Cuadernos de Economía, Año 32, N° 97, pp. 263-289 (diciembre 1995)

TRADABLE WATER RIGHTS: A PROPERTY RIGHTS APPROACH TO IMPROVING WATER USE AND PROMOTING INVESTMENT

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BACKGROUND AND MOTIVATION

Water, which in many cultures has an almost mystical significance, has often been the cause of disputes both between individuals and countries. Conflicts have on occasion escalated into violence and in the case of countries, wars. The aggression that such disputes have provoked rest on the life-giving and agricultural characteristics of water. The fact that it is so essential has frequently been used to justify heavy state intervention in the granting and administration of rights to the use of water. In most countries, public officials decide on who gets water rights, on the purpose with which the water is to be used, and on the price to be charged for its use. However, there is ample evidence that water allocation by administrative edict has resulted in large scale inefficiencies in the supply of water and in the way that it is used. Although there is substantial documentation that ownership backed up by secure property rights has a powerful positive effect on incentives to invest and on efficiency (see, for example, Demsetz 1967, Alchian and Demsetz 1972, and Barzel 1989), only a few countries have tried an approach which embodies tradable property rights in water and which takes advantage of the allocative efficiencies of the price mechanism to assign scarce water resources among various users. Furthermore, substantial controversy still surrounds the evaluation of the success of these efforts to establish water markets.

The purpose of this paper is to show policy makers and water practitioners that a system of tradable water rights is preferable to administrative methods of water allocation in water-scarce countries and to provide guidance on how to implement such system. After describing how water rights are defined, assigned, and enforced under conventional water rights regimes, the paper reviews the experience of such regimes and evaluates past and proposed measures to improve water management. The paper then focuses on tradable water rights. After explaining the nature of tradable water rights, it discusses why and how some countries are promoting tradable water rights regimes. The advantages of tradable water rights are elucidated and problems in establishing tradable water rights regimes are reviewed. Finally, the paper suggests how to design and implement a system of tradable water rights in

order to resolve these problems. The property rights and new institutional economics literature helps in the analysis.

Conventional Water Rights Regimes

In most countries where water is scarce or costly to access, systems of rights for water use have evolved implicitly through custom or explicitly through bodies of law and regulations (or both). These water rights specify how water in a river is to be divided between alternative uses such as industrial use, domestic water supply and agriculture, as well as between individual water users within a sector such as water companies and farmers. Worldwide, 69 percent of water is used in agriculture, 23 percent in industry, and only 8 percent for domestic purposes. Typically, the State owns the water, endowing water rights to individuals or entities to use for a particular purpose. Thus, in order to receive water rights, users usually have to show that they will be using the water beneficially. If the water is not used, it may be reallocated for other purposes or rights may be revoked. The State usually designs, builds, and owns the hydraulic infrastructure for storing and conveying the water (canals, dams, reservoirs, etc.) in order to ensure that the water becomes available where and when needed. In addition, the State often operates the infrastructure and water distribution system.

How water rights are defined, assigned and enforced

Water rights are generally based on one of three systems: riparian rights, prior (appropriative) rights, and public allocation (Sampath 1992). Under the *riparian rights* doctrine, anyone who possesses land next to a flowing river or stream may take its water as long as enough is left for downstream users. Diversions of water to locations not adjoining the river or stream are prohibited. Such systems tend to occur in areas where water is relatively abundant and where strict definition of rights is not crucial (France, eastern part of the United States). In addition, even where surface water rights are determined by other means, countries typically allow ground water rights to accrue to those that own the land overlying the aquifer.

Prior rights are based on the appropriation doctrine, under which the water right is acquired by actual use over time. Diversions of water are permitted and quotas are allocated to specified parties on a first-come, first-served basis and are subject to the "use it or lose it" rule. This system prevails in the arid western part of the United States -those that established a beneficial use early were given senior rights (early settlers and farmers) over those that established them later (cities). A variant of this approach is also found in parts of South Asia. Under its *warabandi* system, South Asian farmers take timed turns to withdraw water from a canal or watercourse. Physical location on the watercourse determines an individual farmer's priority level. Thus, upstream farmers are able to draw amounts of water in proportion to their land holdings, while downstream farmers may be deprived of their water in times of shortage.

Public allocation involves publicly administered distribution of water. Under this system, public authorities decide how to allocate water using guidelines or laws establishing priorities. Most developing countries follow variants of this approach. For example, under the 1969 General Water Law in Peru water rights were assigned by a public water administrator, establishing the following priorities for water use (in descending order): human consumption and basic necessities; livestock, agriculture; energy; industry and

mining; and other. Although there is often a charge for water use (usually based on the irrigated hectarage), the water rights themselves are obtained without charge, with irrigation rights linked to land. In many cases, the rights specify that water can only be used for certain activities, which diminishes the value of these rights[1].

Water rights are typically defined in one of several ways: in volumetric terms (cubic meters or liters/second); as a share of the stream or canal flow or of the water available in a reservoir or lake; or in terms of shifts or hours of availability at a certain intake (e.g., the right to keep a certain gate open for eight hours every two weeks). In some cases, the water rights may be defined as a combination of the above or be conditional upon water availability. For instance, water going into a canal may be based on a share of the river flow whereas water going to individual farmers may be based on hours of water available at an intake point. Some rights are volumetric only if there is a certain level of water in the river; otherwise, they are proportional. Similarly, rights may be defined as a share of the excess water flow above a given stream flow (defined in liters/sec) or above a certain level of water in a lake or reservoir (defined in cubic meters). Certain junior rights under an appropriative rights regime may be exercised only if senior rights have been met. Rights may be consumptive or non-consumptive: while consumptive rights have no obligation to return any quantity of water to a river, non-consumptive rights may face an obligation to return the same quantity and quality of water to a specified location. Generally, only hydropower companies have such rights.

The sophistication of the infrastructure to measure the water varies tremendously from simple dividers within a stream or canal that divert water according to certain established ratios to sophisticated measuring devices that may continuously record water flow and transmit the information instantly to computers at a central monitoring stations. In most developing countries, a public authority is likely to monitor water flows in major rivers and tributaries whereas water user associations, which use dividers and/or gates to control water flow, determine the amount of water going into a canal and into individual farms. The operation and maintenance of the water distribution system and the enforcement of water rights is increasingly done by water user associations and communities rather than public authorities. In cases of dispute, the water user association is typically the first arbiter. If the solution is not satisfactory to either party, the case may be brought to public authorities such as a government ministry or the court system.

Experience with administrative methods of water allocation

The track record of such administered systems of water allocation has not been impressive. Despite growing water scarcity and the high costs of hydraulic infrastructure, water is typically underpriced and used wastefully, the infrastructure is frequently poorly conceived, built, and operated, and delivery is often unreliable. At the same time, there are high fiscal costs stemming from the construction of hydraulic infrastructure, from the institutional bureaucracy to support the design and execution of the projects and to set and collect water tariffs; and from the cost of operating and maintaining the system. Many of the large multipurpose hydraulic projects (irrigation, hydropower, flood control, urban use, etc.) were undertaken on political rather than economic grounds. They were justified using unrealistically high estimates of water availability and economic benefits, and unrealistically low estimates of costs (see box 1). The costs tend to be high because of inappropriate

1 In terms of the property rights literature, the residual property rights are weakened.

design, stemming in part from poor studies done prior to start-up; long gestation periods resulting from funding shortfalls due to changing government priorities and poor capital programming and budgeting; few managerial incentives to control costs; and reported corruption that typically involves kickbacks from construction companies.

BOX 1: PUBLIC HYDRAULIC PROJECTS

Governments from both developed and developing countries have invested heavily in public hydraulic projects. Too often, the results have been far below expectations while the costs have been much higher than anticipated. By the end of 1993, the Government of Peru had spent US$ 3,4 billion (in constant 1993 dollars) on nine coastal multipurpose projects. Although some of these projects have been in execution for over two decades, by 1993 they had realized only 6.6 percent of their planned expansion in irrigation and none of their planned hydropower generation capacity. While the primary justification of these projects was irrigation, the estimated cost per hectare of these schemes at completion ranges from US$ 10,000 to US$ 56,000 even while irrigated land in these areas typically sells for about US$ 3.000 (see World Bank 1995).

Water resources development in Asian countries typically accounts for 20 to 25 percent of total public investment. However, in Sri Lanka, the Mahaweli Development Program alone, at its peak, absorbed 6 percent of GDP and 44 percent of public investment expenditure, thereby crowding out other priority public investments. The costs of land development, excluding headworks, were US$ 12-15,000 at 1987 prices, compared to US$3-5,000 in other Asian countries. Even with a double cropped paddy, the economic returns from the earlier, and cheaper, projects were found to be low or negative. Since not even O & M costs subsequently be recovered, new settlers benefited from massive subsidies and their spatial distribution, if anything, aggravated social tensions (see Frederiksen, Berkoff, and Barber 1993). Similarly, the performance of Pakistan's 13,000 public tubewells has been poor. Despite these tubewells receiving 55 percent of total O & M expenditures even though they account for only 10 percent of irrigation water supplies, their pumping capacity declined an average of 4-6 percent annually, with 20 to 45 percent of public tubewells not operating at any one time as compared to 10 percent of private tubewells (see World Bank 1993).

