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Tradable Water Rights

A Property Rights Approach to Resolving Water Shortages and Promoting Investment

Paul Holden
Mateen Thobani

Even with adequate institutions, administrative methods of allocating water result in inefficient outcomes. But a system of tradable water rights combined with effective institutions solves many of the problems that administered solutions fail to deal with.

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Summary findings

In most countries, the state owns the water and hydraulic infrastructure, and public officials decide who gets water rights, how the water is to be used, and how much will be charged for its use. But there is ample evidence that water allocation by administrative edict has resulted in costly, large-scale inefficiencies in the supply and use of water. Secure property rights have been shown to have a powerful positive effect on investment and efficiency, but only a few countries have tried to introduce tradable property rights to water, thereby taking advantage of the allocative efficiencies of a market to assign water resources among users.

Holden and Thobani compare administered systems of water allocation with a system of tradable water rights. Using an approach derived from the literature on property rights and new institutional economics, they argue that even with an adequate institutional framework, administrative methods of allocating water result in inefficient outcomes. Water is used wastefully. Public hydraulic projects are poorly conceived, implemented, and operated. And the systems have failed to protect the environment or make water accessible to the poor. As urbanization spreads and pressures on the water supply get worse, such solutions are likely to become even more untenable.

Chile's experience in water-scarce areas demonstrates that tradable water rights can benefit the poor and increase user participation on water allocation and investment decisions. They can allow rapid voluntary changes in water allocation in response to changing demand for water and can stimulate investment and employment as investors are assured of access to water. Moreover, agricultural production will become more economically efficient as output will reflect the true scarcity of water rather than the frequently distorted prices set by administrators subject to political lobbying.

Because of water's unique characteristics, an effective tradable water rights system is not easy to introduce and water markets are not a panacea. But these same characteristics make administrative solutions to water allocation difficult — water markets rarely make them worse. Chile's experience and the demonstrated superiority of markets over administrative means of resource allocation suggest that water markets are likely to be a better alternative in most water-scarce countries.

To ensure an effective water market, attention should be paid to:

- Ensuring stakeholder participation in designing and implementing the new legislation.
- Deciding rules for the initial allocation of rights and on how new rights would be allocated.
- Establishing a public registry and block titling.
- Setting up or strengthening water user associations.
- Protecting against the development of potential monopolies.
- Ensuring that trades do not infringe on the water rights of existing users.
- Establishing appropriate environmental laws.

This paper — a product of the Economic Adviser's Unit, Latin America and the Caribbean, Technical Department — is part of a larger effort in the department to focus attention on the effect of establishing secure property rights and using markets to allocate resources. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Patricia Mendez, room I8-451, telephone 202-473-8893, fax 202-676-9271, Internet address pmendez@worldbank.org. July 1996. (23 pages)

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Tradable Water Rights:

A property rights approach to resolving water shortages and promoting investment

Paul Holden and Mateen Thobani

Introduction

1. 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 has provoked rests on the life-giving and agricultural characteristics of water. The fact that it is 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, the state owns the water and hydraulic infrastructure and public officials decide on who gets water rights, on the purpose for 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 costly inefficiencies in the supply of water and in its use. Although there is substantial documentation that secure property rights have a powerful positive effect investment and efficiency (see, for example, Demsetz 1967, Alchian and Demsetz 1972, and Barzel 1989), only a few countries have tried to introduce tradable property rights to water, thereby taking advantage of the allocative efficiencies of a market to assign water resources among users.

2. The paper compares administered systems of water allocation with a system of tradable water rights. Using an approach derived from the property rights and new institutional economics literature the paper argues that even with an adequate institutional framework, administrative methods of allocating water result in inefficient outcomes. However, tradable water rights combined with effective institutions solve many of the problems that administered solutions fail to deal with.

3. 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 on-going measures to improve water management. Next, the paper focuses on tradable water rights, giving their characteristics and showing them to be a form of property right. It then discusses why and how some countries are promoting tradable water rights regimes and discusses their experience and potential. Finally, the paper reviews conceptual and practical problems in establishing tradable water rights and suggests how to design and implement a system of tradable water rights in order to resolve these problems.

Conventional Water Rights Regimes

4. In most countries where water is scarce or costly to access, systems of rights for water use have evolved implicitly through custom or explicitly though 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. Water rights are generally based on a

variant or combination of the following three systems: riparian rights, prior (appropriative) rights, and public allocation (Sampath 1992).

