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Water Markets and Decentralized Water Resources Management

by

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Because of its importance and the perceived inability of private sector sources to meet water demands, many countries have depended on the public sector to provide water services for their populations. Yet this has resulted in many inefficient public water projects and in inadequate supplies of good quality and reliable water. Decentralization of water management, including the use of water markets, cannot solve all of the water problems, but it can improve the efficiency of water allocation. When given adequate responsibility and authority, water user associations have effectively taken over water management activities at a savings to tax payers. Moreover, water markets add the potential benefit of improving water efficiency within the sector as well as providing a mechanism for reallocating water among sectors. The key question involves developing innovative mechanisms for reducing the transaction costs of organizing water users and of making water trades. Water rights need to be established which are recorded, tradeable, enforceable, and separate from land if markets are to operate effectively. Also, institutions are needed that effectively resolve conflicts over water rights, including third party impacts and water quality concerns.

Water Markets and Decentralized Water Resources Management

by

K. William Easter and Robert Hearne1/

With the growing water problems facing many countries in the developing world, new ways are needed to manage this valuable economic resource. Although water is essential for human survival this does not imply that governments must deliver all water services to the individual consumer. It is time to consider a change in the traditional role of government in the provision of water resources from that of a builder and provider of all water services to one of a facilitator and regulator of service providers. In the first part of this paper we will outline the growing demands for water and the serious water problems this poses for developing countries and explain why it is time to consider changing government's role in the water sector. In the second part, we discuss the changes that are occurring in international water policy and highlight a number of cases where governments have decentralized water management through the use of water markets.

Water Use and Future Demands

Human use of water has increased more than 35-fold over the past three centuries and 4-fold since 1940. Recently, water withdrawals have been increasing 4-8 percent per year, with the bulk of the demand arising in the developing world. Sixty-nine percent is used for agriculture, 23 percent for industry, and 8 percent for domestic uses. In Asia and Africa, over 85 percent of the water is used for agriculture. Average consumption rates vary widely with per

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capita consumption in North and Central America being over twice Europe's, three times that in Asia and seven times that of Africa.

With the world's population growing to at least 8 billion by 2025, and assuming steadily rising living standards, the demand for water will increase dramatically. Much of the population growth will be concentrated in urban areas. By the year 2000, seventeen of the world's twenty-four cities with over ten million inhabitants will be in developing countries, compared to only one in 1960. Feeding and providing cheap, clean and reliable water supplies to these numbers will place new demands on the world's water resources.

Food Production

One-third of the world's total food production comes from irrigated land. Since 1950, the irrigated area has grown by 2.5 times — a key factor in allowing food production to keep up with the growth in food demand. Over the past 25 years, the expansion of irrigation has accounted for over one-half the increase in global food production. But it is now becoming increasingly difficult to sustain this expansion. Irrigable land and water are becoming increasingly scarce. Costs of new irrigation are rising rapidly and there are growing environmental concerns about large water projects and the overexploitation of groundwater. Although an estimated additional 110 million ha in developing countries are potentially irrigable, it is likely that location disadvantages, and high investment and operational costs will greatly reduce future expansion. In fact, the expansion of the area irrigated in the 1970s was only about half the 1960's rate. Thus it appears that the strategy adopted by the World Bank and other international agencies, over the past twenty-five years, of expanding agricultural production by increasing irrigated area, high yielding varieties, and fertilizer use is no longer feasible. New irrigated areas are not likely to be the major source of new food supplies; rather the focus must be on more efficient utilization of water in existing irrigation systems. This challenge is particularly acute in countries with mature water systems and where some of the water currently used for irrigation will need to be reallocated to other sectors.

<u>Domestic and Industrial Uses</u>

About 1 billion people in developing countries, particularly the rural poor, do not have access to potable water, and 1.7 billion have inadequate sanitation facilities. As a result, contaminated water imposes a huge socio-economic burden on many countries. Unsafe water is implicated in the deaths of more than 3 million people, mostly children, from diarrhea and causes about 900 million episodes of illness each year. A safe water supply is thus a life and death issue. Improving access to water and sanitation makes good economic sense. For example, in just the first ten weeks of the cholera epidemic in Peru, losses from reduced agricultural exports and tourism were estimated at $1 billion — more than three times the amount that the country had invested in water supply and sanitation services in the 1980s (World Bank, 1992).

The time devoted to fetching water for domestic use often represents a heavy cost for rural households and imposes a terrible burden on women. In some areas women spend over 15 percent of their time in this activity. The benefits of rural water supply projects can be enormous. In the case of a Mozambique village, a water supply project reduced the average time that women spent collecting water from 120 to 25 minutes a day. The time saved can be spent on better child care, food production, and other economic activities.