Administrative water allocation systems have tended to favor the relatively wealthy. Politically influential farmers manage to get easier access to water rights, which are obtained without charge and for whose use farmers pay only a small fraction of the cost of building and operating the associated irrigation infrastructure. In many countries, for cultural, political or religious reasons, water use is not priced at all. When it exists, the irrigation water charge in both developed and developing countries rarely covers the full cost of operating and maintaining the hydraulic system or irrigation infrastructure. Water charges,

therefore, are well below the long-run marginal cost of developing water resources (as is required for efficient economic pricing). The low water charge provides little incentive to conserve water or use it for high-value uses. Therefore, one often finds situations in which an urban municipality, such as Los Angeles or Lima, has to ration its water and forego potentially lucrative activities while farmers just outside the city grow low-value water-intensive crops such as rice and alfalfa.

While government ownership of water is considered necessary to ensure affordable water for the poor, it is the poor who are often denied access to municipal water. Because of operating inefficiencies of public water companies and political pressures to keep municipal water charges low, water companies find it difficult to expand coverage to all parts of the city. Thus, the wealthier residents in many cities in developing countries enjoy access to relatively cheap, municipally supplied water, while many of the poor in the same cities must resort to private water truckers to meet their daily needs at unit prices that are many multiples of those charged for city water. A review of water vending in sixteen cities reported in the 1992 World Development Report (World Bank 1992) shows that the unit cost of vended water is 4 to 100 (with a median of 12) times higher than water from piped city supplies. In some cases, households purchasing from vendors pay as much as twenty-five to fifty times more per unit of water than households connected to the municipal system. Example of this phenomenon are found in the cities of Karachi, Port-au-Prince, Jakarta, Nouakchott, Dacca, Tegucigalpa, and Onitsha (World Bank 1993).

Similarly, although public ownership over water is thought necessary to address environmental problems, most governments have failed to maintain water quality or control soil salinization. Unsafe water causes water borne diseases that result in the deaths of 3 million people annually and render sick more than a billion more. The discharge of untreated industrial waste, the runoff of agricultural chemicals, and poor land use practices in agriculture, forestry, and mining causes widespread degradation of land and water resources (World Bank 1993). Water logging and salinization have destroyed millions of hectares of fertile agricultural soils. In Pakistan, extensive waterlogging and secondary soil salinization has resulted in an estimated 10 percent of its irrigation system covering some 13.5 million hectares to be affected by salinity (Frederiksen, Berkoff, and Barber 1993). Sometimes public irrigation projects themselves lead to salinization. Until the 1960s, the Aral Sea in Russia was environmentally stable with a thriving commercial fishery. The massive diversion of the two largest rivers in Central Asia to expand irrigated cotton production eventually dried up the rivers and shrank the lake by 66 percent. Salinity increased, soils became waterlogged, fish spawning grounds dried up, and the fishery collapsed. An ecological catastrophe developed as winds picked up salt and pesticides from the dry lake bed, caused salt and pesticide storms, and ruined the productivity of the farmland (World Bank 1993).

Measures to resolve water shortages and improve water use

In attempting to address water shortages and other problems described above, most countries (often with the support of the World Bank) have followed three kinds of approaches: (a) technological solutions such as construction of new hydraulic projects and rehabilitation and modernization of existing systems; (b) management reforms such as better planning, changes in bureaucratic structure, changes in pricing policy, and modification of water distribution methods; and (c) communal management, which focuses on farmer and community participation (see Rosegrant and Binswanger 1994). As the costs of hydraulic infrastructure increased and as government budgets became tighter, the emphasis has shifted away from technological solutions towards improving the public management of water

resources through comprehensive and integrated approaches to the planning and management of water resources.

The management approach is perhaps best reflected in a policy paper of the World Bank (World Bank 1993) which takes the view that because of imperfections in water markets, they should be eschewed in favor of comprehensive administered solutions. "At the heart of the approach is the development of a comprehensive analytical framework for water resources management. Water resources should be managed in the context of a national water strategy that reflects the nation's social, economic, and environmental objectives and is based on an assessment of the country's water resources. The assessment would include a realistic forecast of the demand for water, based on the projected population growth and economic development and a consideration of the options for managing demand and supply, taking into account existing investments and those likely to occur in the private sector" (World Bank 1993, p.41). There is an underlying belief that careful planning and public administration will be able to devise investments and prices to achieve these goals. Proponents of such solutions claim that national plans such as the one described above will solve problems of allocation and prioritization and will allow long term investments to be made which will ensure that the demand and supply of water will remain in equilibrium. These advocates concede that such calculations are complicated but maintain that a relatively simple framework will suffice for most countries so that predictions can be made with some confidence.

Essential to the effective implementation of this form of solution is that users be charged the opportunity cost of water which "provides a measure of the scarcity value of water to society, thus highlighting any cross-sectoral differences in value, taking into account society's multiple objectives and water's multiple uses and interdependencies" (World Bank 1993, p.43). Proponents of administered solutions do concede that such calculations will require estimates of current and future demand and supply as well as investment alternatives and the costs of pollution. In particular, a great deal of information is needed to implement such solutions even if the demand and supply curves could be accurately estimated. Moreover, for political or social reasons, it may be impossible to raise water charges to levels that reflect the scarcity value of water.

In evaluating the efficacy of such approaches to the allocation of scarce water resources and in comparing them to alternative systems such as tradable property rights in water, care must be taken to ensure that the same things are being compared. The usual approach of strong advocates of administered solutions (and World Bank 1993 is no exception in this regard) is to point out the existing market imperfections, which reduce the efficiency or effectiveness of water markets, and then to compare this situation with an administrative solution which involves a far seeing, incorruptible, influence-free administrative body that is able to estimate all of the demand and supply elasticities as well as the alternative rates of return between water investments and investments in other parts of the economy and then be able to design and implement the correct policy. In reality, administrative bodies are usually captured by one interest group or another, are rarely farsighted, are unable to estimate future demands with any accuracy, are unable to set and collect appropriate water charges, and in general have many more imperfections than the markets that they are supposed to replace.

A further drawback of the administrative approach is that it tends to favor large scale investments over water conservation. Public choice theory predicts such outcomes in that there are few rewards for administrators from painstaking improvements in water efficiencies such as via better pricing policies. Rather the glamour of large projects and the attendant publicity and power that this brings provide far stronger incentives. In contrast, attempts to

set prices that reflect the true cost of water provision are unpopular and infeasible. Without such prices, there is little incentive for users to conserve water.

The example of the French system of river basin management so often cited as evidence of the strength of decentralized administered solutions is not telling. Without convincing evidence of the economic efficiency of such a system, inferences drawn from the fact that there are no water shortages mean little. Furthermore, the much vaunted use of water boards is not as successful in allocating new water investments as claimed because investment decisions are taken ate central government level. While there are shortages in some areas and sectors, in France there is no overall deficiency in water supply. The usefulness and replicability of the French model to less developed countries with greater water shortages and more stringent fiscal and institutional constraints is therefore questionable.

In conclusion, while the integrated water resources management approach has good goals and a healthy emphasis on empowering and strengthening water user institutions and stakeholders, difficulties with finding incorruptible and competent administrative bodies that are able to design and implement investments and pricing policies effectively suggests it likely that a system of secure and tradable water rights, despite market imperfections, may more closely achieve the water resources management goals in water-scarce countries.

Tradable Water Rights Regimes

What are tradable water rights?

The key characteristics of tradable water rights are that they are secure and can be legally traded under the guidelines established by a legal, regulatory, and institutional framework. In all cases, the water rights are separate from land and thus may be traded separately. Ideally, the water rights should be allowed to be sold at freely negotiated prices to anyone for any purpose. However, sometimes countries impose restrictions such as requiring the buyer to use it for some beneficial purpose and to require that they only be sold to a public agency at an administratively set price, thereby weakening the property right associated with the water right (see example below from the western United States).

Like holders of conventional water rights, holders of tradable water rights would be bound to follow laws and regulations such as those relating to water quality; in addition, there may be laws such as ensuring that a certain minimum flow in a stream or river is maintained for environmental or recreational reasons and that third party water rights are not damaged by the water trade[2]. Like conventional water rights, tradable water rights may be defined volumetrically, as a share of stream flow or stock of water in a reservoir, or by shift. Similarly, the enforcement of tradable water rights may be carried out by the same means and by the same institutions as conventional water rights. Typically, water user associations would play a strong role, with public authorities playing an arbitrator's role in the case of disputes. For rights to be fully verificable, they must be recorded in a public registry. This is important for long-term secure transfers to occur. When such registries do not exist, or

2 One of main sources of hydrological third-party effects stems from "return flows", which is the water returned to the ground after use (e.g., the irrigation water that was not fully absorbed by the crop), and which may infiltrate down to an aquifer that later joins a water source. If another user has rights to this water and if the upstream user were to sell all the water he received to another user whose return flow was different or was no to the same location, the rights of the downstream user would be negatively affected. The return flow problem exists whenever the water available in the lower reaches of the river is substantially greater than in the upper reaches (adjusting for any water from tributaries).

when water trades are not legal, one frequently observes spot sales of water or the leasing of water for a season in what could be called an informal water market.