How Water Rights are Defined, Assigned and Enforced

5. 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.

6. *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 is the main system prevailing 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).

7. *Public allocation* involves publicly administered distribution of water. Under this system, public authorities decide how to allocate water using guidelines or laws establishing priorities and often specify the uses to which the water can be put. Most developing countries follow variants of this approach. Although there is often a charge for water use (usually based on size of the irrigated area), the water rights themselves are obtained without charge, with irrigation rights linked to land.

8. Water rights are typically defined in one of several ways: volumetrically 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. 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/second) 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. Worldwide, 69 percent of water is used in agriculture, 23 percent in industry, and only 8 percent for domestic purposes.

9. The measurement infrastructure varies from simple dividers within a stream or canal that divert water according to established ratios to measuring devices that may continuously record volumetric water flow and transmit the information instantly to computers at a central monitoring station. 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. Similar, in cases of dispute, the water user association is typically the first arbiter.

Experience with Administrative Methods of Water Allocation

10. 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 large multipurpose hydraulic projects (irrigation, hydropower, flood control, urban use, etc.) were undertaken on political rather than economic grounds (see Box 1). Costs tend to be high

Box 1. Public Hydraulic Projects

Governments from both developed and developing countries have invested heavily in public hydraulic projects. However, the results have often been well below expectations. For example, by the end of 1993, the Government of Peru had spent $3.4 billion (in constant 1993 dollars) on nine coastal multipurpose projects. Although some of these projects had been in execution for over two decades, 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 ranged from $10,000 to $56,000, even while irrigated land in these areas sells for about $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! The costs of land development, excluding headworks, were $12,000-$15,000 per hectare at 1987 prices, compared to $3,000-$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 could 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).

because of: inappropriate 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.

11. In many countries, for cultural, political or religious reasons, water use is not priced at all, so there is little incentive to conserve. When it exists, water charges, are well below the cost of developing water resources. Therefore, it is not unusual to find cities in arid areas rationing water and foregoing potentially lucrative activities while neighboring farmers grow low-value water-intensive crops such as rice and alfalfa using inefficient irrigation technologies.

12. Moreover, government control of water has favored the relatively wealthy and has not been effective at ensuring access of the poor to water. In many cities in developing countries it is the poor that are excluded from piped municipal water and must resort to very expensive private water truckers to meet their daily needs. A review of water vending in sixteen cities (World Bank 1992) shows that the unit cost of vended water is 4 to 100 times higher than water from piped city supplies (the median cost was 12 times higher). Similarly, influential farmers manage to get easier access to water rights, which are obtained without charge, often at the expense of reducing availability for the poor, and for whose use farmers pay only a nominal charge.

13. Although public control over water is thought necessary to address environmental problems, governments usually fail to maintain water or soil quality. 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 water logging 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 farmland over a wide area (World Bank 1993).

Measures to Resolve Water Shortages and Improve Water Use

14. In attempting to address the problems described above, there is increased attention being paid to management reforms such as though better planning and changes in bureaucratic structure and pricing policy. This approach is perhaps best reflected in a recent policy paper

(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). 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.

15. 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). Not only would it be difficult to estimate such prices across uses, regions and over time, it may be politically difficult to raise water charges to levels that reflect the scarcity value of water. Presently, water charges barely cover the cost of operating and maintaining the water delivery system, let alone the cost of building the infrastructure. Moreover, for irrigation water at least, a sharp increase in water charges would imply an expropriation of property rights since land prices already reflect the access to cheap water.

16. In evaluating the efficacy of such approaches to the allocation of water resources and in comparing them to a tradable water rights system, care must be taken to ensure that the same things are being compared. The usual approach of strong advocates of administered solutions 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 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 often captured by interest groups, are not known for being far-sighted, are unable to estimate future demands with any accuracy, are unable to set and collect appropriate water charges, and almost always have more imperfections than the markets that they are supposed to replace.

17. A further drawback of the administrative approach is that it tends to favor large scale investments over water conservation; there are few rewards for administrators from painstaking improvements in water efficiencies via better pricing policies. Rather the glamour of large projects and the attendant publicity and power that they bring provide far stronger incentives. In contrast, attempts to set prices that reflect the true cost of water provision are unpopular. Without such prices, incentive for users to conserve water are weaker.