In the urban areas, both domestic and industrial users are facing steeply rising costs of new supplies — sometimes twice or three times previous costs. For example, for Amman (Jordan) the cost of new supplies of water is over three times greater than the present costs (Box 1). In

Lima (Peru), to meet their long term needs, they will have to transfer water from an Atlantic watershed at over twice the current cost (World Bank, 1993).

Environmental Requirements

Besides supplying water to domestic, industrial, and agricultural users, countries are increasingly faced with major environmental problems related to the management of water resources. For example, fisheries and wetlands depend on continuous river flows of reasonable quality and are threatened by growing water withdrawals. Currently, in many countries, the quantities and qualities of water being allocated for instream and flooding uses are inadequate to sustain valuable water dependent eco-systems.

Moreover, in many places, groundwater resources are seriously at risk from overexploitation and contamination by urban and agricultural pollutants and salt water intrusion. In the case of non-renewable groundwater, greater attention needs to be given to possible future uses for these resources before they become exhausted or polluted. There are cases where non-renewable groundwater that could be an important source of water for future domestic or industrial use is currently being pumped to irrigate low-valued crops. Where the over pumping and damage to the aquifer involves international or interstate aquifers, managing the water extraction becomes a difficult political task. For example, Saudi Arabia uses groundwater for irrigation from the same aquifer that Jordan would like to save for future urban use (Box 2).

Water Management Problems

Adding to these water supply and demand problems are management practices that are not sustainable from either an economic or an environmental perspective. The amount of unaccounted-for water is unacceptably high in many urban areas. For example, it amounts to 58 percent of the water delivered in Manila's water supply system and about 40 percent of the water delivered in most Latin American cities as compared to only 8 percent in Singapore. In Algeria, distribution losses alone are as high as 40 percent. Some of the losses are due to poor system design and management, while others arise from the low water charges which fail to provide an incentive to save water. A review of World Bank-financed water supply projects showed that the effective price charged for water was only about 35 percent of the average cost of supply, while for irrigation, the water charges cover an even smaller share of average cost and are generally not based on the volume taken (World Bank, 1992).

The following is a brief summary of the current weakness in water management practices that have caused misallocation, pollution, and waste of water resources:

- Fragmented water resources management has led to over investment and uncoordinnated management, especially for water from different sources, e.g., surface water and groundwater;
- Excessive reliance on over-extended governmental agencies lacking the proper incentive structure has resulted in poor service quality;
- Failure to decentralize the delivery of water services and the lack of stakeholder, community, and private-sector involvement, has yielded a vicious cycle of unreliable service, low willingness to pay, and a further decline in capacity to provide the services;
- Inadequate coordination of international and interstate water resource use and development has caused over-exploitation and pollution of important surface and groundwater resources; and
- Underpricing of water and the lack of cost recovery has resulted in excessive water use, pollution, resource misallocation, and nonsustainable water service entities.

Market and Government Failures

To implement effective water management, institutional and organizational arrangements must be developed to deal with market and government failures. The major types of market failure are: the positive and negative externalities, which lead to non-optimal resource provision; nonexcludability and nonsubtractability, which contribute to the underprovision of goods or services; and natural monopolies, which result in non-competitive pricing. Nonexcludability refers to the difficulty involved in preventing a non-paying consumer from using a good or service which then makes it unprofitable for private firms to supply. Village wells and large gravity-flow irrigation systems are, in many instances, faced with nonexcludability problems. Nonsubtractability occurs when the use of a good or service by one individual does not subtract from its value to another. Examples include capital equipment such as dams, water and sewer pipes, and irrigation canals that are not used to full capacity. If there is little or no cost from added utilization of these facilities then expanded use leads to an increase in society's total economic benefits. Goods and services that are both excludable and subtractable such as bottled water are easily rationed by price and provided by private firms. In contrast, goods that are characterized by nonexcludability and nonsubtractability in consumption are classified as public goods because they are difficult to allocate with market mechanisms and are likely to involve government provision. Flood control and instream uses of water are examples of water services that have required government intervention.

Because of economies of scale that result from large, lumpy investments, the delivery of water services has many of the characteristics of a natural monopoly. As a result of this market power, the organizations that supply water can prevent potential competitors from entering the market by charging low prices and then, after the competition is eliminated, charge much higher prices. Such market power can exist at different levels of a water system depending on who controls the water. A measure of this market power is contestability, which refers to the ability of competitors to enter into a market to gain a share of the clientele.

These market failures have led many governments to dominate the provision of water delivery services and discourage private investment in water resources. Yet the sources of market failure are not the same in all parts of the water system (see Table 1). Many parts of the system can be organized to minimize market failure and make use of the private sector to improve the efficiency of service delivery. Separate organizations can be responsible for different parts of a water system (Kessides, 1992). Government can provide the capital and obtain the reservoir and canal right of ways and then contract out the construction of the irrigation infrastructure to private firms. After the water system is completed, water users associations, local communities, or financially autonomous utilities can operate much of the system and deliver the water. Such arrangements can help introduce appropriate incentives, improve accountability, increase efficiency, and lower the financial burden on governments. Similarly, water markets can be introduced at different points in the system to provide incentives for efficient water allocation.