Informal markets, whereby individuals or groups of water rights holders sell water to other users at freely negotiated prices, have evolved spontaneously in many countries as a response to public allocation of water that is not in line with private needs. A 1990 survey of surface water systems in Pakistan (Pakistan Water and Power Development Authority 1990) found active water trading for irrigation water in 70 percent of the watercourses studied. In India, an estimated one-half of the area irrigated by tubewells belongs to farmers who buy water (Shah 1991). In the Maghreb countries, private arrangements for trading water exist among farmers, even though it is illegal. While such markets have had some success in resolving water shortages and reallocating water toward higher-value uses, the fact they are not supported by existing laws makes such transactions to be limited to spot sales of water or to the sale (lease) of water for a single year rather than to permanent sales of water rights. The difficulty in enforcing contracts in such a market has also tended to confine the transactions to those within the same sector, often between neighboring farmers. The lack of long-term secure access to water under such a system also discourages investment in activities that require access to large quantities of water. Thus such informal water markets can realize only part of the potential gains from trade and do not strictly fit the mold of tradable water rights regimes that are analyzed in this paper.

Countries promoting tradable water rights

To allow water users to secure water on a permanent basis as well as to facilitate water leasing, some countries have begun to pass legislation to permit secure and well-defined tradable water rights. The motivation for these countries to introduce tradable water rights is given below along with a description of the legal framework.

Chile's move to tradable water rights began soon after the change of Government in 1973 from a socialist one to one that stressed property rights, open trade, and economic liberalization aimed at improving economic efficiency and resource allocation. Introducing tradable property rights to water was a natural extension of the reform process: it aimed to strengthen property rights, allow flexibility in water use, and empower water users by requiring their consent to any reallocation of water and compensation for any water transferred. It also allowed the Government to drastically reduce the enormous financial resources for building new water infrastructure and for executing operations and maintenance, although this was partly a consequence of the very large investments in water infrastructure that had taken place in the decades preceding the switch to tradable water rights.

Although Chile's water market started functioning in 1976 following the redistribution of previously nationalized land and water resources to the private sector, it became more effective following the passage of the Chilean Water Code in 1981. Under this law, the State grants existing water users (farmers, industrial firms, water and power utilities) property rights to both surface and ground water without charge. New and unallocated water rights are auctioned. The water rights are completely separate from land rights and their private property status is based on the property laws of the Civil Code. Subject to certain regulations, these rights can be transferred or sold to anyone for any purpose at freely negotiated prices. Thus there is no requirement that the water be used for a particular purpose and no allocation of rights according to pre-determined priorities. As with land and most other commodities, the laws of supply and demand determine the allocation and use of water, once assigned.

Water rights are acquired by being recorded in a public registry as either consumptive or non-consumptive, temporary or permanent. Permanent consumptive rights are defined in volumetric terms (e.g. liters/sec) unless there is insufficient water to satisfy all water rights holders, in which case the water is distributed proportionately. Temporary (contingent) consumptive rights, which are particularly useful when there is storage availability, can only be honored if all consumptive rights have been met. Non-consumptive rights, used for hydropower generation, grant the owner the use of water as long as it is returned to its source at a specified location and a specified quality. Although non-consumptive rights outnumber consumptive rights by 2 to 1 in volumetric terms, the bulk of the estimated 300,000 owners of water rights hold consumptive rights, with agriculture accounting for 89 percent of such rights (Rios and Quiroz 1995).

The monitoring distribution, and enforcement of water rights is carried out by water user associations at the level of the river basin, primary canal, and secondary or tertiary canal. In principle, all hydraulic infrastructure is meant to be owned and operated by private entities. However, some of the largest dams are still awaiting the transfer to water user associations since the Government is not fully convinced that they will be able to operate and maintain the system satisfactorily. In the meantime, they continue to be administered by the General Directorate of Water (DGA) within the Ministry of Public Works, even though all the water in their reservoirs is owned by private entities.

Mexico: While the impetus for Mexico's 1992 water law came partly from growing water scarcities and a desire to rationalize water use, it was driven more directly by broad economic liberalization and by a desire to control the increasing fiscal costs of supporting the centrally administered water management system. As Mexico's agriculture moved from a centralized, highly regulated system to a market-oriented one, policy makers realized that the full benefits of the new agrarian policy with secure property rights to land would not occur with a topdown water allocation mechanism under which farmers had precarious water rights that could only be used for a specific crop. Only a system of well-defined, secure tradable water rights would provide the flexibility of water use needed to be able to respond to changing crop prices and crop demands following economic liberalization. Policy makers also realized that the government could not afford to continue to spend 0.5 percent of GDP on O & M activities or to exploit new and expensive water sources to meet increasing water demands (see Rosegrant and Gazmuri 1994b).

As a result of a Constitutional restriction and lack of consensus on the need for tradable property rights to water, Mexico's new system of tradable water rights gives less security to water users than its Chilean counterpart. Under the Constitution, all water belongs to the Nation and this property right is perpetual and non-transferable. The 1992 water law, and its regulations issued in 1994, gives water rights by means of "concessions" to individuals or legally defined groups of individuals, and by means of "grants" to government departments or agencies. The concessions are given for periods of five to 50 years, with the norm being over 30 years to ensure security of the water right. However, the law simultaneously mentions the possibility of forfeiture for reasons of public interest; if the water has not been used "efficiently", or if it has not been exploited for three years.

The fundamental basis for initial allocation of water rights is the existing informal or formal water right already held. The initial concession of water is based on the normal volume of consumption of water by the individual or group and is for full diversion of the water with no obligation to maintain any return flows. Although the rights are specified in volumetric terms, in practice the rights are proportional since the water user associations are to allocate any deficits or surpluses proportionately across all existing rights. While the quality of the water discharged is specified in the concession, it is only monitored in the case

of non-agricultural use. For the first time in Mexican water law, the new law establishes strong explicit protection of the environment. The rights are recorded in a public registry, which includes the record of the extraction and releases of groundwater. There are no regulations on the length of transfers of water rights or on the amount of water rights traded. However, at present, there are significant restrictions on the transfer of water rights. These restrictions are quite serious for trades between sectors, with indications that the *Comision Nacional de Agua* (CNA), a public commission, will play a strong role in approving and brokering intersectoral trades. There is strong protection from third-party effects through the prohibition of damaging transfers or setting of compensation by the CNA. Despite these restrictions on trading, the new law is sufficiently flexible that it should be able to evolve, if market solutions prove to be efficient, to one where water transactions can be smoothly accomplished, with a greatly reduced role for the State.

Peru: The motivation for Peru's water reform came with the realization that existing water legislation and policies, which had proved unworkable, were even less likely to work in the future as a result of increased fiscal constraints and weakened public institutions. By 1992, following several years of virtually no public spending for maintenance or rehabilitation of public irrigation structure, many public irrigation systems faced a high risk of failure. Water delivery became more irregular, water quality deteriorated and water conflicts grew. There was also widespread reporting of water theft. Even in areas where water was scarce, it continued to be used wastefully. Although Peru's existing water law specified priorities for water use, there was no practical way to implement them. Thus, while residents of Lima were rationed in their water supply, the water company incurred high water losses and farmers just outside Lima continued to grow low-value, water-intensive crops such as rice and alfalfa. In addition, the threat of having the State expropriate one's water rights for higher priority uses discouraged many worthwhile investments that required assured supplies of water. At the same time, many of the large public investments in hydraulic projects, which were supposed to make Peru self-sufficient in agriculture, proved ineffective, uneconomical and a large fiscal drain.

To address these problems, the Ministry of Agriculture proposed, as the centerpiece of its water management and irrigation development strategy, a new water law modeled along the lines of the 1981 Chilean water code. Under the proposed Peruvian law, *existing* water users are to be given property rights to water *without* charge. Rights to *new or unallocated* surface water are to be distributed via *public auction*. The rights may be traded at freely negotiated prices provided that the trade would not reduce water availability to others and that there is enough water to maintain a minimum ecological flow and to maintain the accustomed quality of life in cities and towns. Rights may also be mortgaged or leased. The law prohibitis altering water quality to the detriment of flora or fauna; however, rather than proposing specific sanctions and fines, it defers to the Environmental Code and Environmental Authority to set and enforce water quality standards (For more information on Peru's water problems and its proposed water law see World Bank 1995).

Under the draft law, water rights are to be acquired by being recorded in a public Water Rights Registry, specifying, *inter alia*, the flow or volume (which may be specified in terms of percentage of stream flow or in shifts); the point at which the water will be diverted; whether it is for consumptive or non-consumptive use and whether it is for permanent or temporary use; the point and form in which the water will be returned to the river system; and the amount paid for the rights. The law also establishes a property tax on water rights. In contrast to the current law, the new rights do not have to be used for any specific purpose, there any no priorities among water rights for different purposes, and the water right is

separate from the land right for both surface and ground water. There are plans to pass the water law shortly and to issue its regulations within the calendar year.

The Western United States: Given the shortage of water in the western United States, the riparian rights regime of the eastern United States that disallowed water diversions could not work in the West. Thus the western states developed a system of property rights to water based on the prior appropriation doctrine: those that first diverted water and established beneficial use of the water obtained primary rights to it. Successive claimants could only obtain water rights that were contingent on those with prior water rights having received their allocations.

