

---

# Formal Water Markets: Why, When, and How to Introduce Tradable Water Rights

---

Mateen Thobani

---

*In most countries the state owns the water resources and the hydraulic infrastructure, and public officials decide who gets the water, how it is to be used, and how much will be charged for it. But costly inefficiencies in the supply and use of water support a shift from government provision to a market-based approach that is more effective and less wasteful.*

*Markets can allow rapid changes in allocation in response to changing demands for water and can stimulate investment and employment as investors are assured of access to secure supplies of water. Because of water's unique characteristics, such markets do not work everywhere; nor do they resolve all water-related issues. By designing appropriate water laws and regulations and by strengthening private and public institutions to administer them, formal water markets can effectively address rising demands for groundwater and for water found in rivers, lakes, and canals. Lessons from Chile's experience demonstrate that formal water markets can improve the economic efficiency of water use and stimulate investment.*

---

In many developing countries, governments consider water to be too precious a resource or too difficult a commodity to be left to the market. Decisions about who gets water, at what price, and for what use have thus been entrusted to public officials. Although the state retains ownership of this asset, it typically endows private and public entities, such as farmers, industrial users, and power and water companies, with the right to use surface water or groundwater for a particular purpose. These rights are defined in a variety of ways and have been written into law or have evolved through custom (Sampath 1992). The allocation of water rights is typically the responsibility of the government, as is the construction, ownership, and operation of the infrastructure such as dams, reservoirs, and canals. In some countries that government even installs and oper-

ates wells. Recently many countries have transferred operations and management responsibility to user associations; enforcement is the responsibility of public authorities or water user associations—or both. User associations are typically informal entities that play a role in distributing the water of a canal or river. In some countries, however, such as Chile, Mexico, and Peru, user associations are legally recognized bodies that set and collect fees for operating and maintaining the hydraulic infrastructure. Water companies and industries may belong to user associations, but most associations are made up primarily of farmers.

Publicly administered systems of water rights have all too often resulted in inefficiencies in the use and supply of water. Despite its growing scarcity and increasingly costly hydraulic infrastructure, water is often used wastefully. This is especially true in agriculture, which accounts for 70 percent of water use worldwide, compared with only 8 percent used for household consumption. It is not unusual in arid areas to find cities rationing water even as neighboring farmers grow low-value, water-intensive crops using inefficient irrigation technologies. Although governments normally reserve the right to reallocate water toward more desirable uses, in practice they have found it difficult to do so. Even in the face of rapidly changing demands for water, attempts to shift supplies from agricultural users to domestic urban consumers have often generated conflicts and fomented social disruption.

Moreover, government control has not been effective at ensuring that the poor have access to water. In many cities in developing countries, the poorest are not served by piped municipal water and must resort to buying water from private vendors at prices that are several multiples of those paid by better-off residents. And farmers who are politically influential manage to get easier access to water rights, which are obtained without charge and for whose use farmers typically pay only a nominal fee. Because farmers are unable to sell any surplus water, there is little incentive to conserve water by better soil or water management or by growing less water-intensive crops.

Nor has government control over water been effective at maintaining water or soil quality or protecting ecosystems in most developing countries. The discharge of municipal and industrial wastes, the runoff of agricultural chemicals, and poor land-use practices in agriculture, mining, and forestry have led to widespread degradation of land and water resources. Water-borne diseases cause an estimated three million deaths annually and render sick a billion more. In addition, poorly designed public irrigation projects and insufficient incentives for water conservation have resulted in extensive soil salinization (a process in which salts impregnate soils, making it unsuitable for agriculture) and contributed to ecological disasters in many countries (World Bank 1993). In many countries water from underground aquifers is pumped out at unsustainable

levels, threatening the livelihood of many agricultural and nonagricultural users, as well as seriously damaging ecosystems.

A system of publicly allocated water rights makes the private sector reluctant to invest in hydraulic infrastructure—or in activities whose operation requires large quantities of water. If the water in a reservoir built with private funds can be commandeered by the government to meet social or political objectives, investors will have little incentive to provide such infrastructure. If water can be reallocated from agricultural to urban users when shortages occur, investors are unlikely to invest in agriculture.

At the same time, public investment in hydraulic infrastructure has often been a losing proposition. There is no dearth of taxpayer-financed dams that were ill-conceived and, because of budgetary difficulties, long delays, and cost-overruns, cost far more than their eventual benefits were worth. Similarly, efforts to construct and operate public wells have also been unsuccessful. In many countries sizable shares of the public infrastructure budget have gone toward expensive hydraulic projects with low or negative economic rates of return (Holden and Thobani 1995). Despite high construction costs, many of these projects have not been adequately operated or maintained, leaving users, the bulk of whom are farmers, without a reliable supply of water and unwilling to pay higher water charges (Ostrom 1992).