International Water Policy Changes

In response to past weaknesses in water policies and problems of government failure, many countries, as well as international agencies such as the World Bank, have taken a critical look at their activities in the water resources sector. For the World Bank, it resulted in a new water resources management policy that was approved by the World Bank Board of Directors and published in September, 1993. At the core of the new Bank policy are two key components. First is the adoption of a comprehensive management framework which calls for water to be treated as an economic good. Second is a greater decentralization of service delivery, greater reliance on pricing, and financial autonomous service entities, along with fuller participation of water users in the management of water resource systems. The policy encourages countries to develop national water strategies with coherent and consistent policies and regulations across sectors that involve stakeholders in a transparent process of water planning and management (World Bank, 1993).

Some progress has already been made as a number of countries are in the process or have adopted water policies that reflect many of the basic features of the Bank's policy. Countries such as Sri Lanka, the Philippines, and Indonesia have adopted the approach of promoting and expanding the role of water user associations (WUAs) in water management and system ownership (Gerards, et al., 1991, Uphoff, et al., 1990, and Easter, 1993). Other countries such as Chile and Mexico have taken the additional step of using water markets as a mechanism to help decentralize and improve water management (Lee, 1990). These policy changes reflect two important characteristics of the water sector. First, water has many competing uses that are highly interdependent which gives rise to numerous externalities. What someone does upstream can have an unintended direct impact on downstream users. These interdependencies lead to a wide range of externalities in rivers, lakes, and groundwater use. Second, internalizing these interdependencies through effective government control over water management has proven to be beyond the capabilities of many governments, especially those in developing countries.

Decentralizing Water Management

The realization that government agencies do not have to manage all parts of the system and growing financial constraints have pushed governments to rely more heavily on WUAs, financial autonomous entities, and private firms to provide water services. For example, after the inefficient government attempts to develop groundwater in South Asia, most of the development of well irrigation was turned over to the private sector, resulting in rapid expansion of irrigation and food production (World Bank, 1984). Many of the smaller public irrigation systems in the Philippines and Indonesia have been turned over to farmers (Small and Carruthers, 1991). In other countries, the farmers are taking over operations and maintenance and in some cases the irrigation agency is contracting with WUAs to collect water fees. In Argentina, small WUAs combined to form large ones that could take advantage of economies of scale associated with water development and use professional management. As a consequence, administrative costs dropped and conveyance efficiency has increased by 10 percent. The twenty-one new autonomous organizations raise their own budgets and use their own regulations based on the national water law. The direct hiring of professional management improved accountability and assurance concerning the "fair" operation of the irrigation system (Chambouleyon, 1989).

Water Markets

Another mechanism that can improve decentralized water management is the use of water markets. Because of the previously mentioned market failures, it is not surprising that water markets have not been promoted by governments. Yet with the growing water scarcity and the large differences in water values among uses, markets are being considered more widely as a means to improve water allocation and to reduce the economic impact of water scarcity. In contrast to water allocation by administrative decision, market allocation guarantees compensation for users who relinquish water. Market decisions are based on individual assessments of the value of water. These assessments are made with information that is available to individual water users but expensive for water agencies to collect. Thus, markets reduce the cost of providing the necessary information for efficient water allocation. Furthermore, the incentive to withhold information from central agencies responsible for water allocation is removed.

Water markets are possible when individuals and institutions have a secure claim to water that is transferable and separate from land — either through a right, a permit, or an entitlement. Because of the compensation received by sellers, tradable water-use rights provide incentives for the transfer of water from low valued to high valued uses and for the improvement in water use efficiency through the introduction of an opportunity cost. Furthermore, a secure supply of water increases producer incentives to make long-term investments in production technology.

For an efficient water allocation that minimizes transaction costs, the water market can work at two levels. The first level is among farmers and other water users within a given water or irrigation district. Second is transactions among water users or WUAs in different districts. Markets at these two levels reallocate water so that water prices minus transaction costs are equalized across and within districts. Gains from such water trades can be substantial. For example, Chang and Griffin, 1992, estimated gains in trade from water sales in Texas to be from \$3,000 and \$16,000 per $1000m^3$. In California, Vaux, 1986, estimated that trades within the agricultural sector would move water from the northern to the southern part of the Central Valley and produce gains of \$10 million annually based on 1980 figures.