Although water rights regimes vary widely between states, their common characteristic is that the uses to which water is put cannot be changed without authorization. Only in the case of one large project in Colorado was relatively unrestricted trading of water rights permitted (Box 2). Obtaining authorization to change water use is often a lengthy and costly process, which involves obtaining consent from the relevant governing body after public hearings in which people who may be damaged by the change in use have a right to object. Perhaps the most extreme example of this system occurs in California where water is diverted by various types of infrastructure from the northern part of the state to the southern part. The agricultural sector makes up only 4 percent of the GDP of the state yet receives about 44% of the water used in the state -environmental use also is allotted 44% while the urban and industrial sector receives only 11%. In the agricultural sector water rights vary widely from inherit sources of cheap water to water that is highly subsidized. Some farmers have rights to water for as little as $3.50 per acre-foot[3] compared with costs of up to $3000 per acre-foot that some of the most water-short municipalities have paid during certain periods.

The reason that there is such a huge difference in prices in the various uses is that transfers between different types of use are either forbidden or highly restricted. The anomalies that these restrictions cause are extreme; water is so inexpensive to some users that rice is cultivated in the desert while at the same time some municipalities have built desalinization plants to supplement their supplies of water. Furthermore, incentives to conserve water use are perverse. In agriculture many farmers are forced to operate under a "use it or lose it" rule while in urban use the rationing that occurs during periods of drought is based on family use during periods of plentiful water. Therefore, the more water households use during normal periods, the larger the allocation during times of water shortage.

Clearly the system requires reform, yet the political complications that any reform brings are significant. Assigning to farmers the ability to simply sell their rights would give them millions of dollars in windfall gains on top of the large subsidies that they have already received. This arouses a great deal of popular distaste for making water rights transferable, sentiments that are reflected by the farmers themselves who fear that once rights become transferable they would not be compensated for what they are giving up. Such problems illustrate the deficiencies of administrative solutions to the allocation of scarce water resources. Severe restrictions on the tradability of rights leads to the inefficient allocation of resources, exactly as Coase points out (Coase 1960), yet the legislative and administrative considerations involved in reforming laws and procedures allow interested parties great latitude to attempt to influence how the gains from reform are distributed. In addition, the very large number of people affected by any reform make it costly and difficult to reach a solution that is agreeable to most parties. That is not to say the reform is

3 An acre foot of water is the amount of water needed to cover one acre to a depth of one foot.

undesirable but it does illustrate the problems inherent in circumstances where transactions cost are high. The California case also shows that even when institutions are relatively well developed, administrative solutions to apportioning scarce water among different groups can lead to anomalies that defy logic and waste resources.

BOX 2: WATER TRADING IN COLORADO'S BIG THOMPSON PROJECT

A notable contrast to the various restricted water right regimes which exist in the western United States is provided by the Big Thompson scheme through which 310,000 acre feet of water have been supplied to users in the Northern Colorado Water Conservancy District. The scheme, which brings water from the headwaters of the Colorado River through a tunnel underneath the Rocky Mountains to northeastern Colorado, was partially paid for by subscribers in the water district in return for the right to use the water. Originally, the water was distributed based on an assessment of the need of municipalities and farmers for supplemental water supplies, but the users were given perpetual contractual rights to the water that they were allotted. Soon after the scheme became fully operational, it became apparent that water demand varied significantly between users and areas within the district. The Northern Colorado Water Conservancy therefore established a system that allowed water rights to be traded on a permanent basis with a requirement that the water be put to "beneficial use" and that users abide by the rules of the Conservancy. In addition, water cannot be sold outside the District. A central registry records ownership and ownership transfers. The system has become so refined that a simple postcard is used to notify the Conservancy of a transfer. An important reason for the smooth functioning of this market is that no one has rights to return flows (see footnote 2). Thus no third party rights to return flows need to be taken into consideration when reviewing the beneficial use criteria. As a result, downstream users get the benefit of return flows water users upstream but they have no rights to them and if upstream users transfer their rights, return flows are lost.

An extremely sophisticated market has evolved for this water. Many different types of contracts are used, from straight transfers to the purchase and sale of options to water. Within the District there are no restrictions on transfers between different types of use. Nevertheless, the infrastructure requirements for flexible water markets to operate can be substantial. However, within the Conservancy District these are all in private hands. Water is transferred through privately owned "ditches" and the distribution mechanisms are all privately owned and operated. It is even possible to own shares in the pipe carrying water from one location to the next. The Conservancy's role is to record transactions and to check to ensure that there is no cheating by those taking off water. The system appears to be operating efficiently and although there is undoubtedly an economic cost to owners of water rights not being able to sell their water outside the District, within it water appears to be used at its highest value.

Advantages of water markets

Tradable water rights allow the "opportunity cost" of water to be reflected in its price which creates a built-in incentive to put it to the most productive use. For example, if farmers were able to sell their water rights at freely negotiated prices, some might choose to generate extra income by selling any surplus rights to a neighboring city where the water has a higher value[4]. Often they can generate as surplus by using more efficient irrigation techniques or by switching to less water-intensive crops. In addition, buyers of water rights are likely to use water-saving devices. Thus, most of the new fruit farmers in Chile use water-saving irrigation technologies and when Chile's main water company, EMOS, realized that it could no longer obtain water rights without charge, it invested in a program to significantly reduce physical water losses. A recent study evaluating the Chilean water market experience finds that the net gains from the trading of water rights, as opposed to continuing with existing allocations in the Elqui Valley were about $1000/share, roughly equal to the price of these water rights. In the Limari Valley, the gains from trading shares in the Cogoti Reservoir were estimated to be three times the recent transaction prices of $3000/share (Hearne and Easter 1995).

Thus a tradable water rights system can lead to voluntary conservation and increases in the productivity of water without having to increase water charges. For example, in Chile, water charges *fell* following the introduction of the tradable water rights regime. The fall occurred because this regime facilitate the transfer to user groups of the responsibility for carrying out O & M activities and for setting water tariffs and because users were able to carry out O & M activities at a much lower cost than the Government. Despite the lower water tariffs, the opportunity to sell water ensures that scarce water is not used wastefully. Compared to the often-recommended volumetric pricing of irrigation water at its long-run opportunity cost (as in World Bank 1993), the market-based approach to water rights is more acceptable to farmers and is politically easier to implement. Since the value of traditional water rights are already capitalized into the value of land, imposing opportunity-cost pricing of water is seen by farmers as expropriation of these traditional water rights, which creates capital losses in established farms. One the other hand, the establishment of tradable water rights formalizes existing rights to water, increasing the capital value of land. Thus the main difference between the two approaches is who obtains the economic rents of water (see Rosegrant and Binswanger 1994).

Tradable water rights can help shift water to higher value uses in a way that is cheaper and more just than other alternatives that may include building expensive new hydraulic infrastructure, confiscating water from farmers, or raising water charges substantially to force farmers to conserve water and free-up water for the higher value uses such as for "raw" city water. Although the conveyance infrastructure to transfer traded water must be built if it does not exist already, the cost of building it is often less than that of generating new water rights as the following example shows. The city of La Serena in Chile was able to meet its rapidly growing demand for water by purchasing excess water rights from farmers at a lower cost than the alternative of contributing to the construction of the proposed Puclaro dam. (The construction of the dam has now been postponed indefinitely). Farmers got a good price for their water and faced incentives to use more efficient irrigation techniques. Water conservation may also turn out to help control soil salinization. In cases

4 The price of property rights to water has little relation to the water charges or tariffs for O & M activities. To use an analogy from the condominium market, one can think of the price of water rights as the purchase price for the apartment and the water tariff as the condominium fee.

of salinization, the primary reason is over-watering in areas where there is insufficient drainage. Therefore, by creating tradable water rights Chile was able not only to avoid the water conflicts than often come about when government confiscate water from farmers and divert it to urban domestic consumption, but also to avoid the environmental costs associated with new dam construction. It may also have helped control soil salinization.

Farmers also benefit from having more secure water rights and an asset than can be used as collateral for lower interest loans. Secure water rights are particularly beneficial for smaller farmers, who have been most vulnerable to reductions in their water allocation over time and who have few other sources of collateral. Under administrative allocation, water administrators often five new water rights to politically influential water users even when there is not enough water in the system to meet existing water rights. This reduces the water available to others. Tradable water rights, by empowering existing users, will help reduce the abuses of an administrative allocation regime and give increased assurance to poor farmers that their effective water availability will not be reduced. And because of their divisibility, water rights also give farmers the possibility of mortgaging only part of their water rights for small loans, rather than their entire land and water holdings.

In addition to stimulating growth directly by improving the productivity of water, tradable water rights will encourage investment and growth in activities that require assured supplies of large quantities of water. The existence of such rights assures investors that their water rights will not be subordinated to those of other users during times of shortage and that, in fact, they will be able to buy water from those with a less valuable use for it. While Chile's rapid growth in fruit exports is based on a number of factors, its 1981 water code allowed the growth in investment and production of fruits (such as table grapes) to occur without conflict. It is interesting that Chile's sustained annual growth of 6 percent in agriculture during the 1980s occurred despite the fact that there were no public investments in new hydraulic infrastructure from 1975 to 1990. Although there had been heavy investment in infrastructure during the previous decades, it is unlikely that this growth could have been achieved without significant further investment if the previous system of allocation had been used. Indeed, tradable water rights are most effective when relative demands are changing rapidly because relative prices quickly reflect the new higher value usage. Under schemes of administered allocation, it frequently takes years for planners to recognise that relative demand has changed. Unlike water-scarce areas in other countries, it is difficult to find instances where obviously high-return activities cannot be undertaken because the water needed for them is instead being used for low return activities. For example, presently 99 percent of Chile's urban residents and 94 percent of its rural residents enjoy access to potable water, typically for 24 hours a day. This contrasts sharply with comparable rates of coverage of 63 percent and 27 percent in 1970 in Chile and with developing countries elsewhere in the world (Rosegrant and Gazmuri 1994a). Because of subsidies to lower income water and sewage users and because Chilean water companies are allowed to charge a tariff to cover costs, not all of the access to water can be attributed to the introduction of tradable water rights. However, what is notable is that both agriculture and increased urban access occurred at the same time, something that might not have happened if water use had been allocated administratively.

