ha per WEM. Field studies indicate that the actual gross area irrigated by both WEM owners and water buyers from WEMs is often two to three times greater, especially in water abundant (WA) areas indicating the intensive use of land and water with certainty of water supplies. In the Allahabad District of Uttar Pradesh, Shankar (1987) studied over 150 private WEM owners and found that the average gross area irrigated by them was 24 ha. In Punjab, Jairath (1985) found the average gross area irrigated by a sample of diesel and electric WEM owners in Ludhiana and Amristar districts to be 5.7 ha in case of diesel WEMs and 9.6 ha for electric WEMs. Evidence from West Godavari District of Andhra Pradesh shows that small 5 - 7.5 hp pumps on private bore wells are providing intensive irrigation for crops like paddy, banana and sugarcane on an average of 3.5 ha per WEM. However, the same study showed that electric WEMs in the Kheda District of Gujarat as providing irrigation to an average of over 20 ha of gross irrigated area. Some private WEMs sampled by them in Gujarat irrigated as much as 50-60 ha of gross area (Shah and Raju 1986).

These studies show that the sellers provided sustained intensive irrigation to those who have no access to irrigation water. Often, a seller may provide small amounts of irrigation to a large number of buyers who use this irrigation to grow an additional crop in critical periods of moisture stress. Water selling by private WEM owners can have a dramatic beneficial impact on the community in such a context. Water sales is a pervasive feature where large as well as poor WEM owners are selling supplementary irrigation to their neighbors at prices ranging from Rs.8 to Rs 25 per hour from 5 hp diesel or electric WEMs in the tribal regions of West Bengal (Pant 2004). The seller made a tidy profit of some Rs.3,000 per year but the tribal who could grow an additional potato crop on their land gained much more (Shah 1987). The average number of buyers with whom a WEM owner deals is another indicator of the significance of water markets. As discussed elsewhere in the 'Groundwater Markets and Irrigation Development-Political Economy and Practical Policy' book (Shah 1993), the figures range from 2-3 to 70-80 across regions. In the coastal Andhra (West Godavari), and Uttar Pradesh, the number of buyers per WEM is typically smaller, whereas in Gujarat, the number of buyers per WEM tends to be large. Likewise, a typical WEM in a water-scarce area can serve a smaller number of buyers than in water-abundant areas.

The studies on water markets mostly concentrated on water-scarce regions than water-abundant regions. The reason may be mainly to cope with the increasing water scarcity. Though it is hard to define the size of the water market and though water is unlike other commodities, researchers defined the extent of the spread of the water market as one to be measured in terms of breadth and depth, which Shah and Ballabh (1997) define, respectively, as the proportion of farm and farm lands that come into the beneficial ambit of the water market. At the regional level, water markets have acquired tremendous breadth as shown by multi-village studies conducted by Mukherji and Shah (2002), e.g., in villages where groundwater irrigation is prevalent, groundwater market is all-pervasive. At the micro-level, there is evidence to show that breadth of water markets has increased over time. Evidences show that the breadth of water markets in terms of percentage of irrigated area served by the water sales varied from 20.8 % in Eastern Uttar Pradesh to 100 % in West Bengal.

There are several factors that contribute to the breadth of water markets and, generally, it is seen to be inversely related to the existence of other modes of cheap irrigation, e.g., public tubewells and canals. Another dimension in the size of water markets is the depth of the water market defined in terms of the intensity of water transactions. The depth of a water market is defined as the ratio of average hours of operation of the Water Extraction Mechanism (WEM) per year to the average hours of water sold per year, higher the value the greater the depth of the water market. The depth of a water market ranged from as small as (0.17) in Bihar to as large as (0.68) in Bangladesh (see Mukherji 2004). .

Water Pricing and Water Markets

The water is charged in different modes and it varies across the region. The water charges are paid in terms of cash, kind (agricultural output, labor etc.), and crop sharing agreements between the buyers and sellers. Evidence shows that cash transaction (Clay 1974 cited in Mukherji 2004; Shah 1991; Shah and Ballah 1997; Fujita and Hossain 1995) is very common in water markets. Shah (1991) viewed these kinds of cash transactions as an indicator of market maturity for groundwater. There were also situations where water sale through cash transaction accounted for only 3 % of the total area irrigated in Bangladesh, while the major portion was accounted for by tenancy contracts between landowners and WEM owners (Fujita and Hossain 1995). Sometimes, water sales are dominated by seasonal cash contracts (Lewis 1989). Pant (2003), Ballabh et al. (2002) found that in many of their study villages, water sales are carried out by hourly payments of both in cash and kind. WEM owners are also seen to adopt leasing in and leasing out practices for transactions in the water markets. A review of these studies conducted therefore indicates that there can be two types of transactions in the water market : first, is the outright sale of water (against cash, kind or a mix of both, either at hourly or seasonal rates); and the second, is some kind of tenancy arrangement under which the WEM owner can either lease in land from other landowners or lease out land in lieu of a certain return, either fixed (in terms of money or in kind) or share of the produce (Mukherhji 2004).

Experiences from the earlier studies show that the prices charged by the sellers vary significantly across regions, crops etc. The hourly price ranges between Rs. 3 in the West Godavari District of Andhra Pradesh to Rs. 45 in the Mehasana District of Gujarat (Shah 1993). Non-cash contracts, which typically take the form of sharecropping (i.e., seller collects a water rent in the form of a share of the buyer's output), are not uncommon. They have been found to be incentive compatible (Aggarwal 1999). However, this practice is found in Tamil Nadu, particularly in tank and canal command areas, where the well-owners sell water to the non-well owners for supplemental irrigation requirements. The payment is made in the form of kind, i.e., paddy outputs. These contracts work as a 'double-sided' incentive, providing the seller an incentive to ensure that the water supply is timely and reliable, and providing the buyer an incentive not to shirk the application of labor. In Tamil Nadu, there are cases where water buyers have to offer labor services such as operating the pump and irrigating the well owners' fields for a paltry sum or no remuneration at all (Janakarajan 1993).