The future looks bleak. Demand for water is rising, and because countries have already exploited the less expensive sources of supply, the cost of developing new supplies has increased sharply. Furthermore, as governments face increasing fiscal pressures, they are no longer willing to spend vast public resources to build new dams and wells or even to operate and maintain existing hydraulic infrastructure.

## Market-Based Instruments for Water Allocation

Recent approaches to meet the growing demand for water have focused on voluntary mechanisms to conserve water and reallocate it among competing uses rather than on developing new sources of supply. At the same time, governments are seeking alternative ways to finance the operation and management of existing infrastructure and the construction of new infrastructure. These alternative approaches may be divided into three categories: pricing policies, informal water markets, and formal water markets.

### *Pricing Policies*

By raising the user price of water to reflect its true scarcity, or opportunity cost (that is, the price the marginal user is willing to pay), authorities hope to induce

users to conserve water, making it possible to divert supplies to higher value uses (World Bank 1993).<sup>1</sup> In principle, if irrigation water near a city could be priced at what a water company would be willing to pay for the crude water (adjusting for conveyance costs), some farmers would give up farming, and others would switch to more efficient irrigation or grow less water-intensive crops. The higher charges would free up water that could be transferred to the water company for treatment and subsequent sale. They would also generate fiscal resources that could be used to improve the performance and maintenance of the existing infrastructure or to invest in new infrastructure.

Serious practical and political problems, however, have prevented any government from pricing water at its opportunity cost. Even if governments could find an inexpensive way to measure and monitor water flow, measuring the opportunity cost of water is difficult because it varies according to location, reliability, season, use, and water quality. Reliable and high quality groundwater close to a city that is rationing water will have a high opportunity cost (even after adjusting for pumping charges), while more polluted water along a more distant river with a variable flow will have a low opportunity cost. Even this difference will vary according to the year and season. In a year with average precipitation, the opportunity cost of water will be far lower than it is in a drought year, just as it will be lower in the rainy season than it is in the dry season. Water used for agriculture or mining will have a much higher opportunity cost than water that is used for hydropower generation and is returned to the river in roughly the same quantity and quality. But if water for hydropower is stored during periods when it is needed for other activities such as agriculture, its opportunity cost could be significant.

The political problems are even more intractable. It is politically difficult to charge a farmer for water from a river that serves a town (and therefore has a high opportunity cost) a higher price than a farmer using water from a river that is not near a town. Similarly, it is difficult to charge profitable hydropower companies less than poor farmers. Strong farmer lobbies typically pressure politicians to keep water charges well below their opportunity cost.

Another problem in pricing irrigation water at its opportunity cost is that the price of land already embodies the price of water rights. In areas of low rainfall, irrigated land may sell for ten times the price of unirrigated land, reflecting the expectation that the owner of irrigated land will receive water at a low charge. If charges are later raised to reflect the opportunity cost of water, this land will be valued the same as unirrigated land, resulting in an effective expropriation of the farmer's assets. Although government actions frequently alter the value of private assets, the sheer magnitude of asset expropriation implied, the numbers of people affected, and the socially disruptive aspects (in agricultural unem-

ployment) of such a policy make it highly unlikely that opportunity cost pricing can be introduced within a reasonable time frame.

A unique problem affecting water pricing involves “return flows.” When a farmer waters crops, only part of the water is absorbed by the plant. Depending on the efficiency of irrigation, a significant share of the water—the return flow—will seep underground. This water may enter an underground aquifer and be pumped up by another user, or it may even rejoin the river and be diverted into a canal. If water were priced volumetrically, according to what was received rather than what was actually consumed, farmers using inefficient irrigation (thereby inadvertently helping out downstream users) would pay too high a price. These pricing difficulties do not mean that water should be provided at no charge, but they do suggest that setting water prices administratively to ensure rational use will be difficult in practice and that the consequences could well be socially and politically disruptive.

### *Informal Water Markets*

Where governments have failed to respond to rapidly changing demands for water, local (spot) water markets have emerged in several water-scarce countries. Although such informal markets, in which users contract for water on their own, are technically illegal, governments usually turn a blind eye to them, perhaps because they manage to reallocate water quickly and voluntarily. In a typical transaction, a farmer sells a specified volume of his surplus groundwater or surface water for a season or a specified period to a neighboring farmer. Or several farmers collectively sell some of their water to a nearby town.<sup>2</sup>

In this way water is reallocated to more valuable uses without penalizing existing holders of water rights. At the same time the ability to sell provides an incentive for conserving water and using it more rationally. Such informal markets are widespread in South Asia (Pakistan Water and Power Development Authority 1990; Shah 1991; Saleth 1996). The author found them to have been widespread in Mexico even before the introduction of formal tradable water rights. (See also Meinzen-Dick 1996, who found that informal water markets in South Asia were able to increase poor farmers’ access to water).