Tradable rights should also stimulate private investment in new hydraulic projects. The secure rights will give potential investors the confidence that, once they obtain the rights to the water generated by their investment (e.g. storage reservoirs and conveyance infrastructure), it will be theirs to keep or sell to others (farmers, industry, hydropower and water companies). Secure rights to water could also attract private investment in large public hydraulic projects under construction, enabling faster and cheaper completion. Public

projects tend to run into enormous delays and cost overruns because governments run out of money and because there is less incentive to control costs. If the government wanted to privatize an ongoing project, it could do so by selling the hydraulic infrastructure and unallocated water and land rights associated with the project, but with the condition that buyers respect existing land and water rights. Of course a comprehensive legal and regulatory framework, as is typically prepared for the sale for public utility companies, will have to be in place prior to such privatization.

Problems in establishing water markets

Despite the advantages of water markets, there are few countries that have established them formally. The economic argument rests on the existence of market failure. Advocates of administered solutions claim these failures are so extensive as to rule out the promotion and facilitation of water markets[5]. Market failures arise because:

- There may be high transactions costs from setting up a new legal, regulatory and institutional framework, from obtaining information identifying potential traders and any third-party effects, and from making necessary changes in water intakes and conveyance infrastructure to effect the water transfers. There are also difficulties with defining rights for commodity that varies in volume.
- Capital requirements are very high and time horizons very long so that natural monopolies are created which require regulation, especially since water investments frequently produce joint product such as electrical power, recreation facilities, flood control and so on which raise pricing and allocation difficulties. These drawbacks could reduce the attractiveness to the private sector of investment in water infrastructure.
- There is sometimes an interdependence of water sources such as the possible relationship between stream flows and underground aquifers, which may require extensive and costly monitoring of the amount of water drawn from each source.
- There are public goods aspects of flood control, pollution control and disease control along water course which require government intervention.
- There are national security and humanitarian aspects of many water resources which may require control by government.

Moreover, there are difficulties that revolve around how the scarcity rents from water are distributed. Administrative solutions to allocating water allow for substantial lobbying efforts to protect vested interests and maintain the status quo. The widespread restriction on transferring water from one use to another are a testament to the power of such interests. This should not be surprising given the large percentage of water used by agriculture on the one hand and the obvious political power that agricultural interests have in most countries even though in most places agriculture represents a small and declining share of GDP. Nevertheless, the arguments advanced by such interest groups have to be considered when analyzing the desirability of introducing tradable property rights for water.

5 This sector draws heavily on World Bank 1993.

When and How To Establish Tradable Water Rights

Comparing water market and administrative solutions

The above section suggests that, because of water's peculiar characteristics, it is unlikely than an effective market for this commodity can develop spontaneously, or that an unregulated market would necessarily be preferred to administrative alternatives. It also suggests that there is likely to be much work to be done up-front before efficient and effective water markets can be developed. However, many of the above issues occur even under alternative ways of allocating water. Even under an administered system of water rights, the rights still have to be defined in a way that can be measured and the resulting allocation of water rights still needs to be enforced. The conveyance infrastructure required to effect transfers in line with priorities has to be built regardless of whether the priorities are determined by the market or by legal and administrative means. Similarly, the same environmental laws and institutions needed to enforce environmental quality under an administered regime can operate under a tradable water rights regime. The conflicts between consumptive and non-consumptive rights also exist under an administered allocation system and concerns of monopolistic pricing for water companies and hydropower are valid under either system (see Rosegrant and Binswanger 1994). For the bulk of the issues then, the question becomes which of the two approaches -tradable property rights or an administered regime- is likely to yield better results.

There are several reasons to believe that a water market is likely to function better than an administered allocation in water-scarce countries. Because a market system increases the value of water, there are greater incentives for defining water rights clearly, for improving their measurement and enforcement, and for establishing mechanisms to resolve disputes. Similarly, the transactions cost of identifying potential gains from transferring water will much lower if borne by beneficiaries than by public authorities. The conveyance infrastructure that must be built to effect the transfer is likely to be built more cost-effectively by the private sector, which has greater incentive to control costs. In addition, the decision to invest in infrastructure is likely to be taken on more rational grounds under a water market regime. Similarly, water user organizations, which must play an important role under either a administered allocation system or a water market regime will have a greater incentive to become stronger and better organized when water rights are well-defined and made transferable. Given the enormous inequities that administrative solutions to water allocation have brought, it is also likely that concerns with humanitarian aspects of water allocation will be better handled under a market regime.

A second type of argument against the introduction of tradable property rights in water is that institutional mechanisms for policing water rights markets and ensuring that monopoly rents are not being earned are weak. However, this argument applies *a fortiori* to administrative solutions. If institutions are not capable of ensuring a reasonably functioning market in water rights, it is hard to imagine how they could implement fair and equitable water administration, particularly given the political pressures to which such administrators are subject. Furthermore, weak institutions are unlikely to be capable of the omniscient behavior required of water administrators.

Another argument against the establishment of tradable water rights rests on the externalities that exist in the use of water, both negative externalities such as those related to return flows or the environment, and positive externalities such as those resulting from flood control. In most cases, there is no reason to think that their implications and impact would be very different under either regime. However, if these are substantial, the efficiency gains

from trading rights might be minimal or trades may have to be disallowed. At issue here is the degree to which externalities exist in water markets versus the degree to which improper pricing and allocation decisions under administrative regimes result in the wrong incentives and in misallocation. In many cases, tradable water rights internalize externalities that arise from water being wrongly priced. The example of the California system, under which it is rational for farmers to cultivate rice in the desert while towns are building desalinization plants illustrates just how badly administrative decisions can distort incentives. It is hard to believe that establishing tradable water rights accompanied with some regulations minimizing or internalizing negative externalities would not improve such allocation.

The case for implementing administrative solutions is therefore weak. Most of the problems cited against tradable water markets are present in one form or another in administered allocation. Nevertheless, proponents of administered solutions do raise interesting and important points which have implications for water markets. An important contribution of the aforementioned World Bank policy paper on water resources management is to focus attention on the administrative structure required for water markets. Many of the suggestions that it makes regarding the formation of river basin and water users associations are necessary if water markets are to perform well. The problem with solutions such as those suggested in the World Bank document is that they are incomplete and they do not allow for the manifest imperfections in public administration or for the difficulties in pricing water at its opportunity cost. If the institutional structures that they recommend can be addressed to tradable property rights in water, water markets will function far better than administered types of solutions.

Although a tradable water rights regime is likely to be superior to administered allocation regimes, there are upfront costs to establishing the new legal, regulatory, and institutional framework. Since these costs could be high, it must be confirmed at the outset that water is sufficiently scarce for the net benefits from water trading and from having more secure water rights to be larger than the transactions costs, which includes the initial legal, regulatory and institutional costs of establishing the regime, the costs of identifying potential gains from trade and any negative externalities, and the cost of implementing the transfers. In addition, one needs to ensure that a regime of individual property rights to water is politically and culturally viable. If, for example, there is no tradition of tradable property rights to land, a system of tradable property rights is unlikely to be accepted. Finally, one needs to make sure that there is a minimum institutional capacity to establish the legal and regulatory framework (with foreign technical assistance, if needed) and to monitor and enforce water rights. Without this capacity any scheme for the allocation of scarce water is unlikely to be successful. Determining *ex-ante* gains from trade and measuring transactions costs is a useful are for further research.

There are some factors than can help decide whether the gains from water transfer are likely to outweigh the transactions costs. If water is not very scarce, the need to define water rights clearly and to find effective institutions and mechanisms to transfer water are not necessary under either regime. No substantial transfers are likely to occur under either regime. Thus in the southern part of Chile, which receives large amounts of rainfall, very few water trades occur, even though there is a relatively unrestricted market for water trades. Similarly, if the transactions costs of transferring the water are extremely high, it may not be worthwhile to effect the transfer to the higher value use anyway. An important determinant of this is the infrastructure required to effect the transfers. In areas where there is full gate control over water flows or where there are adjustable flow dividers, the transactions cost to effect the physical transfers are low. However, in areas where there are fixed flow dividers in order to divide water flows according to a certain share, the transactions cost of changing the

gates are likely to be prohibitive. Thus in the main canal of the Maipo river near Santiago where there are fixed flow dividers there are few transactions; however, in the Elqui and Limari valleys slightly further north, there is an active market in water. Finally, if the private and public institutions necessary to operate a water market are just so weak or non-existent that it is impossible for a market to develop, there is no sense in trying to design laws and regulations to establish tradable property rights. In these cases, it is also unlikely that administrative solutions will work and the first step must be to foment the development of such institutions.