Can Water Markets be a Demand Management Tool?

In the midst of growing water scarcity, increased emphasis has been given to market-based instruments to solve the scarcity problem. The advantages and disadvantages of water trading, the nature of functioning and impacts of water markets at different levels have been well documented, argued and debated with evidence from field experiences. When we look at the impact of groundwater markets, the literature ranging from highly positive ones that confirm the groundwater markets are the 'vehicle of poverty alleviation' to those which accuse groundwater markets of 'creating water lords' and appropriating the surplus from the poor. There are two major ways in which the impact of groundwater markets are manifested; first, in changes in cropping pattern and cropping intensity among the buyers and sellers; and second, in terms of employment generation among the landless (Mukherji 2004).

Arguments for Water Markets

The emergence and existence of groundwater markets could be viewed as a response to the nature of groundwater use, extraction and management in the country. The water markets ensure efficiency and equity and, thereby generate adequate social benefits to the society. Efficient functioning of a water market implies the narrowing of margins of the price charged by the seller and price paid by the buyers. In other words, in efficient water markets, sellers sell water at a price close to the average economic cost of pumping. This ensures larger irrigation surpluses and more livelihoods for the resource poor and the landless (Shah 1986). In such a situation, the water markets have beneficial effects: (i) higher and more risk-free income flows from farming for non-well owners who have no access to water; (ii) appreciation of non-well owners land; and, (iii) increased wages, and adequate employment opportunities for the land owners.

Increase in Producers' Surplus and Income

Water markets promote higher efficiency because water users can sell any surpluses they create or use them to increase their production, such as by experimenting with a new crop grown under a different irrigation system. Groundwater markets contribute significantly to agricultural production and growth in a region. In Bengal, private shallow tubewells (STW) diffused very rapidly during the 1980s, which contributed to the high agricultural growth rate and in the reduction of poverty in rural areas. The major reason why tubewells diffused rapidly, in spite of the lack of progress of land consolidation projects was the emergence of a groundwater market.

Reallocation of Resources

In the event of an absence of property rights mechanisms, the water markets may play a crucial role in reallocation of water from surplus regions to scarcity areas and have significant positive impacts and help achieve administered efficiency pricing (i.e., pricing marginal unit of water at marginal cost)—(Mohanty and Gupta 2002). Furthermore, studies show that farmers are sensitive to changes in water price – increasing the price of agricultural water by 10 % decreases demand by 20 %. In other words, the demand is price-elastic. Thus, a marginal reduction in subsidies for agricultural water would reduce its use by this sector. It is not necessary that agricultural output would decline as a consequence. Increasing the price of agricultural water would simply give agricultural communities an incentive to use water more efficiently, e.g., by using new technologies and planting high-value crops such as nuts, fruits and vegetables that are less water intensive (Fowler 1999).Moreover, even if water markets reduced agricultural production, such a reduction would probably be seen in marginally productive lands and crops. In this context, it has been estimated that agricultural water use could decline by as much as 15-20 % through conservation without significant decreases in production (Wahl 1989). Numerous trends indicate that a significant reallocation of water from agricultural to urban regions occurred in western states, and a reallocation of as much as 15 % of agricultural usage is plausible (Haddad 2000). It is also increasingly clear that markets will play an important role in this reallocation.

Water Quality Enhancement

Water quality improvement is also achieved through water markets. In water surplus areas with high drainage problems, the water markets transfer the surplus water to scarcity areas and, thereby reduce many quality-related problems, e.g., salinity (Weinberg et al. 1993). Water markets could also be considered as the best solution to achieve the conjunctive use of surface and groundwater. A study conducted by Kolavalli and Chicone (1989) has been successful in creating an understanding of how farmers in different parts of the canal command supplement canal irrigation with their own or purchased groundwater to obtain better results.

Increased Water Productivity

Water markets lead to high water productivity. In areas where irrigation is done through water markets, the buyers can get the water that they need, when they need, and the water productivity will be high as markets fulfill the requirements in the most crucial stage of crop growth. Evidence shows that the water markets led to additional crop cover of 50-80 acres of 35-40 buyers land. The water seller earned an income of Rs.3,000 per year and the water buyers gained much more with the increase in crop production (Shah 1988). Since water is purchased in a market, the buyers use water more efficiently and judiciously. Thus, the water markets play a vital role in improving efficiency in agricultural production, ensuring equity in resource allocation, managing demand and promoting the conjunctive use of both surface and groundwater, particularly in command areas and improving water quality.

Arguments Against Water Markets

In spite of the positive impacts, water markets significantly generate negative externalities or other ecological and equity problems also.

Creation of Monopolies

Easy access to buy water and the huge initial investment linked with water extraction mechanism have dissuaded farmers from owning such a mechanism. It is also found that the use of unlined channels to transport water to buyers' fields results in seepage losses as high as 30 to 40 %. This implies that buyers who are at some distance from the owner' tubewell incurred an effectively higher price, which has resulted in the emergence of localized monopolies (Shah 1993).

Generators of Negative Externalities

Water markets sometimes lead to adverse effects in the agricultural sector. For instance, the water market in the Tirupur and Coimbatore districts of India has emerged as a major threat to the irrigated agriculture. Due to labor scarcity, high wage rates and inadequate water storage, farmers prefer to sell their water rather than engage themselves in actual farming work. Moreover, the extensive water use in dying and bleaching industries has resulted in making water transfer from agriculture to industry become more significant. Consequently the value of production loss in agriculture also has become significant as indicated below (Table 1).