In some cases these trades have not performed well and have resulted in an economically inefficient allocation of water. In parts of South Asia, wealthier farmers with deep wells charge neighboring smaller farmers a high “monopoly” price for water. As a result crop output is lower than it would be if the water were priced at its opportunity cost—and income inequality is exacerbated. The opportunity to sell such a valuable resource also increases exploitation of groundwater, which can deplete underground aquifers (Saleth 1996). Moreover, be-

cause such transactions are illegal, it is difficult to enforce adherence to the entitlement (water right) and protect the aquifers.

A further complication is that these illegal markets may allow upstream users to sell more than they actually consume (because they may sell the return flow component of their water right), thereby infringing upon the rights of third parties. In addition the buyer lacks the security of an enforceable contract. Trades are therefore limited to spot sales or to sales for a single season, often between neighbors; longer-term trades are nonexistent, depriving potential investors or water companies secure long-term access to water. Finally, compared with opportunity-cost pricing, informal markets do not generate fiscal revenues, nor do they provide sufficient incentives or means for the creation of new infrastructure.

### *Formal Water Markets*

Several governments have established legal tradable water rights in an attempt to retain and extend the advantages of informal water markets while reducing some of the negative costs stemming from their illegal status. The potential to sell water rights makes them more valuable and provides an incentive for conserving water and reallocating it to higher-value uses. In this sense, the outcome is similar to that under opportunity-cost pricing. Tradable water rights also allow leasing of water (for a season, say) and spot sales; in fact, they facilitate such transactions. Finally, by allocating initial water rights, without charge, to existing users or holders of water rights, tradable water rights can circumvent the political problems associated with raising water prices and setting nonuniform charges. Governments can monitor operations and more effectively enforce laws and regulations aimed at preventing the abuse of monopoly power, at ensuring that sales do not negatively affect the water available to third parties (that is, at addressing the problems of return flow), and at protecting the environment.

Chile and Mexico are the only countries that have established formal regimes of tradable water rights at the national level, but many of the western states of the United States and some states in Australia have such systems (see Rosegrant and Gazmuri 1995 and Pigram and others 1993 for descriptions of the California and Australian systems, respectively.) There are also pockets of semiformal water markets in some countries, where well-regulated water markets have existed for more than a hundred years, even though they are not consistent with national and state water laws (see Kemper 1996). In Australia and the United States, concerns about the environment and protecting third parties have led to many restrictions on water trading that have added to the cost of transactions—or blocked potentially beneficial trades. For example, water

markets in some areas of the United States, such as Colorado and New Mexico, which have few restrictions on trading, have functioned quite well for more than a century, but restrictions on trading have limited the usefulness of the water markets in California. As a result, farmers in California continue to grow low-value, water-intensive crops even when neighboring cities face water shortages and rationing. The Chilean and Mexican water market regimes are probably better models for developing countries facing water shortages.

**CHILE.** Under Chile's 1981 water code, the state grants existing water users property rights to both surface water and groundwater without charge.<sup>3</sup> These rights are separate from the land and, except for a few restrictions, owners may sell them to anyone for any purpose at negotiated prices. These water rights may also be leased, used as collateral, and inherited. Interested parties may petition to obtain new and unallocated water rights. If others are interested in the same rights, they will be sold at auction; if not, the petitioner will receive the rights without charge.

Rights are obtained by being recorded in a public registry as either consumptive or nonconsumptive, permanent or temporary (contingent). Nonconsumptive rights oblige the holder to return the same volume of water to a specific location (this right is useful mainly for hydropower generation). Temporary rights can be exercised only if all permanent rights have been met (useful when storage capacity exists). The rights are defined volumetrically (either in liters per second or in cubic meters), but revert to proportional rights (share of the streamflow or of the volume in a reservoir) if the available water does not permit all volumetric rights to be honored. This last feature is particularly important in Chile because few rivers have dams or reservoirs for storage.

Water users' associations are responsible for monitoring, distributing, and enforcing water rights at the level of the river basin, primary canal, and secondary or tertiary canal. They own and operate the bulk of the hydraulic infrastructure and set water tariffs. The government continues to manage the headworks for some large dams and reservoirs and to charge users for these services.

**MEXICO.** Under Mexico's 1992 water law, users may convert their existing nontradable water rights to more secure long-term concessions (with a typical maturity of thirty years). These concessions may be leased or sold as long as the sale does not negatively affect the water rights of other users. For nonagricultural users, farmer associations, and groundwater users, the rights are recorded in a public registry and are defined volumetrically. Because any deficits or surpluses are allocated proportionately, however, the rights are effectively proportional. For individual farmers using surface water, the rights are defined only in terms of area to be irrigated and are registered by the water users association.