Transitional issues

Even though the above section shows that almost all the problems with allocating water via a market are likely to be present to an even greater degree when considering administrative allocation and distribution of water, there are ways of designing laws and implementing legislation to further reduce the problems stemming from water's peculiar characteristics. While the design and implementation of tradable property rights needs to be tailored to specific country circumstances, there are some general guidelines on how to more smoothly make the transition from an administrative water rights regimes to one based on tradable property rights. There are also design issues to be considered in addressing problems such as those arising from return flows, which are more of an issue under a tradable water rights regime.

Once it is determined that there are likely benefits from moving to a regime of tradable property rights to water, a public information campaign needs to be carried out to make policy makers and water users aware of the problems with traditional approaches and provide them with an understanding of the proposed operation and potential benefits of water markets. This is important to build support for the passage of legislation establishing such rights. It may be useful at this stage to prepare a draft water law based on the experience of other countries, but with appropriate modifications to tailor it to specific circumstances. An information campaign and debate can then help ensure that the final design and implementation of the legal framework is done in a transparent and participatory manner. Explaining draft versions of the law officially and publicly, but with a willingness to accommodate reaction is critical to success. Farmers and other water users have to be made aware that their major concerns and objections have been considered and dealt with. The process can also help identify and mobilize groups that stand to benefit the most from the proposed legislation. It is not unusual for this process to take two or more years.

Prior to implementing the law, there is a need to establish effective institutions to draft the regulations and to implement the law efficiently and fairly after approval. This requires ensuring that the water user associations and public institutions, such as water registries, water councils and watershed authorities, are able to carry out their responsibilities and that sufficient budgetary resources are devoted for their effective functioning. It may be useful to contract for technical assistance to draft the regulations and to strengthen water user associations as this stage. It is important to ensure that staff of the public institutions are capable, that they fully understand and support the new legislation, and that they are perceived to be honest and unbiased. Given the key role of public institutions in the initial allocation of water rights and subsequent operation of the water market, poorly trained or corrupt employees could prevent the market for water rights from ever developing or functioning effectively.

There are several issues related to the initial allocation of tradable water rights. For existing users, it may be a good idea that the water rights are granted without charge

recognizing that some farmers have already paid for their rights implicitly in the purchase price of their land and that the government is not likely to recover the capital costs of their investment in hydraulic infrastructure. For new and unallocated water rights, it is important that they be sold via auctions carried out in an open and transparent manner. Information on prices and volumes should be made publicly available, and minimal costs charged to enter the auction (which could be done by sealed bid). In particular, care needs to be taken that the poor are well-informed regarding the need to register these rights and the procedures for doing so. The advantages that the poor can enjoy from secure property rights can only come if they receive the rights to begin with. In addition to water user associations, the public media needs to be extensively used to ensure water rights registration. There is also a need to clarify that where there are large quantities of non-consumptive rights (hydropower), the non-consumptive rights do not prejudice consumptive rights. This may require specifying the volumes that will be released each month of the year (based on historic use of consumptive rights holders) and ensuring that any consumptive rights between the intake and discharge points are respected.

Where functioning water user associations exist, it is desirable to carry out the actual allocation in a two-step process: water rights should be first assigned to the water user associations based on past usage and then assigned to the individual users by the associations according to guidelines issued by the Water Council. The titles to water are registered only at the individual level and not at the user association level. The two-step method has two advantages over direct assignment to the individual. Firstly, it is easier for the water user association rather than the Government to verify past water usage of an individual farmer. Secondly, it leads to titling many users simultaneously. This "block titling" of water rights reduces unit costs and helps resolve conflicts. It will still be necessary to preserve a government role for resolving disputes in cases when an individual water rights holder disagrees with the decision of the water user association. This is particularly important when a water user association is dominated by a powerful individual or small group. It is also important to ensure that elections for the officials of the water user associations are conducted in a transparent and fair manner so that if members of the association are dissatisfied with the way it is being run, the can remove the officials that are not performing satisfactorily. While this will not eliminate unjust allocations or corruption, it will help reduce it and is still likely to more just and less corrupt than when unelected government officials are making decisions on water allocation and pricing.

For the second step of the initial allocation process, the guidelines may vary by region, watershed, and canal. It is suggested that where there already exist registered water rights and where there is sufficient water to honor all water rights, it is sufficient to simply have them re-registered in the new public registry of water rights. However, where the existing registry contains many overlapping property rights (the sum of water rights exceeds the water available), it would be better for the initial allocation to be based on past usage estimated by the WUOs. In situations where there have existed gross abuses of water rights, it is probably best to assign them to communities based on historic use and subsequently to individuals based on proportionally with irrigated land area.

Design Issues

The potential of water trades to infringe upon the rights or water availability of third-parties needs to be well understood and addressed. This is most likely to occur for agricultural "return flows" (see footnote 2). If a farmer were free to sell his entire irrigation water to users outside the area, users downstream that may have received the farmer's return

flows would lose their water without compensation (Figure 1). One way to address the return flow problem is by having both the water user association and public body such as a watershed authority approve requests for changes of water intake to ensure that third parties are not affected. Since virtually all sales of water outside the area will require a modification in water intake, this should in principle protect against water sales that cause negative hydrological effects to third parties. However, the way that this rule is enforced could either penalize downstream farmers or stifle the market. Some alternate ways for formulating the regulations to address this issue are discussed below.

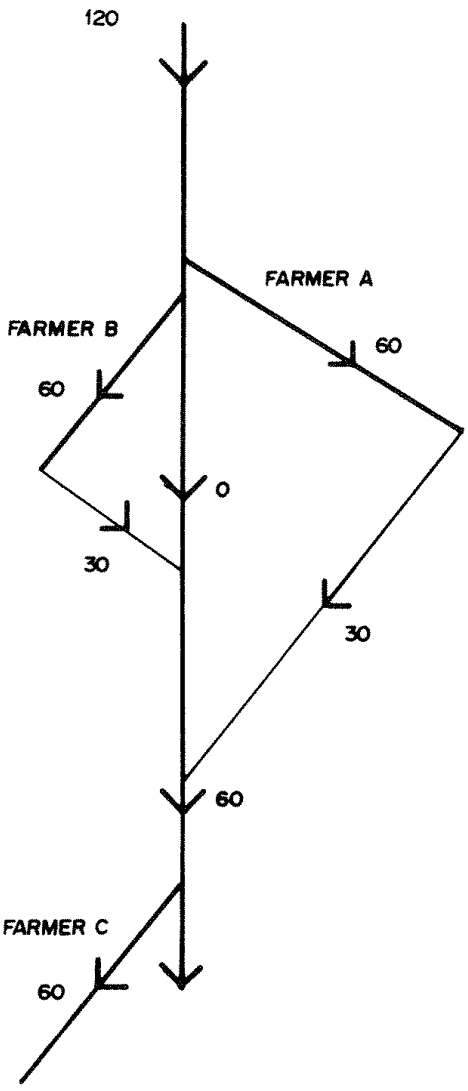
One option is to adopt the Chilean approach. In Chile, all permanent consumptive use rights are expressed as a share of water availability (either in a stream or reservoir), with the shares summing to 100 percent (unless the water availability is greater than a specified amount, in which case it reverts to volumetric measurement, with the excess water going to holders of contingent rights). If, because of the return flow effect, a sale of water rights results in reduced water availability, all consumptive rights holders, including the entity buying the water, would share in the reduced flow (Figure 2). The system works fairly well in Chile, where few irrigation systems have significant return flows. In the case of two Chilean rivers with high return flows, the Elqui and Aconcagua, their respective water user organizations have prohibited upstream users from selling their water to users whose return flows would not flow back into the river. In countries which have significant flows, the Chilean system could restrict trades in too many rivers or reduce the amount of water available to downstream users. Thus other options may be preferable.