Table 1. Loss of agriculture production: Tirupur and Coimbatore districts of India.

Particulars	Loss in area and income
Reduction in irrigated area	431 ha
Revenue foregone	Rs. 54 lakhs / season

Water Mining and Social Inequity

The water markets will lead to social inequity in a situation where water sellers have a monopoly of the market. In this case, the water sellers will have the major share of the buyer's profit too through water sales. As more people resort to water selling, water markets can cause excess pumping of water, making groundwater aquifers more prone to depletion This will pose challenges to achieve sustainable water management, and to ensuring intergenerational equity to resource access, particularly in water-scarce regions. It is evidenced that water markets generate negative externalities such as inequity in agricultural productivity, reduction in efficiency and reduction in agricultural production both at the farm level and regional level. In spite of various negative externalities generated by water markets, it could be viewed best as a demand management tool as it helps in a big way in reallocation of water from surplus to scarcity areas/regions.

Experiences of Water Market

International Experiences

Water markets and associated trading of water has been practiced in many parts of the world since a long time ago. Not only in developing countries but also in many developed countries like Australia and the USA, the water markets function either formally or informally. The functioning of water markets in few countries are discussed below.

United States

Evidence shows that the Western United States (California, in particular) is one of the earliest instances where water markets have played a role in managing water scarcity. Many argued that water markets are the key to redressing the imbalance and achieving a more efficient allocation of water. Irrigators in California have been trading water among themselves for years, both formally and informally, and trading even occurs in some districts that are supplied with federal water. Members of the Westland's Water District (WWD), for example, negotiated roughly 4,500 transfers during 1990-91. In March 1996, WWD introduced an electronic bulletin board system that enables farmers to buy and sell annual entitlements to federal water using a personal computer and a modem (Anderson and Snyder 1997). Perhaps the most established market for federal water operates in the Northern Colorado Water Conservancy District near Fort Collins, Colorado. Annual water entitlements within the district are freely transferable. About 30 % of the water delivered to the district each year passes through the rental market, with rents ranging from US$ 5-7 per acre-foot (Wahl 1989). There are also numerous examples of water trading between agricultural and urban users in western United States in the states of Utah, Arizona, Colorado and Nevada. For instance, groundwater in Arizona was made freely transferable by law in 1980. Following this the cities of Phoenix, Tucson, Mesa and Scottsdale acquired more than 50,000 acres of farmland in order to leave the fields fallow and to utilize the water. A study by researchers at the University of Arizona found that during the late 1970s and during the 1980s there were about 6,000 transactions in Utah, 1,455 in New Mexico, and 1,500 in Colorado (Steinhart 1990 cited in Mohanty and Gupta 2002).

Australia

Water sector in Australia has moved to the forefront of national policy debates aimed at meeting expanding social, economic and environmental objectives. The proportion of water used for agriculture is ever increasing both in absolute and relative terms. Seventy percent of water use in Australia is for agricultural purposes compared with 12 % in France, 40 % in the USA and 53 % in Italy (Stringer and Wittwer 2001). Various policies were introduced by the Australian Government over a period of years such as Environmental Protection (Water Quality) Policy 2003, Natural Resources Management Act 2004, The River Murray Act 2003 etc. The new National Water Initiative for 2004-2014 incorporates regulatory, market-based, informational and educational policy instruments, with demands placed at new and relatively weak administrative scales. The key elements of the National Water Initiative are: a) water access entitlements and planning framework; b) water markets and trading; c) best practice water pricing; d) integrated management of water for environmental and other public benefit outcomes; e) water resource accounting; f) urban water reform; g) knowledge and capacity building; and h) community partnerships and adjustment (Hussey and Dovers 2006).

Australia is also one of the pioneering countries where water trading has been practiced since a long time ago. Australian states have started allowing transfers of water entitlements through markets. Transferable rights were a response to increasing scarcity of water. As in the case of India, informal markets had already evolved before the state enacted legislation during the 1980s that codified water trading. Prior to this, farmers transferred water entitlements through 'dual ownership' whereby they purchased two landholdings and transferred water from one to the other. The fact that they chose to do this despite the high transaction costs associated with such transfers indicates the value of the gains that can be obtained from water trading. It has been estimated that water transfers along the Murray-Darling River Basin stretching over 2,500 kilometers led to a significant increase in farm incomes. In 1988-89 this increase in income was US$5.6 million through 280 transfers of 85,000 mega-liters of water. In 1990-91 the increase was US$10 million comprising 437 transfers of about 120,000 mega-liters (Sturgess and Wright 1993 cited in Mohanty and Gupta 2002). Market-based tradable permits, i.e., transferring of water rights, have assumed importance in Australia and are being widely adopted in different states.

Chile

Recognizing the importance of water trading, Chile established secure and transferable water rights. With these rights, individuals can buy or lease water quite easily. The aim is to strengthen private property, increase private autonomy in water use and favor free markets in water. Water rights in Chile are now completely separate from land ownership and can be freely bought, sold, mortgaged, and transferred like any other piece of real estate. The Chilean experience with water markets is one of mixed success and is "something for other countries to learn from rather than to copy" (Bauer 1997 cited in Mohanty and Gupta 2002). The lesson that emerges from the Chilean experience for India is that water users strongly favor the increased legal security that private property rights provide. Not only have stronger property rights increased the autonomy of local canal associations, they have also encouraged investment in agricultural water use, particularly by those growing high-value export crops like fruits.