18. In conclusion, while the integrated water resources management approach has worthy goals, finding incorruptible and competent administrative bodies that are able to accurately estimate water demand and supply over time and then design and implement investments and pricing policies effectively will be very difficult, especially in developing countries. Despite market imperfections, an alternative approach using a system of secure and tradable water rights is worth serious consideration.

Tradable Water Rights Regimes

Characteristics

19. *Formal Markets*: The key characteristics of formal secure tradable water rights is that the rights are independent of land and can be traded separately from land within a legal and institutional framework. As such they are property rights to water (Box 2). Ideally, the water rights should 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 or 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 the example below from the western United States). There may also be other restrictions relating to water quality, to ensuring that a certain minimum flow in a stream or river is maintained for environmental or recreational reasons and to protecting the water rights of third parties.[1]

20. *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 the failure of public allocation of water. 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). While such markets help resolve water shortages, the fact they are not supported by existing laws limit such transactions 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 such contracts 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.

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1. 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 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 someone whose return flow was different, the rights of the downstream user would be diminished.

Box 2. What Are Property Rights and Why Are They Important?

A property right over an asset consists of the right to consume, earn income from or sell the asset. The process of establishing property rights involves enshrining legal ownership. Property rights encompass both physical rights which allow owners to have possession of assets that they own as well as legal rights which allow effective recourse to the legal system if the physical rights are violated. Formal methods of establishing property rights are found in that part of the legal system which determines how property can be defined and exchanged. Normally there needs to be an efficient process for registering property rights which includes ensuring that nobody else has prior claims. Legal enforcement mechanism are important in dealing with rights that may have been violated. However, the strength of ownership is often diluted by constraints arising from the nature of the asset or from the state which might place restrictions upon its use. In addition, if the costs of enforcing rights are high because of inadequate provision of such public goods as policing and the legal system, the strength of property rights will be weakened.

A key concept that affects the strength of property rights is that of transactions costs, which are the costs of defining, protecting and exchanging property rights. The effects of high transactions cost on property rights and exchange have only recently been recognized fully (see Holden and Rajapatirana 1995). Trades which would increase welfare may not occur if the process of trading is costly or if rights that are traded cannot be protected. Therefore, institutions that lower transactions costs are often necessary to help in the efficient functioning of markets and the market for water is no exception. Once rights are defined and can be traded and transactions costs are low, assets will be employed in the most efficient manner. In this way societal welfare will be maximized.

Countries Promoting Tradable Water Rights

21. 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. *Chile's* 1981 Water Code established tradable water rights in order to strengthen property rights, allow flexibility in water use, and empower water users by requiring their consent to any reallocation of water. 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/or unallocated water rights are auctioned. The water rights are separate from land and their private property status is based on the property laws of the Civil Code. Except for a few restrictions, they can be transferred or sold to anyone for any purpose at freely negotiated prices. As with land, market forces determine the allocation and use of water, once assigned.

22. 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 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 permanent 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 quality. 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, underground aquifer (for groundwater), primary canal, and secondary or tertiary canal. Except for a few large dams and their associated main canals, all hydraulic infrastructure is owned and operated by water users themselves.

23. Chile's experience with water markets has been very positive. Water users are particularly pleased by the flexibility and control over their water rights. In the arid areas north of Santiago, there have been many mutually beneficial sales and leases of water, resulting in a voluntary transfer of water to more productive uses (see following subsection). However, in the high-rainfall areas south of Santiago, there have been few trades since the transactions cost of registering the rights and conveying the water is greater than the gains from transferring the water. There are also few transactions in the main canal of the Maipo river near Santiago because this canal uses fixed flow dividers and the cost of changing the water intakes for transfers is prohibitive.

24. For reasons largely unrelated to water markets, Chile still has problems in water use. For example, Chile continues to suffer from water quality problems since regulations to its tough 1990 environmental law were never issued. Also, because the obligations of non-consumptive rights holders to release water for consumptive purposes at certain times were not clearly defined, conflicts between the recently privatized hydropower companies and farmers have developed in some areas. Some shortcomings in the law have also enabled one hydropower company to obtain huge volumes of non-consumptive rights without charge. Despite these problems, Chile has far fewer conflicts and makes better use of its water as compared to its neighbors.