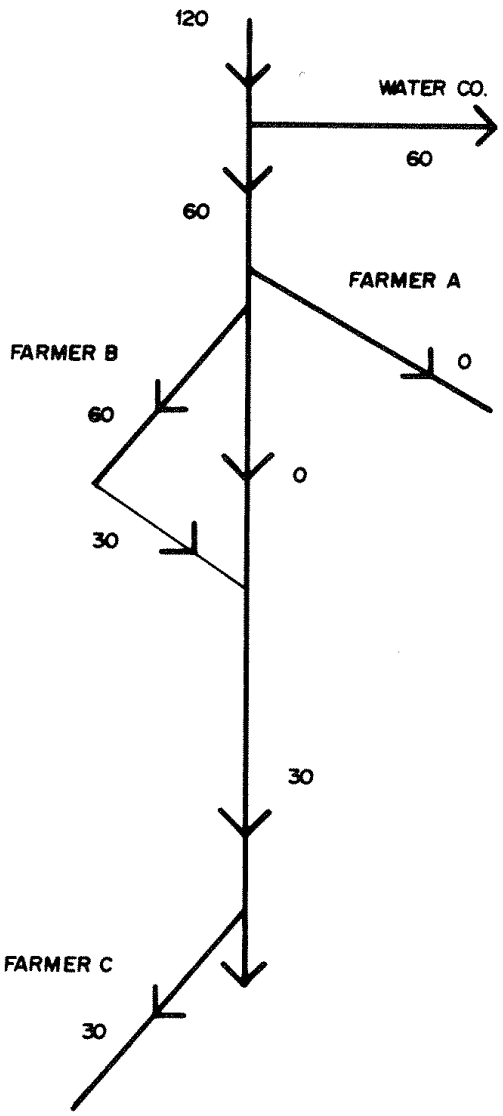
An alternative formulation is to specify in the regulations that all water rights will have both a consumptive and non-consumptive portion. The consumptive portion could be sold without restriction. The non-consumptive part could be sold if it did not deprive others of water. Thus, where there are no return flow issues (most transfers within the same water basin for the same use), owners would be free to sell 100 percent of their water rights. Because of the difficulty in calculating the purely consumptive portion of the water, this approach, which is the similar to that used in California, would not be appropriate for developing countries. However, two variants of the approach might be suitable. One variant is to publish a chart showing coefficients for the consumptive share based on type of irrigation and crop categories. This would reduce the need for each seller to justify the consumptive portion of the water while giving sufficient protection to downstream users (Figure 3). A subset of this variant which may be preferred in some cases because of its low administrative costs is to have a flat presumptive return flow requirement for out-of-basin transfers. The second variant combines the consumptive portion approach with the Chilean percentage share approach with one important difference: the volume that a person could sell would be specified as a share of the *upstream* river flow rather than as a share of the total volumes received by farmers. In areas where there are no return flows this would be no different from the Chilean case; however, in rivers with significant return flows, it would offer greater protection to downstream users without restricting inter-sectoral sales of upstream rights (Figure 4).

It is desirable to introduce a tax on the holding of property rights for water. It is crucial that the tax rate be determined solely on the holdings of water rights (for the same type of water right) and not by the purpose for which the water is used or the quantity of water used. In this way, the tax has some desirable properties similar to those for land taxes: it does not distort production decisions and it helps recover public investment costs in infrastructure. It also discourages the buying of water rights when the buyer has no plans to utilize the water efficiently. In addition, for equity and administrative ease, it is suggested that the regulations exempt farmers and other users that hold small quantities of water rights.

FIGURE 1
RETURN FLOW PROBLEM WHEN UPSTREAM
FARMERS CAN SELL 100% OF VOLUMETRIC RIGHTS*

Initial Situation** After Sale





Farmer A, B, and C all receive 60 units apiece. 50% of A and B's water is returned to river

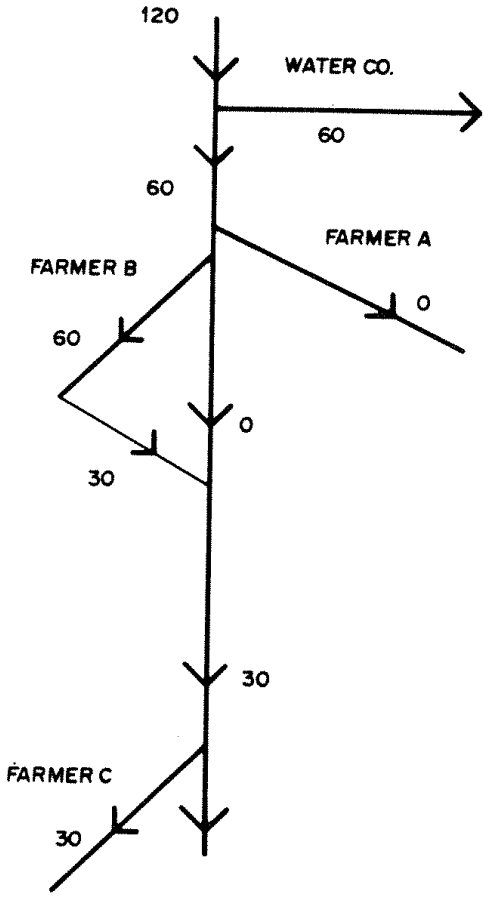
If A sells all his 60 units to a water company, C will receive only half of what he normally receives

* All diagrams assume the upstream water flow to be a constant 120 units/sec. When water flow drops to below 120, all users (including the water company) will experience a proportional decline.

** Assumed to be the same in Figures 1-4.

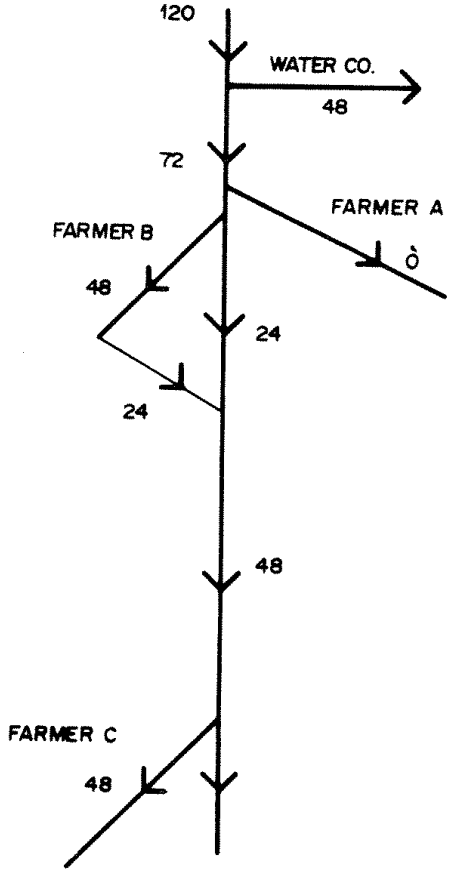
FIGURE 2
HOW CHILE HANDLES INTERSECTORAL TRADES

Without WUA Action



When A sells all his shares to water company, the company will initially attempt to receive the full 60 units. However, this will reduce C's availability to 30, even though C has rights that are equal to the water company's rights.

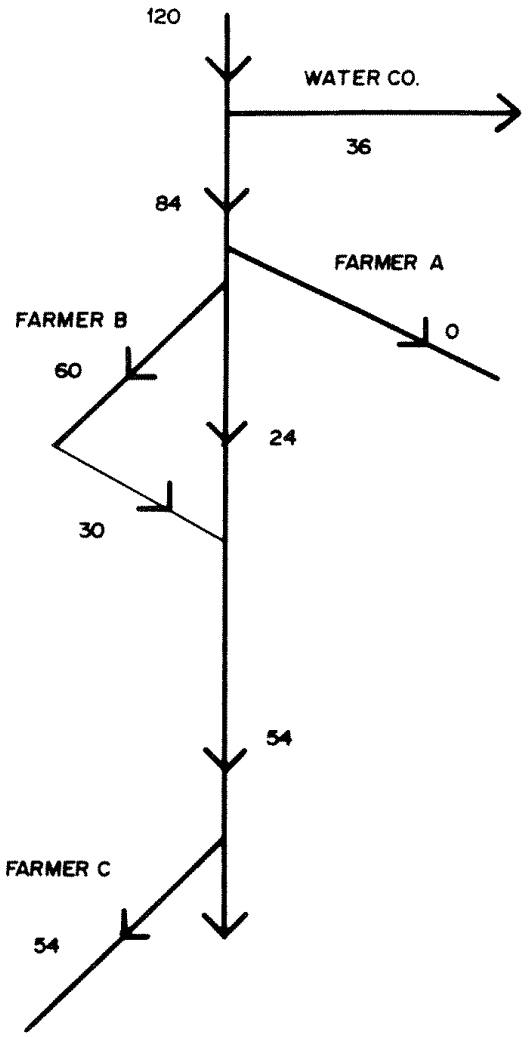
WUA Restores Equilibrium



The water user association will adjust all flows until the water company, B and C all receive the same volume of water (since they have the same shares). This will occur when everyone gets 48 units apiece. Thus A's sale has reduced water availabilities to B and C by 20%. If this is felt excessive, the WUA can simply prohibit intersectoral trades in the upper reaches of the river.

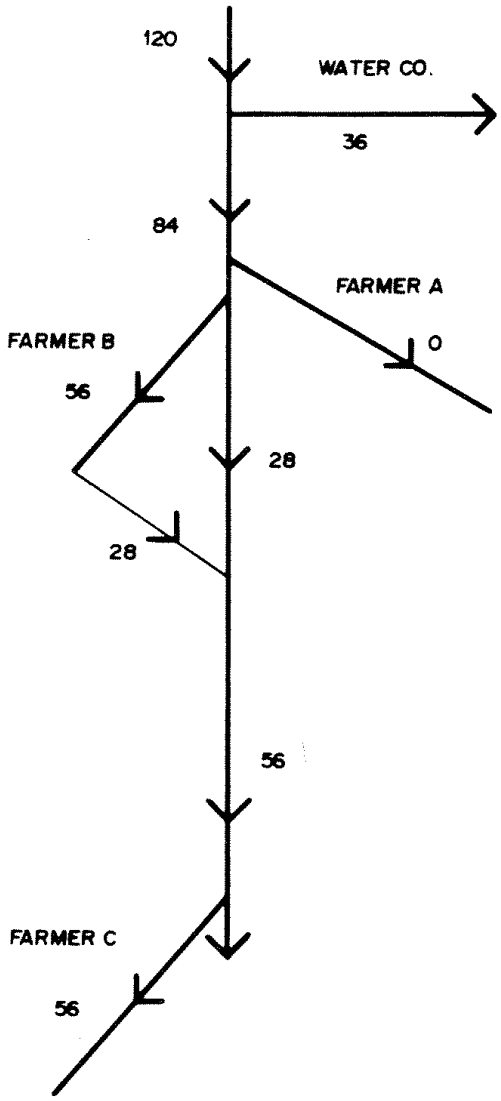
FIGURE 3
VARIANT 1 SOLUTION

Without
WUA Action



According to published chart, Farmer A is determined to have a 60% consumptive portion (in actuality, it was 50%), thus he can sell on 60% of 60 to users outside the area. If B were to continue receiving 60 units, C's allocation would be cut to 54.