Several institutional and organizational arrangements are required if water markets are to operate effectively. First, transferable water rights or use rights should be established based on the volume of water, or on the share (percent) of water from a stream or canal flow. These rights should be recorded, tradeable, enforceable, and separate from land. Where volumetric rights are established in rivers with variable flows, as in the western U.S.A., a certain right may have a priority for water withdrawal relative to other water users. In large river valleys where downstream users are dependent on the return flows of upstream users, these return flows should be accounted for in the water right. The return flows can be accounted for by restricting water transfers outside a region to only the portion of the water right that is actually consumed. In irrigation this is, on average, less than half of the water released from the source of supply. In order to guarantee the advantages of economic incentives in water-use, these rights should not specify either location or type of use. To protect the rights of other water users, these rights should have some specification of the quantity and quality of water returned to rivers and canals after use. In addition, some highly polluting uses of water could be banned.

A second important consideration in establishing water rights involves groundwater. Where surface and groundwater are interconnected, problems are likely to occur if rights for surface water are established without doing the same for groundwater. Surface water rights are not secure if someone can install a well next to the canal or river and draw out "your" surface water. The lack of compatible surface and groundwater rights has caused serious water management problems in a number of areas such as Arizona (U.S.)(Charney and Woodard, 1990).

Third, because of the different externalities and interdependencies in water use, a system of enforcement and conflict resolution will be needed. Guidelines should be established for dealing with water rights disputes, third party effects, and discharges into water sources. Also, guidelines for the regulation of natural monopolies should be established. In the western U.S.A., both water courts and a State Engineer’s office perform this function. Water or river basin commissions such as those in France could provide the same service.

Fourth, if there are important societal water uses (uses with strong public good characteristics) that cannot compete in the market for water, the public sector can either purchase these rights or reserve them in the initial allocation of water rights. This might involve water for instream water uses such as the preservation of fisheries. Water quality also needs to be included in the rights or defined by effective government water quality standards. If this is not done, water may be supplied in the quantity established by the water right but the quality may make it unusable for the purpose desired. For example, farmers near some major cities have had problems growing vegetables because the irrigated water they receive has been contaminated by sewage discharges that can cause serious health problems when used to irrigate vegetables.

Finally, the initial distribution of water rights is likely to be a contentious issue unless defacto water rights already exist and the primary task is to have them formalized. Where defacto rights do not exist many countries have avoided conflicts and maintained political support by allocating water rights based on existing land rights in the irrigated area. This works fairly well if the distribution of land is reasonably equitable as was the case in Chile when water was made tradeable. If land ownership is highly concentrated, such as in the Central Valley of California, where large scale farmers captured many of the direct benefits from the subsidized public irrigation projects, then an alternative water allocation criteria or land reform is needed. One alternative is to allocate the water rights to all families (landowners and landless) in the irrigated area, as was done with a small village irrigation project in northern India (Joshi and Seckler, 1982). In this case, the water market was a means to reallocate water rights since some water rights owners had surplus water. The end result was that even landless families benefitted since they could sell their water rights. Thus all families shared directly in the economic surplus (rents) created by the irrigation project. A complementary alternative would be to allocate some of the rights to the WUAs or a river basin authority and use the revenue from the sale of these rights to fund the operation and maintenance of the water system.

Country Experience

Water markets usually involve either the exchange of a finite amount of water during a specified period of time, or a permanent transfer of water-use rights. The former — sometimes referred to as a spot market — occurs when the owner of a legal or prescriptive right to a certain volume or flow of water sells a portion of that water, sometimes outside of legal sanction, to a neighbor in a simple transaction. These exchanges are for a specified period of time — sometimes for only a few hours of irrigation. Although the unit of sales may not be metered volumetrically, both buyer and seller have good information on the volume involved. A more permanent transaction involves the exchange of the water-use right itself. This generally requires legal sanction to assure the security of the right after the transfer. Transfers of water-use rights are generally permanent, and the burden of uncertain supply falls on the purchaser of the right.

Transfers of water between farmers are common, especially in the Indian subcontinent where neighboring farmers trade hours of canal water or of pumping time, often without legal authorization. Informal markets have developed in the large surface water systems of Pakistan and northern India among farmers along a given water course or canal (Easter, 1986). Farmers have a use right for a certain time period to irrigate from the watercourse that serves their area. The actual volume of water received will vary depending on the water flow but whatever the flow is during farmers' allotted time for irrigation is theirs to use. The trades are made of all or part of an individual irrigation time allotment. Yet, even on an individual watercourse, the coordination required among farmers can make it difficult to transact trades. If there are other farmers on the watercourse in between the two farmers who want to trade, then the intervening farmers must also agree to the change in irrigation time. The fact that such water trades are illegal makes it difficult if not impossible for the government officials to help in the coordination. Still numerous trades occur, indicating that both buyers and sellers receive significant benefits from these trades (Easter, 1986).