25. *Mexico*. As the Mexican agricultural economy became more market-oriented, policy makers realized that the full benefits of the economic liberalization could only come with secure and tradable water rights that offered the flexibility of water use to respond to changing prices and demands. Accordingly, under the 1992 water law, and its 1994 regulations, users may convert their existing precarious water rights to more secure tradable "concessions" with a maturity of five to fifty years, with the norm being thirty years to ensure security of the water right. However, the rights are not as secure as in Chile. Under the Mexican Constitution, all water belongs to the Nation and this property right is perpetual and non-transferable. The law also 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. Although the rights are specified in volumetric terms, in practice the rights are proportional since the water user associations are to allocate deficits or surpluses proportionately across all existing rights. The rights for both ground and surface water are recorded in a public registry.

26. By the end of 1995, the National Water Commission had processed water rights applications accounting for about 85 percent of volumetric water rights. During 1995, there was widespread leasing and selling of both surface and ground water rights in Mexico's water-scarce regions. Even prior to 1994, water trades were common. However, they were limited largely to informal sales of water for a year or season, typically between neighbors. Since such trades were illegal, albeit tolerated by public authorities, permanent sales of water rights were rare and little consideration was given to third-party water rights being affected by such trades. The new law has facilitated such leasing and allowed permanent sales of water rights with better protection for aquifer recharge and third party rights. Most of the recent water sales would either not have been undertaken under the previous regime, thereby inhibiting private investment, or would have occurred surreptitiously, thereby depleting aquifers. The bulk of recent water trades involve farmers selling to industrial users, water companies or more efficient farmers, thereby encouraging investment in more productive activities. It has also allowed unprofitable farmers to reduce their farming debts and to work as laborers on more efficient farms or to seek alternative employment.

27. *Peru*. The motivation for Peru's water reform came with the realization that existing water legislation and policies, which had caused serious problems, were poorly suited for a future of tighter fiscal constraints and weakened public institutions. By 1992, following several years of virtually no public spending for maintenance or rehabilitation of public irrigation structures, many irrigation systems faced a high risk of failure. Water delivery became more irregular, quality deteriorated and water conflicts grew. There was also widespread water theft. Even in areas where water was scarce, it continued to be used wastefully. Thus, while water was rationed in Lima, the water company incurred high water losses, and farmers just outside Lima continued to grow low-value, water-intensive crops. In addition, the threat of having the State expropriate water rights for higher priority uses discouraged many worthwhile investments that required assured supplies of water.

28. To address these problems, the Ministry of Agriculture proposed 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 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 prohibits 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. (World Bank 1995.)

29. 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 are no priorities among water rights for different purposes, and the water right is separate from the land right for both surface and ground water.

30. Passage of this law has been delayed partly because of Congressional concerns on how the initial allocation would be conducted. The delay also stemmed from insufficient involvement of users in the design of the proposed law and from opposition from the few that benefit from maintaining the status quo.

31. The western *United States*. Because of the shortage of water in the western United States, a system of property rights to water based on the prior appropriation doctrine evolved: those that first diverted and established beneficial use of the water obtained primary rights to it. Successive claimants could only obtain rights that were contingent on those with prior rights having received their allocations.

32. 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 of state water authorities. Only in the case of one large project in Colorado is relatively unrestricted trading of water rights permitted (Box 3). Obtaining authorization to change water use is often a lengthy and costly, requiring consent from the relevant governing body after public hearings in which people who could be damaged by the change in use can object.

33. Perhaps the most extreme example of restricting transfer between uses occurs in California. The agricultural sector makes up only 4 percent of the GDP of the state yet receives about 44 percent of the water. Environmental use also is allotted 44 percent while the urban and industrial sector receives only 11 percent. In the agricultural sector water rights vary widely from inherited sources of cheap water to water that is highly subsidized. The anomalies that these restrictions cause are extreme; water is so inexpensive to some users (as low as $2.50 per acre-foot) that rice is cultivated in the desert while at the same time some municipalities have built desalinization plants to supplement their supplies of water at a cost of $2,000 per acre-foot. 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 which encourages high water use when there is no rationing.