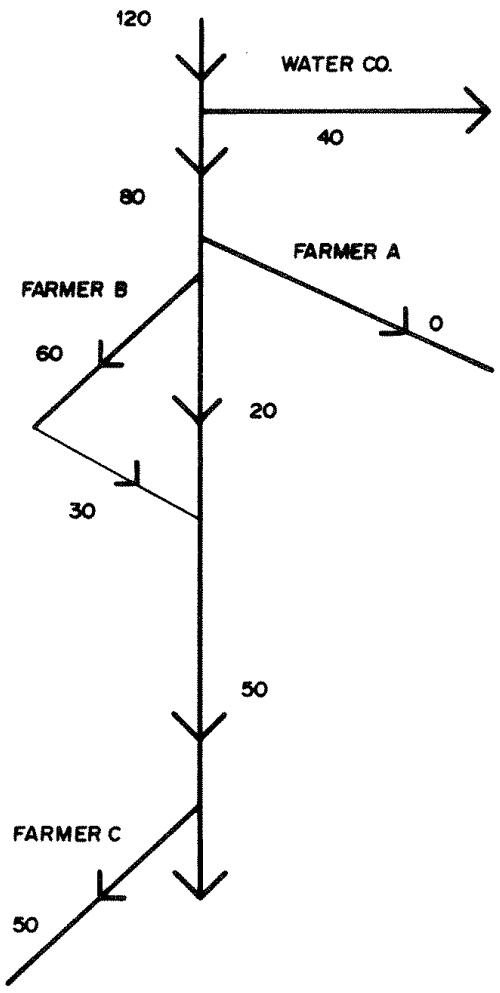
WUA Restores
Balance



To restore the equality between B and C, the WUA would reduce B's allocation until equality is achieved, in this case at 56 units apiece.

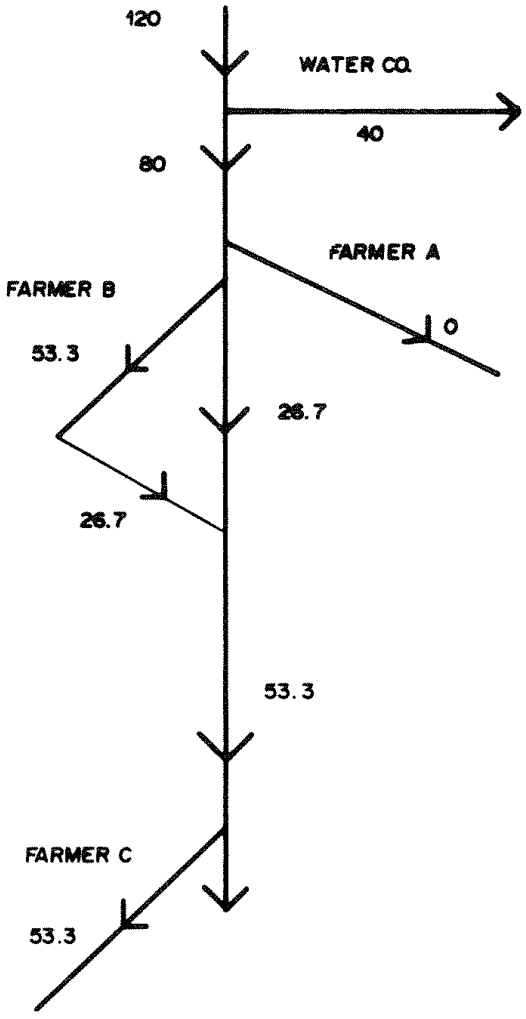
FIGURE 4
VARIANT 2 SOLUTION

Without
WUA Action



Farmer A can only sell 33% of the upstream flow, or 40 units. When B draws his usual 60 units, C is left with only 50 units.

WUA Restores
Balance



To restore the equality between B and C, the WUA would reduce B's allocation until equality is achieved, in this case at 53.3 units each.

To discourage the holding of non-consumptive water rights for monopolistic purposes and to reduce conflicts between consumptive and non-consumptive water rights, the tax should also be applied to non-consumptive rights and to contingent water rights, although these could be at different rates. Similarly the tax on contingent water rights could be at a different rate, or be based on the amount of water actually available rather than the level. The proceeds of the tax could be used both to finance watershed activities of a public goods or externalities nature as well as to partially compensate a rural municipality from any loss in its tax base as a result of water sales to another (urban) municipality[6]. The introduction of the tax on water holding should coincide with the removal of the existing tax supplement on irrigated land so that irrigated land is not double-taxed. There is also a good case for a lump-sum "exit" water tariff that would be paid to the original water user association so as not to burden the remaining water users if a member were to sell his or her rights outside the association[7].

There is a need to implement adequate safeguards to prevent monopolies. The property tax on water rights will serve to discourage the purchase of rights for speculative or monopolistic purposes. There is no additional reason to discourage speculators from entering the water market. As in other markets, speculators can help deepen and widen the market, thereby increasing its stability. The fears of the development of monopolies for consumptive rights are largely unfounded. Given the large numbers of such rights holders in most countries, the danger that monopolies will develop in existing irrigation schemes is small. However, there are two areas where monopolies could develop. One is the process of privatizing the large hydraulic projects or water companies. Here, it is critical that an appropriate regulatory framework be developed prior to the privatization. This should be done in the context of the privatization of each scheme, in a similar manner to ones developed for the sale of other former public monopolies (e.g. public utilities). The second is in the area of non-consumptive water rights. In this case, the tax on non-consumptive water rights, accompanied with regulations determining power tariffs, should help avoid the negative welfare effects from monopolies.

Environmental safeguards also need to be in place. For most environmental issues such as those relating to water quality, there is no need to change standards simply because water trades are now allowed. If a tightening of water quality laws is needed, it is best that this be done independently of the laws establishing tradable water rights. However, there is a need to establish minimum flows in areas where water sales could lead to desertification, damage habitat of value to society, or negatively affect recreational activities.

In areas where the extensive use of groundwater pumping threaten to lower the water table, it is important that ground water rights and use be recorded and subject to regulations, as in the case of Chile. Under most administered systems of water allocation, owners of the land above an aquifer have full rights to its water, even if their use were to result in depletion of the aquifer and even if its extraction infringes upon surface water rights. Under a system of property rights to groundwater, by requiring the establishment of the groundwater users commissions in order to draw upon groundwater, better protection against overploitation of underground aquifers could be provided. In Chile the resolution granting the right of use to underground water establishes an area of protection in which the installation of similar works (e.g. pumps) is banned. Additionally, is the exploitation of underground water by certain users causes detriment to others who are legally entitled to the water. Chile's General

6 Alternatively, a lump-sum "exit" tax based on the discounted value of a stream of future property taxes could be paid to the municipality in whose jurisdiction the water rights originated.

7 This would be based on the discounted value of a stream of estimated future water tariffs.

Directorate of Water, at the request of one or more of the affected parties, may establish temporary and proportional reduction of the rights of use and barring new exploitation.

Conclusion

This paper agues that introducing tradable property rights to water is the best solution to dealing with problems of water scarcity. This conclusion is consistent with other arguments regarding the efficiency enhancing aspects of clearly defined property rights. In a time when urbanization continues to increase and pressures on water supplies and government budgets are growing in many countries, other solutions based on technological and bureaucratically administered approaches are unlikely to ensure that water is allocated to its highest value use. Tradable property rights to water ensure the benefits from improved water use accrue to the owners of the water[8]. Contrary to what proponents of administered solutions suggest, introducing tradable rights will benefit the poorer segments of communities and will more directly increase user participation in water allocation and investment decisions. In addition, the economic efficiency of agricultural production should be enhanced as output will reflect the true scarcity of water rather than the frequently distorted prices set by administrators subject to political lobbying. The fear that water markets in developing countries will be dominated by monopolies or cartels does not appear to be supported by the facts -frequently such markets are quite competitive. Although water markets may be subject to high transactions costs, it would appear that the same problems apply to other solutions to improving water use.

One striking aspect of the debate regarding the benefits and problems of introducing tradable property rights to water and the advantages or otherwise of alternative regimes is the lack of empirical evidence regarding many of the key issues[9]. This is not surprising since transactions costs and institutional considerations are notoriously hard to quantify. Nevertheless, in a debate of such importance the absence of data is hampering reasoned discussion. Some efforts are underway to remedy this problem but much more needs to be done.

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8 In the language of the property rights literature, it ensures that residual ownership and residual returns are more closely aligned that with other solutions.

9 While some studies such as Hearne and Ester (1995) have attempted to measure the gains from water trades, such studies have not attempted to compare the institutional and investment aspect of market-based versus administered solutions.

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