Also in India, where private well development has proven to be the most productive form of irrigation, groundwater markets have made irrigation water available to even the poorest farmers. "Up to half or more of the land served by private modern well extraction mechanisms in many parts of India is likely to be owned and operated by the buyers of water" (Shah, 1993, pp. 48-49). This practice is encouraged by the pricing policies of State Electric Boards which collect flat fees for each pump instead of a charge for the power used. With a marginal pumping cost that is close to zero, the pump owners' selling price is driven down through competition, and water charges remain low, and near the cost of pumping (Palanisami and Easter, 1991 and Shah, 1993). In areas with limited groundwater stocks, water levels are falling and well owners must deepen their wells or stop irrigating. As would be expected, water prices are much higher in these cases, and above pumping costs because of the high scarcity value of the groundwater. In areas with salt water intrusion, rapidly declining groundwater tables, or aquifer compaction, market prices probably fail to reflect the externalities caused by excess pumping of groundwater and increase the rate at which the aquifer is damaged. But in the areas where canal irrigation causes waterlogging, or where groundwater is recharged with monsoon floods, increased groundwater pumping has produced major economic benefits for India (Shah, 1993).

A very different community-based water market developed several centuries ago in Alicante, Spain, just south of Valencia. The market evolved in an irrigation systems of 3,700 ha. which included the Tibi dam built in the late sixteenth century. A system of water rights developed that was partly separated from the land irrigated. Although the water rights were based on allotted irrigation time from a canal, the rights were translated into volumetric units. This was possible because of the control that existed in the system. In contrast to the uncertain flows in the large Pakistan and Indian systems, the Alicante system maintained a constant flow in the canals of 150 l/sec., except in drought years. This, multiplied by the allotted irrigation time, provided a volumetric measure of the water right (Maass and Anderson 1978).

The water market was based on an auction every Sunday morning in the village of San Juan. Buyers purchased tickets for a particular irrigation time during a particular cycle of canal flows. Both irrigators and non-irrigators owned these rights. An analysis of the market exchanges and water allocation by Maass and Anderson (1978) found it to produce higher net returns than two alternate rotation systems used elsewhere in Spain.

A more centralized system of transferring finite quantities of water was established in California. This "Water Bank", started in 1991, takes advantage of the state’s extensive system of canals, and allows entities with high valued water uses to buy finite quantities of water that would ordinarily be employed in low valued uses. Despite the fact that actual purchases were limited, municipal areas were able to ensure future supplies of water during the last part of a severe drought. Because transfers of water are volumetric and temporal, sellers are not threatened with forfeiting their permanent water rights. Thus the political difficulties of permanent water transfers were minimized while the economic incentives of water markets were introduced.

Permanent transfers of water-use rights are common in the western U.S.A., where water is allocated through priority rights based on seniority (Colby, 1990). Much has been written about water markets in this area, where water scarcity and an evolving economy have encouraged the development of physical and institutional infrastructure for water management. Transfers are well regulated and although the legal system and other mechanisms for conflict resolution are utilized, conflicts continue to occur, especially as environmentalists push for the protection of instream flows and Native-Americans press for traditional water rights.

Chile is one of the few developing countries that has encouraged the use of markets in water resource management. Market allocation in Chile is feasible because a system of transferable water-use rights was established with the National Water Code of 1981. This law states that water is a national resource for public use but that permanent and transferable rights to utilize water can be granted to individuals in accordance with the law. Although the law stipulates that rights are to be specified by volume of flow per unit of time, in reality rights are defined as a share of stream flow. This use of shares follows a traditional practice used since the development of canal irrigation by Spanish colonists.

Water-use rights are specified for consumptive and non-consumptive use. Non-consumptive rights oblige users to return the water in a form specified by the right which does not damage the rights of other users. Consumptive use rights are granted for the full use of all the water stipulated in the right. Thus, downstream users do not have rights to return flows generated from upstream users. Water users in downstream sections of a river have rights to the water that enters rivers through springs, rainfall, and return flows from upstream sections of the river. These rights holders are not protected by the law from any change in upstream water use that significantly reduces the water that they receive through return flows or springs. There is also no restriction on the transfer of water to another basin.

Water-use rights are also required for groundwater exploitation. Individuals can request from the General Directorate of Waters (DGA) a right to groundwater, once they have confirmed the existence of a certain well yield at a certain depth. A groundwater use right establishes a specified protective area where other wells are prohibited.

Most water-user rights are prescriptive rights that have been retained from private development of canals and later redistributed, along with land, during the land reforms of the 1960s and 1970s. The Water Code stipulates that individuals can petition the DGA for water-use rights. However, most rivers in the arid north and fertile central valley of Chile were completely claimed and divided before the 1981 law. The government did, however, grant large quantities of non-consumptive rights, mostly to developers of hydroelectric projects in southern Chile. Although these non-consumptive rights were not supposed to interfere with established consumptive rights, conflicts have occurred (Bauer, 1993).