Meinzen-dick (1997) analyzed the functioning of groundwater markets in Pakistan and their impact on agricultural productivity and incomes. The effects of the physical, social and agro economic environments on the density of private tubewells and the activity of water markets were studied, including the participation in groundwater markets. Furthermore, the determinants of tubewell ownership and groundwater purchase at the micro-level were identified using data from a household survey. The impact of groundwater markets on productivity and incomes were analyzed comparing the extent of irrigation acquired by farmers through surpluses attributable to water from canals, purchased groundwater and their own tubewells (Meinzen-Dick 1996). As per the study by Weinberg et al. (1993), in addition to improving the allocative efficiency of water use, water markets reduce irrigation-related water quality problems. This potential benefit is examined with a nonlinear programming model that was developed to simulate agricultural decision-making in an area with experienced drainage problems in California's San Joaquin Valley. Results indicate that a 30 % drainage goal is achievable through improvements in irrigation practices and changes in cropping patterns induced by a water market. Although water markets will not, in general, achieve a least-cost solution, they may be practical alternatives to economically efficient, but information-wise intensive, environmental policies such as the Pigouvian taxes.

Water Markets in India

Water markets in India are quite informal, localized and spontaneous as indicated by Shah (1993) and others. However, the water markets in India are functioning in varying size and degrees across the regions. As far as water markets are concerned, numerous studies were conducted in India by different authors over a period of time. A recent study by Abijit et al. (2006) made an attempt to analyze the institutions and markets that govern groundwater allocation in the sugarcane belt of Uttar Pradesh, India. One of the findings was that plots are water-rationed owing to the inadequate supply of power. Rationing and the village-level mechanism of water sales lead to a great misallocation of water across the plots, and result in large crop losses for plots that irrigate with purchased water. The existence of a social contract will mitigate these potential losses in the study area to a remarkable extent. However, in the absence of such a contract average yields are estimated to be lower by 18 %.

Box.1. Case Study from Tiruppur, Tamil Nadu, India

The domestic requirements of the Bhavani River basin as well as the adjacent Noyyal Basin are met partly by surface water in the Bhavani River. The river provides water to several municipalities, town panchayats and village panchayats for domestic consumption. The municipalities pump water for domestic requirements directly from the river. The annual draw from the river for the existing schemes and the schemes that are proposed in the future by the TWAD Board is in the order of 174 MCM. There are two water supply circles for household water requirements in the Lower Bhavani Basin

As such, nine schemes are running to provide drinking water supply to the 'Coimbatore Circle'. The total draw from the Bhavani River for this circle is 378.50 mld (0.38 MCM) and yearly 138.5 MCM. Among the nine schemes, five schemes are running to give 335.86 mld (0.34 MCM) and yearly 122.58 MCM of water to the Noyyal Basin. There are 32 schemes running to give drinking water to the 'Erode Circle'. The total draw from the Bhavani River in this circle is 97.126 mld (0.09 MCM) and yearly 35.45 MCM. Hence, the total drinking water drawn from the Bhavani River is both for Coimbatore and Erode circles, which is 475.626 mld (0.48 MCM) and yearly it is 173.60 MCM.

About 400 tankers are operating daily in transferring water from the agriculture sector to urban sectors. The price charged at the farm level is about Rs.100/tanker (13,000 lit). and it is sold to the industries at Rs. 400-600/tanker.

Source: Palanisami (2005)

Pant (2004) traces the evolution of water markets in eastern and western Uttar Pradesh. He observed a surge in investment in privately-owned tubewells and in the demand for electricity. The surge is attributable to the demands placed by the high-yielding variety of seeds and the consequent need for timely and reliable water supply, coupled with farmers' drive to maximize the yield. Pant concludes that growth increased the demand for power, which while available in plenty in the 1970s, has now become a constraining factor. Transactions in groundwater are noted for their importance in elevating the position of the small farmer by providing access to water.

Informal Water Markets in Tamil Nadu

Continued progress in water resources development in Tamil Nadu, India, will require that the state's existing irrigation potential be used more efficiently. Only 15 % of surface water potential in Tamil Nadu remains unexploited, and the rapidly escalating construction cost constitute a growing drain on state finances while increasing the already high financial subsidy given to irrigated farms. Further complicating matters the private exploitation of groundwater by individual farmers has tended to result in an indiscriminate and unregulated proliferation of wells, which has lowered the water table in several regions of the state. Additionally, increasing demand for nonagricultural purposes has compelled the government to divert adequate water supplies from the agricultural sector to nonagricultural users on a priority basis. Increasing water scarcity in Tamil Nadu has caused the development of informal water markets, both within the agricultural sector and between the agricultural and nonagricultural sectors.

Informal water trading in agriculture is often initiated by the selling of a small plot of land adjacent to a river to people who can dig a well and pump the water either from a shallow well or directly from the river through underground pipelines to fields 5 to 15 km away from the well. This practice is illegal, however, because wells within 200 m of the river are considered to be recharged directly from the river. Thus, by pumping from these wells, pump owners divert water to which they have no rights. In most cases, farmers who pump water from riverside wells use diesel pump sets to do so. However, some farmers use electricity by transferring their existing electric connections to these new wells. This practice further compounds the illegality of river pumping, selling water from pumps using electrical power is prohibited, because electricity is provided free for direct agricultural purposes only.

Informal inter-sectoral water markets are also operating in and around the major river basins in Tamil Nadu. Well-owners sell water to truckers, who in turn transport the water to urban centers. Two locations, i.e., Coimbatore City and Tiruppur Town in Tamil Nadu have particularly active water markets. In informal markets, well-owners pump water using diesel or electric motors (the latter, again, being illegal) and sell it to middlemen for US$0.08 to US$0.10/m^3 (The middlemen – bullock-cart owners and lorry tanker operators – are the main distributors of water to households and other customers. This cost of water to the end consumer averages approximately US$0.75m^3 more than 10 times the subsidized rate paid by households connected to the public distribution system. (Relatively well-to-do households served by the public water system pay only US$0.06/m^3).