Users may forfeit their rights if the water is not used efficiently or if it has not been used for three years. Thus, in principle, these rights are less secure than those in Chile. But Mexico's National Water Commission does not specify what constitutes inefficient water use, and the author found no evidence of users having forfeited their rights for this reason. Although the rights cover a fixed period, the water commission plans to renew the concessions for only a nominal administrative charge. Therefore, in effect, the rights are longer-term and more secure than they appear.

## Why Establish Tradable Water Rights?

Tradable rights offer water owners an incentive to sell or lease part or all of their holdings to those who have higher-value uses for it. Tradable rights give buyers of water a strong incentive to conserve water to keep their costs to a minimum. Farmers who are considering purchasing new rights are thus more likely to use efficient irrigation techniques, and water companies are more likely to try to reduce water losses.

Such voluntary and flexible transfers that divert water to more productive uses have indeed occurred in the water-scarce areas of Mexico and Chile. In Mexico the transfers benefited some small farmers whose unprofitable farming activities had led to the accumulation of unsustainable debt. In the past they would have resorted either to selling their land and water rights, which would have forced them to leave the land, or to illegally selling their water rights at a lower price. Because they can sell the rights legally, however, and thereby obtain a better price, they have been able to use the proceeds to pay off their debts. Some have even been employed by the farmers that bought the water rights. Similarly, firms that formerly resorted to extracting groundwater illegally have begun buying groundwater rights legally, thereby reducing the problem of aquifer depletion while obtaining secure water rights.

In Chile farmers sold or leased their surplus water rights to more efficient neighboring farmers, industrial users, or water companies. The sales and leases have allowed some water companies and industrial users to obtain reliable access to water without expensive infrastructure investment. The results, according to one study (Hearne and Easter 1997), have been large gains to society. For example, the city of La Serena was able to purchase 28 percent of its water rights from neighboring farmers, allowing the government to postpone the construction of a proposed dam. Similarly, the city of Arica, in the arid north, has been able to meet the needs of urban residents by leasing groundwater from farmers. Such measures have contributed to Chile's success in providing water to virtually all urban residents.



Changes in the structure of water markets create new opportunities for conserving water. When Santiago's municipal water company, EMOS, was notified that it could no longer receive new water rights without charge, the company initially sought to purchase additional water rights. When potential sellers demanded too high a price, EMOS decided instead to rehabilitate its aging pipe structure to reduce water leakages. Similarly, farmers who must pay for water rights to expand production have an additional reason to install efficient irrigation, to use better soil management techniques, or to grow less water-intensive crops. Some Chilean farmers have even used options contracts as a way to avoid buying water that they might not need. The option allows a farmer (who needs to ensure that his trees, say, do not die if there is a drought) to pay a neighboring farmer growing an annual crop for the option of buying water at a prenegotiated price in case of a drought.

The conservation occurred even though water charges were not raised. In fact, several water users' associations in Chile reported that water charges fell after the new water law was passed in 1981. Even before the introduction of the current law, the government was charging users the full cost of system operations and maintenance, which was handled by public authorities. Under the new legislation, those who hold water rights are responsible for setting water tariffs as well as for operating and maintaining the infrastructure. Because they have been able to provide these services at a lower cost, water tariffs have declined.

The situation was different in Mexico, however, where water prices were so low that government subsidies for operating the infrastructure amounted to 0.5 percent of gross domestic product. Just before tradable water rights were introduced, Mexico began to move toward charging full recovery of service costs and to turn over operational responsibility to users. Although costs for operations and management fell, the savings were not enough to compensate for the reduction in subsidies, so water users in Mexico are generally paying higher water tariffs.

### *The Effect on Poverty Reduction*

Secure and tradable water rights reduce poverty in several ways. First, they allow scarce resources to be redeployed for more productive purposes, thus leading to increased output and employment. This occurred, for example, when farmers in Chile and Mexico sold their water rights to more productive farmers or cities. Second, tradable water rights encourage new investment in activities that require large quantities of water. An investment in a fruit farm is more likely to be attractive if the investor knows that water will not be transferred to a neighboring city in times of scarcity and that additional water can be pur-

chased from farmers during water shortages. In Mexico investors built a water-bottling plant after negotiating for the water rights from a farmer. Not only was the farmer better off, but the increased investment also generated additional employment. A World Bank (1994) study on Peru found that tradable water rights have the potential to increase private investment in hydraulic infrastructure, freeing up public resources for other activities while allowing rapid and cost-effective development of hydraulic projects.

Third, by empowering user groups to have a say on the issuance or transfer of water rights, secure and tradable rights help protect the poor. When water rights are granted without charge by public authorities, it is typically the rich and politically influential who have easier access to them, often at the expense of the poor. This is the case, for example, in Peru. Fourth, secure and tradable water rights increase the value of the rights, which are often the most precious assets of poor farmers. In Mexico many small farmers were able to take advantage of their ability to sell their water rights while still remaining on the land.