Conflicts between water users are generally resolved within water user associations. The DGA does have limited powers to regulate natural channels, and can intervene in disputes when water user associations misuse their power. During times of drought the DGA can impound water, with compensation to water rights holders. The ultimate arbiter in water conflicts is the judiciary. Yet the effectiveness of the courts in conflict management has been limited by judicial restraint and formalism (Bauer, 1993).

The market exchange of water-use rights is common in several valleys in the northern and central regions of Chile. All titles and exchanges are recorded in the local real estate registry. Since water flows are controlled by water users associations, these institutions play a key role in all water transfers. Many water-user rights are not formal titles and these are recorded only with the water user associations. The government is currently engaged in efforts to formally title all water-use rights.

Throughout most of Chile, transactions are very limited. But active water markets are found in areas where water is scarce and transactions costs are low. Transactions costs are minimized by effective water user associations and maneuverable physical infrastructure. The presence of fixed flow dividers can make it too costly to move water from some locations. But, in valleys such as the Elqui and Limarí, where movable gates are common, water user associations can easily execute a water transfer.

Probably the most important benefit of this system of transferable water-use rights is the security brought to rights holders that does not exist in a system of government control over water allocation. Chilean farmers have invested heavily in irrigated fruit crops and taken advantage of their favorable growing season to receive high international market prices for their crops. As the value of water in agricultural production has increased, individuals have increased their investment in more efficient irrigation technology.

In Mexico, leases and sales of water among farmers for seasonal water use have existed for many years, even when such sales were not encouraged or were illegal. However, this situation changed in 1992 when a new water law was promulgated. Many of the ideas that went into developing the new law evolved over the twenty year period when Mexico was engaged in a process of trying to improve its water resources management. The new water law makes it legal to lease or sell water and establishes water concessions or use rights on a volumetric basis separate from land rights. These concession to use water will be registered by the Comision Nacional de Agua (CNA) as will permanent sales of water concessions. The commission has an incentive to facilitate the registration process since concession owners must pay a water use fee that will help finance CNA. The use fee is in two parts, one for the volume extracted, and the other for the volume and quality of the discharge. In 1993, the water extraction fee for irrigation was zero.

The actual water rights are held by CNA for the Mexican people and concessions for water use are made for a period of 5 to 50 years, with most of them for 30 to 50 years. These water concession will, generally, be renewed if the use and discharge have not changed. Yet CNA has to approve renewals and will consider the overall river basin supply and demand before making renewals that involve changes in use or discharge.

The water concessions are made to a variety of entities including water user associations, individual users, private firms, irrigation districts (IDs), and municipalities. Initially the concession are made based on historical use and, in the case of irrigation, mostly to WUAs, IDs, or Irrigation Units (IUs). The IDs, WUAs, and IUs determine the allocation of water concessions to individual farmers and WUAs. The idea of water concessions is not new to water users in Mexico since the concept of separating the water right from a use right (concession) was introduced during the Spanish period.

These water concessions are based on consumption use. This means that water sales from agriculture will have to be in terms of the quantity of the water concession that is used for plant growth, water transpired from plant surfaces and water evaporate from the soil surface. Water lost due to seepage cannot be sold. Basing the tradeable water concession on consumption use will reduce third party effects but it does not obligate the water rights holder to maintain a specific amount of return flow.

To maintain ownership of a water concession, the water must be used at least once every three years. In practice this means the owner of the water concession must pay the extraction fee. This requirement was included to prevent speculators from holding water free of charge without using it. Yet for irrigators, it is not clear how CNA will certify water use since the current extraction fee for irrigation is zero and, therefore, no payment can be recorded. Another important question that will need to be answered concerning the three year limit is whether or not instream uses such as the preservation of fisheries and aquatic ecosystems qualify as recognized uses. If instream uses do not qualify then this limit could pose problems for some fisheries and aquatic ecosystems in Mexico.

Since CNA will grant concession at the ID or WUA level, the allocation of concessions among users will vary from district to district and from WUA to WUA depending on the regulations each unit adopts for water resources management. If these concessions to IDs and WUAs are reallocated to individual farmers then they will be able to sell their water concessions to any other farmer or organization in the ID. The individual farmer will receive the proceeds from such sales within the district. When water sales do not change the intake or discharge then the only requirement is that they be recorded.

For sales outside the district, a majority vote of the general assembly of the ID must approve the sale before it can occur. In addition, it requires CNA approval and all the proceeds from the sale go to the district and not the individual water user. These restrictions will limit sales between districts but should safeguard against third party effects. They also mean that most of the sales will occur within the district. Consequently, the value of water will tend to be equalized within an ID but not between districts. At a later date, if IDs and urban areas are legally combined in water districts, there will be greater opportunity for trades between agriculture and urban users. As the current law is written, a lot depends on how CNA administers requests for sales among districts and urban areas as well as on how concessions are allocated among various individual water users. If IDs or water user associations retain some of the water concessions, this will facilitate trades between districts and urban areas, since the districts receive the revenues and thus have the primary incentive to sell water outside the district. The problem with IDs or WUAs retaining some or all of the water concessions is that it will eliminate or reduce price incentives for farmers to use this water efficiently. Only when farmers can receive the revenues from selling the water concessions will they make decisions based on the economic value of water.