Despite significant restrictions on the tradability of water in Tamil Nadu, the state's informal water markets have developed in response to increasing water scarcity and to the differential value of water across the sectors. Particularly active trading takes place between the agricultural and urban sectors. The markets serve a useful function of supplying water to users who otherwise would not be served by the highly subsidized municipal water system. However, the markets would be far more effective if the legal restrictions and excessive electricity and municipal water subsides were removed. Especially, the subsidized municipal system, which leaves out many of the poor, has negative welfare implications. The reform of water laws and water allocation systems in Tamil Nadu to permit more flexible water trading could greatly benefit the state.

Dimensions of Water Markets

No doubt that irrigation water plays a crucial role in agricultural production, and many claim that the irrigation water in most of the water-scarce regions are allocated through water markets (Shah 1997; Palmer Jones 1994 cited in Mukherji and Shah 2002). The size, nature and functioning of water markets significantly vary across hydrogeological and socioeconomic and cultural conditions. A study conducted across regions in South Asia confirms the proposition that the dimensions of water markets vary across regions.

The differences are observed in proportion to well-owners selling pumped water, average number of buyers and sellers, hours of sale per year, proportion of well-owners who bought water, number of hours bought and the area irrigated with purchased water. Considerable variations are found across regions. For instance, average number of hours bought per year varied from 31 hours in Nepal Terai to as high as 140 hours per annum in Bangladesh. Similarly, average annual hours of sale per seller varied from 72 hours in Coastal South India to 680 hours in Western India (Table 2). It is thus clear that the size and functioning of water markets significantly vary across regions and are influenced by different factors.

Table 2. Dimensions of water markets in South Asia.

Particulars	Pak. Punjab	Punjab Haryana West UP	East India	Tribal India	West India	Interior South India	Coastal South India	Bangladesh	Nepal Terai
Percentage of well owners selling pump irrigation	33	24	46	2.5	10	6	9	88	62
Average number of buyers /seller	3	4	5	4	3	3	1	11	4.5
Average annual hours of sale/seller	317	127	150	90	680	340	72	634	98
Average size of buyer area served per seller (ha)	10	5	3.7	0.5	4	1.3	0.53	3	3
Percentage of well owners who bought pump irrigation	5	11	6.6	Negligible	2	1	0	36	2
Average number of hours bought/yr	133	53	85	NA	98	35	NA	140	31
Average area irrigated with purchased water (ha)	6	2	1.1	NA	1	2	NA	0.6	0.67

Source : Mukherji, A and T Shah : 'Socio-Ecology of Groundwater Irrigation in South Asia: An Overview of Issues and Evidence' in Selected Papers of the Symposium on Intensive Use of Groundwater, held at Valencia (Spain), December 10-14, 2002, IAH Hydrogeology Selected Papers, Balkema Publishers

Potential for Water Markets in India

Several micro-studies illustrate the degree of variation in the use of water trading in India. In terms of area irrigated through groundwater markets, estimates vary from 80 % for Northern Gujarat (Shah 1993) to 60 % in the Allahabad District in Uttar Pradesh (Shankar, in his 16-village sample study in 1992) to 30 % in the Vaigai Basin, Tamil Nadu (Janakarajan 1993). There is no systematic estimate at the national level of the magnitude of water trading. The area irrigated through water markets has been projected to be about 50 % of the total gross irrigated area with private lift irrigation systems (Shah 1993). Other estimates, using a methodology based on pump set rental data, put the figure at 6 million hectares or 15 % of the total area under groundwater irrigation (Saleth 1999). Assuming a net addition to output of US$230/ha/year (based on the difference between the average irrigated and rain-fed yields as reported by the Government of India), the total value of the output due to water sales is estimated to be US$1.38 billion per year (Mohanty and Gupta 2002).

Though water markets are not new and the fact that they have evolved over time and for several reasons across the regions, being an important institutional mechanism for managing water scarcity, it would be important to identify the potential areas where the markets for water could be extended or promoted. The size, nature and extent of development of water markets depend on factors such as cropping pattern, water availability, type of water extraction mechanisms installed, irrigation potentials, socioeconomic conditions and the sources of irrigation. Experiences from many parts of India reveal that, water markets are mostly well developed where the groundwater scarcity is predominant. Few studies also attempted to study the functioning of water markets in the command areas where the non-well owners buy water from the well-owners for supplemental irrigation. However, the water markets or trading of surface water in India is rather limited or not well studied. There is significant potential for studying water trading in the surface irrigation system where water is tradable through permits.

Shah (1986) studied the nature and pattern of the development of water markets across regions of India considering the lift irrigation potential as a major criterion. The pattern of development of water markets varies across regions based on the lift irrigation potentials and the extent of utilization. Shah considered mainly five criterion to classify the development of water markets, and they are: (i) mode of transactions (cash or kind); (ii) proportion of water sold by the well owners; (iii) differences in cropping pattern, input use and technology adoption between the well and non-well owners; (iv) percentage of non-lift irrigation systems' owners and percentage of their land that uses purchased water; and (v) objective function of the sellers. In low lift irrigation potential and low utilization areas like many hard-rock areas where well yields are very low, there is only limited scope for development of water markets. For instance, in Karimnagar District of Andhra Pradesh (Shah 1986) where there is limited potential for lift irrigation system, the development of water market is still at the primitive stage.

Regions with low lift irrigation potential and high utilization coupled with wider adoption of modern crop production technologies have greater scope for the development of water markets. Regions such as Mehsana, Sabarkantha, Banaskantha and other regions of Saurashtra, Gujarat and southern Tamil Nadu apparently have developed water markets in spite of having low water potential. Contrary to the above, in regions where there is high potential for lift irrigation system but with low utilization, such as the regions of Orissa, Bihar and West Bengal, in spite of having huge groundwater reserves, the groundwater markets remain highly underdeveloped. The reasons attributed to this negative trend in the development of water markets in these regions are: a) poor infrastructure development; b) slow rate of rural electrification; and c) irrigation being dominated by the traditional water lifting systems.