34. 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—an unpopular result politically. Many the farmers fear that once rights become transferable they would not be compensated for what they would be giving up. Such problems illustrate the deficiencies of administrative solutions to the allocation of scarce water resources. However, the legislative and administrative considerations in reforming laws and procedures allow interested parties great latitude to influence how the gains from

Box 3. 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 annually 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. 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 the only requirements being "beneficial use", no sales outside the District and that users abide by the rules of the Conservancy. 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 from the inception of this project water users retain rights to any return flows. Therefore while downstream users get the benefit of return flows from water users upstream, they have no rights to them and upstream users are free to transfer their rights without the need to compensate downstream users for their loss of water.

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 Conservancy District all of the complex infrastructure is in private hands. The Conservancy's role is to record transactions and to check 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.

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. The California case 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.

Advantages of Water Markets

35. Tradable water rights allow the price of water to reflect the value of its alternative uses, which creates incentives 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 sell surplus water to a neighboring city where it has a higher value. Often they can generate a surplus by using more efficient irrigation techniques or by switching to less water-intensive crops. In addition, buyers of water rights are likely to conserve water more efficiently. Most 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.

36. Chile's transfer of water to more productive uses was carried out voluntarily and without having to raise water charges (Box 4). In fact, water charges fell following the introduction of tradable water rights. The fall occurred because this regime facilitated the transfer to user groups of the responsibility for carrying out operations and maintenance (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 charges, the opportunity to sell water ensures that scarce water will not be used wastefully.

37. Tradable water rights can help shift water to higher value uses in a way that is cheaper 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. Although the conveyance infrastructure to transfer traded water must be built if it does not exist already, the cost of building may be less than that of generating new water rights. For many years, the city of La Serena in Chile was able to meet its rapidly growing demand for water by purchasing water rights from farmers at a lower cost than contributing to the construction of a dam. Farmers received an acceptable price for their water and were induced to use more efficient irrigation techniques. A recent study evaluating the Chilean water market experience finds that the net gains from the trading of water rights in the Elqui Valley were about $1,000/share, roughly equal to the price of these water rights (Hearne and Easter 1995). In the Limarí Valley, the gains from trading shares in the Cogoti Reservoir were estimated to be three times the recent transaction prices of $3,000/share—thus even after the cost of water transfer, water was worth three times more in one use than its next best alternative. Without markets, it would have been difficult to effect this transfer.

38. 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. Tradable water rights, by empowering existing users, help reduce the abuses of administrative allocation and give assurance to poor farmers that their water availability will not be reduced. And because of their divisibility, water rights give farmers the possibility of mortgaging only part of their rights for small loans, rather than their entire holdings.

Box 4. What is the Price of Water?

Many confuse the water charge with the price of water rights. Under a tradable water rights regime, the water charge should equal the O&M cost of the infrastructure, whereas the price of water rights would be the market price for the permanent right to use the water. To use an analogy from the condominium market, the water charge is equivalent to the condominium fee whereas the price of water rights is analogous to the sale price of the condominium. Under an administrative water rights regime, economic efficiency requires that the water charge should equal the opportunity cost of the water, which in our analogy, would correspond to the market rental price of the condominium—usually several multiples of the condominium fee. Whereas this price is difficult to set and enforce administratively, the sale or lease price under a tradable water rights system automatically reflects the opportunity cost of water.

Water conservation may also help control soil salinization, which is caused primarily by overwatering.

39. It is interesting that Chile's sustained annual growth of 6 percent in agriculture during the 1980s occurred although there were no public investments in new hydraulic infrastructure from 1975 to 1990. While this was due in part to heavy investment in water infrastructure in previous decades, the tradable water rights regime facilitated the growth for new uses of water and contributed to the rapid expansion of fruit production. Secure and tradable water rights assure investors that their rights will not 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.

40. Chile has also been successful in increasing access of the poor to potable water. Ninety-nine 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). While this was due to several factors such as ensuring that regulated water tariffs reflect the true cost of water, allowing competition among water companies (Santiago alone has seven private companies), and subsidizing water consumption for those with low incomes, the ability of water companies to buy water from farmers played a significant role.

41. Secure water rights give potential investors in new hydraulic projects the confidence that, once they obtain the rights to the water generated by their investment (e.g. storage reservoirs and conveyance infrastructure), they will be theirs to keep or sell to others (farmers, industry, hydropower and water companies). Therefore ongoing state owned projects, such as in Peru, could be privatized by selling the hydraulic infrastructure and unallocated water and land rights associated with the project, with the condition that buyers respect existing land and water rights. A comprehensive regulatory framework, as is prepared for the sale for public utilities, would assist in such a privatization.