For any new water law, the key to its effectiveness is implementation. The water law in Mexico makes it clear that the responsibility for water management is supposed to be decentralized to WUAs. The associations are supposed to take responsibility for maintaining the system and allocating the water locally. They are, therefore, critical to the effectiveness of the water market. In many cases they will need to make infrastructure changes or change allocation rules so that the farmer who purchased the water can receive the additional supply. How easily a WUA can make such changes will affect the transactions cost of trades and the number of trades that are feasible to make. If the infrastructure gives the water user association only very limited control over the distributions of water then it will be more costly for them to implement the changes necessary to accommodate sales. It also is not clear who would pay for the changes that may be necessary to allow water sales. In the case of water sales in Chile, the buyer must pay for the changes in infrastructure.

Because proceeds of outside water sales go to the district rather than the individual, the new Mexican water law may limit most trades among districts or between sectors to ones similar to the exchange made between Los Angeles and the Imperial Irrigation District of California. The city agreed to pay to improve the water use efficiency of the district and in exchange would receive the water saved. Assuming that it is not profitable for farmers to install system-wide water conservation devices, then farmers would not lose any useable water since Los Angeles would only receive water saved through their system-wide conservation investments. This arrangement would improve the allocation of water between agriculture and the urban sector but it provides no incentives for farmers to use the water more efficiently at the farm level. Farmers are likely to continue to irrigate over 200 thousand acres of alfalfa (a water-intensive crop) which is almost 40 percent of the irrigated area. The gains in efficiency are from improvements in the water delivery system such as canal lining but not from improved on-farm water use.

Conclusions

Although decentralization of water management, including the use of water markets, cannot solve all water problems, such decentralization efforts have improved the efficiency of water allocation in a number of countries. When given adequate responsibility and authority, WUAs have effectively taken over activities commonly performed by government agencies, at a savings to tax payers. Moreover, water markets offer the added potential benefit of improving water efficiency within the sector as well as providing a mechanism for reallocating water among sectors.

If water is scarce, one of the necessary conditions for incurring the expense of establishing water markets is in place. Even when water trading is illegal, private arrangements for water trading have developed in areas with frequent water scarcity. Yet to promote water markets, not only should water trades be made legal, but water use rights should be established and enforced. The key question is whether or not governments would be willing to give up control over water transactions as the government of Chile has, and focus on oversight responsibilities including conflict resolution, regulation, and water quality improvement.

The Mexican law offers another market alternative, where markets are primarily allowed to operate freely within irrigation districts or water user associations. Intersectoral trades are subject to regulation by their water commission and approval of the irrigation district. This allows the government to play a larger role in water planning and allocation while still obtaining market-based improvement in water use at the district level.

Markets might also be used to improve both intracountry and intercountry water allocation. For example, a system of annual or seasonal water sales similar to California's water market might by used by a number of countries to help modify the impacts of localized droughts. A water commission could be established to facilitate such trades. This would not involve a permanent transfer of water, but would be limited to exchanges for a limited amount of time. These trades could offer large economic benefit to both the buyers and sellers.

Countries faced with increasing water scarcity need to consider alternative ways they can use water markets to improve water allocation. If they take steps to reduce transaction costs, water markets can be an effective water allocation mechanism. Yet markets alone will not bring about a socially optimal distribution of water. Governments will have to take an active role in protecting third party rights, in regulating monopolies, and in resolving water use conflicts.

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Table 1. **Public and Private Good Characteristics, Market Power, and Externalities in Water Systems**

	Subtract-ability	Exclud-ability	Contest-ability	Externalities
I. Water Supply				
A. Piped				
1. Trunk System[1/]	H	H	L	PH, GD
2. Distribution System	L	M	L	PH
3. Terminal Equipment				
a. Common (i.e. handpump)	M	L	H	PH
b. Individual (i.e. home faucet)	M	H	H	PH
B. Village wells	M	L	H	PH
C. Vending (tanker trunks etc.)	H	H	H	PH
II. Irrigation				
A. Production				
1. Trunk System (dam, main canal)[2/]	M	M	L	WL, ND
2. Small dams and reservoirs[2/]	M	M	M	
3. Run of the River Systems[2/]	M	M	M	
4. Deep Tubewells[1/]	H	H	M	WL, GD
5. Shallow tubewells[1/]	H	H	H	WL, GD
B. Distribution System[2/]	M	M	M	WL, ND
C. Terminal system (on farm) gravity				
1. Field to field irrigation	H	L	H	WL, ND
2. Field channels	H	H	H	WL, ND

PH = Public health

WL = Water logging and salinity

ND = Introduction of new diseases

GD = Groundwater depletion

L = Low, M = Medium, H = High

[1/] The degree of subtractability associated with a given well actually depends on the nature of the aquifer from which the well is drawing. High water resource scarcity is assumed. Excludability refers to the tubewell, not the aquifer.