Additionally, by making it easier for cities to obtain water, such markets benefit the poor because they are the most likely urban residents to have been excluded from piped service. Chile provides almost universal coverage of piped water in urban areas. A contributing factor to that extensive coverage is the ability of water companies to obtain "raw" water at a reasonable price (as in Arica and La Serena). In cities such as Lima or Karachi, where municipal water availability is often limited to certain hours of the day, improved availability of raw water would allow households to receive water at any time. Finally, because the transfer of water to higher-value uses occurs without confiscating water from less productive users (farmers) and without having to build new infrastructure, it is cheaper and fairer than alternatives, such as raising water charges substantially.

No one has measured the effect of tradable water rights on economic growth in Chile and Mexico. Anecdotal evidence and studies showing the gains from trading water suggest, however, that water rights have facilitated economic growth. Agriculture in Chile grew 6 percent a year in the decade following the passage of the water law. In Mexico more efficient farmers were able to expand their output substantially by buying surface water rights. Similarly, the purchase of groundwater rights made it possible for industry to expand production and employment. Without the opportunity to sell water rights legally, the adjustments following the peso's drop in December 1994, which led to changes in relative prices and a decline in domestic demand, would have been more difficult.

In principle, inadequately regulated water sales could lead to erosion from deserted land or threaten the environment if minimum flows at the lower sec-

tions of rivers are not maintained. In practice, neither the author nor Hearne and Easter (1997) found any evidence of such problems in Chile, mainly because Chilean farmers rarely sold all their water rights, because rivers in Chile are short, with little return flow, and because some water users' associations forbid trades that could reduce the availability of water downstream. In both Chile and Mexico, trades require the approval of the pertinent users' association as well as the public water authorities. Although Chile's water authorities recently reported instances of environmental degradation caused by water sales, such transactions do not appear to have caused serious problems. In fact, by inducing conservation, water markets have postponed the need to build new infrastructure, such as the proposed dam near La Serena in Chile, thereby averting potential environmental problems.

### *When to Establish Tradable Water Rights*

If water markets have all these advantages and have worked well for several years in Chile, why have most other countries not adopted them?<sup>4</sup> There are many possible reasons, the relative importance of which varies.

- Some countries, for cultural or religious reasons, object to the idea that life-sustaining water should be bought and sold.
- Some fear that rich individuals or companies will buy up all the rights, excluding the poor from access to water and raising equity and monopoly concerns.
- Another concern is that small-scale farmers, either in desperation or ignorance, will sell their rights for a pittance and lose their livelihood.
- Some maintain that water transfers will damage the environment by depleting aquifers, increasing water pollution, or changing ecosystems.
- In some cases, the few that stand to gain from the current system may effectively oppose changing it.
- And because water use often has social benefits that exceed private ones, there may be a sense that public control of water is necessary to ensure adequate investment and low prices.
- The final reason relates to the costs stemming from setting up a new legal, regulatory, and institutional framework; from defining, measuring, and enforcing water rights; and from making necessary changes in water intake and in the conveyance infrastructure to effect the transfers. Closely related to these costs are the difficulties of implementing the initial allocation of water rights, of ensuring that sales of water by one user do not affect the water rights of others (the return flow problem), and of establishing or strengthening public and private institutions to permit a well-functioning market. Given

these costs, the potential benefits from trading water must be sufficiently large for governments to consider establishing tradable water rights.

These problems, however, are not unique to tradable water rights; even publicly administered systems of water allocation must cope with them. Water rights are difficult to define, measure, and enforce even when they are not tradable, and institutional arrangements are essential to manage allocation and distribution. Although water markets may require more complex infrastructure, delivery systems to transfer water are needed regardless of the method that is used to reallocate the water. And most publicly administered systems of water rights have not protected the poor. Efforts to keep water charges low have often resulted in poor service and excluded low-income residents even while better-off farmers and wealthier urban residents obtained water at highly subsidized prices. Although water markets can lead to monopolies, experience shows that suitable antitrust and tariff legislation often results in lower prices and a higher level of service compared with government management of the resource. Similarly, where social benefits exceed private benefits, a subsidy may be preferable to government ownership and control.

Formal water markets tend to reduce the extent of the water problems facing countries. For example, by increasing the implicit value of water rights and by empowering users, water markets provide better incentives to define, measure, and enforce rights to water, and they strengthen private institutions such as water users' associations. The infrastructure needed to implement the transfers is likely to be less expensive if it is undertaken by the users than by public authorities. Moreover, the users will build the infrastructure only when it is economical to do so. Government provision is often hampered by the demands of vested interest groups that promote costly projects, such as dams, tunnels, and other infrastructure, even when the benefits provided by such services are well below the costs of construction.