When and How to Establish Tradable Water Rights

Difficulties in Establishing Water Markets

42. Despite the promise that water markets hold, few countries have established them formally. The economic argument against tradable water rights rests on the perception of market failure which arise because:

- There are high transactions costs from setting up a new legal, regulatory and institutional framework, from defining, measuring, and enforcing water rights, from

identifying potential beneficial trades, and from making necessary changes in water intakes and conveyance infrastructure to effect the transfers.

- Capital requirements may be high and time horizons long so that natural monopolies are created which require regulation.
- There are issues of aquifer depletion and return flows.
- There are public goods aspects of flood control, pollution control and disease control along water courses which may justify government intervention.
- There are national security and humanitarian aspects of many water resources which may justify control by government.
- Using water markets may exclude the poor from access to water.

Comparing Water Market and Administrative Solutions

43. For the reasons mentioned above, an effective market for water will require regulation and be more difficult to establish than say a market for land. However, the same characteristics of water make it difficult to allocate water under alternative regimes. Even under administrative systems of water allocation, the rights 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 (see Rosegrant and Binswanger 1994). 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 and concerns of monopolistic pricing exist under either system. Similarly, public goods aspects and issues of access of the poor to water exist in both regimes. 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 outcomes.

44. There are reasons to believe that a water market will function better than 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 be lower if borne by beneficiaries than by public authorities. The conveyance infrastructure that must be built to effect the transfer will probably be built more cost-effectively by the private sector. Water user associations and river basin councils, which must play an important role under either system, have a greater incentive to become stronger and better organized when water rights are well-defined and transferable.

45. Equity concerns are often raised within the context of tradable water rights. However, the enormous inequities from administrative allocation of water suffered by the poor have been well documented. The poorer sections of cities frequently resort to expensive water from tanker trucks while the rich sections have piped water provided below cost. Similarly, poor farmers are more vulnerable to reductions in their water rights without

compensation under administrative regimes. Allowing rights to be traded increases the value of the right and its transfer to more productive purposes increases employment possibilities. As a result, the humanitarian and equity aspects of water allocation are likely to be better under a market regime. In this regard, Chilean policies which subsidize water charges and sewage connections for the poorest sections of the community appear to have dealt with potential inequities more effectively than those countries where water is allocated administratively.

46. An argument against tradable water rights 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.

47. Another argument against the establishment of tradable water rights rests on the externalities that exist in the use of water such as those related to return flows or the environment and those resulting from flood control. Tradable water rights could indeed exacerbate these. Therefore, 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 California experience illustrates just how badly administrative decisions can distort incentives.

48. Although a tradable water rights regime is a promising alternative to administered allocation regimes, there are upfront costs to establishing the new legal, regulatory, and institutional framework. The net benefits from water trading and from having more secure water rights must be larger than the transactions cost, 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. The political and culturally viability of individual property rights to water and the institutional capacity to establish the legal and regulatory framework to monitor and enforce water rights are important issues that need to be addressed.

Issues of Transition

49. While the design and implementation of tradable water rights needs to be tailored to specific country circumstances, the following general guidelines may be useful in the transition.

50. First, it is important to build support for the passage of legislation establishing tradable property rights in water. It may be useful to prepare, with appropriate

modifications, a draft water law based on the experience of other countries. A vigorous 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 with a willingness to accommodate reaction is critical to success. Farmers and other water users have to be made aware that their 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.

51. Second, there is a need to establish effective institutions to draft the regulations and to implement the law efficiently and fairly. 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 at this stage. In addition, 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 role of public institutions in the initial allocation of water rights and in the subsequent operation of the water market, poorly trained or corrupt employees could prevent the market for water rights from ever developing or functioning effectively.

52. There are several issues related to the initial allocation of tradable water rights. For existing users, it is suggested that water rights be granted without charge in recognition of the fact that some farmers have already paid for their rights implicitly in the purchase price of their land and that the government is unlikely to recover the capital costs of its investment in infrastructure. For new and unallocated water rights, it is important that they be sold via auctions carried out in an open and transparent manner and that a minimum reservation price be established prior to the auction. Information on prices and volumes should be made publicly available, and minimal costs charged to enter the auction. In particular, care needs to be taken that the poor are well-informed regarding the need to register their 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, for example), they 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.