[2/] The degree of subtractability depends on the scarcity of water and the canal capacity.

Source: Adapted from World Bank, 1993.

Box: 1. Increasing Costs of Water Supply

Many cities convey water over long distances and make extensive use of high-cost pumping. In addition, pollution has created the necessity for additional water treatment or the rejection of existing sources.

Amman: When the water supply system was based on groundwater, the average incremental cost (AIC) was estimated at $0.41 per cubic meter, but chronic shortages of groundwater led to the use of surface water sources. This raised the AIC to $1.33 per cubic meter. The most recent works involve pumping water up 1,200 meters from a site about 40 kilometers from the city. The next scheme contemplates the construction of a dam and a conveyor, at an estimated cost of $1.50 per cubic meter, which is also about the cost of desalinating water of $1 to $2 per cubic meter.

***Shenyang (China)*:** The cost of new water supplies will rise between 1988 and 2000 from $0.04 to $0.11 per cubic meter, almost a 300 percent increase. The main reason is that groundwater from the Hun Valley Alluvium, the current water source, has to be rejected as a source of potable water for reasons of water quality. As a result, water will have to be conveyed to Shenyang by gravity from a surface source 51 kilometers from the city. In Yingkuo (China), the AIC of water diverted from the nearby Daliao River is about $0.16 per cubic meter. However, because of the heavy pollution, this source cannot be used for domestic purposes. As a result, water is currently being transported into the city from the more distant Bi Liu River at a cost of $0.30 per cubic meter.

***Lima*:** During 1981, the AIC of a project to meet short- to medium-term needs, based in part both on a surface source from the Rimac River and on groundwater supplies, was $0.25 per cubic meter. Since the aquifer has been severely depleted, groundwater sources cannot be used to satisfy needs beyond the early 1990s. To meet long-term urban needs, a transfer of water from the Atlantic watershed is being planned, the AIC of which has been estimated at $0.53 per cubic meter.

***Mexico City*:** Water is currently being pumped over an elevation of 1,000 meters into the Mexico Valley from the Cutzamala River through a pipeline about 180 kilometer long. The AIC of water from this source is $0.82 per cubic meter, almost 55 percent more than the previous source, the Mexico Valley aquifer. The newly designed water supply project for the city is expected to be even more costly, since it will have a longer transmission line, and water will be pumped over an elevation of 2,000 meters.

Source: World Bank, 1993

Box: 2. Water Scarcity in Jordan

Jordan's economy has been transformed since the early 1950s, when its population was only 0.6 million, with agriculture largely confined to rainfed farming and livestock raising. A rapidly expanding population (currently 3.2 million, increasing at 3.8 percent per annum), increasing urbanization (currently 70 percent of the population), and rising incomes have brought about increasing demands for water. Approximately 48,500 hectares have been brought under irrigation in the Jordan Valley, the northern highlands, and the Disi wells area in south-east Jordan. This has raised increasing concerns about the balance of water use between irrigation and municipal and industrial (M&I) purposes. The strategy had been to use surface water principally for irrigation, and groundwater for both M&I and irrigation because of groundwater's location near population centers in the uplands and its better quality.

Municipal and industrial (M&I) water currently accounts for about 25 percent of total water use, and water consumption is modest for a country with Jordan's per capita income. Water is metered and charges are high by the region's standards. However, as the population is expected to increase to 7.4 million in 2015, even with modest consumption rates, M&I water demand is expected to increase so that by 2015, it will account for about 40 percent of total water demand. In response to the growing scarcity, irrigation is now done by sprinkler and drip irrigation pressure pipe systems.

The three remaining under-exploited sources of water in Jordan are: water which would be made available by construction of a storage facility on the Yarmouk River, known as Wahdeh (or Unity) Dam; water from the Disi wells in south-east Jordan; and treated sewage effluent, which will be increasingly available for collection and re-use for irrigation. Water planning strategies in the 1980s envisaged using all the water from the proposed Wahdeh dam for irrigation, permitting an expansion of irrigation in the Jordan Valley. Licenses were also granted for developing the Disi aquifer for irrigated agriculture. Increasing awareness by the government of water scarcities, however, brought about a revision of this strategy. It was realized that the Disi aquifer should be regarded as a strategic reserve, to be used for M&I water as the need arose, and that "mining" this water source for agriculture was not in the interests of the country. Yet because the Disi aquifer is also being mined for irrigation by Saudi Arabia, it can only be saved through an international agreement.

Source: World Bank, 1993.