The existing literature on water markets and groundwater economy suggests that challenges to manage the groundwater differ across the regions. In spite of the abundance of groundwater resources in water surplus regions such as eastern Indian states like Bihar, the state is yet to solve its problem of poverty and achieve economic growth and development at a much faster rate. Contrary to the above, in water-scarce regions like Peninsular Southern India and Western Indian states, the groundwater resource degradation is alarming and it is imperative that the water markets should be promoted in regions where supplies are rechargeable with the available surface water.

Scholars like Shah and Saleth projected the size of the water market in terms of the area covered under the market. Based on the estimated projections, an attempt has been made to assess the size of the water market across regions of India. The size of the water market would be quite larger in Western Indian states like Maharashtra, Gujarat, Rajasthan and also in Madhya Pradesh and Southern Peninsular states like Andhra Pradesh, Karnataka and Tamil Nadu (Table 3). In the face of growing water scarcity, encouraging water markets in these states would be a viable option to manage water scarcity and in the efficient allocation of water resources.

The earlier researchers projected the size of water markets based on the area under groundwater irrigation only. It is mainly based on the perception that the water markets in India operate where the lift irrigation system is a common one coupled with water scarcity. However, there is also another area one has to focus on, i.e., the surface irrigated areas. In areas where the surface irrigation is predominant, water sharing issues often arise between the water users. At most times the head reach farmers enjoy maximum benefits of increased crop yield due to irrigation supplies and tail end farmers face acute water scarcity. This is also a common phenomenon in a chain of tanks which share water from a common source (Palanisami and Suresh Kumar 2004). In this case, the tradable water rights can be introduced so that the water savers would get an incentive for saving water. The surplus water could be sold to the scarce regions at a price accepted by the farmers in the surplus region. Thus, the size of water markets should allow for the total area under irrigation rather than the area under groundwater irrigation only. The studies on tradable permits are rather limited in India and there is scope for introducing such institutional mechanisms to manage the growing water scarcity.

Table.3. Estimated size of water market in India across regions (‘000 hectares)

		Groundwater Irrigation			Total Irrigated Area		
Regions	States	Area under well irrigation	Size of water markets[1]	Size of water markets[2]	Gross area from all sources	Size of water markets[1]	Size of water markets[2]
Southern	Andhra Pradesh	2,573	1,286	385	4,781	2,390	717
	Karnataka	1,323	661	198	2,702	1,351	405
	Tamil Nadu	1,529	764	229	2,479	1,239	372
Western	Maharashtra	2,384	1,192	357	3,668	1,834	550
	Gujarat	3,188	1,594	478	3,637	1,818	546
	Rajasthan	4,368	2,184	655	6,393	3,196	959
	Madhya Pradesh	3,829	1,914	574	5,776	2,888	866
Northern	Uttar Pradesh	13,356	6678	2,003	17,690	8,845	2653
	Punjab	5,739	2,869	861	7,667	3,833	1150
	Jammu /Kashmir	3	1.5	0.45	446	223	66.9
Eastern	Bihar	3,131	1,565	469	4,567	2,283	685
North-eastern	Mizoram	0	0	0	18	9.0	2.7
	Nagaland	0	0	0	104	52.0	15.6
	Meghalaya	0	0	0	82	41.0	12.3
	Manipur	0	0	0	42	21.0	6.3

Notes: [1] Data pertaining to 2003-04, http://www.indiastat.com
Based on the assumption that 50 % of total gross irrigated area is with private lift irrigation (Shah 1993)
[2] Based on the assumption that 15 % of the total area under groundwater irrigation (Saleth 1999)

Supporting Conditions

Market-based instruments are proving to be an effective mechanism for increasing the productivity of water and reallocating the water saved. Experiences from many parts of the country and elsewhere clearly show that there are no formal water markets functioning in India and also that there is no legal binding for such formal water markets. Another important issue that emerges is that no defined property rights system is followed. In spite of these lacunas, the emergence and existence of informal water markets were noticed across the regions. In these circumstances, it is essential to identify the supportive conditions which are needed to transform the water markets into an effective demand management tool in the event of growing water scarcity. Hence, the water market reforms may include the property rights, water charges and the tradable water rights.

Property Rights for Water

Unlike in other countries, there is no proper property rights system that exists in India. Traditionally, the water resources have been managed either by the State or State Agencies or through property systems that focus on land ownership. Issues relating to ownership of water are not only complex but also different from other resources. In India, the use, control, management and ownership of water is linked to the other resources like land in the case of groundwater and irrigation structures in the case of surface irrigation. Thus, appropriating and defining property rights in water is complex in the present day context and, as such, need to be dealt with separately for groundwater and surface water. Though no property rights system for water exists, establishment of some sort of water rights and responsibility system, specifying the withdrawal or entitlement of water, is crucial for the development and promotion of water markets in a much more formalized manner.

Institutional Arrangements

The study revealed that there are no institutional arrangements in place to: a) govern water rights; b) property systems; c) control the functioning of informal water markets; d) pricing in informal water markets; and e) resolving conflicts. Furthermore, institutional arrangements are needed for resolving conflicts over water rights. There is an increasing emphasis today on the formation of water markets, and many experiments are underway. However, effective water markets do not emerge naturally from local systems of exchange or from individual market behavior. Legally protected water rights for all water market actors depend on state institutions above the local level. Informal and traditional systems of rights in local systems of collective management often rest on traditional power structures, which do not provide solid foundations for effective water markets. Thus the legal formalization of property rights in water is the necessary basis for effective water markets.