Before governments consider establishing a costly new legal and institutional framework, certain minimum conditions must be met. First, because of the costs of identifying potential trades and of making, recording, and enforcing changes in water intakes and conveyance infrastructure, water must be quite scarce—and therefore of high value. Additionally, the infrastructure must be flexible enough to allow trades (for example, adjustable gates rather than fixed-flow dividers). Second, society must be willing to enact legislation that respects private property rights to water and recognizes such rights for a reasonably long period. Where cultural, constitutional, or religious factors preclude this commitment, effective formal markets are unlikely to develop or to stimulate private investment and improved water use.<sup>5</sup> Third, minimum institutional capacity in the public and private sector must exist or be developed before tradable

water rights can be established. Private institutions such as user associations that operate at the level of a ditch, canal, or river basin are needed to help establish the initial allocation of water rights and to operate the system. Public institutions must establish the legal and regulatory framework to register the rights, to operate parts of the system that users cannot, and to settle disputes that cannot be resolved by user associations. Finally, because of the likely opposition from those with a vested interest in maintaining the status quo, the political leadership must be prepared to withstand the opposition. If these conditions are met for a substantial part of the country, governments should consider legislation establishing tradable water rights.

## Introducing Tradable Water Rights

Even when policymakers are convinced of the advantages of tradable water rights, they need to address several issues to ensure a successful outcome. In addition they must be strongly committed and patient. Water allocation is an emotional subject and because of the technical and legal issues involved, the process of changing to a new regime may take several years.<sup>6</sup> Although the design and implementation of tradable water rights need to be tailored to specific country circumstances, the following guidelines, which build upon Chile's successes but avoid its mistakes, may be useful.

### *Conducting an Information Campaign*

Experience shows that it is essential to explain to users and other affected groups the advantages of formal property rights to water. A well-designed information campaign can overcome the opposition to reform by powerful vested interests. The mechanics of trading could be explained by calling on the expertise of representatives from user associations in countries that have successfully introduced formal water markets. Users and other stakeholders can be invited to participate in designing and implementing the legal framework. Discussions and analyses of draft versions of the law demonstrate a willingness to accommodate the concerns of farmers and other users and are essential to successful implementation.

### *Registering Rights without Charge*

The best way to ensure support for the law is to assign rights to users, without charge, based on their historic usage. Although this approach may provide a windfall gain to some farmers, it acknowledges that the land price already reflects access to water at low prices and that the government is unlikely to re-

cover directly the capital costs of investment in infrastructure. Because this procedure also rewards users that are taking more than their fair share of water, there may be merit in trying to rectify some of the most egregious wrongs. If the government were to try to use this opportunity to correct all such mistakes or to confiscate all illegally obtained rights, however, chances are good that the legislation will fail and the injustices will continue.

Once the rules are established, the individual registration process should be coordinated by water users' associations using "block-titling" methods, where the government provides titles simultaneously to all users in a geographic area (Holden and Thobani 1995). The establishment of a registry, whose officials are perceived to be honest and who are given an adequate budget, is a high priority. One way to ensure fiscal autonomy is to impose a small registration charge to cover operational expenses. The public media should be used extensively to enhance compliance with registration and to make sure that farmers are fully aware of the consequences of their failure to register or to sell their rights. Where large quantities of water are allocated for hydropower, the government should ensure that the initial assignment of such rights does not affect the historical supply available for downstream users. This may require specifying the minimum volume of water that will be released each week (box 1).

### *Auctioning New Rights*

New and unallocated water rights should be sold at auction in an open and transparent manner, making active use of the public media. Before any auction, the government should establish a minimum reservation price and verify that the water is not being used and is not needed for environmental or recreational purposes. Information on prices and volumes of past auctions and on transactions in the area should be made public. Any costs to enter the auction should be kept as low as possible.

### *Protecting the Rights of Third Parties*

Even if the initial allocation procedure protects existing users, subsequent sales could infringe upon the water rights of third parties—the return flow problem described earlier. In countries where the reuse of such flows is substantial, procedures to protect third parties must be instituted before trades are authorized. One way to do this would be to specify that all water rights have both a consumptive and a nonconsumptive element. While the former can be sold without restriction, supplies for hydropower use can be sold only if the distribution does not deprive other users of water. Thus for most transfers within the same water basin for the same use, owners would be free to sell 100 percent of their

---

**Box 1. Chile's Misunderstood Water Problems**

---

Despite its success in improving water use, Chile still suffers from conflicts between hydropower companies and farmers, from water quality problems, and from anticompetitive behavior in electricity generation.

*Farmer-Hydropower Conflicts.* The problem developed when the privatized hydropower companies were granted water rights that failed to set out their obligation to release specified volumes from the reservoirs when farmers need them. The problem was exacerbated when the companies requested additional water for nonconsumption uses from rivers where consumption rights had not yet been assigned (Rios and Quiroz 1995). This experience underscores the need to specify weekly releases of nonconsumption rights—whether the rights are tradable or not is irrelevant.