53. Where functioning water user associations exist, the actual allocation should be 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 a 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 individuals. First, it is easier for the water user

association rather than the Government to verify past water usage of individual farmers. Second, it leads to titling many users simultaneously. This "block titling" of water rights reduces unit titling costs and helps resolve conflicts. 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, then 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.

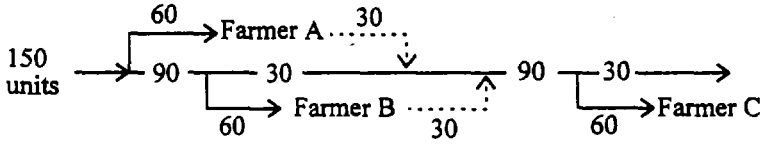
54. For the second step of the initial allocation process, the guidelines may vary by region, watershed, and canal. Where there already exist registered water rights and where there is sufficient water to honor all water rights, it is probably sufficient to have them re-registered in the new public registry 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 water user associations. 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 proportionally to individuals based on irrigated land area.

Design Issues

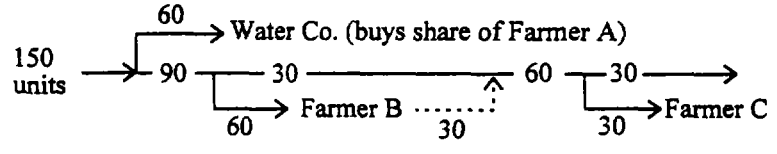
55. The potential of water trades to infringe upon the rights or water availability of third-parties needs to be well understood and addressed. This is most likely to occur for agricultural "return flows." If a farmer were free to sell his entire irrigation water to users outside the area, users downstream 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 the water user association and/or a public body such as a watershed authority approve requests for changes of water intake to ensure that third party rights 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 reduce the water available 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.

56. One option is to adopt the Chile approach where all permanent consumptive use rights are expressed as a percentage share of water availability (either in a stream or reservoir), with the shares summing to 100 percent. 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

Figure 1. Return Flow Problem When Upstream Farmers Can Sell 100% of Volumetric Rights

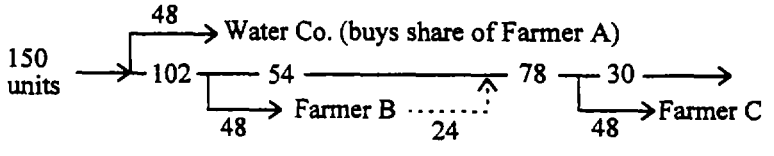


Initial Situation
With A and B returning 50% of their allotment to the water supply, A, B, and C can each receive 60 units of water, with 30 units reserved for environmental purposes.



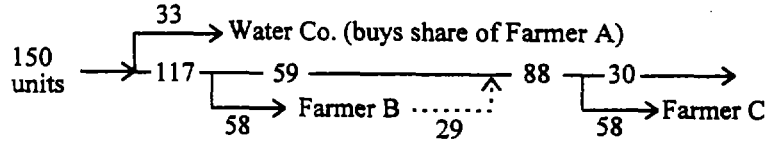
After Sale
If A sells his share to a water company, C will receive only half his previous allotment.

Figure 2. How Chile Handles Intersectoral Trades



The water user association adjusts shares until all users have the same volume. Thus, A's sale reduces water for B and C by 20%.

Figure 3. Proposed Solution



According to published averages, A's crop consumes 33 units of water (in actuality it is 30 units) and so A can sell only this volume to the water company. The WUA will adjust B and C's usage at 58 units apiece

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.

57. An alternative formulation would be to specify that all water rights 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 difficulties in calculating the purely consumptive portion of the water on a case-by-case basis, this approach, which is the similar to that used in California, may not be appropriate for developing countries. However, it may be suitable to calculate and publish averages for pure consumptive use as a basis for the trade. These averages could specify the volume of water consumed by a certain crop or activity, with owners being free to sell only this amount. 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). This system would work equally well for surface and ground water.