Tradable Water Rights

The introduction of a system of trading in water rights will provide opportunities for individuals who own water rights to trade that property right to other potential users anywhere within the basin. At present, there are opportunities for owners of property rights to trade within the catchment in which they operate and in some cases between catchments. There is limited opportunity for individuals to trade between states. From a national perspective, it is argued that the best economic returns from water resource will be generated if it is allowed to move to its highest value use. For this to occur, the necessary infrastructure, and water itself, must be available. This is not always the case. Existence of a water trading market would mean water could be purchased from elsewhere and thus make the venture feasible. The introduction of a market for water could provide substantial assistance for some irrigators: in situations where the demand for water is not high in a region because of shallow water tables, or the need to maintain minimum flows, irrigators could both reduce environmental impacts and generate income by selling their water rights to a user in another area.

Water Pricing

Pricing is an effective strategy for demand management as long as the water-rate structures contain strong incentives to conserve water. The development and implementation of pricing strategies aimed at achieving economic efficiency and demand management could become the most important option for balancing water supply and demand in the future. Water providers can encourage consumers to conserve water by reforming water rates or introducing surcharges to deter high usage of water, or by establishing fines as a deterrent to wasteful practices of water use. A major shortcoming of the literature on groundwater prices in India is that it generally does not record prices per unit volume of water; obviously a volumetric measure is necessary for a variety of reasons, including the assessment of the efficiency of water allocation within and across river basins. The percentage of area covered under water market as per the studies conducted in the Bihar and Uttar Pradesh states of India varies from 23 to 90 % in Bihar and 55 to 80 % in Uttar Pradesh.

In India, the water rates presently being charged from the users are highly subsidized and have resulted in low revenue realization. The revenue realization from water charges has proved inadequate and has been meager, and much less than even the recurring O & M charges, thereby adversely impacting the satisfactory nature and adequacy of maintenance. There is an urgent need for a review and to restructure the water rates to ensure full recovery of recurring O & M cost initially, and a part of the capital cost subsequently. Although states are giving due considerations to the cost aspects and crop water requirement etc., in the fixation of water rates, in reality the rates fixed by the states seem to be restricted ultimately to the paying capacity of the farmers. No doubt the paying capacity of the farmers cannot be ignored altogether, but if the water rates are to ensure full recovery of recurring O & M cost initially and a part of the capital cost subsequently as stressed in the National Water Policy Statement 2002 and also recommended by various Finance Commissions and Official Committees, the alternative may lie in adopting differential water rates as per the holding size of the cultivators.

In most cases in India, water is charged on crop basis and it also incorporates the cess and surcharges using the crop water rate as the basis. For instance., in the case of Lower Bhavani System, the water charge is Rs. 37.5/ha and the cess is the same and the cess surcharge is five times this rate thus making the total charge as Rs. 187.5 /ha (see Table 4). In the case of the tank irrigation systems of South India, the water market works in the later part of the crop season (see Table 5). The rate varies from Rs. 20 to 50 /hr depending on the crop period and the demand. Normally, about 2-3 buyers are covered under single well-owner (Palanisami 2004).

Water Demand

Palanisami et al. (2000) made an attempt to project demand for water among competing uses using the SHACOWAR model in the Bhavani Basin of Tamil Nadu, India. It was found that the nonagricultural demand will increase from 6.56 TMC to 13 TMC in 2010 and 16.86 TMC in 2015 and the revenue from water will be about Rs.1,062 million and Rs.1,382 million (Table.6). In the case of the Bhavani River, which has the riparian rights, the supply of water will be constant over the years. However, in the case of Lower Bhavani Sector the total water demand in odd season is estimated to be much higher than in the even season. Since, it is impossible to operate the second season without the required water supply of 8 TMC, the second season may be abandoned from 2010 onwards. The rice area will be reduced only marginally whereas the other irrigated crops will decline dramatically. In these circumstances, the groundwater use should be encouraged in the turn of seasons because with future energy pricing, the water use will not be much affected, as the energy is found to be inelastic or much lower.

Table 4. Water rates for major crops in Tamil Nadu, (Rs. /ha).

Crops	Water Rate
Rice	37.5
Sugarcane	50.0
Groundnut	25.0
Pulses	19.0

Table 5. Water charging on cost basis, tank irrigation systems in Tamil Nadu.

Months	Tank Storage (Meter)	Yield (Meter)	Well Pumped (Hrs)	Quantity (Rs./hr)	Price (Rs/1,000 lit)
October	5.3	4.6	12	6	0.40
November	1.5	1.7	6	8	0.53
December	0.5	0.3	4	8	0.53
January	0	0.3	4	10	0.66

Note: Quantity pumped will be about 15,000 lit/hour.

Table 6. Agricultural and nonagricultural water demand in the Bhavani Basin.

Particulars	1995	2000	2005	2010	2015
Water use (TMC)					
Nonagricultural	6.56	8.28	10.48	13.28	16.86
Agricultural					
a) Bhavani River	19.79	19.79	19.79	19.79	19.79
b) Lower Bhavani					
1) Odd season	16.88	16.88	16.88	16.88	16.17
2) Even season	8.96	8.84	8.11	4.39	0.62
Revenue (Rs. Million)					
Nonagricultural	489.50	632.67	819.20	1,062.99	1,382.21
Agriculture Area (000ha) :					
Rice	71.48	71.21	70.48	70.48	70.48
Other Crops	52.01	47.00	45.20	28.40	9.30

Note: TMC = Thousand million cubic feet

The inter-sectoral water allocation can thus be defined under the framework of a water market, as the nonagricultural sectors are paying the agreed charges to the canal authorities, including the industries which are also paying the rate fixed by the government departments. Under these circumstances it should be carefully examined how in the future the inter-sectoral water allocation could be covered under the framework of a water market. Thus, even in the command areas, there is potential for promoting groundwater markets as groundwater plays a crucial role in supplementing the surface water. This is further supported by another research on estimation of the 'Stabilization Value of the Groundwater' (Palanisami et al. 2008).