*Water Quality.* These problems reflect Chile's failure to enact regulations to enforce the high standards set in the environmental law. The security or tradability of the rights is not an issue.

*Anticompetitive Behavior.* Although not directly related to water markets, a shortcoming in Chile's water code has allowed one power company to obtain nonconsumption rights to most rivers, in a bid to keep out competition. Moreover, the company did not have to pay for these rights because the auction operates under rules that grant the rights to the petitioner without charge if no other parties approach. By establishing a minimum reservation price, by taxing holdings of water rights (analogous to land taxes), and by passing appropriate antitrust legislation, governments can prevent the abuse of monopoly power.

---

water rights. But if a farmer were to sell his rights to a water company whose return flows do not return to the same aquifer or river, he could sell only that amount which did not return to the aquifer or river.

Because of the technical difficulties in calculating the return flow component on a case-by-case basis, this approach may not be appropriate for developing countries. But it may be possible to calculate averages that specify the volume of water consumed by a certain crop or activity. In those cases in which return flows are an issue, this published volume would become the limit on the amount that owners could sell to buyers (Holden and Thobani 1995). This procedure would work for both surface water and groundwater. Even though the system has shortcomings, it would be a vast improvement over prohibiting all transfers or having no controls, as is the case with informal water markets.

In addition to these hydrologic effects, there may be other important third-party economic effects. It is neither feasible nor desirable to protect against all of these effects, but two points warrant attention. First, when sales of water from one canal system to another result in a loss of water tariff income to a water user association, it may be desirable to compensate the association for some of that lost income. For instance, in the La Lagunera region of Mexico, buyers must pay 70 percent of the water tariff to the original association and 30 percent to the new association. Second, where municipalities lose significant revenues when water rights are trans-

ferred to other regions, arrangements can be made to pay property taxes on these rights to the original municipality; alternatively, an exit lump-sum tax may be worth considering. This is an important issue in some western states of the United States where rural municipalities lose their revenue base when irrigation water is transferred to cities.

### *Addressing Monopolies through Taxes and Legislation*

Because of the large number of owners of water rights and the high prices they will demand to sell those rights, a monopolistic structure in consumptive water rights (agriculture, industry, and so forth) is unlikely—with two exceptions. First, a monopoly could occur when governments auction new water rights, as happened in Chile (box 1). An appropriate minimum reservation price in auctions should help protect against this outcome. This arrangement could be accompanied by taxes on both consumptive and nonconsumptive rights. A tax on the rights, and not on the purpose for which the water is used or the quantity of water used, has desirable characteristics similar to those of land taxes: it does not distort production decisions, and it helps recover public investment costs in infrastructure. The level of the tax could, at a minimum, be set at the difference in land taxes between irrigated and unirrigated land. For reasons of equity and administrative efficiency, small holdings of water rights should be exempt from this tax. Second, monopolies could occur when awarding large volumes of new water rights in the process of privatizing public hydraulic projects under construction. To protect against this risk, an appropriate regulatory framework for each hydraulic project being privatized should be developed (World Bank 1994). In addition antitrust legislation could help protect against any possible monopolies arising from the auction of new water rights, such as in the granting of nonconsumptive rights for hydropower generation.

### *Water Pollution and Aquifer Depletion*

Water quality standards or their enforcement need not be changed when establishing tradable water rights. If the standards need revision or enforcement needs to be improved, such measures can be introduced independently. But water markets could exacerbate aquifer depletion because they provide an additional incentive to pump more water from the ground. Formal water markets provide a feasible way to protect against aquifer depletion, because the law would require that groundwater rights be registered. In regions where aquifer depletion is a concern, groundwater users could form an association that would work with government officials to monitor the level of the water table and each



others' use. If the aquifer were not recharging adequately, the user association would decrease the extraction limits of its users proportionately. Moreover, if exploitation by a user resulted in a shortage of water available to others who are legally entitled to it, public authorities could establish proportional reductions in volumetric rights and bar new exploitation. Such a system is preferable to most existing regimes, whereby owners of the land above an aquifer have full rights to its water, even if their use results in its depletion.

## Conclusion

Publicly owned water allocation systems have recorded costly inefficiencies in the supply and use of water. Even in water-scarce areas, water is wasted and public hydraulic projects are poorly conceived, implemented, and operated. Moreover, public approaches have failed to protect the environment or to make water accessible to the poor. With increasing populations and budgetary pressures, these water systems are likely to become even more untenable.

Informal water markets, which evolve spontaneously, are politically easy to implement and can lead to improved water use. But, because they are illegal and thus unregulated, they often result in problems. Formal water markets have greater potential for success.

Economic principles and lessons from experience suggest that formal enactment of tradable water rights permits rapid and voluntary changes in water allocation in response to changing demands, thereby improving water use. These formal water markets also increase user participation in allocating water and planning new investments, while allowing businesses to invest in activities that require assured access to water. The resulting increase in employment and income generation can help reduce poverty.