58. It may be desirable to introduce a tax on the holdings of property rights for water whose rate is determined solely on the holdings of water rights and not by the purpose for which the water is used or for the quantity of water actually 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. For equity and administrative ease, the regulations could exempt farmers and other users that hold small quantities of water rights.

59. To reduce conflicts between consumptive and non-consumptive water rights, the tax should also be applied to non-consumptive rights, although the tax rate could be lower. Similarly the tax on contingent water rights could be at a different (lower) rate, or be based on the amount of water actually made available. The proceeds of the tax could be used both to finance watershed activities of a public goods or externalities nature. The introduction of the tax on water holdings 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.[2]

60. There are two areas where monopolies of water rights could develop; in privatizing large hydraulic projects and in the sale of non-consumptive water rights. To deal with the first problem, it is crucial that an appropriate regulatory framework be developed prior to

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2. This would be based on the discounted value of a stream of estimated future water tariffs. Some Mexican water user associations oblige buyers to pay a percentage of the water tariff to the original association.

privatization. This should be done in the context of each scheme, in a similar manner to those developed for the sale of other former public monopolies. In the latter case, the tax on non-consumptive water rights and minimum reservation prices at auctions, accompanied with regulations determining power tariffs, should help avoid monopolies.

61. Environmental safeguards may also be needed. 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 water quality laws need tightening, it is best done independently of the laws establishing tradable water rights. However, it is important to ensure that minimum flow requirements exist in areas where water sales could lead to desertification, habitat could be damaged, or recreational activities threatened.

62. In areas where the extensive use of groundwater pumping may lower the water table (as in parts of Chile), it is important that ground water rights and use be recorded and subject to regulation. 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 the Chilean law, there is better protection against aquifer depletion by relying more on users themselves to monitor extraction. To register ground water rights, the Chilean law requires owners to belong to a ground water users commission that helps monitor extraction. If the exploitation of ground water by a user causes detriment to others who are legally entitled to the water, Chile's General Directorate of Water, at the request of one or more of the affected parties, may establish temporary and proportional reductions in volumetric rights and bar new exploitation. The law also establishes an area of protection in which the installation of similar works (e.g. pumps) is banned.

Conclusion

63. This paper argues that as compared to administrative methods of water allocation, secure and well-defined tradable property rights to water in water-scarce regions are likely to improve water use. The experience with administrative water management systems has not been impressive. Water is used wastefully, public hydraulic projects are poorly conceived, implemented and operated, and the systems have failed to protect the environment or make water accessible to the poor. As urbanization increases and pressures on water supplies and government budgets grow, solutions based on such approaches are likely to become more difficult. In principle, and reflecting the Chilean experience in water-scarce areas, tradable rights can benefit the poor and increase user participation in water allocation and investment decisions. They can allow rapid and voluntary changes in water allocation in response to changing water demands and stimulate investment and employment as investors are assured of their access to water. In addition, the economic efficiency of agricultural production will be enhanced as output will reflect the true scarcity of water rather than the frequently distorted prices set by administrators subject to political lobbying.

64. However, water markets are not a panacea. And because of water's unique characteristics, an effective tradable water rights system is not easy to introduce. There are high transactions costs. In addition, an unregulated water market also could lead to environmental problems and monopolies. It could also result in under-investment in activities that may be socially but not privately profitable. However, these same characteristics make administrative solutions to water allocation difficult. As shown by the experience of Chile, water markets rarely make them worse. The challenge is to decide when water markets are a better alternative and to enact legislation to establish them. The design and implementation of the legislation should involve all those that have a stake in how water is used. It should also pay particular attention to the initial allocation of water rights, to the creation and maintenance of a water rights registry, and to ensuring that the rights of third parties are respected. As with any system, public authorities will also need to design and enforce environmental laws and to subsidize those high-return activities where the benefits accrue to persons that are not sharing in their costs.

65. One striking aspect of the debate on water markets versus administrative methods of water allocation is the lack of empirical evidence regarding many of the key issues. 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.[3] Further investigation of water markets that are currently working is required as well more work on the inadequacies and shortcomings of administered solutions to problems of water scarcity. Given the widespread perception of failure of governments in developing countries to solve problems of scarcity by administrative fiat, many people feel that the burden of proof on the superiority of an administered approach is on its advocates. Additional evidence will allow the alternatives to be compared and evaluated more objectively.

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3. 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 aspects of market-based versus administered solutions.

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