The stabilization value of groundwater is about 19 % higher than what it is now in the tank systems. Furthermore, the higher stabilization value may be acting as an indirect incentive to the non-well owners to buy the groundwater even though the well-owners are increasing the selling price during the peak demand periods. However, this also will encourage more large farmers to invest in wells. The stabilization value of groundwater will be always higher (19 %) even if a charge is levied on electricity, indicating the importance of the conjunctive use of tank and well water in the tank command as without the groundwater supplementation, the crop yield will be much less or in several cases crop failures will be seen. Since rice yield response to supplemental irrigation is attractive to farmers, efforts should be made to augment groundwater supplies to enhance the rice yield by providing technical and financial assistance to small and marginal farmers. This will also reduce the demand for as well as the price of groundwater in the long-run.

Increasing the water supplies in the tank through sluice management strategies (where about 20 % saving is possible) is looking very attractive. Furthermore, this could be achieved with lesser investment. The stabilization value of groundwater will also be very high (77.5 %) when tank water is used at higher levels thus minimizing the groundwater use. This also will have more implications for the sustainability of tanks, in that since a greater number of wells in the tanks always results in poor tank performance, improving the tank management will enhance tank supplies, which in turn will reduce the demand for a greater number of wells in the tank command. Hence, efforts should be made to improve the system efficiencies through tank modernization strategies. Since the tank management by the farmers will be a more attractive proposition, efforts should be made to strengthen the water user's organization at the tank level. Since most of the water user's organizations at the tank level are informal, it is important to make them formal, so that they could handle financial transactions when undertaking tank improvement activities. In a conservative estimate if we take the entire tank systems in southern India, the potential for localized water market will be about 2 mha. This estimate assumes the potential for water markers in non-system tank areas, which accounts for 80 % of the total tank area of 2.5 mha. Besides encouraging the urban (domestic) water allocation with different pricing regimes, stabilization value of groundwater is also justified in big cities like Chennai in India, where increased water pumping is realized from tank commands in a radius of about 50 km for domestic uses. The stabilization value there is high since, without the groundwater, people get lesser surface supplies without meeting their demand. This is also an interesting area to be examined under the framework of water markets.

In summation, market forces, which treat water as a commodity, offer an effective way of reallocating limited water supplies among competing uses. Both the rights to the use of water and the actual volumes of water can be exchanged in market transactions within regions. This will facilitate better allocation of scarce water resources across different sectors so that the overall developmental objectives could be achieved at a much faster rate.

Conclusion

The debate on water markets as an option for demand management has diverging views. Water markets have been in operation in many parts of the world including India. Although informal water markets have been in existence for decades, formal markets with clearly assigned, private and transferable water rights are of relatively recent origin. In Chile, Western USA and Australia, where there are developed formal water markets, there have been significant gains from water trading, particularly from trades between agricultural and urban users as water gets reallocated to more productive uses. International experiences also show that formal and developed water markets strengthen the incentives for conservation and more efficient use of water. For example, farmers have responded by switching to water-saving technologies and high-value, less water intensive crops. The Indian experience with water markets has been positive, although there have been only limited gains, because markets have remained informal, localized and primitive. Thus, while these markets have led to some efficiency gains and have expanded the scope for many resource-poor farmers to access irrigation, inter-sectoral water transfers have not taken place so far.

The current challenge in India and similar countries, where no such formal water markets have been established, is therefore to establish formal water markets, which will facilitate the trading of water and help achieve inter-sectoral water allocation. Furthermore, since formal water markets have a legal basis, effective regulation can be designed to address the issue of environmental sustainability. Formal water markets not only can provide low-cost solutions for quick augmentation of water supply, but be a viable demand management tool as farmers could use the water efficiently thus resulting not only a saving in water use but an increase in water productivity as well. So far a wealth of studies has been carried out on water markets and their implications in water-scarce regions. However, the water markets in water surplus regions are limited or rather water markets are not pervasive in these regions except in West Bengal, India. Hence, the development and promotion of water markets in the water surplus regions should be encouraged. In the water surplus regions, groundwater markets can transform a stagnant agricultural economy into a vibrant one, with positive productivity and equity impacts.

Like in Australia, market-based instruments such as tradable permits could be introduced, particularly in the surface irrigation areas. This could be introduced either at the basin level or at the sub-basin level. As the tradable water rights provide incentives for the water conservators, this would be the best bet option for managing the increasing demand for water in surface irrigated areas. Assigning separate rights to groundwater would be the first step needed for the development of water markets. Under the riparian system being used in India, ownership of groundwater accrues to the owner of the land above. This constrains the potential for inter-sectoral allocation. To establish an active water market, rights to water use must be authorized separate from the land.

Growing water demand in nonagricultural sectors may demand more water diversions from irrigation. There is evidence that payments to the irrigation water are justified for increased water diversions, besides National and State Water Polices too give priority for domestic water use. The related issues once defined will strengthen the case for encouraging water markets. Formal institutional mechanisms at different levels must be established so as to govern the functioning of water markets. Furthermore, institutional arrangements are needed for resolving conflicts over water rights. The Water Users Associations (WUAs) can be involved in this process. The role of such groups would depend on how clearly water rights are specified and how well they are established and distributed to users. If water rights are unclear and hence, allocation is contentious, conflicts would become complicated and difficult to resolve. In such cases, courts rather than committees of users will become the conflict resolving forum.

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