But tradable water rights are not a panacea, and an effective system is not easy to introduce. Chile's experience and the demonstrated superiority of markets over publicly administered means of resource allocation in general suggest that markets are preferable when water is scarce, when the infrastructure to effect transfers exists or can be cheaply developed, when there is a minimum institutional capacity to implement trades, and when there is political will to establish appropriate legislation.

## Notes

Mateen Thobani is senior economist in the World Bank's Latin America and Caribbean Region. The author would like to acknowledge the useful comments of Lorena Alcazar, Ariel Dinar, K. William Easter, Karin Kemper, Larry Simpson, and Ashok Subramanian.

1. Note that a policy of pricing water to cover the full cost of building and managing the infrastructure (the long-run marginal cost) is not optimal if the infrastructure is ill-conceived and built at high cost. In the unlikely event that full cost pricing could be enforced, most irrigators, who typically account for the bulk of water use, would be unable to afford water and would be forced to give up farming. Most of the water would therefore go unused.

2. It is useful to distinguish between the water charge paid by a user for system operation and maintenance and the price paid to a seller to use a given volume of water or to lease a certain volume of water for a given period. To draw an analogy from the condominium market, the former is the condominium fee, while the latter is the fee paid for renting the condominium from its owner.

3. The registration process is costly, however; it requires posting announcements in major newspapers, so most small farmers do not actually register their rights. Nonetheless, these rights continue to be honored, but the farmers are unable to sell their rights independently of their land.

4. Because of the limited sales of such rights as well as serious water-related problems, some observers question this statement. In fact, although few trades occur in the high rainfall southern regions and in canals that use fixed flow dividers, many beneficial sales and leases of water are made in the water-scarce north. Also, Chile's water problems are largely unrelated to water markets (see box 1).

5. Mexico chose to get around the constitution by calling water rights long-term concessions but treating them as if they were property rights for land.

6. In Peru, despite more than three years of debate and technical assistance, passage of a law establishing tradable water rights is still uncertain.

## References

The word "processed" describes informally reproduced works that may not be commonly available through library systems.

Hearne, Robert R., and K. William Easter. 1997. "The Economic and Financial Gains from Water Markets." *Agricultural Economics* 15:187-99.

Holden, Paul, and Mateen Thobani. 1995. "Tradable Water Rights: A Property Rights Approach to Improving Water Use and Promoting Investment." *Cuadernos de Economía* 97(December):263-89.

Kemper, Karin. 1996. *Water Resources Allocation and Use in the Cariri Valley—Ceara, Northeast Brazil*. Linköping, Sweden: Linköping University.

Meinzen-Dick, Ruth. 1996. *Groundwater Markets in Pakistan: Participation and Productivity*. Research Report 105. Washington, D.C.: International Food Policy Research Institute.

Ostrom, Elinor. 1992. *Crafting Institutions for Self-Governing Irrigation Systems*. San Francisco: Institute for Contemporary Studies.

Pakistan Water and Power Development Authority. 1990. *Trading of Canal and Tubewell Water for Irrigation Purposes*. Islamabad: P&I Publications.

Pigram, John J., Robert J. Delforce, Michelle L. Coelli, Vol Norris, George Antony, Raymond L. Anderson, and Warren Musgrave. 1993. "Transferable Water Entitlements in Australia." Report to the Land and Water Resources Research and Development Corp, Australia. Center for Water Policy Research, Armidale, NSW. Processed.

Rios, Monica, and Jorge Quiroz. 1995. "The Market for Water Rights in Chile: Major Issues." *Cuadernos de Economía* 97 (December):317-45.

- Rosegrant, Mark W., and Renato Gazmuri. 1995. "Reforming Water Allocation Policy through Markets in Tradable Water Rights: Lessons from Chile, Mexico, and California." *Cuadernos de Economía* 97(December):291-315.
- Saleth, R. Maria. 1996. *Water Institutions in India: Economics, Law and Policy*. Institute of Economic Growth. New Delhi: Commonwealth Publishers.
- Sampath, Rajan K. 1992. "Issues in Irrigation Pricing in Developing Countries." *World Development* 20(July):967-77.
- Shah, Tushaar. 1991. "Managing Conjunctive Water Use in Canal Commands: Analysis for Mahi Right Bank Canal, Gujarat." In Ruth Meinzen-Dick and Mark Svendsen, eds., *Future Directions for Indian Irrigation*. Washington, D.C.: International Food Policy Research Institute.
- World Bank. 1993. *Water Resources Management*. A World Bank Policy Paper. Washington, D.C.
- . 1994. "Peru: A User-Based Approach to Water Management and Irrigation Development." Report 13642-PE. Country Department 3. Washington, D.C. Processed. Also in Spanish. 1995.